

## **The Role of Engineering Summer Camps in Preparing for the Changing Engineering Profession**

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### **Abstract**

Current projections indicate that the US needs 100,000 new engineers each year, but only about 65,000 will graduate each year from the nation's colleges of engineering. It is well recognized that the engineering profession of the future must take advantage of the background knowledge and experience of the diverse population that composes our nation. To help prepare future engineers in the numbers and backgrounds that will be required to fill this deficit of engineers, the University of Texas at Arlington has undertaken, in the last 4 summers, two ambitious programs for middle-school and high-school students. These programs entitled Gateway to Engineering and Bridge to Engineering, respectively, give the participating students the opportunity to learn about various engineering careers. Students with strong interests in math and science are sought, and underrepresented students (females and minorities) are consciously recruited. Students reside on the university campus and interact continually with counselors, mentors, professors, and other students. A significant feature of this program is the use of public school teachers (ideally math and science teachers) as counselors. These teachers shadow the students during the week of camp and carry back to their regular classrooms a new sense of what engineering is about and what students need to pursue engineering as a career. Support for these programs is provided from a modest tuition, grants from local industry and funding from the state workforce commission. This paper will describe the objectives, the implementation, and future plans for the Engineering Summer Camps, with the intent of generating discussion with

others in the Gulf-Southwest Region who are involved with programs for students of this age and interest.

## **Introduction**

Current demand for new engineers exceeds 100,000, but only 65,000 will graduate this year from the nation's colleges of engineering [1]. In fact, futurists project a widening gap between supply and demand as we enter the next century. Clearly, if the current trend is to be reversed, more young people need to prepare themselves for engineering careers. While there is no instant solution, an orchestrated effort by industry and academia is needed to encourage more young people to consider engineering. For this effort to succeed, it must focus on middle, junior high, and high school students, so that they enroll in the prerequisite mathematics and science courses in high school. It is the only path to a career in engineering.

## **Program Overview**

The summer of 2002 will mark the fifth year of these one-week residence programs: Gateway to Engineering and Bridge to Engineering. The Bridge to Engineering program is for students entering the 9<sup>th</sup> or 10<sup>th</sup> grades. For the summer of 2002, the Bridge to Engineering program will be offered in the first week of June. Gateway to Engineering is for students entering the 7<sup>th</sup> and 8<sup>th</sup> grades. For the 2002 summer, this program will be offered the 2<sup>nd</sup> through the 4<sup>th</sup> weeks of June. The Gateway program is offered for three sessions due to the higher demand for this program. These camps offer exceptional opportunities for pre-college students to learn about the engineering profession and to experience the college environment at UTA. The camps are designed to provide students with a broad exposure to a variety of engineering disciplines, including aerospace, biomedical, civil, computer science, electrical, environmental, materials science, and mechanical.

Students arrive on Sunday evening and leave the following Saturday morning, staying during the week in UTA campus dormitories. They attend classroom lectures, see laboratory demonstrations, participate in team design project competitions, watch "engineering" movies, and enjoy recreational activities. Teams of engineering professors and graduate and undergraduate students teach the programs. Field trips to local points of engineering interest, including American Airlines, Sabre, Six Flags Over Texas, UT Southwestern Medical Center in Dallas, Verizon, and Tarrant County College, supplement these events. The week culminates in a Friday evening design competition and awards ceremony to which parents are invited. Session enrollments are limited to 50 students and 4 ISD teachers. Demand for these camps exceeds UTA's ability to accommodate all applicants.

Selected middle, junior high, and high school teachers from Dallas-Fort Worth Metroplex Independent School Districts are invited to participate fully in the program with the students and are paid stipends. These teachers take back the knowledge they have gained in these programs to their respective schools. Their experience in working with 7<sup>th</sup> – 10<sup>th</sup> graders is an invaluable assistance to the UTA faculty and students who are responsible for conducting the camps.

## **Student Application Procedure**

Students wishing to attend either program are required to submit an application package by the announced deadline consisting of the following:

- application form
- evaluation form from their science or mathematics teacher
- transcript or copy of cumulative folder

The application form requests essay answers to several questions and information pertaining to a student's awards, honors, and extracurricular activities. These answers are often revealing of the desires and ambitions of the students and are significant in the selection process.

The following criteria are considered for acceptance into a program:

- age appropriate for the program
- mathematics grades
- science grades
- conduct grades
- science or mathematics teacher evaluation
- awards, honors, extracurricular activities

Students are required to pay a fee once they are notified of acceptance into a program. The fee for 2002 is \$250 and will cover all student expenses. If the fee places a hardship on the student, a scholarship is provided to the student to partially cover this fee.

## **A Typical Week at Gateway to Engineering and Bridge to Engineering**

The Gateway to Engineering and Bridge to Engineering programs are organized identically. However, the Bridge program is designed to accommodate the more advanced science and mathematics abilities of the older Bridge students, which is most evident in the team design projects. The week's schedule for a typical Gateway Program and the Bridge Program and a typical daily schedule can be found on the camp web site:

[www-eng.uta.edu/summercamps/](http://www-eng.uta.edu/summercamps/).

The schedules reflect the camp organizations which feature:

- lectures from UTA faculty
- laboratory demonstrations
- field trips
- team design projects
- project presentations and competitions engineering movies
- educational TV demonstrations
- computer laboratory usage
- awards reception (including parents)
- group meals
- recreational activities
- enrichment times

- free time in dorms

The field trips vary for each camp session. Three field trips are scheduled for each camp session. The following sites are some of the companies visited by the students:

- GTE
- Tarrant County College (computer lab)
- Six Flags Over Texas (behind-the-scenes view of how things work)
- National Semiconductor
- American Airlines C.R. Smith Aviation Museum
- Verizon
- Sabre
- UT Southwestern Medical Center - Dallas
- Texas Motor Speedway
- Ballpark in Arlington

The week starts with students, parents, ISD teachers, and the UTA program staff meeting early Sunday evening to get acquainted, go over the plans for the week, and check into the dorms. The parents are given the internet web site addresses where photographs of the daily activities are posted each day during the camp and can be viewed. All participants are given notebooks containing daily schedules and ample pages for note taking during the week. Additionally, everyone is given a "MAV camp card", which can be used to charge incidental items (up to a \$3/day limit) during the week.

A typical day begins with 7:00 a.m. breakfast, followed by the start of planned activities. Lectures, laboratory demonstrations, or field trips are mixed throughout the week to provide variety for the students. The students are kept on a busy schedule until 8:30 p.m. each night, with the early evening hours usually devoted to team design projects. In the late evening they are given recreational time or see engineering movies. The day ends at 10:30 p.m. The week ends with design competitions being completed and the awards ceremony on Friday night. Parents are invited to attend the awards ceremony. This ceremony is the highlight of the week, with all students, parents, ISD teachers, and UTA camp staff sharing in the advances made by the students during the week.

## **Summary of Participation**

### **Student Participation**

The following information describes the background of students registered in the program since its inception 4 years ago:

- number of applicants – 848
- number attended - 534
- Gateway participants - 411
- Bridge participants - 123
- % underrepresented\* groups - 40 %

- % female - 33 %
- % minority - 23 %
- 7<sup>th</sup> grader attendees - 269
- 8<sup>th</sup> grader attendees - 142
- 9<sup>th</sup> grader attendees - 81
- 10<sup>th</sup> grader attendees - 42
- number of schools represented - 131
- number of independent school districts represented - 31
- number of private schools represented - 17

\* Underrepresented groups in engineering include blacks, Hispanics, American Indians, and females.

Students participating in these summer programs attend schools in the following Independent School Districts in the metroplex and nation:

Aledo	Hurst-Euless-Bedford
Arlington	Irving
Austin	Keller
Birdville	Kennedale
Boswell	Lewisville
Carroll	Mansfield
Carrollton/Farmers Branch	Mesquite
Clifton Park, NY	Midlothian
Coppell	Palacios
Crowley	Plano
Dallas	Richardson
Duncanville	Round Rock
Everman	Saginaw
Fort Worth	Weatherford
Garland	
Grand Prairie	
Grapevine-Colleyville	

Additionally, a number of students participating in these summer programs attend the following private schools:

Cistercian Preparatory School	Oakridge Christian School
Covenant Christian Academy	Ovilla Christian School
Fort Worth Academy	Pantego Christian Academy
Forth Worth Country Day School	Saint Elizabeth Diocese of Dallas
Gateway Institute for the Gifted	Saint Maria Goretti
Hill School of Fort Worth	Saint Monica
Meadowbrook Christian Academy	St. Marks School of Texas
Metro Christian academy	St. Rita Catholic School
Nolan Catholic High School	

## **Teacher Participation from Independent School Districts**

A unique part of these summer programs is the inclusion of teachers from Dallas-Fort Worth Metroplex middle, junior high, and senior high schools. The teachers are predominantly mathematics and science teachers. The primary purpose of their participation is to allow them to learn and understand what engineering involves, so that they can better convey to the students that they teach the career possibilities of engineering and the importance of studying mathematics and science as they go through their secondary education. In addition, these ISD teachers participate fully in every aspect of the week's activities, staying in the dorms with the students, sharing meals, participating in leisure activities, attending lectures, going on field trips, viewing laboratory demonstrations, and assisting with the team design projects. Their experience in working with this age group is of invaluable assistance to the UTA faculty and students who are responsible for running the camps.

In both the 1998 and 1999 programs, all ISD teachers who were selected to participate in the summer programs were from Tarrant County Independent School Districts, since funding for their stipends, meals, and dorms was provided from a restricted grant from Work Advantage. Since then teachers from other parts of the Metroplex have been included, as funding has expanded. The following characteristics pertain to the teachers which have participated over the years:

- number of ISD teachers - 69
- school districts represented - 7
- junior high schools represented - 7
- senior high schools represented - 9

The College of Engineering seeks to keep an on-going relationship with the teachers who participate in the summer programs. Some of the teachers are asked to participate in future summer programs. Beyond this continuation, UTA looks to these teachers as key contacts in their schools who can collaborate on future mutually beneficial special events and programs for their students. Similarly, the teachers are encouraged to develop long-term individual professional relationships with faculty and administrators at UTA.

## **UTA Faculty, Student and Staff Participation**

A large number of UTA faculty, students and staff are involved in the camps. The Program Director for the camps is Dr. Kendall Harris, Assistant Professor of Mechanical and Aerospace Engineering. The management of the programs is the responsibility of the Dean's office for the College of Engineering. Dr. Harris is constantly with the students from breakfast until late evening, starting on Sunday night and ending on Saturday morning. He is assisted by UTA undergraduate and graduate students. For a typical camp, a graduate student serves as the principal assistant to Dr. Harris. That student has four other student mentors (either undergraduate or graduate) who provide support. The UTA student assistants are with the campers and the ISD teachers 24 hours a day, staying in the same dorms, sharing meals, attending all activities, and helping with design projects. Staff support comes primarily from the College of Engineering Dean's office. Many of the faculty in UTA's College of Engineering

participate in the camps. A total of 13 UTA faculty give lectures and provide laboratory demonstrations during the sessions of Gateway and Bridge. They represent chemistry, physics, mathematics, and various branches of engineering.

## **Financial Support**

Unlike many summer programs at other universities for this age group of students, UTA desires to include students beyond just the typical "gifted and talented" group. Indeed, UTA's programs seek to include all of those students who demonstrate interest, motivation, and ability in mathematics, science, and engineering. Recognizing that enrollment fees can be a deterrent to a student's participation in these camps, the College of Engineering solicits help from a number of sources to provide sufficient funding so that student costs for these programs can be kept low.

The genesis of this support was from a grant by the GTE Corporation, which provided the seed money to start the Gateway to Engineering program in 1998 and the Bridge to Engineering program in 1999. Another strong partner in the development of these programs has been the Arlington Independent School District. AISD has successfully obtained funding for the ISD teacher participation from Work Advantage (formerly known as Tarrant County Workforce Development Board) in connection with its Electronics Partnership Grant. Additionally, AISD provided transportation for all the field trips and conducted a detailed parental feedback evaluation after the camps. The remaining funding in the first year of the programs came from The University of Texas at Arlington through the commitment of UTA's Provost, Dr. George Wright.

Students are required to submit the camp tuition once they are notified of acceptance into a program. The fee is \$250 for the summer of 2002 programs. However, if the fee places an undue financial hardship on the student, a scholarship is provided to partially or completely cover the fee.

The operating expenses for the summer programs approaches \$115,000 per year, or approximately \$29,000 per each week session. Typical expenses include:

- housing
- meals/snacks/beverages
- lecture/mentor stipends
- lab and project materials
- ID badges
- transportation
- awards
- scholarships
- administrative cost
- insurance

These expenses total approximately \$580 per student. Since the tuition is capped at \$250 per camper, the College has approached various foundations and industries in the metroplex to

offset the cost of the program. Since the inception of the camps in 1998, there have been a number of sponsors of the camps:

- Verizon
- Sabre Group
- Boeing
- TXU Electric and Gas
- Ericsson Inc.
- GTE Foundation
- SBC Global Networks
- Lockheed Martin
- Centex Corporation
- Collmer Semiconductor, Inc.
- Rockwell Collins
- Halff Associates
- Lucent Technologies
- Arlington ISD

### **Expansion of the Programs**

Over the past five years the Engineering Programs at the University of Texas at Arlington have evolved considerably. In 1998 a single week session of Gateway to Engineering was the only program offered. Fifty-four students attended that inaugural camp, but since there were more than 125 applicants, most were turned away. So, in 1999 the summer program was significantly expanded. That year the Gateway to Engineering program, for students entering the 7<sup>th</sup> and 8<sup>th</sup> grades, was expanded from a single one week session to three one week sessions. Additionally, the Bridge to Engineering program was added for the age group of students entering the 9<sup>th</sup> or 10<sup>th</sup> grades. A total of 160 students attended the 1999 camps. In 2000 and 2001 the same trend continued with three sessions of the Gateway to Engineering Program and one session of the Bridge to Engineering program per summer. A total of 174 students attended in the Gateway and Bridge programs in 2000 and 146 attended in 2001 (when one week of Gateway was dropped for dorm availability). It is important to note that these programs fill to beyond capacity with limited publicity.

From experience it has been found that enrollments must be kept below approximately 50 students per camp session. Larger group sizes become unmanageable and create numerous logistical problems. Consequently, it is difficult to accommodate all of the students who would like to attend. As publicity about these programs increases in the future, this will be a significant issue. Further expansion of the programs to accommodate this demand is planned, as more funding support is attained; however, it is expected that the number of applicants will still far exceed the number that can be accepted. Another part of the summer program expansion will involve gaining participation of Dallas County ISD teachers in a similar manner to Tarrant County ISD teacher participation. This will also be dependent on obtaining additional funding.

Once funding for expanded Gateway and Bridge programs is achieved, the College of Engineering plans to develop a third and final summer youth program for the next higher age



group of students, i.e., for students entering the 11<sup>th</sup> or 12<sup>th</sup> grades. This program will be designed to provide college credit for those chosen to participate and will not be a residence program. It is the desire of the college to have these programs on line by the summer of 2003.

### **Assessment**

During each camp session students and ISD teachers completed written evaluations of individual events and daily activities. Additionally, the Arlington Independent School District conducted a survey of parents after the completion of the programs. Lastly, UTA has received follow-up notes and letters from a number of students and parents. Feedback from all groups has been extremely positive and supportive for continuing and expanding these programs.

At the end of the camps, students were asked to provide evaluation and comments. But in addition, while the camps were underway, each individual activity was rated on a 1-5 scale with a summary “liked” or “didn’t like” checked and comments requested. Students typically were extremely frank in their assessments. For example:

Dear Dr. Harris, Thank you so much for sending my T-shirt and certificate for the Gateway to Engineering program. I loved being in the program and was disappointed to have to leave early. I thought I wanted to be a payload specialist for NASA, but love engineering also. My parents told me I could do both! I am really looking forward to college!!. I look forward to next summer at UTA! Best wishes.

ISD teachers also provided the same immediate feedback and longer term evaluation and comments. At the end of the day the teachers also answered a set of questions:

- What did you learn today?
- What activities did you participate in today that could help with career interest planning with your students?
- How could you modify those activities to get the same idea across during the school year with your students?
- Based on your experiences, what ideas do you have that might facilitate transition from middle school to high school?

In general wonderfully thoughtful responses were obtained.

Finally, comments were solicited from parents of the campers. Each summer it has been clear that parents appreciated the efforts being made. Among the obvious “thank you” letters was one that bears citing:

“Even though you didn't ask for additional information on your survey, I'd like to take advantage of this opportunity to "have your ear" so to speak.

The Gateway to Engineering Camp that my daughter attended in June was a wonderful experience. I was very pleased with the way the whole camp was run, from registration Sunday evening to pick-up Saturday morning. They gave ..... a very realistic view of what her life would be like if she chose an engineering career. This may seem incongruous, but the reason I'm

pleased is that my daughter chose NOT to pursue a career in engineering. This program was real, not cotton candy.

I am so impressed that some intelligent, intuitive, experienced person had the guts to make this idea become a reality. I believe 7<sup>th</sup> and 8<sup>th</sup> grade students are at a critical time in their lives that will form what kind of adult they will be. This kind of program brings the future into stark relief, makes it real and relieves some of their fear. I believe more programs like this would give students in these formative grades something real to aim for and take away the fear of trying something new.”

This year will provide the first opportunity to evaluate the success of the programs in terms of the objective to positively influence the numbers of students planning to study math, science and engineering in college. Comments like these from a parent of a camper indicate that the results are not guaranteed. The actual results should be available this summer.