AC 2012-3440: MATERIALS CAMP AT UAB: LAUNCHING TECHNOLOGY TO NEW HEIGHTS

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Materials Camp at UAB: Launching Technology to New Heights

Abstract

In June of 2011, the Materials Science and Engineering Department at the University of Alabama at Birmingham (UAB) organized its first Materials Camp for high school students, based loosely on the model followed by ASM Education Foundation-supported camps. Selected from nearly sixty applicants, twenty-four students from more than twenty area high schools took part, making it a wide-reaching outreach program. Throughout the 3.5 day non-residential program, participants worked with department faculty and graduate students to explore the field of materials science and engineering (MSE), the possibilities available at this university, and the opportunities available for MSE graduates. Students also worked in teams to design and build model rockets from high-tech composite materials, which were launched on the last day. The logistics of implementing such a program are discussed, as well as the successes, challenges, and lessons learned during the first year of Materials Camp at UAB, along with plans for the future of the program.

Advertising and Application Process

The decision to hold a Materials Camp in 2011 was made relatively late, and efforts to promote the camp did not begin until after the spring semester ended. A webpage with information about the camp was added to the department website the second week of May, and several days later an email was sent to science and math teachers at local high schools announcing the camp and including a printable promotional flier with a link to the website. A notice was also run several times in the bi-weekly electronic newsletter distributed to all university employees.

Initially, applications were solicited from high school students who would be entering their sophomore, junior or senior year because we wanted to ensure enough student participation to make the camp worthwhile. It quickly became clear that there would be an abundance of student applicants, so the decision was made to limit the camp to rising 11^{th} and 12^{th} graders. Younger students who had already applied were informed of the decision and encouraged to apply again next year.

To apply, students were required to submit an online application form and to secure one teacher recommendation. Both student and teacher forms were created online using the free Zoomerang survey website. Students were asked for personal information (contact information for themselves and a parent, birth date, name of high school, etc.), their most recent grades in science and math courses, and a statement of 100 words or more explaining why the student wished to participate in Materials Camp. In the future, an additional question will be added asking how applicants found out about the camp program.

By the application deadline of June 1, 38 male and 19 female students from 34 different high schools had applied for Materials Camp. Based on their personal statement, teacher recommendation and grades, thirty students were selected. Students and parents were notified via email, and those selected were asked to confirm their intention to participate using another

Zoomerang questionnaire, which also collected information about t-shirt size and dietary restrictions. Of the thirty selected students, 24 participated in some or all of the Materials Camp program (three declined to participate due to other commitments and three simply did not show up). The participants included 17 males and 12 females, ten of whom were ethnic minorities, representing twenty area high schools and two home schooling groups. There were eleven rising 11^{th} graders and eleven rising 12^{th} graders, as well as one rising 10^{th} grader and one student who had just graduated who were admitted under special circumstances.

Camp Content

With the exception of the final day, which ended after lunch, the camp ran from 8:30 a.m. to 4:30 p.m. The first day began with a basic introductory lecture on materials science and engineering, which included lots of real-world examples and demonstrations. As an icebreaker, students were tagged on the back with the name of a specific material (copper, glass, steel, etc.) and required to figure out their material by mingling and asking each other yes or no questions, and then find the other student with the matching tag. At the end of the activity, students were asked to introduce their partner to the group.

During the week, students participated as a large group in several interactive lectures about high-interest topics including plastic recycling and microgravity materials research (a faculty member's area of expertise). Students toured the department's large-scale processing facilities, and a guest speaker from local industry came in to talk about his experience as a metallurgist and the types of job opportunities available to MSE graduates. As an enthusiastic and successful alumnus of the MSE program at UAB, the guest speaker was an excellent spokesman for both the materials field and for the UAB materials department.

In smaller groups, students rotated through a variety of hands-on experiences, including slip casting, metal casting, Charpy and tensile testing, and processing and testing of polymer nanocomposites. Students came away from each activity with something that they had made (or broken) and could take home with them. Throughout the week, the fundamental connection between structure, properties, processing and performance was emphasized. Due to time constraints, not all students were able to experience each small-group station. The students disliked that aspect, and in the future, care will be taken to ensure that all students have the opportunity to participate in all activities.

A highlight of the program was an afternoon trip to a local steel mill, which included lunch, a talk about the company and some of the materials problems that they tackle, and a tour of their recycling and production facilities. The students were very engaged in the tour and had many questions afterwards, particularly about the environmental impact of the facility.

Design Project: Model Rockets

The camp experience also included a multi-day engineering design project. On the first day, students were given a crash course in composites and model rockets. They were then asked to design, fabricate and assemble their own rockets, using carbon or glass fiber composites to replace the cardboard and balsa wood parts provided in a standard model rocket kit. On the final

day, students' family and friends were invited to watch the launch. Local media was also invited, providing excellent exposure for the program and the department with footage of the event shown on three local news stations and a photo spread in the local paper. The rockets were judged on design, performance, and simulated cost, and prizes, along with certificates of completion, were awarded at a final celebratory lunch for student participants, their families, and camp volunteers.

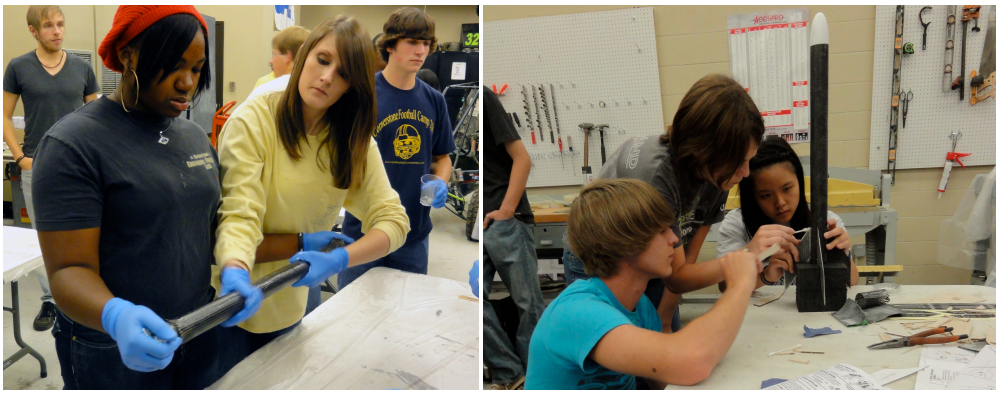

Figure 1. Students fabricating (left) and assembling (right) model rockets.

To begin the project, students were presented with a basic introduction to composites, including terms like matrix and reinforcing phase, and an explanation of how composites have revolutionized many fields, including sports, transportation, and aerospace, with many specific examples. Students were also given an introduction to basic model rocketry, including the parts of a rocket, flight stages, and motors. In predetermined teams of three or four, students designed their rockets by choosing between glass fiber, carbon fiber, and a glass/carbon hybrid for the body and fins, and selecting the length of the body tube and the number and shape of the fins, within certain constraints. The carbon fiber composite was the lighter and stronger, but more expensive, option. Students were informed that the rockets would be evaluated on simulated cost, weight, height, trajectory, parachute action, reusability and appearance.

On the second morning, students created their rocket tubes by stretching fiber sleeves over hollow mandrels and impregnating the fiber with epoxy as shown in Figure 1. The wet composites were placed in vacuum bags and allowed to dry overnight. Creating the composite components of the rockets was greatly assisted by the composites research group in the department. They provided the carbon and glass fibers, and the graduate students from the group assisted both in preparation of the materials beforehand and with the students during the camp.

Figure 2. Students displaying their rocket before launch.

On the third morning, student cut their composite tubes to the length that they had chosen and assembled the rockets using components and directions from the Estes® Big Bertha rocket kit. Students were encouraged to name and decorate their rockets. The rockets were launched with B6-2 motors and the help of the Birmingham

Rocket Boys club on the campus football practice field. Each rocket had the opportunity to launch three times and the maximum height obtained was estimated. The highest rocket reached an apogee of approximately 345 feet. Despite the need for some on-the-field repair work, all rockets launched successfully at least twice.

Camp Logistics and Budget

On the first day of camp, registration opened half an hour before the program began. At the registration table, students were given name tags and the liability release forms which had been emailed to students and parents ahead of time were collected. Next year, a media release form will be collected as well, so that more students can be used in photo and video footage. The lunches (pizza, wrap sandwiches, and barbeque on the final day) were ordered in and received a positive review from students. Snack breaks for were helpful for getting students through longer morning and afternoon sessions, and included juice, soda, pretzels and/or cookies, as well as one afternoon outdoor break with popsicles. After the camp ended, thank you notes which had been signed by the students and included a group photo of all the students in their camp t-shirts were mailed to sponsors and industry volunteers.

In 2011, the MSE department covered all direct expenditures for Materials Camp, which came to about $2400, as outlined in Table 1. The costs were kept down because of the time and resources donated to the program from within the department, particularly the composites research group. Transportation costs were avoided by borrowing 15-passenger vans from other UAB departments. Some of the supplies, such as the slip casting molds, will be reused for undergraduate labs, as well as future camps.

Table 1. Budget for 2011 Materials Camp

Item	**Cost**
Rocket Kits and Engines	$420
Epoxy and Hardener	$400
Composite Fibers	In-kind donation
Slip Casting Molds	$220*
Transportation to Field Site	$0
T-Shirts	$380
Lunches (2x) and Snacks	$250
Thursday BBQ	$600
Misc. Supplies	$100
TOTAL	$2370

Changes and Challenges for the Future

Materials Camp at UAB is scheduled to take place again during the last week of June, 2012. With more time to prepare, this year's timeline is somewhat different, as outlined in Table 2.

Table 2. Timeline for upcoming Materials Camp at UAB

Date	Action
September	Submit proposal and budget to ASM Education Foundation for financial support
March 1	Online applications available to students
mid-March	Advertise program in various media and directly to local high school teachers
April 15	Application deadline
May 1	Applicants informed of their selection status
May 15	Deadline for selected students to confirm their participation
April-May	Solicit donations from local industry and recruit industrial mentors for program
May	Follow-up surveys sent to past participants
Last week of June	Materials Camp program
July	Thank you letters sent to sponsors and volunteers; evaluation of camp and student feedback
August	Incoming freshman class checked against past participant lists for assessment of recruiting effectiveness

This year's program will be 4.5 instead of 3.5 days to allow more time for the design projects. The rocket project was adapted from a similar project that has been facilitated by department faculty several times for students in freshman and sophomore engineering design classes. For the Materials Camp program, the calculation components of the design process were scaled back significantly to accommodate the limited time frame. Although the students were given all the information needed to calculate the expected height of the rocket given different design choices, very little quantitative work was actually done. This is a valuable opportunity for high school students to apply math skills to a real-life situation, while developing a quantitative solution to an engineering design problem that includes both technical and economic components. UAB student mentors as well as mentors from local industry have been recruited to help guide student groups through the process and the calculations at the next Materials Camp. Students will also be asked to bring their own calculators.

A new addition to the schedule will be a panel discussion with current undergraduate students, talking about why they chose materials engineering and what their experiences have been at UAB, offering also a chance for the high school students to ask questions about college and studying engineering. Future efforts will also involve providing more opportunities for current MSE students to take on organizational and leadership roles for the program. Working with the department's student society chapters, it is hoped that an increasing number of logistics associated with Materials Camp can be passed to interested students, as well as having the students interact more with camp participants.

Although a large number of positive comments were received from students and parents at the conclusion of the program, no formal survey was taken. At the end of the 2012 program, students will be given an exit survey to provide the organizers with more concrete data about what worked well and what students would like to see changed or added. Students will also be asked for their impressions of materials engineering and whether it is something they will consider as a future career. Student contact information will be kept and follow-up surveys will be sent to past participants to find out what role, if any, the program had in helping the students choose a college and field of study. The incoming classes of UAB students will be checked against the list of Materials Camp alumni to determine how many of the camp participants have chosen to enroll at UAB, how many enter STEM disciplines, and how many select MSE in particular.

As department budgets continue to tighten, continued funding of Materials Camp while keeping it free for participants will be a challenge. An important source of support for the 2012 camp will be the American Society of Materials Education Foundation, which generally funds one third of the cost of Materials Camps across the country. Support from industrial partners will be sought as well for sponsorship of the rockets, the t-shirts, or a meal.

Conclusions

The first Materials Camp at UAB came together successfully because of intense collaboration between the primary organizer, other department faculty members, many graduate students, several enthusiastic undergraduate helpers, and supportive industrial partners. Another specific thing which helped to facilitate such a large undertaking was choosing a design project that was familiar to faculty and utilized materials and knowledge already available within the department.

The experience in 2011 proved that there was significant interest among area high school students in this type of program. Materials Camp introduced a large number of diverse students, their families, and their teachers to the field of Materials Engineering and the opportunities available at UAB, and also provided valuable exposure for the department within the local community. The program will continue to be developed, with a focus on strengthening the hard science and math content and increasing teaching and leadership opportunities for current UAB students. Materials Camp participants will be tracked to determine if the program is valuable as a recruiting as well as an outreach tool.