

## **Extracurricular Engineering Activities and College Success**

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## Extracurricular Engineering Activities and College Success

Common wisdom contends that the most fulfilling and beneficial experiences students have in college occur outside of the classroom. There is a vibrant literature on the effects of extracurricular activities in middle and high school that definitively show that extracurricular activities such as clubs, sports, and volunteerism increase academic engagement,<sup>1</sup> standardized test performance,<sup>2</sup> and reduce drop-out rates.<sup>3</sup> On the college level, it has been shown<sup>4</sup> that there is a positive correlation between participation in such activities, self efficacy, and academic engagement. Nonetheless, there is little in the literature about the benefits of participating specifically in professional engineering societies and student design teams in college.

We conducted an observational study to address the paucity of data in this realm. Specifically, we used quantitative data (admissions and demographic data, and academic records) to determine what kind of students tend to participate in engineering-based co-curricular activities, and whether that participation is related to college success. For the purposes of this initial study, college success is defined as performance in courses as evidenced by grade point average (GPA). Clearly, this is a limited view of college success, which the authors hope to address in later work. Several research questions were considered:

- What fraction of the student body participates in different types of cocurricular science and engineering-centric activities
- What kind of student typically participates
- Do these students take a different course load and/or sequence to accommodate their activities
- Whether there is a grade penalty for participation

### Methods

University of X (UX) is a large (>40,000 undergraduates) highly respected top-tier research institution, and the flagship school of its home state school system. Eight engineering-based student organizations in the engineering college at the UX were examined in this study, as summarized in Table 1. (Some organization names were changed to preserve anonymity of the institution). Six were chosen because they attract the largest populations of students, according to the rosters submitted to the student life office on campus. The other two were included because they serve underrepresented minority (URM) groups.

All of the student organizations were contacted to request permission to use their rosters, and to obtain the most up to date versions. No effort was made to parse the rosters in terms of degree of participation. That is, the assumption was made that all listed participants were equally active in the student organization. Student data, names and memberships, were coded and compiled using appropriate anonymization, and correlated with established databases maintained by the university. The types of data that were examined include admissions data (incoming high school GPA, college entrance exam scores, advanced placement scores, etc), demographic data (ethnicity, gender, family income, parents' education level, etc.), and academic record (i.e. transcripts). In total,

739 students (or 12 % of the total engineering population of UX) constitute the participant group, and 5397 (the remainder of the population) constitute the non-participant group.

*Table 1: Summary of the student organizations, including the purpose of the group, percentage of female and underrepresented minority participants (URM), and number of participants (N). The values in parentheses indicate the percentage of those groups in the general college of engineering population. Some organization names were changed to preserve anonymity of the institution.*

Team	Purpose	Females (23%)	URM (7%)	N (12%)
SHLab	Sustainable, human centered design	48%	10%	170
Society of Women Engineers (SWE)	Stimulate women to achieve full potential in careers as engineers and leaders	96%	5%	202 (14%)*
National Society of Black Engineers (NSBE)	Support Black students in earning degrees in and succeeding in engineering professions.	34%	93%	95 (52%)*
Society of Hispanic Professional Engineers (SHPE)	Empower Hispanic community to succeed in STEM professions.	18%	95%	33 (12%)*
Hybrid Racing	Design, build, test, and finance a high-performance, hybrid-electric Formula-style race car	7%	4%	144
Society of Automotive Engineers Baja Racing	Design, build, and test a single-seat off-road car	24%	12%	17
Solar Car	Designs, builds, and races solar vehicles	11%	0%	53
Alpha Sigma Mu	International professional and academic honors society	44%	6%	36

\* Percentage of the general female/Black/Hispanic population in the college of engineering that participate in the organization.

### **Findings**

It was found that women and URM participants in most teams in proportions similar to their fraction of the general engineering population at UX. Two exceptions were found. The first exception is the racial and gender population of student organizations that focus on those specific populations. Unsurprisingly, women participate in SWE at much higher

rates than in other teams. The fraction of all women in engineering that participate in SWE is 14%, similar to the fraction of all students participating in these particular teams (12%). Similarly, the participants of NSBE and SHPE are predominantly comprised of URM students. However, the rate at which African American and Hispanic students participate is strikingly different. 12% of all Hispanic students in engineering participate in SHPE, the same rate at which all students participate in these organizations overall. However, 52% of all Black students participate in NSBE. While the reason for the higher rate of participation of Black students is not known, it could be that NSBE is a more established organization compared to SHPE. After all, the membership of NSBE is almost three times that of SHPE. A more likely explanation may be in how strongly Black or Hispanic students identify themselves as such. For instance, a recent Pew Research Center survey found that Hispanics, defined as originating from Spanish-speaking countries, are more likely to identify with their country of origin than with that pan-ethnic label.<sup>5</sup> Thus, SHPE may not appeal to Hispanic students as much as might be expected. Furthermore, Black students have been shown to perform better in environments that also have a strong social justice component.<sup>6</sup> Therefore, NSBE may be likely to appeal to a larger fraction of Black students.

The second exception is in the participation of women in different types of student organizations. Organizations that are described by having a “design, build, test” cycle have an average of 14% female participation, significantly less than the overall fraction of women in the College of Engineering (23%). Compare this to the 44% of women in an honors society and the 48% of women in SHLab, an organization focused on sustainable, human-centric design. This latter finding is consistent with the commonly held belief that women are more attracted to<sup>7</sup> and succeed in<sup>8</sup> more altruistic and/or humanistic pursuits.

*Table 2: Summary of incoming academic indicators. Higher values are in bold*

	Participants	Non-participant	Significance
High School GPA	<b>3.86</b>	3.84	
Total SAT	2048	<b>2063</b>	
Math SAT	727	<b>733</b>	*
Verb SAT	656	<b>667</b>	*
Write SAT	657	<b>667</b>	*
ACT	31.3	31.3	
Math ACT	31.8	<b>32.3</b>	***
Engl ACT	30.9	<b>31.2</b>	*
Sci ACT	<b>30.9</b>	30.6	*
Read ACT	30.4	<b>30.7</b>	
Math AP score	8.2	<b>8.5</b>	

\*p<0.1, \*\*p<0.01, \*\*\*p<<0.001

The incoming academic factors are similar for participants and non-participants, as shown in Table 2. High school GPA, total SAT, ACT, and Math advanced placement scores are not significantly different between the two groups. There are small but statistically significant differences between the groups with regard to performance on the individual sections of the college entrance exams, with non-participants achieving somewhat higher scores overall. The most significant difference is that non-participants achieve higher Math ACT scores. The only individual exam on which participants achieve significantly higher scores is the ACT Science test. This particular assessment is designed to measure the student’s ability to interpret scientific data; therefore, it is not surprising that participants score higher on this scale. However, the statistical significance of this finding is small ( $p=0.06$ ), and needs to be probed more deeply.

The socioeconomic factors are quite different for participants compared to non-participants. Perhaps the largest difference is that the parents of the participants are considerably more likely to have a Masters degree or higher. The reported family income of participants is also likely to be higher, as is the likelihood that the participants are U. S. Citizens. There is also a small but real increase in the percentage of participants that are alumni legacy students. That is, students who participate on teams are more likely to have had a grandparent, parent, or sibling that attended UX. These factors suggest that the participants’ families influence their decisions to participate in these student organizations. It may be that more affluent students are in a better position to participate in cocurricular activities because they do not need to hold jobs. On the other hand, more highly educated families and families familiar with UX may be more aware of the available resources and benefits of participation in these teams.

*Table 3: Summary of socioeconomic factors. Higher values are in bold*

	Participants	Non-participant
Parents Masters Degree or higher	<b>56%</b>	47%
Reported Family Income >\$100k	<b>48%</b>	43%
Alumni Legacy	<b>9%</b>	7%
In-State Residency	57%	57%
U.S. Citizen	<b>88%</b>	85%

The breakdown of class standing (freshman, sophomore, etc.) is skewed towards underclassmen in student organizations (Table 4). Because of the high proportion of students who are admitted with advanced placement credit, there is also a very large number (>60%) of students in their first year who have enough credits to be considered sophomores. Teams have a larger proportion of these students, perhaps because they have more flexibility in their schedules to participate. Students who transfer from other colleges tend to participate in teams at lower rates. These data together suggest that the

first two years of a student's college career are seminal in establishing whether or not they participate in these student organizations. Information about how long students were members of the team is not present in the current data set, making this hypothesis impossible to test.

*Table 4: Summary of class standing. Higher values are in bold*

	Participants	Non-participant
Underclassmen	<b>33%</b>	25%
1st yr Sophomores	<b>65%</b>	61%
Transfer students	13%	<b>20%</b>

Once they arrive on campus, the data show that participants of these eight teams perform better (GPA 3.30) than non-participants (GPA 3.20). The reason for this could be due to the fact that participation in a cocurricular activities leads to deeper academic engagement and success.<sup>4</sup> However, these particular students also tend to take a different sequence of courses than the norm. As a case study, we examined the course load for the first semester taken by current seniors. Table 5 shows the fraction of all courses in the first semester by discipline. Overall, most students take Chemistry, Engineering, Math, and Physics in their first semester. However, participants take Physics somewhat less often. Of those students who take Chemistry, a large fraction of team participants take Organic Chemistry. This may arise due to the fact that team participants tend to major in disciplines that require this course. It is interesting to note that the average grade in Organic Chemistry is 0.1 higher (3.25) compared to Inorganic Chemistry (3.15). Participants also tend to take other courses that are not related to science, engineering or math at somewhat higher rates than non-participants. These non-technical courses tend to award higher grades. Thus, the higher participant GPA may be explained by either a benefit of participation, or course selection.

*Table 5: Fraction of first semester courses taken by current seniors. Higher values are in bold*

	Participants	Non-participant
Chemistry	32%	<b>34%</b>
Inorganic	69%	<b>83%</b>
Organic	<b>31%</b>	17%
Physics	7%	<b>10%</b>
Engineering	<b>29%</b>	28%
Math	19%	19%
Other	<b>13%</b>	9%

\*p<0.1, \*\*p<0.01, \*\*\*p<<0.001

## Summary

This study compared the admissions, demographic, and academic data for students from eight engineering-based student organizations (representing 12% of the total engineering students at UX). It was found that women and URM students participate at nominally similar levels across most organizations, except for those teams that cater to those specific groups. Furthermore, women participate at higher rates in altruistic and honors societies. There is no real difference in incoming academic promise between participants and non-participants, as indicated by admissions data such as college entrance and advanced placement exams, but there appears to be a difference in the socioeconomic status. Participants tend to come from more highly educated and affluent families, and are more likely to have family members who graduated from UX. The student teams examined in this study have more “first year sophomore” participants, and fewer transfer students. Overall, participants have a higher GPA than non-participants despite their similar academic preparation. While it is possible that participation in the student teams confers benefits that translate to better academic performance, these students also tend to select courses that on average award higher grades.

This initial study clearly shows the need for further research to better address the reasons students chose to, or not to participate in engineering-centric student organizations. Future work will also develop an understanding of how these groups can enhance social capital, aid students in developing an engineering identity, and act to better integrate typically underrepresented groups in STEM fields.

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