AC 2012-5156: CREATING A CULTURE OF STUDENT-DRIVEN ECE RECRUITING AND RETENTION

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David Vreeland is an electrical engineering sophomore at the University of Oklahoma. He has served as President of the OU Robotics Club, Captain of the IEEE Region 5 robotics competition team, Chair of Sooner Competitive Robotics, and an Officer in the general-purpose Engineers' Club. With these organizations, he has regularly experienced the challenges and rewards of student involvement first-hand. In 2010, he won the President's Award for Outstanding Freshmen at OU. His future includes an internship with Raytheon Space and Airborne Systems during the summer of 2012.

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Christopher Griffin is an electrical engineering senior at the University of Oklahoma, graduating in May 2012. During his time at the university, he has held the position of President for both IEEE and Eta Kappa Nu, giving him the opportunity to develop leadership skills, along with student recruiting and retention techniques. The primary focus of his studies at OU has been in power systems, and he will be joining the ExxonMobil Corporation in Baton Rouge, La., upon graduation.

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Mark B. Yeary received the B.S. (honors), M.S., and Ph.D. degrees from the Department of Electrical Engineering, Texas A&M University (TAMU), College Station, in 1992, 1994, and 1999, respectively. Following his graduation in 1999, he was a member of the DSP group and a lecturer with the Department of Electrical Engineering, TAMU, where he continued to lead a variety of industrially sponsored projects. Since Fall 2002, he has been with the University of Oklahoma (OU)'s School of Electrical and Computer Engineering, where he has been recently named the endowed Hudson-Torchmark Presidential Professor. His research and teaching interests are in the areas of digital signal processing as applied to radars, atmospheric studies, customized DSP systems, and interdisciplinary pedagogy. He has served as a PI or Co-PI on grants from NASA, NSF-ATM, NSF-DUE, NSF-ECCS, DoD-EPSCoR, NOAA-CSTAR, NOAA-NSSL, LMCO, Raytheon, and DoD-AF. In the past, he received the 1998 NSF/FIE New Faculty Fellow Award for excellence in teaching. He has received the IEEE Outstanding Young Engineer Award from the I&M Society in 2005. He has received OU's Teaching Scholars Initiative Award in 2009. In 2010, he received the ASEE Midwest Section Distinguished Teaching award. By invitation, he was selected to participate in the U.S. National Academy of Engineering's Foundations of Engineering Education Symposium in 2010. Yeary is a Faculty Fellow of OU's Sooner Engineering Education Center (SEED), a founding member of the Atmospheric Radar Research Center (ARRC), and the Faculty Advisor for AISES at OU.

# Creating a Culture of Student-Driven ECE Recruiting and Retention

Abstract:

This paper discusses many aspects of ECE recruiting and retention with an emphasis on the role of students in the process. The foundation of this work was documented by the authors in a 2011 ASEE publication.[1] This paper will complete the previous work by providing details on ECE retention best practices and look deeper into the role that student culture plays in recruiting and retention. While this study occurred in an ECE department, most aspects will translate to any engineering discipline.

When the enrollment reports at the University of Oklahoma (OU) were released in the fall of 2008, the number of ECE undergraduate enrollments declined to an alarmingly low 246 students. With a history of ECE undergraduate enrollments often exceeding 400 students, a corrective action plan was created to improve our recruiting and retention practices. As of the fall 2011 reporting period, the number of undergraduates enrolled in ECE at OU is now 345. Prior work details our methodology, which is focused on advanced engineering technologies, innovative demonstrations, and hands-on activities at a level that the individual student can understand and appreciate.[2] The implementation of the program was likely more important than the methodology. One of the primary reasons for this 40% increase in ECE enrollment in only three years is a drastic change in the student culture. Prior to 2008, our ECE students had minimal involvement in recruiting and retention efforts. Since 2008, a radical change has been made that resulted in students driving the process. Two of these students are co-authors of this paper and will give a student perspective on the dynamics of the culture change that occurred in our department and provide details of how they contributed. Active student organizations were the primary vehicle used by OU-ECE to create this culture change. Data will be presented that correlates student organization growth and involvement to recruiting and retention. We hope our experiences will help other ECE and engineering departments reverse declining enrollment trends.

   I.   Introduction:

When the enrollment reports at the University of Oklahoma (OU) were released in the fall of 2008, the number of ECE undergraduate enrollments declined to an alarmingly low 246 students. With a history of ECE undergraduate enrollments often exceeding 400 students, a corrective action plan was created to improve our recruiting and retention practices. The leaders in our department set a target for undergraduate enrollment number at 350 students. As of the fall 2011 reporting period, the number of undergraduates enrolled in ECE at OU is now 345 as shown in figure 1.
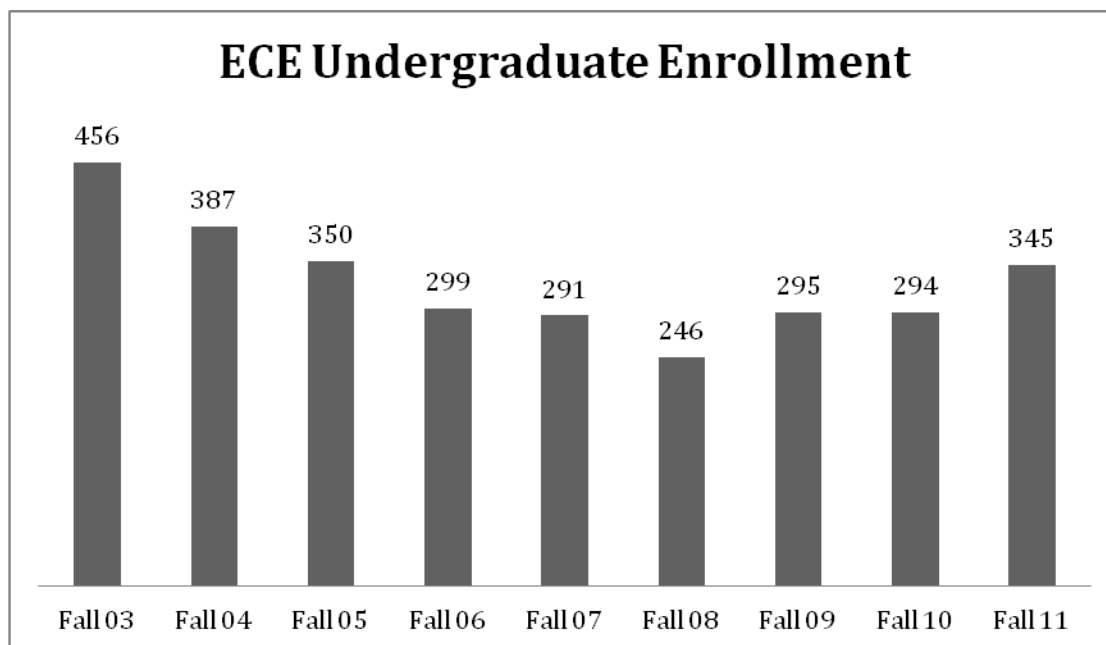
Figure 1: ECE undergraduate enrollment over the last nine reporting periods.

Prior work details our methodology, which is focused on advanced engineering technologies, innovative demonstrations, and hands-on activities at a level that the individual student can understand and appreciate.[2] Since we could not predict how long it would take to reach our target enrollment number a significant amount of effort was spent on outreach to younger students that have not reached college age at the time of this publication. The outreach portion of our plan has been decided to be sustained even if our enrollment numbers exceed the target in the future. The main reason for this approach is that we believe outreach will pay dividends in the future for females and underrepresented minorities. Most of our effort in outreach is spent specifically on these demographics. Increasing the diversity in our student body is a focus and

continued effective outreach to these groups will likely be the only way to make a significant difference.

Three years after implementing our corrective action plan we are realizing that the implementation of the program was likely more instrumental to its success than the methodology. One of the primary reasons for this 40% increase in ECE enrollment and nearly reaching our target number of ECE students in only three years is a drastic change in the student culture. In later sections, recruitment and retention metrics will be looked at that show additional details to the enrollment numbers presented in figure 1. These metrics are designed to analyze performance in three key areas: high school recruitment (declaring ECE as a major when arriving at the university), retention of freshmen ECE students, and recruiting college students with an emphasis on non-engineering students.

II. Recruiting High School Students

During our enrollment decline period of fall 2004 to fall 2008 the average number of freshman entering OU as ECE majors was 60 students per year. After the corrective action program was implemented in the fall of 2008 this number increased by 27% to 76 students per year for the three year period of fall 2009 to fall 2011. The recruiting practices that were used to produce these results is highlighted in previous work.[1,2] One high school student that was recruited with these practices is a co-author of this paper. He is the current president of the robotics club and is one of the students that have been instrumental in changing the ECE culture at OU. The following is his response when asked why he gets involved.

"I knew I wanted to get involved on campus since I arrived at OU. My experiences in high school proved to me that classes are only a fraction of the learning experience, and I was certain that college would reinforce that belief. From there, I suppose it was simply human nature that led me to recruiting. As a freshman at OU, I had just assembled a collection of experiences that were very valuable to me, and naturally I wanted to share that with everyone else. In brief, my goal was to inspire younger students in the same way that upperclassmen had inspired me."

He also discussed a high priority on the facilities and tools available to students and listed it is one of the main reasons he chose to come to OU and major in electrical engineering. He closed his response with the following statements: "I believe that the combination of exceptional tools and passionate minds creates the ideal learning environment. The university gave us the tools; it's our job to bring the minds. That's why I recruit: to bring the brightest minds to the most valuable facilities, advancing the frontier of learning for all."

There are many other OU-ECE students that have a similar mindset. The other student co-author of this paper will be highlighted in later sections, but his testimonial offers some insight into this topic. This student is the current president of the ECE honor society organization known as HKN and past president of the IEEE student chapter at OU. Using his leadership methods that will be discussed later he has increased passion and ownership in the members of HKN and IEEE and the result has been an increased willingness of students to participate in recruiting events. From his experience, he states "after first volunteering for on campus events, most members enjoy the experience and gladly volunteer for later events." This statement adds supporting evidence that our goal of using recruiting methods that is fun and exciting for both the recruiter and recruited is being achieved.

III. College Freshman Retention

As previously stated an average of 60 freshmen per year entered OU as ECE majors between the fall of 2004 and the fall of 2008 and 76 freshmen between fall of 2009 and the fall of 2011. Bringing in 27% more students was a great achievement, but the next challenge was to retain them. In order to have a consistent measurement and include recent data, the number students that persisted in ECE into the 3rd semester was used as the retention metric. This allows the retention rate to be calculated for freshman that entered OU-ECE up to the fall 2010 reporting period and completed the 3rd semester in fall 2011. The retention percentage for freshmen entering OU-ECE between the fall 2004 to fall 2008 reporting periods was 41% and the retention rate between the fall 2009 to 2010 reporting was 55%. While bringing in 27% more students and retaining an additional 14% more, the number of students that entered OU as ECE majors and

persisted into the 3rd semester increased by an average 71% per year after implementing the corrective action program.

During the creation of our corrective action plan to counteract enrollment declines, we recognized that outreach and recruiting efforts are futile if the students do not continue in the program and receive an ECE degree. Therefore, improvements to the retention program were another important part of this effort. In keeping with the focus of our overall program, the most desired new retention program was a mechanism to continue to present advanced engineering technologies, innovative demonstrations, and hands-on activities to students into the freshman year. In a recent publication from the ACT, the top practices that make the greatest contribution to retention are listed. A freshman seminar/university course that is taken for college credit is listed as the number one practice by a large margin.[3] This section of the paper will describe how we applied a new retention program into freshman seminar/university courses.

At OU all engineering majors are required to take an engineering orientation course. During the fall 2009 semester, the College of Engineering added a one credit hour discussion section to these courses that receives a letter grade, which coincides with the ACT best practice for retention.[3] The primary goal of these discussion sections was to increase retention by providing the students an engineering experience. Most students in the orientation course are first year freshman and many are non-engineering students that enroll due to interest in the particular discussion section or to learn more about engineering. Some students are able to take discussion sections that are in their primary area of interest, but many are not able due to the limited size of sections or scheduling conflicts. The end result is many multidisciplinary groups of 20 to 50 students experience a certain area of engineering together. In order to expose incoming freshman to different ECE topics (electronics, robotics, and solid-state physics), the School of Electrical and Computer Engineering taught three discussion sections in the fall 2009 semester that had a combined enrollment of 100 students. The following year an additional section was added bringing the total enrollment to 134 students. Details of these sections are described in previous work.[2]

The first aspect of retention is that the students stay enrolled in the university. The metric to determine how many students stayed in the university and persisted in engineering was analyzed after the 3rd semester. There are two ways that these students could be lost (or not retained): either they drop out of the university or they switched to a non-engineering major. Of the 234 students that went through these ECE freshmen experience section, 202 (86%) were still enrolled at OU after their 3rd semester. Furthermore, less than 10% of the students (14/141) that declared engineering majors switched to non-engineering majors. This program is being furthered in the 2011/12 academic year to reach even more students. The total enrollment will be increased to approximately 170 students.

When analyzing why we were not successful in retaining more students a common indicator was noticed. 26 out of 32 (81%) that left OU either didn't pass or withdrew from a math class. Furthermore, the same can be said for 10 out of the 14 (71%) that switched out of engineering. It appears that a common denominator to determining success in engineering at OU is the student's ability to pass the required math classes. This indicator will be analyzed next fall with 170 more data points and could lead to a new retention program focused on correcting this problem.

IV. College Freshman Recruiting

Another important factor in enrollment numbers is to get a higher rate of students matriculating into ECE. We believe that freshmen are the primary target for this matriculation. The main reason for the focus on freshmen is there has not been enough progress in an alternate field of study that would prevent them from graduating with an ECE degree in their desired time frame. Additionally, freshmen are often unsure of what degree they want to pursue and are the most open to new ideas. The metric used to analyze matriculation success is the number of students who were enrolled in ECE into the 3rd semester that didn't initially enroll in ECE when coming to OU as freshmen. From the five year period between the fall of 2004 to fall 2008, there were 328 students that matriculated into ECE by the 3rd semester. In the latest three year period from fall 2009 to fall 2011, there were 249 students that matriculated into ECE by the 3rd semester. Coincidentally, the percentage increase in this metric is 27%, which is the same percentage increase in new freshman ECE enrollments over the same time period.

The ECE freshman experience orientation sections previously discussed played a role in this metric increase. Of the 202 students that went through the ECE-led freshman orientation sections and are still enrolled at OU, 61 entered as non-engineering or undecided majors. 35 (57%) of these students switched to an engineering major. Furthermore, 8 out of the 179 (4.5%) non-ECE majors that are still enrolled at OU switched to an ECE major. The focus of the college of engineering for the freshman engineering experience course is the promotion of engineering and not a particular major, so this 4.5% influx into ECE came naturally without coercion.

Other factors are the methods of recruiting (discussed in previous work)[1], the rapid growth in ECE student organizations, and the increase in ECE student recruiting activities. The student's influence in enrollment is an interesting dynamic that is hard to quantify. It is difficult to determine if the excitement and passion exhibited by students of a particular major leads to other students deciding to persist in or switch to that major. This is what is believed to be happening in ECE at OU as a culture of student-driven recruiting and retention has been created.

The current president of Eta Kappa Nu (HKN) and co-author of this paper provides some insight into this dynamic. This student initially declared a non-engineering major when entering OU. He contributed the high-tech nature of electrical engineering as the reason he first began to think about switching to the field. He stated that by seeing the "finished product" and "applied electrical engineering" he was motivated to change his career plans and major in electrical engineering. As an ECE student organization leader he has been actively engaged in planning new recruiting events to attract more students in the same way he was attracted. The following data and student testimonials will show evidence of this occurring and provide information on how it can be replicated.

a. Increase in ECE DLC Mentors

The first evidence is the growth in ECE students applying to and being accepted into the Dean's Leadership Council mentor program. "The Dean's Leadership Council (DLC) establishes connections leading to a strong sense of community within the College of

Engineering through student-to-student interaction. This community will be built through service, dedication, respect, and honesty toward others, engineering as a profession, the College of Engineering, and the University of Oklahoma. The Council members are engineering students with excellent academic credentials, leadership and communication skills. They serve as mentors to freshman engineering students, tutors for courses in engineering curricula, and student recruiters for engineering major." [4] Historically, ECE students have not served as DLC mentors to a large extent. Prior to 2009, the ECE student culture at OU didn't appear to appreciate and engage in these types of activities as much as current students. The pride in ECE and the desire to represent their major was not an important issue until recently. The data that was obtained showed that only 7 DLC mentor appointments were granted between fall 2006 and 2008 and 16 appointments were granted between fall 2009 and 2011. This 129% increase is one example that demonstrates the culture change in ECE. An ECE student who is currently serving as a DLC mentor stated that he applied for the program so that he could pass down his experience and knowledge to newer students. He commented on how it is fun to teach new students electrical fundamentals and how rewarding it is when he is able to help them solve problems.

b.   Increase in ECE Student Organizations

Our recruiting plan focused primarily on reaching out to ECE student organizations and trying to get them involved. Adding additional emphasis on recruiting to their mission was found to be an excellent idea for both our ECE department and the student organizations. The three student organizations that have been instrumental in the effort are the Robotics Club, IEEE and HKN. More recently, a new student group named Exempli Gratia was formed and became involved to help create and improve outreach and recruiting demonstrations. Some of the demonstrations they created are a draudio, electromagnetic launcher, and a tesla coil.

The Robotics Club is a great example of ECE student organizational growth at OU. Prior to 2009 this multidiscipline group was primarily comprised of CS students and had almost no ECE members. However, it is now predominantly an ECE student group. Its membership has also grown by approximately 400% in the last couple of years and is now one of the most

dynamic organizations at OU. IEEE and HKN have also grown by over 200% in the last couple of years. By engaging in recruiting activities to bring in more ECE students, the groups also see the benefits in recruiting to increase their own organization's memberships. A byproduct of this relationship is that all three of these organizations have grown substantially in numbers and accomplishments over the last three years. As these student organizations grow, there will be more outreach and recruiting activities that follow, resulting in a continuous cycle.

c. Increase in ECE Student Involvement

The most significant indicator of a culture change in ECE at OU is the incredible amount of student involvement. After our recruiting methodology was developed, the next challenge was to mobilize our ECE student body because they are the people who could relate best to the students we were recruiting, With the busy schedules of ECE students, getting them involved with recruiting has always been difficult. In the fall of 2008 there were virtually no students involved in ECE-directed recruiting and outreach efforts. In the last three years, over 40 students have participated. Many of these students are volunteering under the leadership of the aforementioned student organizations, but many are simply asked if they want to help by the ECE faculty member serving as the recruiting coordinator.

Females majoring in ECE are often asked to get involved in recruiting. Getting more females involved is an important aspect to our plan to increase the diversity of our student body and is especially important because mentor influence is a prominent motivator for females in selecting a major.[5, 6] As a result, we have transitioned from zero females involved in ECE recruiting to more than ten different female students who have volunteered to participate in recruiting activities over the last few years. The level of interest in ECE by females appears to have gone up substantially as a result. ECE female enrollment trends will be analyzed in the future in order to measure the effectiveness of this area of our program. Hopefully, it will correlate with other studies that show that actively engaging females, especially peers, to help in the recruitment process is highly effective.[7, 8, 9]

V. ECE Student Leader Testimonials

The two student organization leaders and co-authors of this paper provided a summary of the leadership style and methods that were used to influence the culture of ECE students and grow their memberships.

a. <u>2011/12 Robotics Club President Testimonial</u>

In managing student clubs and organizations, I believe very simply that passion is the key to success. Passionate leaders draw passionate members, and passionate members produce extraordinary results. This starts with the young students: freshmen tend to be excited about college as a whole, and therefore they are a great place to start building an organization. Technical experience will come with time – as long as the members want to learn! If a few experienced members who love what they do spread that enthusiasm to the younger members, everyone learns more.

Continuity and success will follow. I was inspired to lead and to teach by older students throughout the years; in theory, the next set of leaders will be inspired by the current set. As long as people remain interested and excited, I believe that some of them will naturally want to pass that on to the next generation – which precisely implies continuity. If intelligent people with good tools are learning about exciting things, they will produce results – which precisely implies success.

This is not solely the responsibility of student leaders. One of the most interesting and inspiring people I met when I arrived at school was the faculty member that gave me an ECE recruiting tour. He was impressed by his university, excited about engineering, and willing to go the extra mile so that I would personally be happy and successful. Ideally, this is how every student and faculty leader would perform.

If I were to boil down my strategy for creating and managing clubs and teams, I would break it down into three parts:

- <u>Passion</u>: If you love what you're doing, people will want to follow you.
- <u>Planning</u>: If you know exactly what you're doing and when – and then deliver –

people will trust you as a leader.

⚔   Perception: You must know what the group wants and needs before you and deliver it to them.

Robotics Club Weekly Meeting Summary: Many of our projects were competition based. The inexperienced members loved getting a robot on the ground at all, and the more savvy members loved pitting their robots against each other. We varied the general topic frequently. We had two weeks dedicated to artificial intelligence, which the programmers loved; we used Lego MindStorm bots frequently, which the mechanicals loved to design and assemble. We ensured that each topic was taught in a way that everyone could understand – and then we let everyone practice it. Generally, almost every team would produce a functional result. Now, we're starting to use microcontrollers to create more complex robots "from scratch." In only a semester a group of mostly young members went from zero robotics experience to preparing to build robots that interact with each other using microcontrollers and motor drivers.

b.   2011/12 HKN and 2010/11 IEEE President Testimonial

This student leader listed three keys to creating and maintaining student organization participation. HKN and IEEE are predominantly upper classmen so the organizational goals are different than the robotics club.

Incentivizing: The first tool I found increase student involvement as an organization president on campus was to incentivize success. As the IEEE and now HKN President I worked with career services to establish a "resume book" or rather a tag applied to active members of the chapter's career services profile. This way I could reward active participation by giving their name to be tagged. Also I make sure to schedule fun events outside of volunteering events to allow members to relax and enjoy the organization; for example this year's HKN Christmas party was a huge success.

<u>Develop new leaders</u>: Another way I have found that increases participation and personal investment in the organization is to develop new leaders. What I mean by this is to give members roles within the organization. This not only allows for the growth of the organization by allowing more tasks to be accomplished but also develops a sense of individual ownership in the group. With this sense of ownership the collective desire to further the organization becomes strong.

<u>Networking Opportunities</u>: Providing networking opportunities also greatly influences the membership of a technical based student organization. I have found that by communicating with members and receiving feedback as to the types of industries they are interested in; and then bring in technical presentations from these industries/companies. With the end goal of all members of student organizations is to gain employment in a certain field; to offer this opportunity to meet, ask questions, and network outside of the classroom or career fairs is a big recruiting tool to obtain new members.

VI. Conclusions

This paper shows that the corrective action plan implemented at OU to reverse ECE enrollment declines has been a tremendous success. By increasing our enrollment by 40% over the last three years we have been able to nearly reach our target enrollment. By analyzing the enrollment data, it was shown that after implementing our corrective action program we had a 27% increase in freshmen that declared ECE as a major upon arriving at OU. During this time period we were also able to retain 14% more of these freshmen. Additionally, we had a 27% increase in the matriculation into ECE by the 3rd semester. These metrics show that our program is producing positive results in retention and in recruiting both high school students and college freshmen.

Another finding was that the primary indicator of a student not successfully remaining in the university and persisting in engineering is lack of math skills. The creation of a math tutoring program for ECE freshmen would be a good idea to produce an additional increase in retention. With a foundation of an effective recruiting methodology and a student culture that is driving the process, continued sustainment in our enrollment numbers is anticipated. The testimonials

presented in this paper of ECE student leaders give valuable insight into how this culture was created.

With ECE in the forefront of technological innovation, reduced enrollments are not just a local problem, but a national crisis. As stated by Steven C. Beering, the Chairman of the National Science Board, "The long-term prosperity of our Nation will increasingly rely on talented and motivated individuals who will comprise the vanguard of scientific and technological innovation." [10] We hope our experiences will help other ECE and engineering departments reverse declining enrollment trends.

VII. References

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