

# PATHWAYS TO PROGRESS: PROPOSAL AND RECOMMENDATIONS FOR IMPROVING GENDER DIVERSITY IN THE COLLEGE OF ENGINEERING

## SOCIETY OF WOMEN ENGINEERS

### CLIMATE AND BACKGROUND

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In November 2007, acting on the suggestion of College of Engineering administration and the urging of its membership, the University of Illinois section of the **Society of Women Engineers (SWE)** launched a new diversity initiative to explore and address issues of gender diversity within the University of Illinois College of Engineering. An anonymous online survey was sent to all female engineering students (undergraduate and graduate) in the College of Engineering and a total of 175 responses representing 15% of the College's female population were received. **Two-thirds of respondents reported being "treated differently"** at some point in their tenure here as a result of being a woman in engineering, while 43% reported they face such issues *sometimes to often*. The same survey was distributed to female engineering students at Purdue University, an institution that has been nationally recognized for its substantial investment in gender diversity. Results from that survey illustrated the impact of these investments, with nearly two-thirds of respondents reporting having *never* experienced being treated differently as a female in engineering. **The marked success of Purdue University and other well-known successes like Carnegie Mellon's Computer Science program suggest that a strong investment in diversity can have a tremendously positive impact on gender climate.**

The results from this survey and a subsequent analysis of data from the campus Division of Management Information (DMI) and National Center for Educational Statistics (NCES), part of the United States Department of Education, were used to compile a wide-ranging report on the gender climate in the College of Engineering. This report, titled Status and Summary of Gender Diversity in the College of Engineering, was distributed to College administrators and is included as Appendix B to this proposal.

### THE VOICE OF THE CUSTOMER

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In the twelve months since it launched its original survey, SWE's diversity initiative has worked to develop a series of action points that would directly address the most pressing of these issues and improve the overall gender climate in the College. One early component of this was to reach out not only to its own membership, but across the College to its sister organizations such as Women in Aerospace, Women in CS, Women in ECE, and Women in Physics, and learn more about the issues specific to each of their departments. The issues, concerns, and suggestions of those discussions have been incorporated into this proposal. In addition, SWE has forged a lasting bond with these departmental societies by establishing an ad-hoc advisory committee through which the other female engineering societies may have an officer attend SWE's officer board meetings to offer unique visibility into issues faced in that major, as well as to explore possibilities for joint events and other collaborations. Most recently, SWE commissioned a second survey that asked female engineering students in the College to help prioritize the areas they felt had the most immediate impact on the issues they face, and the results of that survey have been used to guide the structure of this proposal.

## PATHWAYS TO PROGRESS:

### Proposal And Recommendations For Enhancing Gender Diversity In The College Of Engineering

**Uniquely, this report speaks as the voice of the female student body of the College of Engineering, representing a bottom-up process**, a collaborative effort of those who face these issues. As then-Provost Richard Herman's campus-wide Diversity Initiatives Committee noted in 2000, students would be an integral component of the committee because "we don't want to do something for the students; we want to do something with the students. And we need to understand what the student point of view is." In keeping with that call, this proposal has been prepared by the University of Illinois section of the Society of Women Engineers in consultation with campus and college administration, engineering faculty, campus experts on diversity, and most importantly, the female students of the College. As the College's Planning Committee for Enhancing Diversity observed in their 2006 report, "despite substantial attention and effort expended over the last two decades in characterizing, studying, and starting programs to address diversity, the gender and ethnic face of the science and engineering community at UIUC has not changed in a significant way" and notes "it is clear that new approaches are needed...it is time to try something new", to which we offer this proposal in response.

As an organization we have tremendous hope that we may begin to effect real change in the College through these solutions, but it is important to remember that there is no constant but change itself. Therefore, **the recommendations proposed in this report do not constitute an ultimate solution to the unique barriers and challenges that female engineering students face**, but we hope instead will form a new beginning. While encouraging more women to become engineers is something that must be addressed at a national level, it falls to us as an institution to ensure that those women who do decide to embark upon a career in engineering are able to learn and grow in a welcoming environment. By making the College a more welcoming place for female engineers, we teach our students the virtues of difference, tolerance, collaboration, and teamwork, all of which are critically important to engineers in the 21st century.

#### THE SIX SIGMA APPROACH TO DIVERSITY

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As noted above, this proposal stands as unique among previous efforts in the College of Engineering in that it was generated from the bottom-up, representing the "voice of the customer" in the terminology of Six Sigma. From an early stage it was determined that the most effective way to develop this proposal was to follow an established process that industry has refined over the years and demonstrated to be successful in many different applications. When converting a process to Six Sigma, there are five primary phases: Define, Measure, Analyze, Improve, and Control (DMAIC). In the Define phase, the problem is articulated and the voice of the customer collected. During the Measure phase, the customer needs, known as the Critical to Quality metrics, are defined and measured against Baseline data of the process' current capability to meet those metrics. Customer needs that are not currently met by the process are examined in the Analyze phase through the identification and prioritization of Root Causes. The Improve phase consists of developing and prioritizing solutions for the Root Causes and creating an implementation plan for the selected solutions. Finally, the Control phase consists of implementing the solutions from the Improve phase and assessing and reducing the risks that come with the new solutions.

In the case of this proposal, the voice of the customer was Defined through meetings with SWE's sister organizations, the original survey, and DMI and NCES data. The voice of the customer was subsequently used to validate the problem statement and objectives, together with identifying the baseline data for the current system. In the Measure phase, the results of the Define phase were used to stratify the customer needs into three distinct areas: the interaction of female students with their Peers, Teaching Assistants, and Faculty. The Measure phase was documented in more detail in the report Status and Summary of Gender Diversity in the College of Engineering, attached as Appendix B. The Measure phase suggested that none of the three customer needs were being adequately

## PATHWAYS TO PROGRESS:

### Proposal And Recommendations For Enhancing Gender Diversity In The College Of Engineering

satisfied through the current system; therefore the Analyze phase was used to determine possible root causes.

The second survey suggested that **peer issues represent the most pressing concern of women engineering students in the College**, with nearly three-quarters of respondents reporting gender diversity issues with their male peers and **75.5% listing it as their highest priority for change. Faculty were second, with 59%** of students identifying faculty as their highest priority, while **51.7% identified TAs as their highest**. (The three were ranked via independent scales, so they do not add to 100%). Using these priorities developed during the Improve phase, these needs were integrated into a set of three “pathways” we believe will have the greatest impact on the gender diversity climate in the College of Engineering. Each of these is developed further in the subsequent sections and their concurrent implementation will constitute the Control phase of this process.

#### PATHWAY 1: DIVERSITY TRAINING

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The first step towards a more welcoming climate involves **instituting a training program to help faculty, teaching assistants, and peers better understand the ways in which their actions impact the environment for female students**. Experience has shown that visual and interactive delivery mechanisms have a more lasting impact than the written word; hence the primary delivery method for these training modules will be in the form of skits followed by interactive discussion sessions. We have included in **Appendix A a compilation of the stories students have shared with us of their experiences here**, offering a rich collection of material to seed and help guide these training workshops to target the areas students have identified as the most problematic for them.

##### *Peers*

The primary training vehicle for peers will be through a **revised version of the current Engineering 100 diversity module**. Converting the current module to a more interactive skit-based delivery mechanism that focuses on the issues most cited by female students should help male students become more aware of how their actions can affect their female peers. In addition to this module, female students will also be offered an optional “**communication course**” that teaches communication and coping mechanisms for interacting with their male peers and help them be more assertive against negative behaviors. For example, if an all-male laboratory group assigns secretarial duties to its only female member, this module focuses on ways in which she can stand up to the other members of the group to take on a more substantive role, reinforcing a positive perception of females as intellectual peers. This course would likely be offered as one of the lectures that are part of the Engineering 199W (Professional Development and Leadership Skills in Engineering Through Mentoring (for women)) program.

##### *Faculty*

**Faculty set the overall tone for their department and classrooms, through not only their own actions, but also their responses to the actions of others**. A faculty member who routinely makes suggestive jokes in class or singles out female students sets an overall tone of acceptance towards such behavior that may encourage similar behavior from male students. Similarly, if a student makes a derogatory public comment in class, that student will be encouraged to proceed with further outbursts if the faculty member ignores the comment. If, however, the faculty member avoids gender-related comments and behavior in the classroom and reprimands male students who make such comments, it will send a strong message to the next generation of engineers that such behavior is not acceptable.

## PATHWAYS TO PROGRESS:

### Proposal And Recommendations For Enhancing Gender Diversity In The College Of Engineering

Indeed, in recognition of their impact on the overall gender climate, one of the recommendations of the 2006 Dean's Diversity Committee was the addition of faculty training. Yet, it is critically important that these workshops be strongly encouraged, as previous experience has shown that those most in need of the guidance often do not attend diversity workshops when they are optional. As with the Engineering 100 module, Faculty training will utilize skits and interactive discussion sessions, but tailored to the unique situations they encounter as instructors.

#### *Teaching Assistants*

Training for teaching assistants largely mirrors that of faculty, since the two groups have similar contact environments for undergraduate students.

## RECOMMENDATIONS

- **Peers: Revise Engineering 100 Module.** Move to skit-based module with interactive discussion. On-campus theater troupe Inner Voices already focuses on related topics, and has campus funding for its core presentations; leveraging this troupe would require a low amount of additional supplementary funding from the College. Helps male students focus on how their actions impact the environment for female students. Use contents of Appendix A to tailor these skits to the most pressing needs.
- **Communications Course for Female Students.** Optional “communications course” for female students teaches communication and coping mechanisms for interacting with male students. Offer one of the lectures that are part of the Engineering 199W (Professional Development and Leadership Skills in Engineering Through Mentoring (for women)) program.
- **Faculty and Teaching Assistants: Interactive Skits.** Skit-based module with interactive discussion focuses not only on the actions and comments of faculty/TAs themselves, but also on how to manage those of male students. Use contents of Appendix A to tailor these skits to the most pressing needs. On-campus theater troupe Inner Voices already focuses on related topics, and has campus funding for its core presentations; leveraging this troupe would require a low amount of additional supplementary funding from the College.

## PATHWAY 2: DIVERSITY NETWORK

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*That's just the way things are.* This single phrase seemed to dominate many of our discussions with female engineering societies on campus. Many female students we have spoken to have been so demoralized by these issues that they have often largely given up on the hope that things can change and simply accept things the way they are. This points to a **critical need for empowerment, a series of structures that encourage and embolden female students to speak out against negative situations.** The model we propose for empowerment revolves around the first of the “immediate timescale” recommendations of the 2006 Dean's Diversity Committee report: the establishment of a College-wide Diversity Network. From our discussions with faculty, staff, and administrators across the College in the past twelve months, we have come across numerous small pockets of diversity innovation, from faculty who go the extra mile in their classrooms to programs like the one recently initiated in the Department of Computer Science. Yet, the common theme is that each of these presently occurs in isolation and hence do not benefit from being a collective organization that can share ideas and resources.

There are two primary areas in which we believe the Diversity Network, as conceived by the Dean's Diversity Committee in its report, should be extended: the **addition of a student liaison** and the

integration of **proactive student assistance** based on the model established by the Department of Computer Science.

### Student Liaison

One of the most common requests heard by SWE is the need for a **central person that students can go to when they encounter gender-related issues**. The current Diversity Network emphasizes a top-down approach to diversity coordination, with faculty and staff coordinators managing the activities of each department, but without a strong feedback mechanism to allow bottom-up propagation of new ideas and approaches. Computer Science offers a webpage for anonymous suggestions or concerns, but the students SWE has talked with have had concerns about reporting issues to a website where they do not know concretely who will receive their messages. **Students want to know exactly who will receive their information, and have someone they can talk with for follow-up**. Yet, at the same time, we have found that students are often intimidated by the idea of approaching a faculty or senior administration member out of fear it could affect their grades or standing in the department, and even whether that person will understand the issue from their perspective. It is for this reason we **recommend the establishment of a student liaison to the Diversity Network, who will act as a conduit for student concerns**. Having this occur within the auspices of the Diversity Network ensures that complaints about faculty and teaching assistants can be tracked over time in cases of sustained issues.

Our research over the past year suggests that underclassmen tend to face the most gender-related issues and that by the time they reach their junior and senior years they have garnered greater respect from their male peers and/or have developed support networks to help them better cope. For this reason, the student liaison would be introduced to female students right from the beginning, by attending the Women in Engineering (WIE) summer camp before school begins and through an email to all female freshmen engineers at the beginning of the fall semester. This helps students know that the College is working to support them from Day 1 of their tenure here and that they have someone to reach out to with issues. It is important that this liaison have **fixed office hours** either in a designated space in the College or perhaps rotating through neutral areas such as student lounges. We have found that many students would not feel comfortable with the formalities of scheduling a meeting to discuss their issue and would prefer to be able to just “drop in”, which office hours would permit. The student liaison would also have a list of the various resources available in each department, in the College, and in the wider campus, to be able to refer students to those resources as well. For example, a female Computer Science student having difficulty finding student groups might be introduced to the Women in Computer Science organization as a possible peer support group

### Proactive Intervention

The Department of Computer Science stands out among its College of Engineering peers as a model of how diversity appreciation can be furthered within an academic environment. Among the many changes enacted by the department is the creation of an Advancement Team that brings together the complementary roles of Development, Communications, Engagement, and Outreach. The role of outreach in this department is particularly important, as it focuses inwardly as well as outwardly, ensuring that students meet with continued success while enrolled in the department. At-risk students (of all genders) are **proactively identified by faculty and scheduled for intervention before they fall behind** and become discouraged. This is especially important for female students, who often face continual negative reinforcement from peers that they do not belong and so may not be as likely to reach out for help when they need it. The department has worked extensively to bring female students into the fold with social events, such as a freshman picnic that provides an opportunity for female students to meet one another and network. Women in Computer Science

## PATHWAYS TO PROGRESS:

### Proposal And Recommendations For Enhancing Gender Diversity In The College Of Engineering

(WCS), a student organization in the department for the advancement of women in the discipline, receives considerable active support from the department, and numerous faculty make themselves available to it. The department also has “town hall” meetings where students can voice concerns about issues confronting them.

The Dean’s Diversity Committee recommended intervention for at-risk students, but focused primarily on out-of-band solutions like Physics 100 and bridge programs such as UIUC at Parkland. Discussions with students suggest that greater emphasis should be placed on inline initiatives like the one established by Computer Science, with the inward focus potentially having an even greater effect on retention. The most important consideration is that such a program **must be proactive, not simply reactive**, in that instead of remedial action after a student has already failed, it should identify those most at risk and intervene *before* they fall substantially behind.

#### *Faculty*

The **Diversity Network** works to address diversity concerns with faculty by providing a centralized core diversity thrust within each department. It **works in concert with the diversity training to provide longitudinal reinforcement and expansion of diversity concepts and efforts across the College**. In particular, the student liaison position offers students a way to more comfortably report issues they encounter with faculty and provides a way for the College to better understand longitudinal patterns with particular faculty.

#### *Teaching Assistants*

The role of the Diversity Network with respect to teaching assistants is largely the same as for faculty, with the exception that the high turnover rates mean there will always be a large influx of new assistants each year. It is expected that this **high turnover** will require the **Diversity Network coordinator** in each department to **work more closely with the TAs** in that department since their short tenure does not offer the same opportunities for longitudinal improvement as do faculty. In particular, diversity coordinators might attend class sessions at random of TAs cited in multiple diversity complaints to offer more in-depth feedback to those instructors, similar to the process used to train student teachers.

#### *Peers*

The Diversity Network primarily focuses on faculty and teaching assistants, with the understanding that these individuals **help set the overall tone of the classroom and can help influence how students behave in the classroom**. However, the student liaison and proactive intervention components are designed to directly address peer issues, with the student liaison offering an outlet to report concerns and proactive intervention helping to improve female retention.

## RECOMMENDATIONS

- **Proceed Immediately with Diversity Network.** Prioritize the implementation of the Diversity Network recommended by the 2006 Dean’s Diversity Committee. Ideally interim departmental coordinators should be stood up during Spring 2009 semester in order to adequately accommodate the incoming fall freshmen.
- **Student Liaison to Diversity Network.** Integrate a student liaison to the Diversity Network to offer female students a familiar face to go to with issues. Fund additional student position with Women in Engineering (WIE) office to fill this role. Have set office hours and introduce liaison to incoming freshmen. A fixed outlet for concerns, comments, and issues is a critical need identified by most students and acts as an empowerment device.

## PATHWAYS TO PROGRESS:

### Proposal And Recommendations For Enhancing Gender Diversity In The College Of Engineering

- **Integrate Proactive Intervention.** Replicate the model developed by Computer Science to **cover all departments**, where at-risk students are proactively identified and scheduled for intervention *before* they fall substantially behind. This is especially important for female students who may view their difficulties with material as reinforcement that they do not belong in engineering and may not seek help as readily as male students.

### PATHWAY 3: STRUCTURED TEAMWORK

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Just as in K-12 education, there are numerous ways in which a class, lab, or discussion section can be **unobtrusively structured to emphasize inclusiveness and discourage negative behavior**. Many courses have discussion or laboratory sections, and this is an ideal opportunity for faculty and teaching assistants to structure activities such that **female students are emphasized as peers** and to take corrective action when they are excluded. Through additional training of TAs and guidance to faculty, we believe this can have a profound effect on encouraging male students to view their female counterparts as true peers, equally as capable as themselves. Left to itself, groups tend to perpetuate and reinforce gender diversity issues, with females often the first to arrive in a lab class, but the last to find a partner. Even within groups, male peers often delegate females to secretarial roles. *Structure* is therefore required for constructive teamwork to ensure that roles are equitable and that everyone is treated equally. In such structured teamwork faculty form groups and assign group roles based on a number of factors designed to encourage maximum integration of females with their male peers and to reinforce a positive non-stereotyped role for the female members of those groups. Faculty retain an active role in monitoring groups, ensuring that group dynamics maintain a positive environment for female students.

Encouragingly, **structured teamwork is already a component of the new Illinois Foundry for Innovation in Engineering Education (iFoundry)** initiative in the College, and so rather than recommend that a new program be initiated to focus on increasing structured teamwork, this proposal recommends only that iFoundry prioritize this application of structured teamwork in its continued curriculum development.

### RECOMMENDATIONS

- **Prioritize Structured Teamwork Within iFoundry.** The iFoundry initiative already contains aspects of structured teamwork, and curriculum development should prioritize the integration of gender-focused structure in both classroom structure and pedagogy.