Summer Program at Christian Brothers University for Female High School Students Interested in Civil and Environmental Engineering

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Abstract – A two-week long summer program for female high school students (grades 9-12) held at Christian Brothers University is discussed. The program attracted female high school students who had displayed strong academic performance in engineering, math and science classes. The two-week summer program provided a hands-on introduction to civil and environmental engineering. The program was made possible by a grant from the American Society of Civil Engineers (ASCE) and additional funds provided by the local West Tennessee Branch of the ASCE. The School of Engineering at CBU provided the facilities and additional monetary assistance for the program. Morning sessions were taught by School of Engineering faculty in various disciplines including Transportation, Water Resources, Geotechnical, Mechanics, Structural, Recycling, Solid Waste Management and Environmental Engineering with a one-hour lecture on a topic and a one-hour hands-on activity. The hour before lunch was devoted to a presentation by a civil or environmental engineering practitioner on the topic discussed earlier in the morning. Female alumnae were invited to participate in the presentations. After lunch, the female high school students visited various project sites and companies including trips to a local highway construction project, a water purification station, a steel fabricator, a chemical company, a crane company, an airport and two consulting firms. On the final day of the program, a presentation on college selection, admissions procedures and financial aid was made by CBU's Admissions office.

Keywords: Female High School Students, Female Engineers, Summer Program, Civil and Environmental Engineering.

INTRODUCTION

According to a report issued by the American Association of University Women [AAUW, 1], girls do not receive equitable amounts of teacher attention, are less apt than boys to see themselves reflected in the materials they study, and often are not expected or encouraged to pursue higher level engineering, math and science courses. Consequently, the current education reform movement cannot succeed if it continues to ignore half of its constituents [Cronin and Roger,2].

The Memphis City School System is the largest school system in the State of Tennessee and the 19th largest school system nationally. The Shelby County School System District is the fourth largest

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school system in the State of Tennessee. These two school systems have an approximate total of 150,000 students enrolled; 61% are females of diverse background. In the recent past, these school systems experienced an average dropout rate of 41%. During 2000-2001, approximately 1500 young girls dropped out of school and became young mothers. In addition, the Memphis Urban Systematic Initiative data shows that the average performance of girls in Science, Engineering, and Math (SEM) is below the national standard. Since the Memphis City School System and the Shelby County School System District have not targeted this student pool, it is evident that educational efforts should be made to tap these students. Female students must be encouraged and educated to understand that mathematics and sciences are important and relevant to their lives. Teachers, administrators, and counselors must be prepared and encouraged to bring gender equity and awareness to every aspect of schooling.

For this project, Christian Brothers University, the Memphis City Schools, the Shelby County School System District, Memphis District U.S. Army Corps of Engineers, Girl Scouts in Memphis, and ASCE West Tennessee Branch will collaborate to develop a summer camp program to promote young girls from age 15 to 17 years to be engineers. The goals of this project for Women and Girls are to bring interesting topics in Civil and Environmental Engineering to the selected participants that will eventually motivate female students to become interested in the study of Civil Engineering.

PROJECT DESIGN

Under the assistance from the Girl Scouts in Memphis, twenty girls from the Memphis City Schools, the Shelby County Schools and independent schools will be selected to participate in this summer camp program. The selection criterion includes:

(1) Female students in 10th, 11th, and 12th grades;

(2) U.S. citizen or permanent resident;

(3) Strong academic performance in Engineering, Math, and Science;

(4) Recommendations from schoolteachers or counselors.

The activities of this two-week summer camp include morning hands-on activities in structural, transportation, geotechnical, water resources, and environmental engineering areas, professional engineer/scientist speakers programs, and field trips. The detailed schedule and activities are listed below:

(1) Morning hands-on activities (8:30 a.m. – 10: 30 a.m.)
- Balsa Wood Bridge and competition
- Survey/GPS and project
- Water purification and project
- Runoff simulation
- Soil density and foundation project

(2) Break and Snack (10:30 a.m. – 11:00 a.m.)

(3) Professional engineer speaker program and Friday Party (11:00 a.m. – 12:00 noon)

(4) Afternoon field trips (1:00 p.m. – 3:30 p.m.)
- Allen & Hoshall - I-40/I-240 interchange construction site
- City of Memphis – water treatment plant
- Providential Fabricators, Inc. – structural fabricators
- VP Building – structural engineering firm
- City of Memphis International Airport – runway design
- PSI –geotechnical testing firm
- Barnhart Crane & Rigging – equipment supplier
- The Pickering Firm – consulting engineering firm

PARTICIPANTS

The participants in the 2004 Civil Engineering Summer Program were a diverse group from public and private high schools in the Memphis area. The group consisted of one recent high school graduate, six next year seniors, one rising junior and one next year sophomore. Even though the students had different backgrounds and experiences, they soon meshed as a group and became good friends during the two-week program.

TRANSPORTATION SESSIONS

The first session included a PowerPoint presentation regarding the Transportation Engineering profession. The presentation discussed the various modes of transportation including air, water, train, bus, light rail, vans, automobiles, motorcycles and bicycles. Intermodal operations were discussed citing the movement of goods via container ships in Los Angeles harbor and the intermodal transfer facility at the Los Angeles Port Authority Terminal. The movement of people via airlines was discussed featuring the terminal at the Los Angeles International Airport as well as the movement of people via cruise ships in Los Angeles Harbor. A high-speed prototype Amtrak train was discussed as a future means of moving people via trains. Local intermodal operations were discussed using the Port of Memphis as an example. The transportation of products by barges on the Mississippi River was discussed and a train transfer facility's operations were depicted in the PowerPoint presentation. The local Memphis Area Transit Authority (MATA) Plus Service that consists of specially equipped buses was discussed as a means of moving people who do not own automobiles and cannot travel on conventional buses. The Dallas Area Transit Authority (DART) System and the local MATA Downtown Trolley System were identified and discussed as examples of Light Rail Systems. The PowerPoint presentation included a discussion of the various specialties in transportation engineering. A planning application as to whether to extend an existing light rail line in California was discussed in terms of what a planner would do in order to make the right decision. Examples of work performed by transportation designers were discussed using a proposed marina in Malaysia and a unique proposed interchange in Australia. The final specialty discussed was the work performed in the field by transportation engineers during the construction phase of a project.

The participants were shown another PowerPoint presentation on the theory of differential leveling with the intent of giving the participants enough background to conduct a profile and cross-section survey of an existing ditch on campus. The students performed the survey on the following day. The data gathered by the participants was used in the Water Resources session later in the week.

A Christian Brothers University (CBU) alumnus was invited to speak to the girls about her job with a local consulting firm. She informed the girls of her day-to-day activities as a transportation design engineer.

A campus tour was conducted by the admissions staff and an engineering facility tour conducted by the faculty in the Department of Civil and Environmental Engineering completed the day's activities.

On the second day of the session, the girls completed the survey of the existing drainage ditch on campus and recorded their data in field books. The participants did very well for the first-time surveying experience. In the afternoon the participants took a field trip to a local construction site managed by CBU alumni. The project involves the widening and improvements of a major interchange in downtown Memphis, the I-40/I-240 interchange. The speaker spoke to the participants regarding the existing bridges, ramps, geometrics and drainage conditions of the project. He discussed the environmental considerations involved in the project and proposed construction for his contract. He showed the participants the plans and specifications for the interchange. The group then visited several locations on the site including two bridge abutments under construction and an area where they were drilling shafts for some foundations. This concluded the final session regarding transportation engineering.

WATER RESOURCES SESSIONS

The initial session introduced the background information and contents in water resources engineering. Several concepts including hydrologic cycle, water movement, flood control, water distribution, and water

consumption were introduced. A videotape edited by the U.S. Army Corps of Engineers was shown to the participants. The tape describes the historical information of the Mississippi River and flood control along the Mississippi River.

In order to help the girls understand water resources, a hands-on project was assigned to the participants. The statement of the project was: "the parking lot at CBU has historically flooded, particularly the north side of the parking lot. Girl Group Associates will be hired by CBU to solve the flooding problem." The design criteria includes (1) runoff flow rate- 120 cfs, (2) cross section survey data collected from the field, (3) any open channel or storm sewer to convey runoff.

After the project was assigned, the girls were brought to the Fluid Mechanics and Hydraulics Laboratory. Open channel system and closed conduit system were demonstrated to the participants. The design criteria of the project were specially explained, so that the participants can visually understand the quantity of 120 cfs and the delivery system in physical aspect. After the demonstration, ten participants were divided into two groups. Each group spent twenty minutes to conduct their study. The participants used the hydraulic bench model to learn how open channel or conduit sewer can deliver stormwater.

After the lecture and laboratory, the participants met a female engineer from the U.S. Army Corps of Engineers who has worked in the Hydraulics and Hydrology Branch for thirteen years. As a female water resources engineer, she provided insightful information, projects, and her personal view of water resources. The participants were very interested in her presentation. They were also encouraged to ask questions regarding their project.

In the afternoon, the girls visited a local drinking water treatment plant. The participants had a chance to see civil infrastructure, water treatment process, water resources, and a water distribution system. At the treatment plant, the girls met a female water resources engineer, who had just graduated from college and worked at this treatment facility. She told the female participants how to prepare themselves to become a civil engineer.

On the second day of the water resources session, the participants continued working on their water resources project. They used their data collected from the field and the laboratory to do analysis, calculation (computation), alternative designs, assessment/evaluation analysis, and final design of the stormwater management system and presentation preparation. Each group made a PowerPoint presentation on their results. According to their presentations, they indicated that the girls understood and very enthusiastically applied their theory to their design. However, their solutions may not be practical or reasonable. To verify the results, a computer software program by Haestad Methods was demonstrated to the girls. With assistance, the participants were able to enter their data and run the program. From the output, they compared it with their solutions to determine the efficiency of their design.

STRUCTURE SESSIONS

The first session was spent discussing the behavior of structures in general and trusses in particular. Static and dynamic loads were addressed but more emphasis was placed on static loads. The bulk of the second session was spent on the properties and behavior of different materials, such as steel and concrete. Force-Deflection (or Stress-Strain) curves were developed for a rubber band and a spring. A guest speaker from the Arkansas Ready Mix Association was invited to talk about concrete and its various uses.

The next sessions moved into the lab, where steel, aluminum and brass samples were subjected to tensile loads in the Structural Stress Analyzer. This equipment has a data collection system that plots force versus elongation of the tensile specimens, demonstrating yield strength and strength-to-weight ratios of the specimens. Finally, the students were divided into two groups and asked to prepare a concrete mix for test samples. They prepared the mix, performed slump tests and placed the mix in 6-inch cylinders. Compression tests were performed (using Test Mark's 300,000 lb capacity machine) on samples that had been prepared previously. Results were documented, compared to expected results and discussed further as to the reasons for the differences between actual and expected results.

GEOTECHNICAL SESSIONS

The geotechnical session activities took place on two days: morning sessions were spent on discussions on geotechnical engineering and laboratory hands-on sessions; afternoon sessions were spent on field trips.

During the morning sessions, various courses offered at the university in geotechnical and geo-environmental engineering were discussed. General discussion on types of soil, soil investigation strategies, laboratory and in-situ testing of soils in collecting pertinent data for the soil properties took place. Some basic ideas on foundation design, use of geo-textiles and their use were discussed. Different types of geo-textile samples were displayed in the classroom. A video from the Industrial Fabrics Association International titled, "Geomembrane & GCL's – The Engineered Alternative" was also shown to the students. One CBU female alumnus, an employee of the U.S. Army Corps of Engineers, showed a video about the Corps' organization and discussed various job opportunities with the Corps along with her own experiences with the Corps.

A visit was also made to the geotechnical laboratory: different types of soil samples were displayed and students were encouraged to classify the soils by touch and feel. The students were grouped and were supplied with four 8 ½ x 11" sheets of paper and a bucket of sand. They were required to reinforce a sand pile using the paper strips (application of geo-textiles). The winning team had the maximum load carrying capacity of the paper reinforced sand pile.

Two afternoon sessions were spent on field trips. One trip was to a construction site at the Memphis International Airport and the other trip was to a local engineering consulting firm.

Prior to our field visit to the Memphis International Airport construction site, the students met with the Chief Structural Engineer, a Junior Engineer, and the Construction Engineering Manager of the airport at their conference room and listened to a presentation related to the overall construction activities at the airport. All of the three engineers are alumni of Christian Brothers University. The subgrade preparation related to earthwork, installation of lighting fixtures on the runway, drainage work, and asphalt paving work were all underway at different sections of the runway. The junior engineer and the construction manager accompanied the students to the worksite; they explained to the students what was being accomplished in the field. At the consulting engineer's office, the students were shown the various departments within the office and the ongoing work at their offices. Then the students listened to a presentation related to the overall activities of various departments of the consulting firm.

ENVIRONMENTAL ENGINEERING SESSION

Environmental engineering is the fastest growing division in the CE Department. Due to demands from the national infrastructure and new government policies, more environmental engineers are in demand resulting in more engineering students selecting this area for their majors or their career. In this summer camp, basic divisions, such as water pollution, air pollution, solid/hazardous waste, noise pollution, and industrial hygiene were discussed. The session started with an introduction to environmental engineering via a PowerPoint presentation. Several hands-on activities and examples associated with the lecture were presented to the girls to help them understand the material presented in the PowerPoint presentation.

The participants were taken to the environmental engineering laboratory. The lab is mainly used for undergraduate students in the Civil and Environmental Engineering Department to exercise water, solid waste, and air analysis. In this summer camp, the participants were asked to analyze a solid waste sample obtained from the CBU campus. The waste contained plastic bottles, paper, metal cans, textiles, cardboard, wood, food, dirt, ashes, etc. The dry weight, the wet weight, and the volume of each waste were determined. This exercise assisted the girls in conducting a project during the second day of the session.

A female president of a local environmental engineering consulting firm was invited to talk to the participants. She used very simple engineering language and terms to explain why she started her business and what she is doing for her company. She also invited the participants to visit her company.

On the second day, a hands-on project was assigned to the girls. Based on the solid waste distribution on the CBU campus, the weight and volume calculations were determined and how many solid waste collection tanks should be located on campus. From the current tank distribution, two groups of female engineers were hired to design the collection route for the removal of solid waste at CBU. The girls were given a CBU campus map and unit collection cost. The participants surveyed the campus and found the volume and location of the solid waste trash tank. Finally their results were verified by a computer analysis.

EVALUATION AND ASSESSMENT

The following is the summary of participants' evaluations: Scale: 5 – Strongly Agree; 4 – Agree; 3 – Not Sure; 2 – Disagree; and 1 – Strongly Disagree.

Seven close-ended questions and five open-ended questions were asked. The results are listed below:

1.	I have learned more about civil engineering from this program.	4.9
2.	I may choose civil engineering as my future career.	3.1
3.	The program was appropriate for my level of education.	4.4
4.	The format of the program was appropriate.	4.6
5.	The facility (classroom, labs, cafeteria, etc.) was appropriate.	4.7
6.	The lectures were well presented.	4.4
7.	The field trips were interesting.	4.3

In your opinion, what is the best part of the program?

1. Field trips
2. Performing experiments/ hands-on activities
3. Meeting girls from different schools
4. Talking with professional female engineers
5. Learning different types of civil engineering

In your opinion, what is the worst part of the program?

1. Cafeteria food
2. Hot weather
3. Starting at 9:00 a.m.
4. Some lectures were boring
5. Speakers that were off-topic

Any suggestions/recommendations for future programs?

1. Have something to do or end the program earlier. Prevent speakers from going off on random tangents that do not relate to engineering.

CONCLUSIONS

The evaluations definitely indicated that the participants learned valuable information regarding careers in civil and environmental engineering. Overall the participants were satisfied with the program as the evaluations indicated that the girls believed the program was structured well and contained the necessary elements for a successful summer program. At the conclusion of the program, the girls indicated that they

were still not sure if they would pursue a career in civil and environmental engineering. One of the participants is now enrolled at CBU and is a civil and environmental engineering major.

The civil and environmental engineering faculty are very encouraged by the outcomes of this summer camp program. The participants were very cooperative and showed enthusiasm toward civil and environmental engineering. However, they are still too young to determine their future major in college. The Department of Civil and Environmental Engineering at CBU is planning to continue the program next summer and beyond to meet the important goal of increasing female enrollment in civil and environmental engineering programs.

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