

Initiatives for Creating a More Inclusive Engineering Environment with Limited Resources and Minimum Disruption

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Abstract

In recent years the need for and benefits of diverse and inclusive science, technology, engineering, and math (STEM) disciplines have been highlighted by educators, industry, and governmental agencies. It has been shown that a diverse workforce is critical to the generation of new ideas, creativity and innovation [1]. It is widely acknowledged that mechanical engineering departments at the undergraduate level, in most instances, do not have a diverse student body that is representative of the general population [2]. Therefore, the development and implementation of practices and initiatives for increasing diversity of the student and faculty in the mechanical engineering discipline must be a focus. Additionally, we believe that having a welcoming, inclusive environment is a precursor to improving diversity and thus should be an important consideration in mechanical engineering education. We propose that introducing a few carefully designed practices that require very few resources and cause minimum disruption could result in a more welcoming and inclusive environment.

Bringing about change for a more inclusive environment can be challenging, namely in that it can be disruptive and require resources, but careful planning and strategic use of resources can help alleviate these challenges. A more inclusive STEM environment could be created by trying to address numerous complex existing issues (such as the gender-gap or the lack of participation of underrepresented groups) individually, but multifaceted solutions are essential to address these issues as a whole. Our vision of a fully inclusive program includes students, faculty, and staff from all backgrounds who are comfortable and fully engaged in the educational process and have equal opportunities to be successful. We are working to further improve recruitment and increase retention of the best and brightest minds, regardless of sex, ethnic background, or sexual orientation by strategically focusing on several initiatives in our school.

The University of Oklahoma is currently participating in a NSF funded program titled Transforming Engineering Culture to Advance Inclusion and Diversity (TECAID). In this paper we present some of the initiatives that we are undertaking as a part of this program to achieve our vision for a more inclusive environment, while minimizing disruption and strategically utilizing the limited resources available. We believe that our strategies may provide other institutions with a starting point for creating a more inclusive mechanical engineering educational experience.

Lack of Diversity in Mechanical Engineering

A gender and ethnically diverse engineering population has been recognized as a critical aspect for the U.S. to remain a leader in the global economy [3]. A more inclusive and diverse engineering workforce is a more innovative and productive workforce [1]. Recognizing this need, significant attention and resources have been allocated in the recent past towards increasing female and underrepresented minority student enrollment in STEM fields, including engineering. These efforts have resulted in a more diverse undergraduate population in US institutions, but overall graduation rates still do not reflect a fully diverse student body. For instance, women and underrepresented minorities earned only around 19% and 13% of the 2012

bachelor degrees in engineering, a small increase from previous years [2]. Additionally, this increase in diversity is not uniform across disciplines; traditional engineering disciplines have much smaller percentages of female and underrepresented minorities. As examples, in 2014 mechanical and electrical engineering disciplines had undergraduate female student enrollment rates of 13.5% and 13.7%, respectively, whereas environmental and biomedical engineering disciplines had 48% and 40.6% [4]. The University of Oklahoma (OU), which is in the South Central region of the U.S., has slightly lower percentages of female students in these traditional engineering disciplines example fields (mechanical – 12.0% and electrical – 11.5%).

Clearly, traditional engineering disciplines, especially mechanical engineering, are struggling to attract and retain a diverse student population. Recruitment of a diverse student population plays a crucial role in improving diversity, but creating an inclusive environment is vital to retaining and nurturing a diverse population. This has not received significant attention, possibly because creating a more inclusive educational environment requires a transformation of the culture, which, especially in institutions of higher education, can be a disruptive and challenging endeavor.

Our program is interested in discovering more effective ways to recruit *and* retain underrepresented students in mechanical engineering in such ways as will improve the educational experience for all of our students. We want to develop an approach that addresses cultural change towards a more inclusive environment in our department. We want to ensure that we are reaching top students from all groups and providing learning opportunities to those who may otherwise be overlooked.

Although we have been working toward these goals for some time, our department has been particularly active in these endeavors over the last year. We are currently participating in a National Science Foundation funded program titled Transforming Engineering Culture to Advance Inclusion and Diversity (TECAID), to implement and investigate cultural transformation projects in mechanical engineering departments. We believe our faculty, staff, and students can benefit from increased awareness of and empathy for others, and we believe that participating in this program will help us achieve our desired atmosphere of inclusion. In this paper, we will present our efforts in changing the culture of a mechanical engineering department, while trying to minimize resistance to change and improve the overall educational experience for all students.

Our vision of a fully inclusive mechanical engineering program

At the University of Oklahoma's School of Mechanical Engineering, student enrollment and faculty representation for the fall semesters of 2013 and 2009 are shown in Table 1 and Table 2, respectively. The level of diversity in our department is representative of many mechanical engineering departments around the nation. We believe that transforming our department into a more inclusive learning environment will result in a better educational experience for all of our students.

Table 1. Enrollments/Representation in Mechanical Engineering for 2013-2014 School Year

	Number in Mechanical Engineering Department	Percent Underrepresented Racial/Ethnic Minority*	Percent Women
Undergraduates Enrolled	565	18%	12%
Graduates Enrolled	47	9%	4%
Tenured/Tenure-track Faculty Employed	20	5%	10%

*Underrepresented Racial/Ethnic Minorities includes African Americans, Hispanics, Native Americans, Alaska Natives, and Pacific Islanders.

Table 2. Enrollments/Representation in Mechanical Engineering for 2009-2010 School Year

	Number in Mechanical Engineering Department	Percent Underrepresented Racial/Ethnic Minority*	Percent Women
Undergraduates Enrolled	416	17%	9%
Graduates Enrolled	66	8%	9%
Tenured/Tenure-track Faculty Employed	19	5%	11%

*Underrepresented Racial/Ethnic Minorities includes African Americans, Hispanics, Native Americans, Alaska Natives, and Pacific Islanders.

Our vision of a fully inclusive program includes students, faculty, and staff from all backgrounds feeling comfortable and fully engaged in the educational process and having equal opportunities to be successful. We would like to see improvement in the recruitment and retention of the best and brightest minds, regardless of sex, ethnic background, or sexual orientation, in our student and faculty bodies. We envision a learning community that demonstrates its culture of inclusion through

- (i) providing training to the student body in cognitive empathy to foster a more inclusive learning environment
- (ii) encouraging more engaged participation from female and underrepresented students and faculty on extracurricular engineering competitive teams
- (iii) increasing the recruitment and retention of female and underrepresented students, faculty, and staff
- (iv) developing a more diverse set of engineering design projects (Capstone) and activities to show the broader inter-disciplinary nature of ME and, as a result, further increase student motivation and engagement in the field
- (v) increasing the awareness of the department as a whole of the need for an inclusive environment

Our current departmental goals include recruiting and retaining underrepresented students and faculty, and encouraging their active participation as stakeholders of our school. Our current goal closely aligns with our College's Strategic Initiative on Diversity, which has a stated goal to:

“Expand diversity, inclusion, and capacity to enhance success of students, faculty, and staff - In addition to expanding the size of our student body, faculty and staff, we will accomplish our goals most effectively within an inclusive environment where ideas from a diverse community are valued.”

Strategic Plan for Improving Inclusion and Diversity at OU

As part of the TECAID program's initiative, five U.S. Mechanical Engineering departments were selected from across the country who are working to improve diversity and inclusion related to race, gender, and other social identities and that wished to benefit from an infusion of support and expertise. Participating departments will be attending a total of four workshops as well as monthly conference calls with each other, the TECAID program PIs, and at least one of the subject matter experts working with the PI team. No funding has been received from the TECAID program by any of the teams. The direct benefits of participation are in the form of guidance and support, although some of the participating departments have established funding for their initiatives outside of the TECAID program. Our department has secured funding from our College and other sources for certain aspects of our initiatives, but there are many facets of our proposed initiatives that require minimal or no funding.

The application process for the TECAID program required us, among other things, to form a departmental change team, which would ideally be representative of the makeup of the department. Our team consists of five members, including the department chair, one full professor, two associate professors, and one senior staff member. We are four men and one woman; one team member is from an underrepresented minority group.

One of our top priorities of our participation in the TECAID program was to assess where our department currently stands so that we know how best to proceed on different projects to transform our culture. We want to establish what areas need improvement, determine how best to improve them, and create tools and metrics we can use going forward to maintain an increased level of inclusiveness, and we have therefore tried to incorporate assessment and measurement tools into the projects where possible and appropriate.

Although we recognize the major influence of faculty and staff on the school's environment, our overall strategy for transformation is to implement an approach where we focus largely on the students. This is both because they need to have the training and tools to have a broader impact in creating an inclusive environment during their studies and as professionals, and also because we believe this avenue, if executed properly, would cause the least overall disruption. To improve inclusiveness and fulfill our vision, our school is currently implementing several projects, which will be described in more detail next.

A. The Project: Diversity and Inclusion Training

A diversity and inclusion training program specifically created for engineering students, faculty, and staff has been designed with our input by an expert in the field. The objective of this training is to provide students with research-based cognitive and behavioral frameworks for practicing inclusive intergroup communication that facilitates intellectual diversity and innovation in work teams. The 2.5 hours of training is facilitated over two classroom meeting times. Each year, we will require our senior students to go through training as part of their pre-Capstone coursework in the fall semester. Members of our student competition teams will also be asked to participate in this training, as well as departmental faculty and staff. We will require sophomore students to go through a similar training in the spring semester as part of a class to be determined. Both the senior and sophomore training will be carried out yearly.

This research-based training curriculum provides experiential modules on: intercultural communication skills in teamwork, inclusive dialoguing skills that lead to cognitive complexity and innovative thinking, and inclusive conflict skills that promote productive collective problem definition and problem solving. Modules include interactive exercises, intercultural communication practice sessions, and coached case study sessions. Our subject matter expert, Dr. Wong, has worked with members of our school's Board of Advisors to create true-to-life examples for the case studies. The training program will be carried out as follows:

Session 1

- Understanding social and cultural identities across race/ethnicity, gender, immigrant/international status, sexual orientation, and socio-economic class
- Intercultural/intergroup small group skills
- Cognitive empathy as an inclusive skill to facilitate innovative problem solving, cognitive complexity and inclusive climate

Session 2

- Intergroup conflict skills that optimize conflict rather than suppress or avoid conflict
- Case studies

The training is designed within a framework of three major curricular goals: 1) provide cognitive framing to understand interaction across groups; 2) provide opportunities to practice communication skills anchored in new cognitive framing; and 3) shape future social action in intergroup connection. Social action, in the case of social and behavioral science, means an individual takes account of the behavior of others and is thereby oriented to a reflexive course of action. Cognitive framing and structured facilitated interaction have been shown in intergroup dialogue research to significantly reduce prejudice and stereotyping and significantly increase cognitive empathy and productive conflict solving across groups on difficult topics such as race, ethnicity, and gender. Based in social psychology and the reduction of prejudice, intergroup dialogue practice is a theory-based practice and pedagogy. The curriculum tacks back and forth between cognitive framing and practice of communication skills.

Our subject matter expert is very strategic in how the topics are covered. She first focuses on helping the students understand why diversity, inclusion, and communication skills that encompass diversity and inclusion are important to our students. The first several minutes of her

presentation focuses on the business case for diversity; she points out research showing that employers are interested in having a diverse workforce and that they actively seek inclusive employees. Only after laying the groundwork of why diversity and inclusion should matter to our students (beyond the moralistic reasons) does she start addressing diversity and inclusion terms and ideas and helping our students learn to better communicate and empathize with diverse groups.

The training sessions are also quite collaborative. During lecture portions of the training, she mixes in real-life examples, many based on her own experiences. She also has students complete interactive exercises with each other, which, based on some of the comments received, seem to be eye-opening for many of them. Finally, that members of our Board of Advisors provided information for the case study that is used has a significant impact on how seriously our students take this training. First, it shows that diversity and inclusion-related incidents really are happening in their chosen profession and hopefully drove home the importance of having excellent communication and empathy skills. However, because these Board members are all executives at prominent engineering firms that employ many of our graduates, it also signaled to our students that the information covered in our training sessions really is of importance to their future employers. For the full explanation of training activities and supporting research, see our related paper, *Cognitive Empathy – Making a Better Designer and More Inclusive Mechanical Engineering* [7].

We have requested a modest increase to the course fees for the courses in which our training is taking place so that we do not have depend on outside funds to continue to hold the training each year and to institutionalize the program. We also plan to revise the catalog description of these courses to include the topics covered in the training sessions, thus making them an essential part of the course content.

What We Hope to Achieve: We want to expose our students, faculty, and staff to inclusion and diversity issues of which they might not be aware. By requiring students to go through training in both the sophomore and seniors years, we hope to achieve maximum impact. The early exposure as sophomores will give the students a chance to apply the concepts they learn throughout their academic careers, while the second round of training as seniors will serve as a refresher course before they begin their team-based senior projects and, later, enter the engineering workforce.

We specifically designed this training curriculum to focus largely on diversity and inclusion within the framework of communications and teamwork, two areas of particular importance to both engineering students and professionals because of the nature of engineering work. We believe that by asking nearly everyone (students, faculty, and staff) involved in our department to attend training, we can affect the current environment in a positive way as people start to consider their words and actions with a new understanding.

B. The Project: Building Design Changes

Creating an inclusive environment needs to build on past achievements. Showcasing inclusiveness of the department through success can have a positive effect and help bring about change more easily, because it provides precedence that the environment already has many of the components in place. One of the TECAID program team members is heading up an effort to

create a showcasing display for a heavy foot-traffic area within our building. This showcasing area will be people-centered, highlighting the stories, projects, and achievements of both our current students and alumni from underrepresented groups. We will also showcase students and alumni who are working outside of the “robots, rockets, and race cars” realm of engineering. The designed space has areas in which we can present basic profiles, 3D objects (for example, a small design project), and more in-depth profiles or stories on a flat screen display.

What We Hope to Achieve: This showcasing display will help highlight the full array of engineers that have come through our school. We want to emphasize to all of our students the full breadth of people who are thriving and successful engineers. Also, showcasing high-achieving alumni and students from underrepresented groups will allow them to serve as role models to our current students. Finally, we want to show that mechanical engineers are not limited to the more traditional fields like defense, manufacturing, automotive, and oil & gas.

C. The Project: Humanistic-Centered Capstone Projects

The faculty coordinator of the mechanical engineering Capstone program, also a TECAID program team member, is seeking out humanistic-centered Capstone projects for our senior students. Our Senior Capstone Design course provides students, organized as a team of four or five, with the opportunity to work with a faculty advisor and an industry liaison on an authentic, industrially-relevant design problem. The design problems are sponsored by industry, and a liaison provides guidance and feedback to students. The course starts in the fall semester and lasts the full academic year. During the spring semester students give two presentations, along with participating in a Poster Fair. The Poster Fair and work done by ME Capstone teams are judged by a team of judges from industry and governmental agencies.

We have examined College-wide enrollment data from 2005 to 2015 and found that some other engineering schools within our College have grown or sustained higher levels of female student enrollment than our school. The data revealed that the most popular majors among female undergraduate students in these other schools have been Environmental Science and Environmental Engineering in the School of Civil Engineering and Biomedical Engineering in the School of Chemical, Biological, and Materials Engineering. Most of our current Capstone projects are made up of our race car competition teams, oil and gas industry-related projects, or other more traditional projects, but this data analysis has shown that there is a definite student interest in environmental and medically-themed engineering projects that we have not fully addressed. We are therefore working to establish projects outside of our traditional realm, including possible projects related to energy efficient buildings, a project in conjunction with the local veterans’ hospital, and a project in the area of medically assistive devices.

Once the new projects have been established, we will institute an assessment program to track how many students are participating in the new projects as well as the demographic data of these Capstone teams. We will continue to monitor the overall enrollment trends in our school and others in the College of Engineering and will include questions about the effectiveness of this aspect of our program in annual student surveys and focus groups.

What We Hope to Achieve: Our current Capstone projects might not have broad appeal to all of our students and we may be losing excellent students to other engineering schools as a result.

Providing a more diverse array of projects based on the trends we have observed in undergraduate enrollment, specifically the student interest in environmental and biomedical engineering, should help us recruit a more diverse group of students to our school and give the students we already have something to work on that they are passionate about. Expanded projects could also help give our current students a better idea of how many career options they have as engineers.

D. The Project: Alumni Seminars

We will invite 1 or 2 alumni per year to talk to our students about their careers and how our school helped to prepare them. Ideally, the guest speakers will be recent alumni (between 5 and 10 years out of school) and would be either alumni from underrepresented groups or alumni who work in nontraditional fields.

What We Hope to Achieve: The goals for this project are the same as the showcasing initiative: we want to show the full array of engineers that have come through our school. We want to emphasize to students from underrepresented groups that others like them are thriving and successful engineers. Additionally, we want to show that mechanical engineers are not limited to the more traditional fields involving machines and manufacturing.

E. The Project: Student Team Recruitment Sessions

Mechanical engineering at University of Oklahoma has several student competition teams that participate in national competitions. The projects are extracurricular (although they can also be used as senior Capstone projects) and provide our students experiential learning opportunities. These student teams usually lack diversity and can benefit from a more diverse and inclusive team environment. Our department will help organize and participate in student competition team recruitment events that specifically target students groups currently underrepresented on our teams. We recently participated in a College-wide student team and social club recruitment event aimed at underrepresented students and asked each of our student teams to attend as recruiters. We are also planning to assist our student Society of Women Engineers (SWE) chapter and our Multicultural Engineering Program (MEP) to host recruitment events in which the student teams visit a regular meeting of each group. The idea is to have our student teams, most of which are not currently very diverse, go to events on the terms and turf of the underrepresented groups to recruit new members. One of our team members, Prof. Baldwin, is looking into the demographics of our student teams in recent years and we will continue to track that information going forward to assess progress in this area.

What We Hope to Achieve: According to research done by the Research Institute for STEM Education (RISE), the vast majority of student competition team members are encouraged to join by a friend already on the team, leading to a homogenized team and an environment into which it is difficult for outsiders to integrate [5]. By asking the teams to specifically recruit members from our MEP and SWE groups, we hope to break that cycle. Also, by asking the MEP and SWE groups to host the events, we are removing the teams from their “home” environment and hopefully making it easier for outsiders to break through. Finally, we believe requiring our student team members to attend our diversity and inclusion training (Project A) will help to improve the environment on the teams themselves and hopefully make students belonging to underrepresented groups feel more comfortable in participating.

F. The Project: Faculty Hiring

We have three open faculty positions in the 2015 Academic Year and expect to have more in the coming years as our undergraduate enrollment continues to increase. As such, we will be making a concerted effort to establish better practices for both recruiting a diverse pool of faculty candidates and hiring diversity and inclusion aware faculty members.

To increase the diversity of our faculty applicant pools, we have listed all open positions on job boards for the Society of Women Engineers, the Society for Hispanic Professional Engineers, the National Society for Black Engineers, and INSIGHT into Diversity, in addition to research field-specific advertising platforms. In order to ensure that best practices are being followed during the hiring process, a brief presentation covering diverse hiring practices was presented at a faculty meeting to all faculty members. The Director will also meet with the search committee chairs to review the search and interview process and provide them access to a University handbook, “Recruiting for Excellence and Diversity,” and resources on implicit bias [6].

Our department’s interest and dedication to inclusion and diversity was signaled in the faculty position advertisements by mentioning our participation in the NSF-funded TECAID program, hopefully sending a message to potential faculty candidates that our department values inclusion and diversity. Additionally, members of our College’s Engineering Education Center, which is dedicated to the creation and application of innovative engineering education initiatives and research leading to recruiting, nurturing and retaining diverse students within engineering pathways at all stages of the educational enterprise, will be meeting with each of the faculty candidates.

What We Hope to Achieve: We have multi-faceted goals related to this thrust of our project. Increasing the diversity of our faculty applicant pool will help us achieve our stated vision of a fully inclusive mechanical engineering program that recruits “the best and brightest minds, regardless of sex, ethnic background, or sexual orientation.”

If it is possible to recruit a female or underrepresented minority faculty member from this pool, it would give our department another potential mentor and role model for our students. However, we are also hopeful that additional screening of faculty candidates for diversity and inclusion awareness will both send a message to incoming and existing faculty members that these are priorities for our department and also ensure that incoming faculty members will be able to make a positive contribution to the diversity and inclusiveness of our department. In short, we hope to be able to use the faculty hiring process not only to find high-achieving engineering faculty members, but also potential new allies or advocates for diversity and inclusion.

G. The Project: Workshop for Low-Skills Students

Our curriculum has a strong focus on experiential learning, especially through extracurricular activities related to student teams. Students in these teams need to have a certain level of skill in machining, but many of our students come to us with little to no experience with shop machinery and tools. We are therefore encouraging our students to sign up for the new seminar being given by our College. This zero-credit hour course will take place for 8 weeks of each semester, and it will focus on assisting undergraduate students in learning safety and operations of machines and

tools in the machine shop. This class will teach students to be proficient in the operations of a lathe, mill, welders, and other tools to assist in the completion of student projects.

What We Hope to Achieve: We believe that students who have not been exposed to shop machinery and tools prior to coming to our school might feel intimidated at the prospect of participating in projects or joining teams in which they are expected to use this equipment, and therefore avoid participation. By evening out the skill set of all of our students, we expect to remove at least one of the obstacles keeping students from being fully integrated into the AME community.

H. The Project: Data Gathering for Assessment

We will gather data about the current environment and behavioral trends in our school. Our College's Multicultural Engineering Program (MEP) has already provided us with data from a survey of female engineering students in our College that was carried out in the Spring 2015 semester. This survey examined how the female students came to choose engineering and whether they feel supported and respected in the College, among other things. MEP has also agreed to help us set up a survey and focus group with some of our students from underrepresented groups so that we can gain a better understanding of their experiences as well. We hope to be able to continue this on a yearly basis.

In addition to the tracking and assessment we will be doing for individual projects, we will also continue to look at the demographics of our entire student population, particularly at the percentage of incoming female and underrepresented minority freshman compared to the percentage of the students in our graduating classes. This information will be tracked annually and included as part of our annual program assessments.

What We Hope to Achieve: We need this data in order to give us a starting point from which we can track the progress of our projects' impacts. Also, by including the freshman enrollment and graduate data in our annual review, we are taking a first step towards institutionalizing our change projects.

Progress to Date: Results So Far

Project A – Diversity and Inclusion Training

The first round of our 2.5 hour diversity and inclusion training described above (see Project A) was facilitated by our subject matter expert during the first week of September 2015. The training took place over two days in our pre-Capstone course. All mechanical engineering seniors attended as well as students on our design competition teams and several faculty and staff members. We believe that the training was generally well-received (see Training Outcomes below).

Training Outcomes

To assess the success of the training, we distributed a brief survey to all of the ME seniors in the pre-Capstone class during the last week of November and first week of December. Of 90

students enrolled in the course, 72 responded and the feedback was extremely positive. See Table 3 for a breakdown of the survey results.

Table 3: Survey Results – Pre-Capstone Inclusion and Diversity Training

	When people make mistakes in communication on diverse teams, I now have some understanding of why these mistakes may occur.	When I make mistakes in communication on diverse teams, I now have some understanding of why these mistakes may occur.	I believe that the training component in the pre-capstone course raised my awareness about the importance of communication in teamwork on diverse teams.	I believe that the training component in the pre-capstone course taught me valuable skills that will help me in my future at OU and in the working world.	I believe that this type of communication and empathy training should be a regular part of the educational experience for Aerospace and Mechanical Engineering students.
Strongly Agree	47%	46%	39%	38%	42%
Mildly Agree	35%	36%	33%	31%	26%
Neutral	15%	15%	10%	19%	17%
Mildly Disagree	1%	0%	11%	7%	8%
Strongly Disagree	1%	3%	7%	6%	7%

The survey also asked students to describe the most significant thing they learned from the training. Students provided insightful responses about the value of diverse teams and the importance of good communication and empathy within teams. The survey also asked students to describe something that they learned from the training that they have used already. Overall, outside of a couple of “common sense” comments, the feedback was very positive. Communication skills were widely referenced and many students indicated that they had already changed the way they are communicating in their teams. Other students talked about the heightened awareness they have that a teammate might feel like an outsider and the importance of trying to see things from other points of view. One student even wrote, “Consciously considering the perspectives of others has caused me to not completely change, but at least to reconsider my own personal views on the Syrian refugee situation.” Based on our feedback, we feel that this training went extremely well and that it is in a large part due to the way the material was presented to the students.

Project B – Building Design Changes

One of our team members, Dr. Merchan-Merchan, worked closely with an outside design firm to create our first display area (see Figure 1). We anticipate the installation of the display to be completed before the end of the spring semester. It will feature six semi-permanent posters, a flat screen display that will feature additional slides and video content, and some 3D display areas. The posters will include a photograph and quote from each person featured, and we will also interview each person for a more in-depth story to be shown on the flat screen slides. We will cycle out the posters every six months or so, but the flat screen slides will remain in the rotation longer. The 3D display area will feature design prototypes or other small items created by our alumni and students.

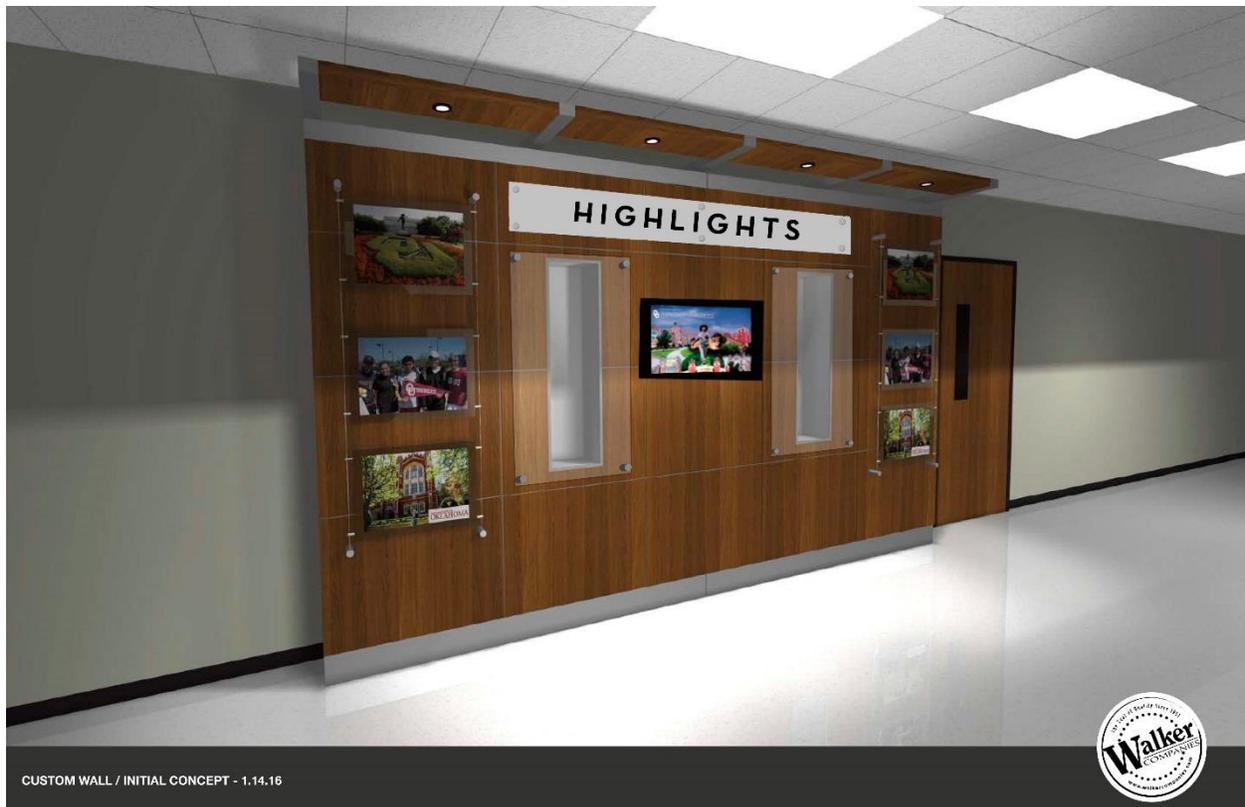


Figure 1: Design of School of AME Display Area

The design for the display was presented to our full faculty at a recent faculty meeting and was well received. Faculty were initially concerned about the cost of the design, but were happy to know that the cost is being covered by funds from the College and from the Chair account of one of our team members. The faculty had an engaging and productive discussion about the value of the display and contributed several suggestions about potential features and the location of the display.

It is still early in this process, but we also plan to engage student opinion on this issue. We will be including questions specifically regarding this display in upcoming student surveys and focus groups.

Project C – Humanistic-Centered Capstone Projects

We were able to secure three new humanistic-centered Capstone projects for the current academic year, all involving green energy initiatives.

- (i) Energy Savings Assessment on Covered Facilities by Using Autodesk’s Rapid Energy Modeling (REM) building audit software, in which students will learn the building mechanical systems and their relationship to energy consumptions, understand energy savings estimation per each energy conservation measure, and evaluate the software tool in energy assessment process.

- (ii) HVAC Design Competition on Existing Building Retrofits, in which students will learn building mechanical systems and their impact on energy and environment provide an innovative idea in HVAC design.
- (iii) Green Bicycle Project, in which students will design a green tricycle with a sale price less than \$2,000, powered by green energy (solar) and human power (peddling) to serve as an alternative to electric cars for short-range transportation. One goal of this project is create a green transportation device while overcoming current challenges, such as battery technology and infrastructure, in bringing electric cars to U.S. households.

Although we do plan to add additional projects in the field of medical assistive devices, we were unable to secure such a project in time for this academic year. However, we had several students specifically indicate that they wanted to work on projects other than from the oil and gas industry, and those students are all participating on one of the three new projects. It is clearly far too early to fully assess the success of this project, but we are encouraged by the progress we have made so far.

Projects D-H

We are still in various stages of planning and implementation for the other projects we have described above, so it is not possible to discuss results for these projects in detail. We have, for example, seen some early results in our faculty hiring project, in that many applicants addressed issues of diversity and inclusion in their application materials or during their interviews, which has not been something we have seen in past hiring. However, this is anecdotal and will require further study and tracking to determine any longer-term impact. Although we realize that some of our planned projects may be less successful than others, given the results we have attained so far, we are hopeful that each of our planned projects will be received in the same enthusiastic manner that we have experienced up to this point and help us create our desired inclusive environment.

Lessons Learned and Concluding Remarks

Our approach to change projects presented in this paper has some salient features that can be applied to other change projects for academic units, especially for mechanical engineering departments aspiring to create a more inclusive culture. Namely,

- Students need to have awareness and skills to create a more inclusive environment. Framing transformation from a student need perspective seems so far to be the path of least resistance and can open opportunities in academic setting. We believe if students are properly trained, they will have the cognitive empathy to reach across gender and race to support each other more effectively.
- Students and faculty need to see the value of developing the skills to create and work in an inclusive and diverse environment. For students, one way to achieve this is by providing context, examples, and case studies that are related to engineering work place. Additional student buy-in can be generated by involving faculty, employers, and other stakeholders.

- Starting with smaller, lower resistance projects and showing results is critical to building momentum. A compilation of small projects when put together can be a starting point for transformation.
- People are the most crucial part, but making changes to the physical environment to show inclusiveness is also important. Showing success from a diverse set of student and alumni is especially important.
- Courses, projects, and examples with humanitarian aspects of engineering and how it relates to the students can help in creating an inclusive environment.

In addition to the change projects themselves, we believe the way we have administered these projects has been just as important in determining our successes and failures. One key factor to being able to effect change within our department has been our ability to create an effective change team. Our core team has been able to work together well, with everyone doing his or her part, following through on commitments made, and respecting each other even while disagreeing. We therefore propose that a vital component to changing an educational culture is the team leading the drive for change. Admittedly, there is an element of luck involved in creating a well-functioning team, but thoughtful reflection on personalities, work styles, etc. should be given by a department in establishing a change team. One of the greatest potential hurdles we have found so far is the time commitment required to create and support a change initiative, and we believe any department considering similar programs should also carefully consider the makeup of their team in the light of the needed time commitment. All of the faculty on our team are tenured. This structure was intentional, keeping in mind that junior faculty members working towards tenure already carry large time burdens in establishing their research programs. Additionally, projects of this kind are inherently prone to resistance and may lead to various level of pushback by the students, faculty, and administrators. Although we very much value the input and participation of junior faculty members, we thought it would be best for the core team to consist of faculty who were already well established in the department.

Another factor to be considered when attempting environmental change is the level of engagement in a change project that faculty members outside of the core team will take on. So far we have been successful in engaging many of our junior faculty members to participate in various projects and we have added one senior faculty member as a “satellite member” of our core team. However, we have not yet identified a strategy to bring in additional allies from among our faculty, particularly for those who might be less open to inclusion and diversity issues, and we believe it will be important to engage with more of our faculty as our program becomes more established and institutionalized. At the same time, expecting too much too soon, or trying to achieve enthusiastic participation from all faculty, may not be realistic, and thus, may create unwarranted disappointment.

One of the biggest concerns for our department in particular is our very high undergraduate enrollment, which has in turn led to a very high student-to-faculty ratio. One way that we have tried to cope with this high ratio has been to implement a new enrollment management program, effective Fall 2015 for incoming freshman. Although this enrollment management program was necessary to maintain a reasonable educational environment, we are concerned with the potential impact it may have on inclusiveness and retention. We expect this to be a common issue as enrollment in mechanical engineering programs across the country continues to grow. For our

department, it is still too soon to assess what the impacts of the new enrollment management program will be, but we certainly plan to track it closely and make adjustments as necessary.

We also recognize that the availability of financial resources can be a concern for many programs. Although we have several projects that do not require outright financial support, many of our projects do involve some element of necessary funding. We have taken steps to establish permanent funding for our training program by including it in the course curriculum and adding a modest course fee to those courses in which it is held, but other funding has come from one-time funds from the College and discretionary funds of one of our team members. In tight budget times, financial resources like these may not be available, and departments should carefully factor potential costs into any projects they plan to take on.

Finally, we believe that the atmosphere of the greater unit (college, university, etc.) plays an important role in the outcome of change projects like ours. Although our department applied to the TECAID program in early 2015, our University has since created a required diversity and inclusion training program for all incoming freshman and transfer students. The University also hired a Vice President for University Community, a position that oversees all University diversity programs as well as initiatives to make our campus more inclusive. Also, as part of their Strategic Initiative on Diversity, our College has named this year “The Year of Diversity,” with numerous programs (including the student team recruitment event we participated in) planned to increase awareness and improve diversity and inclusion. We recognize that working in an environment that is very supportive and heavily invested in diversity and inclusion has been a distinct advantage for our change projects; indeed, the clear overall investment in this area from the top down may be one reason that we have experienced little pushback on our projects thus far. We therefore recommend that a department considering undertaking a change project researches any existing programs on campus that could provide assistance or guidance, and also seek out support from upper administration that could lend additional legitimacy to their efforts.

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