AC 2009-1226: ENGINEERING INSIGHTS SUMMER PROGRAM

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Engineering *Insights* Summer Program

Abstract

Engineering *insights* (E*i*) Summer Camp is a recruitment program for the College of Engineering (COE). This program is a 4 day, 3 night residential summer camp for high school juniors and seniors that has been operating for 4 years. The primary goals of the camp are: 1) introducing participants to engineering as a career choice, and 2) encouraging them to pursue a baccalaureate degree in engineering at our university. In summer 2008, an evaluation was collected at the end of each of three camps. This paper will discuss the general strategy of the camp, provide an overview of the experiential learning projects, and report evaluation results from admissions data and surveys collected from summer 2008 camps.

In all of the recruitment programs for the college, great effort is made to attract traditionally underrepresented groups, including African Americans, Hispanics, and women. A large part of our recruitment plan involves the use of targeted high-achieving majority-minority schools. These schools were heavily recruited for participants in the camps. A total of 163 high school students participated, with 46 coming from the targeted schools. The participants included 109 (67%) males and 54 (33%) females. The ethnicity breakdown included 16 (10%) African Americans, and 32 (20%) Hispanics. While not reflecting the demographics of the Texas high school population, this breakdown is more diverse than the 2007 COE enrollment numbers.

The camp agenda included tours/demonstrations with each of the engineering departments, and team design projects. For the design projects, the participants were divided into teams of 4 or 5 and assigned to 1 of 3 design projects. The projects included: design and assessment of a solar car, a laser communication system, and industrial fabrication optimization modeling. The camp culminated in a design competition on the last day, judged by faculty and research engineers.

Evaluation results presented in this paper indicate that the camp clearly had a positive impact on the participants' impression of engineering in general, with 99% of participants indicating that the camp had improved their knowledge of engineering careers and the differences in the engineering disciplines. In addition, 86% of the participants indicated that they were more likely to study engineering after coming to the camp. The design projects were shown to be excellent tools to engage the students and pique their interest in engineering. This fact is indicated by the high marks (mean of 4.2 on a 5 point Likert-type scale) received by all the projects. The departmental tours were also evaluated as useful (mean of 4.1 on a 5 point Likert-type scale, although comments revealed some room for improvement.

The Engineering *insights* summer camp is an effective tool to interest prospective students in the University, with an average of 66% of the participants applying. More than half of the participants (an average of 67%) that applied were admitted to the COE, and an average of 67% of the participants that were admitted to the COE, actually enrolled in the COE.

Background

The U.S. economy and strength are in large part based on engineering, science, mathematics and technology. The number of students entering careers in engineering, however, has been declining at the same time that demand for engineers is increasing[1]. Companies are addressing the deficit of engineers for the workforce by outsourcing to other countries or employing immigrant engineers. Women, African Americans, and Hispanics are underrepresented in engineering fields at all levels, creating an untapped pool of potential engineers to fill much of the growing need for engineers. Texas must tap this diverse and growing population and channel more students into engineering degrees if the state is to remain economically competitive[2]. The College of Engineering (COE) at Texas A&M University is working on this problem through a focused recruitment plan that involves summer camps.

Another recent publication by the National Academy of Engineering documents a study performed to find more effective ways of improving the public understanding of engineering[3]. This study points out the need to change the way we are presenting engineering to the public, including prospective students. In particular, it was clear that a successful recruiting effort would focus on the impact of a career in engineering, instead of the skills needed (i.e. math and science). The summer 2008 camp incorporated this finding by ensuring that the projects chosen were those that had an obvious impact. And the projects were designed to demonstrate that math and science were necessary skills to complete interesting, fun, and impactful projects, but not the final goal. This paper gives an overview of the camps, focusing on the summer 2008 camp, where a survey was conducted. This overview is followed with an evaluation of the camp's effectiveness as a recruitment tool, and notes its effectiveness with underrepresented groups.

Goals

Three separate camps were held in the last three weeks in July 2008. The primary goals of the camp were: 1) introducing participants to engineering as a career choice, and 2) encouraging them to pursue engineering education at our university.

Participant Breakdown

There were 163 high school students that participated in summer 2008. There were 65 aspiring high school seniors, 98 aspiring juniors. The participants came from schools across the state of Texas, with the majority coming from Houston, Dallas/Ft. Worth and San Antonio. In addition, 2 students attended from California, 1 from Florida, 2 from Louisiana, and 1 from Rhode Island.

In all of the recruitment programs for the COE, great effort is made to attract traditionally underrepresented groups, including African Americans, Hispanics, and women. A large part of our recruitment plan involves the use of targeted high-achieving majority-minority schools. The COE recruited heavily at these schools for participants. The results were that 109 participants (67%) were male and 54 were female (33%). The ethnicity breakdown is given in the table below.

Ethnicity	Number of Participants	% of Participants
African American	16	9.8
Asian	7	4.3
Caucasian	103	63.2
Hispanic	32	19.6
Native American	1	0.6
Unidentified	4	2.5

While not reflecting the demographics of the Texas high school population, this breakdown is more diverse than the 2007 COE enrollment numbers for females (18.3%), African Americans (2.4%), Hispanics (10.5%), and Native Americans (0.4%).

Funding

Funding for this camp came from a combination of COE and industry sponsor support. The COE primarily covered salaries of the many staff, faculty, and undergraduate students involved. The other costs were covered by either industry gifts, or the money paid by the participants for the camp. The cost to the participant of the camp was $325. However, participants who were eligible for the free lunch program were considered eligible for a $200 scholarship. Thirty students used this scholarship.

Camp Activities

The day-to-day operation of the camp was administered by the recruitment team including 1 Dean, 4 staff members, and 12 counselors who are undergraduate students in the COE.

Departmental Tours/Demonstrations

In general the participants spent the mornings of the camp with the 12 departments in the COE. This time was intended to introduce the participants to the various engineering disciplines including future career opportunities, and the types of classes they would be taking in that major. The tours varied in content and style from department to department. For the most part, they included presentations, laboratory tours, and/or hands-on demonstrations.

Design Projects

The afternoons and evening were used to prepare a design project. The participants at each camp were divided, roughly equally into 3 groups of approximately 20 participants, and assigned to a particular design project. This division allowed for more one on one time between the faculty and participants. The project groups were then divided into teams of 4 or 5 (depending on the project). Each design project was led by at least one faculty member in the COE, and often had at least one graduate student assistant. In addition, the counselors and staff provided support.

This activity culminated in a design competition which was judged by engineering faculty, technical staff and research engineers. The design competition consisted of each team from each project constructing a poster display that was presented at the end of the camp. The timing of the competition was also done such that the student's families could observe the presentations. A winner was selected from each project group, and an awards ceremony ended the camp.

Description of Projects

During the initial planning stages for the summer 2008 camp a consensus was reached that the projects and the hands on portion should not belabor that you need to know science and math, but rather focus on the overall approach in tackling engineering problems. All three projects focused on some identifiable need for the project, a set of required tasks to assess the project, logging observations, and a list of deliverables for the design poster. In addition, team building skills, communication skills, and use of computer skills were incorporated.

The three project groups into which each camp was divided were; a solar car, a laser communication device, and an industrial optimization. The scopes of the projects were based on an area of emphasis of the faculty member that developed and led the project.

A challenge for each project was to establish a suitable amount of work to be conducted during each session. The afternoon sessions lasted about 3 hours and there was around 3 hours in the evening. Although there were a total of four sessions in which to complete the work, there was only 3 ½ sessions as the last session was dedicated to the participants put together there poster presentation. This required development of power point slides, printing out the slides, and then mounting them on a poster board.

Solar Car Project:

The objective of the solar car project was to have the students assess the utilization of a solar panel array to power a vehicle. The activities given to the participants were; a) to research solar cells on usage and limitations, b) examine performance capabilities of the cells under various light intensities, and c) build a buggy and measure its performance by timing over a set distance while carrying different loads.

The first task given to the teams was an exercise to observe how a solar power meter responds to the power from an incandescent bulb at different distances. The participants then entered the data into an Excel spreadsheet and performed a curve fitting exercise to observe how the power is a function of distance. The next exercise had the participants look at how energy transformation can be measured. This was accomplished by having the teams attach a solar cell array and a motor with a wiring harness so that voltage across the motor and current through it can be monitored. The participants were required to measure the radiant power on the cells, the voltage and current out of the cell, and then the speed of the motor. The tests were conducted outside and the intensity was varied by using layers of tinted transparency sheets. The final set of exercises had the students build a buggy that was powered by the solar cell and capable of carrying a set of weights. The participants built the buggies utilizing Lego kits.

The list of tasks presented was not necessarily carried out sequentially, and in fact there was a bit of overlap between the tasks. That is, some participants were building the buggy while some were collecting the data. This really made the teams interdependent on each other in completing the tasks and not having to redo any portion. Once the teams got their buggy built, they spent time measuring the radiant power and then measuring the ability of it to travel a set distance and to climb an incline. The participants had many challenges in developing their buggies as the encountered issues with attaching the solar cells, making sure the buggy would not collapse when a 500 gram load is applied, would not collapse when going over a bump, and that it would move if there was a cloud passing over head.

Laser Communication Device Project:

The laser communication device required the participants to use a simple laser pointer and photodiode to create a photophone, similar to Alexander Graham Bell's original invention but with updated components capable of transmitting an audio signal. The participants were given a prototype board, wires, circuit components, microphone and speaker, batteries, laser, and a receiving photodiode. The participants began with the transmitter and then worked on the receiver. A set of tasks were defined to complete the circuits and a set of tasks to measure the performance. The participants were then given an opportunity to test their system by sending the laser down hall ways and the use of mirrors to send the signal around corners. The participants were able to successfully use their Ipods as an audio source to transmit their favorite tunes. The project involved electrical circuits, optics and audio aspects.

Industrial Optimization Project:

In this project, participants worked in a team to perform the modeling and analysis of a manufacturing systems. A modeling tool based on system dynamics called MPX was used to model the production of printed circuit boards. Participants were first introduced to the concepts of system modeling and production planning. A short tutorial of the MPX system was also provided to participants. The main task of the project was the find ways to reduce the production cycle time with the minimum investment. A spread sheet cost model was used to determine the cost of proposed alternatives. Teams were exposed to the full design cycle by analyzing multiple alternatives based on cost and benefits. The problem was open-ended and teams competed to figure out the best alternative. Teams are required to maintain a log of design alternatives and all what-if scenarios based on the minimization of cost and production cycle. In the log, the teams also explained the rationale used in the selection of design alternatives.

Scheduled Fun Time

The camp also included scheduled activities for the participants to relax and have fun on campus. These activities were primarily done with current students and included such items as a trip to the campus recreational center, tour of campus, games and activities in the dorm, and sporting activities outside.

Evaluation Results

A survey tool was collected at the end of each camp and 154 of the 163 participants completed the evaluation. These evaluation results are based on the participant's application information and the survey.

Overall Camp Evaluation

The evaluation for overall camp operation is given below. The rating scale for this portion of the evaluation was 1- poor, 2- fair, 3- good, 4- very good, and 5- excellent.

	Mean	**Standard Deviation**
The **E*i*** Check-In Process	4.4	0.80
The Residence Hall	3.6	0.91
Meals (overall)	3.7	0.83
Activities (overall)	3.9	0.97
Engineering Insights Counselors (overall)	4.6	0.65

These ratings indicate that the participants were happy with the general operation of the camp, with no averages below 3.0 and very few fair or poor evaluations given. The lowest score (ave 3.4) was given to the meals in dining halls. The second lowest score (ave 3.6) was for the residence hall.

Department Tour/Demonstration Evaluation

The participants evaluation of the departmental tours/demonstrations overall was an average of 4.1 (standard deviation 0.78). These ratings indicate that on average the participants felt the department tours and demonstrations were very good. In addition, the participants were given the opportunity to comment on what they liked about the tours/demonstrations. The comments fell roughly into 3 categories. The most common reason given was that the tour/demonstration was interactive, hands-on, or entertaining (65%). The participants also commented that they enjoyed the tours/demonstrations in the departments which they are the most interested in studying (24%). The remainder (11%) of the participants either did not comment or made a number of other specific comments about the tours/demonstrations.

The participants were also asked to comment on what they did **not** like about the tours/demonstrations. Not surprisingly, these comments mirrored the above comments, with the most common reason being that the tour/demonstration was boring (52%). The participants also commented that they did not enjoy a particular tour/demonstration because they were not interested in that engineering discipline (21%). The remainder of the participants either did not comment (11%) or had other comments about the tours including criticism of specific aspects of the tours (17%).

Design Projects Evaluation

On the evaluation, the students were asked to identify which project they worked on and rate various aspects of their experience in the design project. The ratings are for these projects are shown in the tables below.

	Mean	**Standard Deviation**
Solar Car Project (overall)	4.2	0.67
Faculty Leadership and Guidance	4.5	0.57
Classroom Condition	4.7	0.61
Provided Materials	4.5	0.61
Amount of Work Required	4.1	0.83
Laser Communications Device Project (overall)	3.8	0.90
Faculty Leadership and Guidance	4.2	0.89
Classroom Condition	4.7	0.53
Provided Materials	4.2	0.90
Amount of Work Required	4.2	0.79
Industrial Optimization Project (overall)	3.6	1.03
Faculty Leadership and Guidance	4.6	0.61
Classroom Condition	4.8	0.47
Provided Materials	4.3	0.95
Amount of Work Required	3.8	1.22

The design projects portion of the camp received good ratings by the participants with the lowest overall average being a rating of 3.6. The teams were small enough that there was significant faculty interaction, which was well received by the participants. The faculty leaders also reported enjoying these interactions. The other detailed ratings of the project demonstrated that adequate project materials and facilities were provided. Finally, for the most part, the participants were happy with the amount of work required. The Industrial Optimization Project received the lowest rating for amount of work required (ave 3.8). The comments associated with the survey on this section revealed that the participants felt there was not enough work.

Impact Evaluation

The following true/false questions were asked on the evaluation to get a measure of the impact that this camp experience had with respect to the COE recruitment objectives. The percentage of participants that answered that the question was true is noted after the question.

1) Since attending **E*i*,** I now understand more about what engineers do.- 99% T
2) Since attending **E*i*,** I now understand more about the different fields in engineering.- 99%T
3) Since attending **E*i*,** I am now more likely to study engineering in college.- 87%T
4) Since attending **E*i*,** I am now more likely to attend Texas A&M University.- 79%T

These results indicate that the camp is accomplishing its goals of introducing participants to engineering as a career choice, and encouraging them to pursue engineering education at Texas A&M University.

Performance Evaluation

This program has been operating since summer 2005. Approximately 180 participants were served each summer. Because this camp was designed to be a recruitment program for the COE, the primary performance measure was the number of students who applied for and enrolled in the COE. A secondary measure was the number of students who applied for the University, even if they enrolled in a different college. In addition, data was gathered regarding ethnicity and gender, to track effectiveness with underrepresented groups. Finally, although this camp is part of a recruitment program, retention of these students in engineering is tracked. The COE has significant retention programs in place, of which the participants can avail themselves once they are enrolled in the COE. The seniors that applied to Texas A&M University, and the subset that applied to the COE, in the fall after they attended camp were tracked. The juniors from each camp were tracked when they become seniors.

The data in the tables below indicates that the summer camp is an effective tool to interest prospective students in the University, with an average of 66% of the participants applying. More than half of the participants (an average of 67%) that applied were admitted to the COE, and an average of 67% of the participants that were admitted to the COE, actually enrolled in the COE. It should also be noted that in the fall of 2008 an additional requirement of a score of 550 or greater on the math portion of the SAT test was instituted for admittance to the COE.

Fall 2005 Applicants to TAMU										
Participants by Ethnicity	Total		Applied to TAMU		Admitted to COE		Admitted to Other		Enrolled in COE	
	M	F	M	F	M	F	M	F	M	F
African American	10	1	8	1	6	1	1	0	4	0
Asian	7	2	3	1	2	1	1	0	2	0
Hispanic	13	11	8	8	8	8	0	0	3	4
Native American	2	0	1	0	0	0	1	0	0	0
White	94	26	73	22	57	17	9	5	47	13
Other	5	1	3	0	0	0	2	0	0	0
Total	131	41	96	32	73	27	14	5	56	17

Fall 2006 Applicants to TAMU										
Participants by Ethnicity	Total		Applied to TAMU		Admitted to COE		Admitted to Other		Enrolled in COE	
	M	F	M	F	M	F	M	F	M	F
African American	16	5	11	1	7	0	2	1	3	1
Asian	6	2	3	1	0	1	2	0	0	1
Hispanic	14	8	9	5	4	2	1	0	2	1
White	82	34	65	28	44	23	10	3	33	16
Other	2	0	1	0	0	0	0	0	0	0
Total	120	49	89	35	55	26	15	4	38	19

Fall 2007 Applicants to TAMU										
Participants by Ethnicity	Total		Applied to TAMU		Admitted to COE		Admitted to Other		Enrolled in COE	
	M	F	M	F	M	F	M	F	M	F
African American	18	6	11	3	9	3	2	0	3	2
Asian	3	1	3	0	2	0	1	0	2	0
Hispanic	17	7	11	5	7	4	4	1	2	2
Native American	2	0	1	0	1	0	0	0	0	0
White	87	33	48	17	41	14	5	2	24	11
Other	0	2	0	2	0	1	0	1	0	1
Total	127	49	74	27	60	22	12	4	31	16

Fall 2008 Applicants to TAMU								
Participants by Ethnicity	Total		Applied to TAMU		Admitted to COE		Admitted to Other	
	M	F	M	F	M	F	M	F
African American	4	2	3	2	1	1	0	0
Asian	2	1	2	1	0	1	1	1
Hispanic	11	6	9	2	5	1	1	1
White	47	21	28	11	15	2	1	1
Other	1	0	0	0	0	0	0	0
Total	65	30	42	16	21	5	3	3

In an average sense there is not much difference in admittance due to gender or ethnicity, with an average of 67% for males that applied being admitted to the COE, 68% for females, 63% for African Americans, and 67% for Hispanics. An average of 67% of participants who were admitted to the COE, enrolled in the COE. There is some variability due to gender and ethnicity for enrollment with an average of 66% for males, 70% for females, 52% for African Americans, and 43% for Hispanics. Finally, the first year retention rate of the participants is very good with an average of 79.4% of participants still being in engineering after the first year. The program has not been in place long enough to determine retention to graduation.

Conclusions

The Engineering *insights* camp is successful on all levels. The overall evaluation showed it to be well organized and executed. The departmental tours were evaluated as useful, but it appears that some of them need to be improved to be more interactive with the students. There are two aspects of the departmental tours that will be further examined as a result of this evaluation. First, the COE will consider if it is necessary for the students to visit every department, or if it is plausible for the students to choose which departments to visit. In addition, some interdisciplinary tours and demonstrations will be examined as alternatives.

The design projects were shown to be excellent tools to pique the student's interest in engineering and engage the students with the faculty, the college student counselors and aides, and each other. An intrinsic aspect of having projects that emphasized a variety of engineering applications was to facilitate the participants gaining exposure to more than one area of engineering. This was accomplished in two ways. First, the students were allowed to visit other team's posters during the design competition. Secondly, the camp participants talked amongst themselves about their projects, and conveyed how their understanding of their project and their overall grasp of the engineering process grew.

Finally, the camp is shown to be a highly effective recruitment tool at interesting students in the University and the COE. This outcome is confirmed both in the survey results and in the actual application, admittance, and enrollment data. The camp clearly had a positive effect on the participant's impression of engineering and the Texas A&M University COE.

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