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## **AC 2012-5501: WOMEN IN MECHANICAL ENGINEERING: A DEPARTMENTAL EFFORT TO IMPROVE RECRUITMENT, RETENTION, AND ENGAGEMENT OF WOMEN STUDENTS**

### **Prof. Sriram Sundararajan, Iowa State University**

Sriram Sundararajan is an Associate Professor of mechanical engineering at Iowa State University. He is currently the Associate Chair for Undergraduate Programs, and he oversees curricular and program matters, including assessment and continuous improvement efforts. His research areas encompass scanning probe microscopy, multiscale tribology (friction, lubrication and wear), and surface engineering. More recently, he has focused on atom scale mapping of thin film material systems using 3D-atom probe microscopy. He has authored more than 50 articles in peer-reviewed journals and conference proceedings and two invited book chapters. He serves on the conference committee for the International Conference on Wear of Materials and has been recognized for his accomplishments with the Young Engineering Faculty Research Award and Early Achievement in Teaching Award at Iowa State University. He received his B.E. degree in mechanical engineering from the Birla Institute of Technology and Science, Pilani (India), followed by M.S. and Ph.D. degrees in mechanical engineering from the Ohio State University, Columbus, Ohio. He is a member of ASEE, ASME, and ASM.

### **Dr. Theodore J. Heindel, Iowa State University**

### **Dr. Baskar Ganapathysubramanian**

### **Shankar Subramaniam, Iowa State University**

Shankar Subramaniam is an Associate Professor in the Department of Mechanical Engineering at Iowa State University. He received his B.Tech. in aeronautical engineering from the Indian Institute of Technology, Bombay (Mumbai) in 1988 and is a recipient of the President's Silver Medal. He earned his Ph.D. at Cornell University, subsequent to an M.S. in aerospace engineering at the University of Notre Dame, USA. After his Ph.D., he spent two years as a postdoctoral researcher at Los Alamos National Laboratory in the Theoretical Division's Fluid Dynamics Group. Prior to joining the ISU faculty in 2002, Subramaniam was an Assistant Professor at Rutgers University. He is a recipient of the U.S. Department of Energy's Early Career Principal Investigator award. His areas of expertise are in theory, modeling and simulation of multiphase flows (including sprays, particle-laden flows, colloids, and granular mixtures), turbulence, mixing, and reacting flows. His current research concerns hierarchical coarse-graining approaches, mesoscale models of colloidal aggregation, and direct numerical simulation of gas-solid flows.

# **WiME: a departmental effort to improve recruitment, retention and engagement of women students in Mechanical Engineering**

## **Abstract**

The Mechanical Engineering department at Iowa State University started the ‘Women in Mechanical Engineering’ (WiME) program 3 years ago. WiME is a student run, faculty moderated, and department funded program with a three pronged approach to enhance women participation in mechanical engineering – retention, outreach, and recruitment. WiME organizes various social and professional development activities that are intended to

- Provide a forum for women to socially interact with faculty and their peers;
- Provide students with women role models in engineering and academic professionals thereby helping to develop and sustain a network of professional colleagues and;
- Leverage the interests of the WiME group to undertake outreach to local K-12 schools, thus creating a sustainable group.

Several specific events and activities include (a) the “Chat-with-ME” series where students are provided an opportunity to interact with a successful women mechanical engineer in a very informal setting; (b) social events like picnics, bowling evenings and ‘Ice-cream socials’ where the women students can interact with each other and ME faculty; (c) professional development events like mock interview and interview walk-up sessions before career fairs and more recently; (d) “efficient energy use” outreach sessions to local middle schools in collaboration with industrial partners. Students have pointed to the social interaction opportunities with their peers and with faculty as a major attraction of the program. The department has also set up WiME scholarships to prospective high school students to enhance recruitment and also employs personalized phone calls from the department chair to all women applicants to highlight the program. Since the launch of the WiME program the women enrollment in the ME program has increased from 76 to 128 women (7.0% to 10%).

## **1. Introduction**

With the changing demographics of the nation and state of the engineering workforce, the underrepresentation of women among engineering undergraduates and the subsequent lack of females in the workforce is a subject of national concern<sup>1-3</sup>. Studies show that about 20% of engineering baccalaureate degrees are awarded to women, which is significantly less than corresponding numbers in mathematics, statistics and various science degrees.<sup>2</sup> Consequently, studies focusing on identifying the factors contributing to the lack of women at the degree program level<sup>1,4</sup> and in the engineering workforce<sup>5,20</sup> have been invaluable in suggesting best practices<sup>6-8</sup> to address this critical issue. For example, peer-peer interactions and faculty-student interactions that promote respect and encouragement<sup>9</sup> as well as learner-centered approaches to pedagogy<sup>10-13</sup> have been shown to have a positive impact on the college experience of women students as well as on their decision to pursue an engineering career. These studies and others suggest that creating environments that emphasize care and respect for students as well as positive student interaction during group work<sup>14</sup> can make a difference in students’ satisfaction in the engineering major and in interest in engineering as a career, particularly for women.

Mechanical Engineering (ME) in particular is challenged with lower than average women engagement amongst the engineering disciplines. Between 2002-2008, 13% of undergraduate degrees in Mechanical Engineering were awarded nationally to women (compared to about 20% for engineering). At Iowa State University, women enrollment in the college of engineering has averaged 15% compared to a national number of 18% over the last 10 years.<sup>15</sup> The Mechanical Engineering program at Iowa State University has averaged about 9% women enrollment in the same time. Between 2004 and 2007, women enrollment in the Mechanical Engineering dropped from 10.5% to 7.6%, while the College numbers dropped from 15.5% to 14.5%. There may have been several causes for this decrease, ranging from changing demographics of high school graduates to issues in recruitment and retention and it is not clear what the dominant cause was. In any case, the ME department think-tank was challenged to respond creatively and decisively to not only address this negative trend but help attain or in the best case surpass the national average for women in mechanical engineering (13%). While several college and institutional level programs exist to provide a supporting and positive environment for women and under-represented minority students, the mechanical engineering department hypothesized that a program at a departmental level would afford a more meaningful and close-knit interaction and social support structure. Accordingly the department ventured to create a long-term platform at the departmental level to increase the participation of women in the degree program. The rationale was to create a sustainable peer-driven, faculty-mediated effort to recruit and retain women and enhance their overall satisfaction and experience in the department. A particular focus was placed on scholarship based recruitment and activities promoting positive peer and faculty-student social interactions, the latter of which has been shown to be a major factor in affecting overall satisfaction of the educational experience amongst women students.<sup>16</sup> This paper describes the genesis and evolution of the program, christened as '*Women In Mechanical Engineering (WiME)*', its major programmatic features, challenges and short-term impact to date.

## **2. The Women in Mechanical Engineering (WiME) Program Description**

### **Genesis and evolution**

The WiME program was conceived in the fall semester of 2007 and launched summer of 2008. The department chair at the time, Jonathan Wickert, envisioned the program and assigned personnel and resources to get the program off the ground. Specifically, the program was envisioned to be student-run, faculty-moderated and department-funded. In accordance with this vision, a core group of women students was formed through informal meetings and discussions that would serve as a board for the program. A major aspect of the first year's operation was to arrive at a mission for the program, obtain support and funding from various constituents and sources and to publicize the effort among various constituents. The mission was established by the board in consultation with the faculty and chair and reads as: '*WiME strives to provide a uniquely welcoming and encouraging environment that fosters academic, professional, and social opportunities for women in Mechanical Engineering (ME) at Iowa State University*'. WiME's main focus was initially to develop social networking and professional development opportunities for the women students, thus creating a positive environment for the women students to thrive in. Another important aspect of the WiME program that featured personal involvement of the department chair included a personalized recruitment effort and scholarship

monies for incoming women students to the program. There was significant support and enthusiasm for the WiME program from various constituents including the Industrial Advisory Board, alumni and other supporters of the program.

Today the program continues to be an important feature of the Mechanical Engineering Department at Iowa State University in the recruitment and engagement of women students. Recent changes include expansion of the mission to include elements of outreach to the community and K-12 students in the region. The mission now includes the additional statement: *‘WiME also endeavors to build awareness amongst pre-college women of the opportunities in Mechanical Engineering in order to foster interest in the discipline.’* Personalized recruitment and scholarships continue and have expanded to include all women students in the program through the generous support of alumni and friends of the department. The program has also served as a template for other departments in the College of Engineering, including the formation of ‘Civil Ladies’ in the Civil, Construction and Environmental Engineering Department and the ‘Digital Ladies’ in the Electrical and Computer Engineering Department. The following sections will explain the various operational aspects, impacts and challenges associated with the program.

### **Program Structure**

Student board: A WiME board handles the idea-conception, planning and execution of all professional development and social activities. The WiME board consists of a group of 4-6 women ME students. The chair of the WiME board is usually a senior student, who has several years of active participation in planning, organizing and participating in WiME activities. She works closely with the vice-chair, who is a junior student and is the chair-elect for the next year. The WiME board consists of at least one student from each year as well as one graduate student. This ensures that memory and protocol of current activities are sustainable across multiple years. In addition, each year every member of the board identifies one interested woman student in ME to attend bi-weekly WiME board meetings to encourage participation in WiME activities. This also ensures a sustainable cohort of women students who are both interested and enthusiastic in WiME activities as well as have the experience to continue WiME activities.

Faculty oversight and staff support: In accordance with the program vision, a faculty member acts as the group advisor, providing guidance, oversight and acting as liaison between the board and the faculty as well as for representation of the activity outside of the department (e.g. college, university etc.). More recently, this role is specifically described as a formal expectation in the specific faculty member’s annual contract or ‘position responsibility statement’. A staff person whose overall responsibilities fall under programs support helps handle logistics, scholarships, publicity and resource management (budget etc.). This overall structure has proved to be efficient and reliable. The faculty liaison’s term is typically two years.

### **Description of activities:**

To date, WiME activities are focused in the following three areas:

- Recruitment efforts;
- Social interaction events aimed to foster positive peer-peer interactions and faculty-student interactions that promotes a strong social support environment for women students in the department;

- Professional development events aimed at providing opportunities for students to learn about opportunities and challenges related to being a women engineer and professional.
- Undertake outreach to local K-12 schools, thus creating a sustainable group.

### **Recruitment**

Starting with the Fall 2008 recruiting and admissions cycle, the department chair began to engage in recruitment efforts for women students by personalized contact with each women applicant to the program who had not yet accepted admission and by leveraging of department funds for WiME scholarships for women applicants. The fall cycle typically starts around December of the previous year. In early February, the department receives a list of woman student applicants to the ME program who have been admitted to the University but have not yet accepted. The department chair calls each woman applicant on the list to discuss our program and to answer any questions they may have. Most often, the call goes to voice-mail and a message is left to call the chair directly if they have any questions about ME at Iowa State University. A few of these students (or their parents) will call back. When contact is made during the initial phone call with a parent, they are reluctant to hand the phone to their daughter until they hear the call is from the chair of the mechanical engineering department. The parent is generally surprised that the chair would call their daughter. If the daughter is unavailable, the parent usually has a lengthy conversation with the chair. When contact is made directly with the student, they are typically excited that the chair would call them directly. Many factors contribute to the decision of which University and program a high school senior will pick, including personal interactions and impressions of the school. This personalized contact is intended to help tilt the balance in favor of our program.

One of the major strengths with these phone calls is having the ability, thanks to generous supporters, to offer each incoming woman student a scholarship per year for four years. The students (and their parents) are surprised and thankful and it is apparent they end the phone call very excited. In the first two years (2008-2010), these ‘WiME’ scholarships were offered only to those applicants who had applied but had not accepted, and the funding level was \$750 per year. With increased corporate and alumni support, starting with the 2011 class, these scholarships were offered to all women applicants at \$1000 per year for four years (\$4000 total to each female student). These scholarships have the following stipulations: (i) the student must remain in the ME program and maintain a minimum GPA of 2.0 and (ii) the student must apply to the general scholarship pool every spring semester after receiving the first scholarship. With the generous support of the department’s friends, this model is expected to continue for many years to come and be sustainable.

### **Social Activities**

From the board’s perspective, it was felt that promoting strong social networking opportunities where women students could connect with each other and with faculty was a priority. This, they argued, would be a major contributor to creating a welcoming and positive environment and consequently a more satisfying program experience. This notion is consistent with observations and recommendations in several studies<sup>9, 14, 16</sup>. WiME strives accordingly to create several such opportunities that foster peer-peer interactions as well as student-faculty interactions in an informal setting. Some of these are described below:

a) Welcome Picnic (Early Fall): The kick-off to the academic year is via a Welcome WiME picnic (Fig. 1). This catered picnic provides a venue for returning students to meet and socialize with students and faculty in an informal setting. During the WiME picnic, several additional events occur including: (a) introducing the WiME board to the women ME students; (b) board members detailing the various planned events for the year; and (c) a comprehensive survey eliciting student interest in various newly planned social, professional development and outreach activities. Being the first event in the fall semester, this event attracts about 50 or so students and provides a good forum to announce plans for the semester and obtain student feedback on events they would like to see.



**Figure 1: Fall 2011 WiME Welcome Picnic**

b) Mini-Golf Event: During the spring semester, WiME organizes a social event called “Mini-Golf in Black”. This event consists of a mini-golf course designed and built by the women members of WiME (Fig. 2) and placed in the mechanical engineering building (Black Engineering). ME students unwind while playing some mini golf on the second floor of the Black Engineering building and the course ends with food sponsored by the student chapter of the Society of Women Engineers (SWE). This social event provides a good opportunity for ME women across years to interact among themselves and with faculty and their families. This event attracts about 20-30 students, 10 faculty and staff as well as their families, providing for a very informal and social gathering.



**Figure 2: Selected holes of the WiME designed mini-golf course.**



**Figure 3: WiME Ice-cream social**

c) Ice-cream social: This event is planned for mid-fall to encourage increased interaction between the women students and faculty. The students select several faculty members as “celebrity scoopers” who serve ice cream to the students (Fig. 3). All staff and faculty are welcome and are encouraged to meet the students. The women students particularly like this event as it offers them the opportunity to interact closely with their faculty in an informal setting. This is one of the most popular events – it attracts 25-40 students, predominantly women, each time it is held. This event also attracts women students outside the department (typically 10 students) as well as about 8-12 faculty and staff.

d) Dead week treats: This event is held the week before the final exam week in fall and spring. This event provides the women students with a small break from studying, test taking, and

working on final projects. Food, refreshments and various stress-busting activities are provided. The students particularly appreciated this event because it provides a social activity during a stressful period and also allows them to chat and exchange notes with their colleagues. Typically 20-30 students participate in this event each semester.

### **Professional Development Activities**

Another important aspect of WiME's mission is to provide professional development opportunities for women students. These activities typically have a focus or theme that is directly relevant to women in today's professional settings. We detail some of these events below.

a) Chat with ME: The "Chat with ME" series seeks to provide women students in mechanical engineering the opportunity to meet, discuss and network with women who are in the profession of mechanical engineering. In this event, prominent and successful women engineers are invited to visit Iowa State University and chat with the women ME students. Examples of speakers range from professionals from industry (Ms. Margaret Harding, a nuclear industry veteran) and academic faculty (from within Iowa State University as well visiting ME seminar speakers) to post-doctoral associates (to provide the students with the perspective of a women in her early career). This allows the students to come face-to-face with a successful mechanical engineer in a very informal setting, and provides them with an opportunity to ask questions (inspirations, approaches, challenges faced,) regarding managing a productive academic career and understanding the formal (and informal/implicit) values, rules and operating procedures in mechanical engineering practice. This has been a very successful and appreciated program that also informs the students about various career paths. Typical attendance levels at these events ranged from 6 to 20 women students each time.

b) Career Fair Prep: The Iowa State University College of Engineering Career Fair is the world's largest indoor career fair, with more than 270 hiring employers and over 5,000 students, ranging from freshman to alumni, looking for internships, co-ops, or full-time positions. A major aspect of WiME's efforts is focused on ensuring that students are adequately prepared to interview during the Career Fair. As part of this focus, WiME organizes a help session to fine tune resumes and walkup skills before the Career Fair. The WiME board in conjunction with the department invites two senior members (one HR executive, and one technical executive) of an engineering consulting company (KJWW, Des Moines, IA) to clarify expectations and provide interview tips. This event usually consists of a short presentation followed by a help session on resumes, walk-ups, and all questions related to the career fair. This event turned out to be quite popular, garnering 20-35 women student attendees each time.

c) Lab/company tours: WiME usually organizes a tour of various research labs in the fall semester and a site visit to a nearby company/factory in the spring semester. This is geared towards providing the women students an opportunity to gain first-hand knowledge of various research activities in the department (thus encouraging them to continue on and get a graduate degree in engineering) as well as in the corporate world. This activity was sponsored by a Women's Enrichment grant available through the Office of the Executive Vice President and Provost. A total of \$5,000 in seed funding for a "NEST: A Nurturing Environment for Women in Science and Technology Research" project was developed to introduce undergraduates, especially female students, to research opportunities in the department. Lab tours have included



the bio-renewable lab, the combustion research lab and spray diagnostics lab. It appears that labs that primarily work in the areas of renewable energy and biotechnology are particularly appealing to the women in mechanical engineering. Each of these events attracted about 8-20 students, 75% of which were typically women.

Other activities: In addition to these activities, WiME has also held (a) panel discussions (“Being a Woman in Engineering”) where women professionals and women faculty explore the different life paths each panelist has taken to achieve a balance in her personal and professional life, and discuss inspirations, approaches, and challenges faced regarding managing a productive career and maintaining a proper work/life balance, (b) a self-defense workshop where a representative from the Iowa State University Martial Arts Group demonstrated basic self-defense techniques. The expert covered everything from precautionary advice to tips on how to avert a threatening situation to escaping an actual attack, presenting women with insights that can be useful in any setting.

### Outreach Activities

WiME has recently started engaging in outreach activities. The rationale for this decision was that such activities provide two valuable outcomes: (a) showcasing the excitement and usefulness of engineering to young girls thus encouraging them to pursue engineering in college, and (b) empowering and enthusing our women graduates by providing a forum where they can excite and educate the next generation of engineers.



**Figure 4: Activity Center at the Science Center**

A particularly successful outreach activity was organized in conjunction with the Science Center of a Iowa State to promote engineering to K-12 students. The WiME students organized a hands-on activity center where children had four activities from which to choose: seeing Gears in Motion, constructing paper airplanes, and building gumdrop/spaghetti towers (Fig. 4). This activity center was sponsored through an ASME Diversity Action grant.

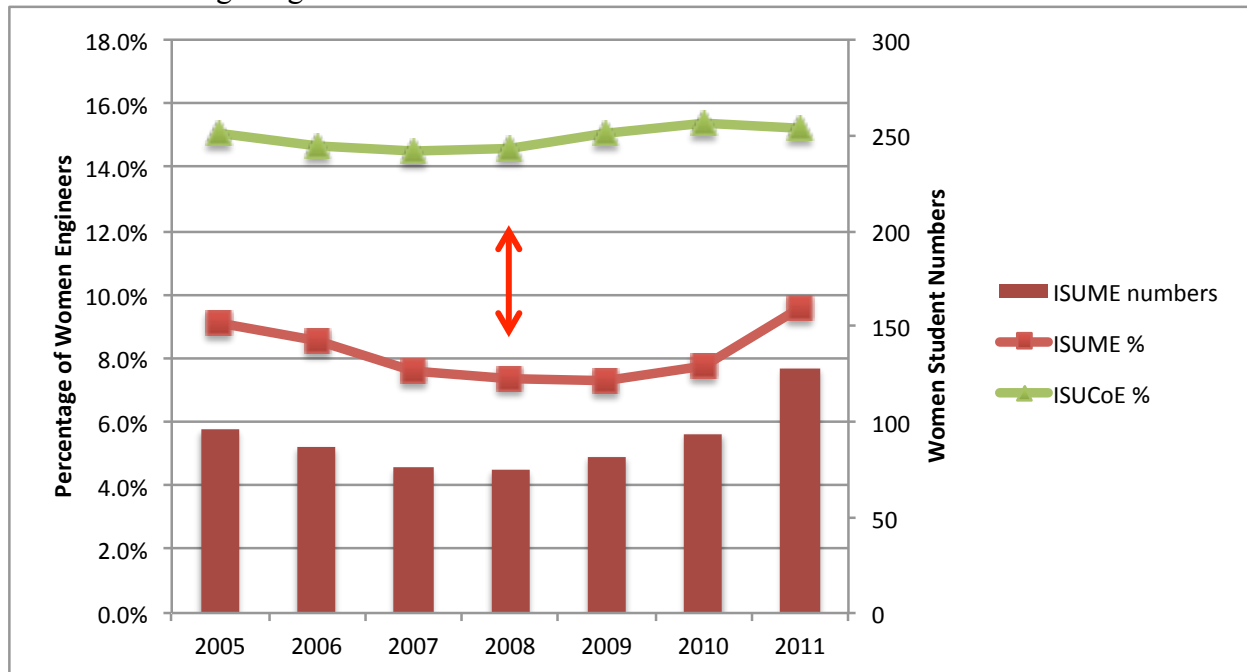
In addition to these activities, the WiME board is planning two outreach activities aimed at middle-school girls: (a) in conjunction with Trane Inc. – which will train participating women in ME in utilizing its energy outreach toolkit ‘fun with energy saving’—WiME will organize sessions at several middle-schools in the local school district to teach middle-school kids fun activities that result in energy savings around the house and at school, and (b) in conjunction with the Science Center of Iowa State and the Nanoscale Informal Science Education (NISE) network, host a Nano-Days festival that consists of educational programs about nanoscale science and engineering and its potential impact on the future.

### 3. Assessment and Impact of program

The goal of the WiME program was to increase participation of women in the mechanical engineering program at Iowa State University through a combination of recruitment and student engagement. Recognizing that other factors such as demographics of the applicant pool and relative popularity of the engineering disciplines may have an effect as well, the primary measures that were looked at to assess the short-term impact of WiME were:

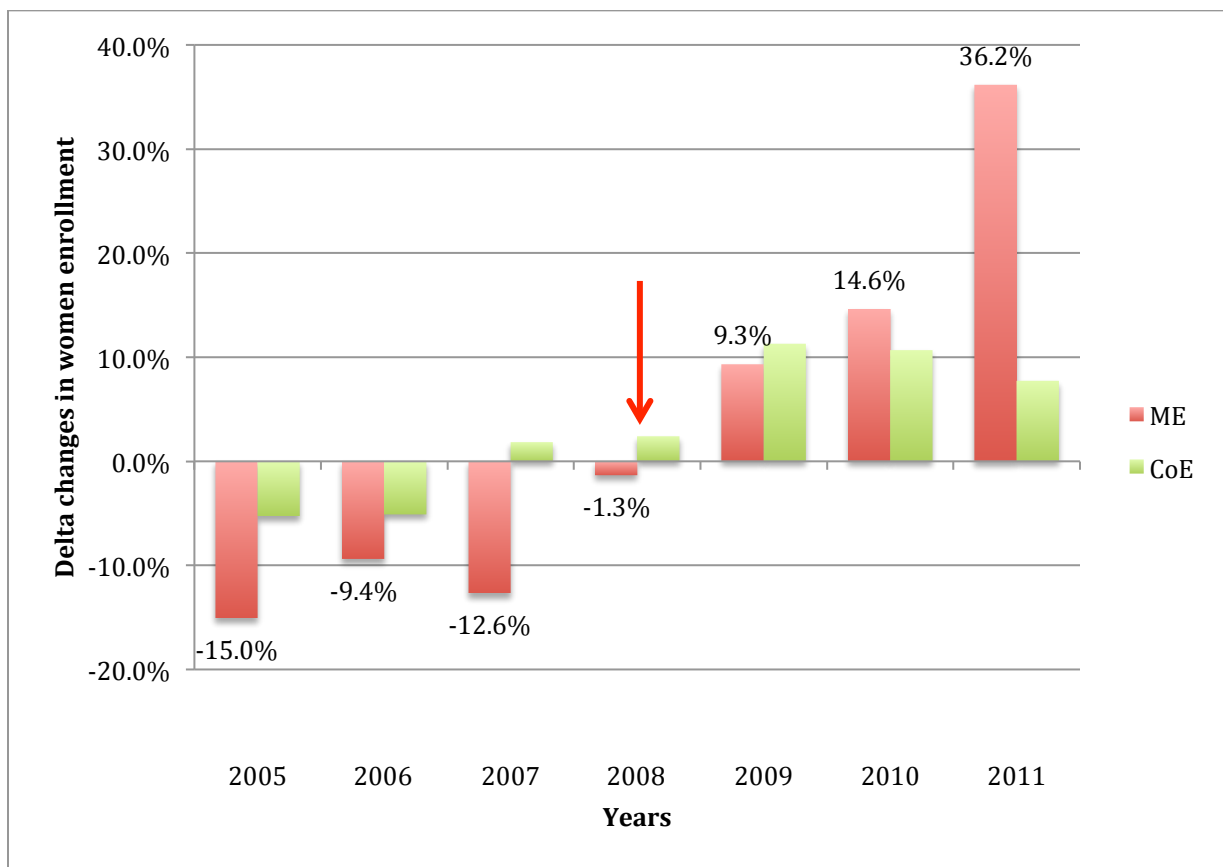
- 1) Enrollment trends in terms of number/percentage of the women in the program
- 2) Student perception of and feedback on social and professional development activities
- 3) Perception of the industrial advisory board

Enrollment trends: Figure 5 shows the percentage of women in the program between 2005-2011 for the mechanical engineering program and the College of Engineering at Iowa State. The data shows that while the percentage of women in all the engineering programs overall fluctuated slightly, the percentage of women in mechanical engineering has risen from about 7.6% in 2007 to 9.6% in Fall 2011. It is worth noting that the college of engineering and mechanical engineering in particular has experienced large increases in overall enrollment during this period. Mechanical Engineering for example went from 1051 to 1338 students in the same timeframe representing a 27% increase, while the College of Engineering experienced a 30% increase from its enrollment of 4551 in 2005. This comparison suggests that Mechanical Engineering has been quite successful at attracting and retaining women students during this timeframe, especially when considering the growth in actual number of women students.



**Figure. 5 Trends in women enrollments for the College of Engineering (CoE) and the Mechanical Engineering (ME) program at Iowa State University. The arrow indicates the launch of the WiME program (Summer 2008).**

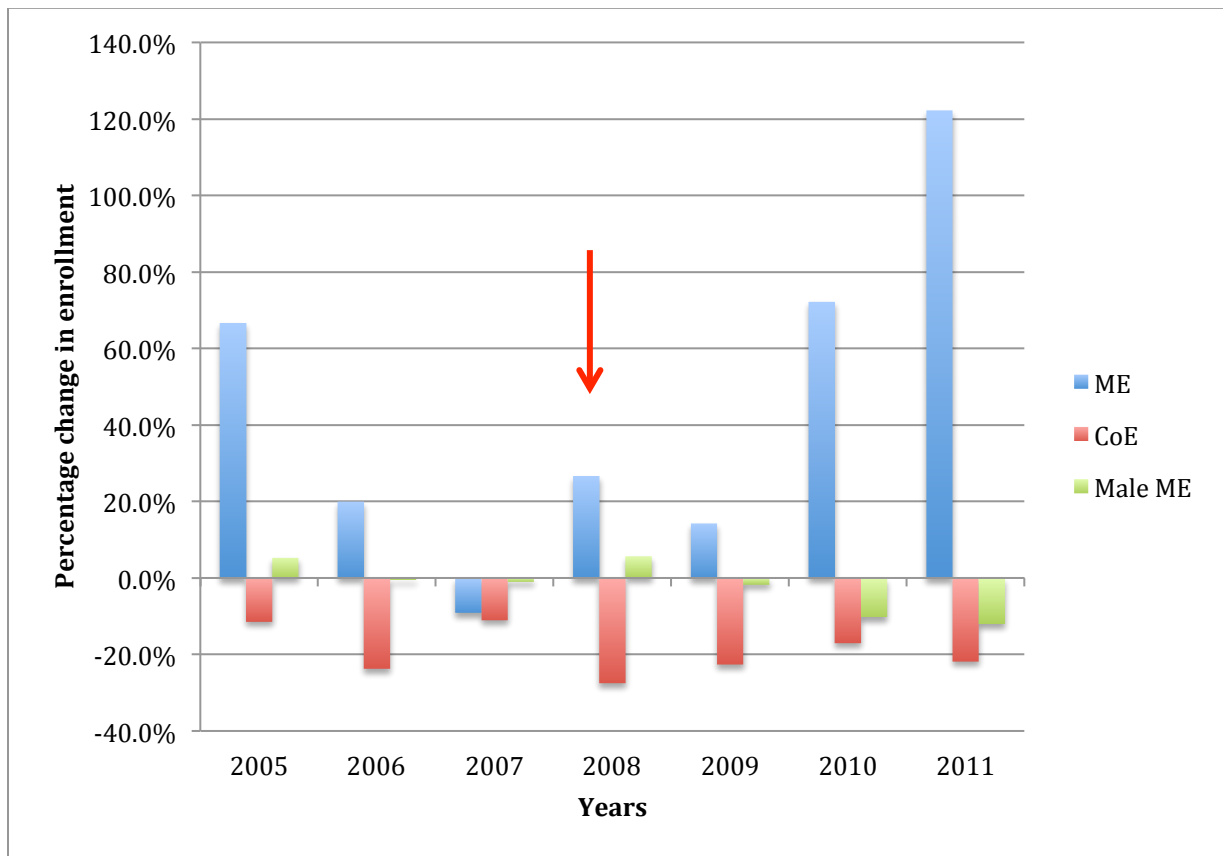
Figure 6 shows the yearly relative changes in women numbers in the program (delta values) compared to the college, expressed as percentages. An increase for a given year signifies an increase in number of women in the program compared to the previous year. This set of data shows that the launch of the WiME program is almost immediately followed by a positive trending in women enrollment changes. This suggests that the WiME program may be partly responsible for the healthy growth in women numbers in the program, especially when taken in context of the college level numbers, which have remained relatively low (~10% compared to up to 36% for ME). One point of interest is the sudden, large increase for Fall 2011 (36% over 2010), compared to 9% and 15% in the previous two years. This coincides with the expansion of scholarship offers from only women applicants who were offered but had not accepted to ALL women applicants as well as the scholarship offers being made in March (previous years had some scholarships not being offered until June or later).



**Figure 6: Yearly (delta) changes in women enrollment for the College of Engineering (CoE) and Mechanical Engineering (ME) program at Iowa State University. The arrow indicates launch of the WiME program.**

Based on the idea posited by various studies that activities fostering an environment of respectful and supportive peer and faculty-student interaction<sup>18, 19</sup> can lead to a more positive learning experience for women students<sup>9, 14, 16, 17</sup>, the retention rates from freshman to sophomore years for women students were considered. This data is shown in Figure 7 and is compared to the retention rates for women across the engineering college. The numbers are reported as percentage increases compared to the freshman numbers, therefore a negative number indicates

attrition, zero indicates 100% retention and a positive number indicates growth. The growth may be attributed to transfers from undeclared freshmen and other disciplines, most likely due to popularity of the program and other considerations. Transfers for other universities and community colleges also accounts for some of the growth. The data shows that while there is a small amount of attrition at the college level over the years, ME, which was experiencing declining growth/retention rates of women students up to 2007, shows a healthy trend after the launch of the WiME program. One may attribute WiME programming as one of the reasons for stemming the decreasing trend of the past years and increasing retention and growth of women students. This idea is strengthened when the retention and growth rates of the women students is compared to that of the male student freshman cohorts in ME for each year, as shown in Figure 7. The male numbers are actually trending in the opposite direction. As a reference, the total student enrollment in 2005 was 1022, with 87 women. It should be noted again that for the years shown, our total student numbers average about 1050 students with 96 women while in 2011 it rose to 1338 students, 128 of which were women. Some amount of overall attrition is perhaps expected with large total enrollment numbers but the fact that we are gaining women students at the same time is an encouraging sign. This data appears to support our hypothesis that a department level program may be more effective in recruitment and engagement of women students. This hypothesis may be applicable for under-represented minority students as well.



**Figure 7: Yearly (percentage) changes in Mechanical Engineering (ME) women enrollment from freshman to sophomore years. As a comparison, data for male ME students are also shown. The arrow indicates the launch of the WiME program.**

Student Feedback: Surveys were administered to all the women students in the program on a yearly basis since 2009. These are typically online or hand-filled at the welcome picnic. The surveys are primarily intended to obtain feedback on 1) programming (professional development and social activities) ideas that are most appealing to the students; and 2) activities that are going well and aspects that can be improved. The typical response rate for the surveys is 45-50%. A few key trends that were apparent from the responses are: (a) the students appreciate activities (like the ice-cream social, bowling and ‘Chat with ME’) that entail increased student-faculty interactions, (b) the students seemed to prefer social events (where they can interact with their peers and faculty) over more formal professional development events, (c) there is sustained interest in pursuing outreach activities, particularly at the middle-school level. In addition, constructive suggestions on (a) improving publicity and dissemination of upcoming activities, and (b) optimal timings for organizing events (students prefer events starting at 4:30 PM) have helped in streamlining WiME activities.

Advisory Board Feedback: The department’s industrial advisory board has been extremely supportive of the program. Several of the members have actively engaged in the program’s activities by volunteering members of their companies and groups to participate in professional development activities as well as to provide funds in support of the program activities. As was discussed previously, they would like to see a more formalized approach to the mentoring program. The women on the board did comment that such a program during their student days would have been immensely beneficial to their learning experience.

Other feedback: Feedback from various visitors to the department (invited seminar speakers from academia and industry, all women) who participated in the ‘Chat with ME’ series were extremely appreciative of the format and commented that they would have benefited from such experiences when they were students.

#### **4. Summary and outlook**

The department continues to be committed to the long-term success of the WiME program. Launched in mid-2008, the WiME program is a department-level effort to increase the participation of women in the mechanical engineering program at Iowa State University. The rationale was to create a sustainable student-driven, faculty-mediated effort to recruit and retain women and enhance their overall satisfaction and experience in the department. In the short time since its launch, the WiME program has become quite popular and the data suggest that various aspects of the program have positive impact on the number of women students. Students have commented on the value of the social activities in increasing their overall satisfaction of the learning experience for women students. One student commented that *‘It is nice to have fun activities with (friends) so that we can make more connections and friends in the program’*. Another student commented *‘I am particularly excited about meeting the faculty and staff outside of the classroom setting...I am more comfortable interacting with them and seeing them as ‘normal’ people’*.

Since its launch, the number of women in the program has grown from 7.6% (74 women) to 9.6% (128 women). This trend is consistent with the goal of the program’s goal to move towards the national average for participation of women mechanical engineering at the undergraduate level (13%). Another a very encouraging and rewarding indicator of the program’s positive

impact is the adoption of similar programs in other departments in the College of Engineering. The current governing structure appears to be efficient and sustainable. Due to the national area of need in improving women engagement in engineering, corporate and alumni friends of the department continue to show interest and financial support for the program, suggesting that the program is also sustainable in terms of resource requirements. Areas of improvement include 1) better deployment and oversight of the mentoring program; 2) increased opportunities for faculty-student engagement, not only amongst the women students, but for all students; 3) improved publicity and dissemination of program events and; 3) a focus on collaborative activities with other student groups and organizations. It is our intent to continue assessment of the program in order to measure long-term impact and persistence of the program. From the assessment standpoint, a better idea of which particular aspects of the program (if any), contribute to decisions by women students to choose or remain in the program as well as impact on their choice to continue in an engineering career can further contribute to our understanding of gender-based differences in engineering education.

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