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Work in Progress: Will looking "over the fence" of academic challenges to a future as a successful engineer, support the persistence the WiE students need to succeed?

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Olga Stavridis is the Assistant Director for Diversity, Outreach and Inclusion's Women in Engineering Program. She served as Senior Lecturer for six years for the College of Engineering at The Ohio State University. She has taught Fundamentals for Engineering I and II for the Freshmen Engineering Scholars Program; Engineering Graphics and Spatial Visualization Courses for the last five years. She was previously the Director of the Engineering Co-op and Internship Program at Ohio State. Olga received her Bachelor's Degree in Industrial and Systems Engineering from Ohio State and Master's Degree in Industrial Engineering from Arizona State University. She has twelve years of industry experience in areas of Automotive and Systems Engineering.

Aimee T Ulstad P.E., Ohio State University

Aimee Ulstad, P.E is an Associate Professor of Practice in the Integrated Systems Engineering Department at The Ohio State University. Prior to joining the faculty at Ohio State, Aimee was an industry professional in various field in engineering for over 30 years. Aimee received her degrees in Mechanical Engineering and Masters in Business Administration from Ohio State. She began her career as a packaging equipment engineer at Procter and Gamble, then moved to Anheuser-Busch where she worked for over 27 years. She worked as project manager, engineering manager, utility manager, maintenance manager, and finally as the Resident Engineer managing all technical areas of the facility. During her tenure, the brewery saw dramatic increases in productivity improvement, increased use of automation systems, and significant cost reductions in all areas including utilities where they received the internal award for having the best utility usage reduction for 2014. Since joining Ohio State, Aimee has joined the American Society of Engineering Educators and serves as the treasurer of the Engineering Economics division.

Ms. Lisa A. Barclay, The Ohio State University

Lisa Barclay has 20 years' professional experience in higher education. Under her leadership Ohio State engineering recruitment doubled the number of new first year student applications; with more than 25 percent increase in underrepresented minorities and women between 2006 - 2012. In her current role as Senior Director for Diversity, Outreach & Inclusion she oversees a staff of six and is responsible for College of Engineering Undergraduate Recruitment, Retention and Student Success, Minority Engineering Program and Women in Engineering, impacting hundreds of prospective students and more than 2,500 enrolled engineers. In addition to overseeing the daily operations of the DOI office she also serves as an advisor to the National Society of Black Engineers and the Society of Hispanic Professional Engineers where she has the opportunity to work closely with undergraduate students to support their efforts to excel academically and serve the community. Prior to assuming her current role she worked with the Ohio State University Upward Bound and Young Scholars programs. While at OSU she has been recognized for outstanding service by Mortar Board & Sphinx, College of Engineering Above and Beyond Award and the Alpha Kappa Alpha Sorority, Inc. Black Girl Magic Award. Currently she is serving as the Regional Chair for the National Association of Multicultural Engineering Program Advocates – Midwest region and is an active member of Delta Sigma Theta Sorority, Inc. Lisa and her husband have two daughters and the entire family remain Cleveland Browns fans :-)

Women engineer student success: Looking "over the fence" of academic challenges to a future as a successful engineer

Premise:

Women engineering students remark that engaging in the rigors of their academic career is analogous to climbing a very large fence. The barriers often seem insurmountable during their 2nd year when classes become more abstract and the impact of their grades on admission to major looms large. The researchers for this paper sought to understand if assisting women students in determining how they could use engineering later in their career by understanding the paths that other engineers took and what they do now on a regular basis would increase their self-efficacy and persistence toward their degree. According to Albert Bandura, self-efficacy is developed through four factors: master experiences, vicarious experiences, social persuasion, and impact models.[1] The researchers wanted to understand if providing unique vicarious experiences to familiarize students with engineering careers after graduation could impact their persistence.

During the second year of their challenging academic career, a portion of women engineering students become discouraged at Ohio State University. Classes are very difficult and concepts are intangible. Admission to the major is highly competitive, and for some majors the admission rates are below 40% of applicants. Students really start to question if pursuing their major is "worth it." They often do not have a firm grasp on why they chose engineering other than they were good at math and science in high school, someone told them they should be an engineer, or they had met an engineer and thought their job sounded interesting. Persistence to degree is a problem especially if they believe they are not being as successful as they would like or had been in high school. The purpose of this research is to determine if the students can get some exposure to people working in their field of engineering or other fields that they may not have considered, will it help them feel connected to the end goal and will this connection help to keep these women engineering students in engineering.

Background:

To support the Women Engineering students at Ohio State, a cohort of 40 new first year students were admitted to a housing group called the WiE LC (Women in Engineering Learning Community). This program for first-year students has early move-in privileges where they live in contiguous rooms; they experience programming to support their education focused on social relationships, community building and academic support. Autumn 2017 semester was the first year that students completing WiE LC1 from the 2016-17 academic year could enter the second year program of the Learning Community (LC2). The focus of this program changed to help students determine how they can (1) impact the world as engineers through panels and tours led by engineers in the field; (2) learn from existing engineers that they do not have to be experts in a particular subject but that a wide range of skills make them successful; and (3) by offering opportunities to see engineering that is accessible at their campus, the coursework might be more easily tied to their end goal. The objective of this project was to help them "see over the fence" of their academic hurdles and encourage them to persist to degree. The objective of the research

was to gain insights into the effectiveness of our approach and allow us to share that with others supporting diversity efforts.

One of the unique parts of this program was recruiting working engineers who support the buildings, infrastructure, and medical center at our campus. Recognizing that there are engineers conducting projects on campus similar to those these students might do post-graduation, the researchers set out to find unique experiences in our own backyard.

Outlined below were the key features of this program:

During the first full day of early arrival, the students were taken to the Research & Development center for Owens Corning. At this facility, they engaged in multiple experiences, including; (1) a build and test quick challenge where they installed insulation on small mock house frames and tested their effectiveness to retain heat using a heat source and FLIR camera which attaches to a smart phone, (2) having lunch conversations/open dialogs in small groups with practicing engineers and researchers, (3) observing how Owens Corning is using 3D imaging, 3D printing, and virtual reality to create specialty parts and systems.

Figure 1: Photos from the visit to Owens Corning

Comments from the WiE LC second year students about the experience at Owens Corning included:

> *"…the one on one questions/discussions with the female engineers of OC were helpful; inspiring to hear from the women engineers. Lunch was favorite part because of the discussions with the engineers. It was a fun and interesting experience".*
>
> "*.. really enjoyed the monetary challenge - to follow the economic constraints because it exposed me to the ISE side of things and I'm FABE…"*
>
> *"I took away a different side of industry and gained networking time with questions that was super helpful. Honestly, I really enjoyed all the activities and presentations we did that day and think it was great."*

On the second day of early arrival, the students were given a behind-the-scenes tour of the Schottenstein Center by the head facility engineer. As part of this tour, we also included a mini-session to show students cut-away mechanical parts such as valves, steam traps, solenoid valves, and thermocouples while standing near that equipment in the mechanical room. Because this facility is so large and is used for ice shows, basketball, and popular rock concerts, the facility manager discussed the challenges of handling all these events. He discussed the creativeness and ingenuity required to react to new problems every day, and the need to never stop learning and knowing how to use your resources. Of course, the students were intrigued because he could talk about stars like Katy Perry, Justin Bieber, and hosting two U.S. Presidents.

Figure 2: Photos from Schottenstein Center Mechanical Room

Figure 3: Photos from Event Center Building Tour

Comments from the WiE LC second year students about the experience at the event center:

"Disney in our town… The guy was really cool who met Presidents, and rocks stars, not a stereotypical engineer."

"Interesting to learn more about the (event center) and to be able to use engineering with planning. It shows me that we can use our degree for more than just engineering."

"I would love that job - Take away. Gave me a new side to what my degree can do."

"It is a new experience to consider. Yes! It allowed me to experience more in an engineering career field so I would know what I would potentially be doing."

- When classes began, student availability was more limited, which posed some challenges. The next tour was a short walk by the students to the mechanical room of their residence hall. During this tour, they could see the hot water and cold water systems, controls, and devices like the variable speed drives. A facility engineer was able to bring up the control computer screens from his laptop on the 'big screen' in a team room and they could see the temperatures from their thermostats and all the controls in the building. The next day, students went to the Building Information Management (BIM) department on campus where they could look over 3D drawings of their building in Revit and witness how the various layers of the drawings could be turned on/off, replicating what they saw physically on their tour.

Figure 4: Photos from tour of Residence Hall Mechanical Room

Comments from the WiE LC 2nd year students after tour of the Mechanical Room of their Residence Hall included:

"...didn't like pipe overviews; but liked Johnson Controls computer displays."
"…liked seeing everyday things."
"…liked the relatability of what they saw to their daily life living in the residence hall."

One of the most popular events was a tour with biomedical engineers at the Ohio State Wexner Medical Center on campus. Students visited a functioning electrophysiology lab actually involved in patient care and an electrophysiology lab (EP) in the room next door undergoing renovation and upgrading. In this room, they could see the equipment, back-up power supply (in case of power blip during surgery), and how the electrical, mechanical, and computer technology had to come together with doctors performing work to create a positive outcome for the patient. Further, on this tour, they got to visit the fully operational training linear accelerator used for cancer radiation treatment. The engineers talked about the equipment and systems, the thickness of the walls, and special brick that had to be used block radiation transfer, as well as how thickness of the doors impacted how slowly they could open or close. Moreover, they connected the physical structure to the relationships among all the different types of physicians, specialists, and engineers that it takes to operate and properly treat patients with this very high-tech equipment.

Figure 5: Photos from tour of Medical Center

Comments from the WiE LC second year students after a tour of the medical center included:

> *"… robots were memorable; really cool."*
>
> *"Medtronic (an employer with whom the student was communicating) understood what she saw when she told them she saw a pacemaker."*
>
> *"…liked how the hospital setting could apply to my IE degree."*

During the semester, a panel of seasoned practicing engineers consisting of four women and two men with various engineering backgrounds came to class to talk about diversity in engineering. Three of the panelists were from electrical engineering, two were industrial engineers, and one chemical engineer. The panel kicked off the discussion by asking questions centered around best practices for under-represented groups in engineering. Students previously submitted questions based on the bios of panelists. Some of the students' questions included "What was the hardest obstacle you had to overcome?" and "Have you ever felt you were overlooked because you are a minority in engineering?"

Figure 6: Photos from Practicing Engineers on Panel

During the latter part of the semester, there was a second panel with four young women engineers who began their full-time engineering careers in the last six years. They included one electrical engineer, one industrial engineer, one civil engineer, and one mechanical engineer. This panel was focused on helping students to prepare for securing internships and best strategies for approaching them when they start. The key topic of interest students was "Did you ever feel there was an explicit or implicit bias?" The young engineers effectively relayed their experiences and outcomes of such episodes, which sparked a rich conversation. The career engineers explained to the students that often they were taken aback by some biased comments and did not know how to respond right away. Later they would come back to the person and address the bias more effectively after they had some time to process. This is a great strategy that they had not considered.

Figure 7: Photos from Practicing Women Engineers on panel

Throughout the process of doing these tours and at the end of the entire semester of events, the students were surveyed for the effectiveness of their experience with the goal of trying to help the researchers understand its effectiveness.

Research Methodology and Results:

Not all second year students in the WiE LC could enroll in the ENGR seminar course due to class scheduling conflicts. Additionally, some of the tours to campus sites had to occur at different times than the regularly scheduled class times. Therefore, not all students attended all tours and for some tours, other engineering students were invited to participate. The number of students that completed each survey varied and completion of the surveys after the tours and/or panel discussions did not factor into students' grades.

Table 1: Follow-up Survey after Tour 1 and Tour 2

Survey questions regarding Owens Corning and Large Events Stadium Tours and interactions with the site engineers:	**% Positive Responses**
Did the brief interactions with the engineers on the tours help you see how you as a future engineer might reach out to people like them?	88%
Provided more ideas of what you can do with your degree – not previously considered	75%
Reaffirmed your enthusiasm for current engineering plan of study	69%
Improved your confidence to continue in Engineering	56%
Considered an alternate major within engineering disciplines	38%
Heard Engineers share stories of their own obstacles and that encouraged me that I too can overcome my obstacles	56%

Table 2: Follow-up Survey after Tour of Residence Hall Equipment Room

Survey questions:	**% Positive Responses**
Can you see yourself in an internship position having to learn about a total system like what you saw in Torres?	71%
Exposure to overviews of systems like those in the residence hall are intended to show you how coursework is linked to real world applications; to prepare you for possible industry systems you'll encounter and to build confidence that you too will learn how to work with skilled trades and other engineers to ask the right questions to learn on the job. Please rate the following:	
Learned a great deal:	7%
Learned a moderate amount:	43%
Learned a little:	43%

Made me feel more confident:	43%
Did not make me feel more confident:	7%

Table 3: Follow-up Survey after Tour of Medical Center

Survey questions:	**Responses %**
Did the trip to the OSU Medical Center help create some ideas of what an engineering student like you could do in the healthcare/hospital industry?	
Definitely yes	70%
Probably yes	30%
Might or might not	0
Probably not	0
Definitely not	0
Do tours like this help you to see the broader picture of what engineers can do?	
Definitely yes	60%
Probably yes	40%
Might or might not	0
Probably not	0
Definitely not	0

Table 4: Follow-up Survey after Panel Discussions

Survey questions regarding Panel Discussions:	**% Positive Responses**
Yes, the panel discussions prompted me to seek internship opportunities with industry or employer that you were exposed to in this class	40%
Provided more ideas of what you can do with your degree – not previously considered	60%
Reaffirmed your enthusiasm for current engineering plan of study	60%
Improved your confidence to continue in Engineering	47%
Considered an alternate major within engineering disciplines	40%
Heard Engineers share stories of their own obstacles and that encouraged me that I too can overcome my obstacles	73%

Conclusion and Continued Research:

Second year students in the WiE LC2 had unique opportunities to meet engineers and learn about engineering applications that surround them every day. These students genuinely seemed to enjoy these experiences and take away insights from the engineers in the panels and during the tours. From our data gathered so far, the researchers can only begin to understand if this will impact their persistence. Historical data shows that women engineering students participating in the learning community persist in degree at an 89% rate vs. 76% from students in engineering overall. Students graduating and beginning their careers will offer verification if this experience will improve their persistence rate; however, the authors of the paper thought the method was worthwhile to report as information sharing. Recognizing engineering occurs on the university campus and those engineers and technical staff are great resources to teach students and provide context to their academic curriculum is something that can be done at any university. Further providing these students the vicarious experiences that help them see that engineering requires a broad set up skills may make them more interested in pursuing their degrees. Whether the data further supports this will be reported as data becomes available.

For further improvements in the course for next year, we have identified:

- Make the class time 1 hour 20 minutes, rather than 50 minutes
- Cluster the students in discipline-related groups
- Identify more opportunities for computer science engineering students
- Improve research questions to probe findings more thoroughly

References:

1. Bandura, A., Self-efficacy: The exercise of control. New York: Freeman