

Gearing up for Transportation Engineering, A Summer Institute: Phase III

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16. Abstract The numbers of female and minority students enrolled in engineering schools are increasing slowly; however, there is still a relatively small percentage drawn to the field of transportation civil engineering. As a consequence, there is a need to educate young people about the profession to encourage under-represented individuals to appreciate the contributions of engineers and encourage them to become transportation engineers. This Summer Institute project consisted of inviting twenty middle school students to the University of Alabama in Huntsville campus to learn about engineering as a career and experience a variety of transportation engineering design topics. The participants gained knowledge about the role of engineers in society as well as learn how engineers use their knowledge in design applications. Several University of Alabama faculty members as well as professions representing the Society of Women Engineers, NASA Marshall Space Flight Center, and the National Society of Black Engineers acted as team mentors. As an important part of this project, local minority and female engineers served as mentors for the program. This is the third year of this successful summer program.					
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Executive Summary

The numbers of female and minority students enrolled in engineering schools are increasing slowly; however, there is still a relatively small percentage drawn to the field of transportation engineering. As a consequence, there is a need to educate young people about the profession to encourage under-represented individuals to appreciate the contributions of engineers and encourage them to become transportation engineers. This summer institute project consisted of inviting two groups of twenty middle school students to the University of Alabama in Huntsville (UAH) campus to learn about engineering as a career and experience a variety of transportation engineering design topics. The participants gained knowledge about the role of engineers in society as well as learn how engineers use their knowledge in design applications. Four University of Alabama System engineering faculty members, as well as professionals representing the Society of Women Engineers (SWE), NASA Marshall Space Flight Center, and the National Society of Black Engineers acted as instructors for the hands on laboratories mentors. As an important part of this project, several minority and female engineering students served as mentors for the program.

Section 1

Introduction

Problem Statement

Objectives

The numbers of female and minority students has been increasing overall in engineering and science (National Commission on Excellence in Education. 1983); however, there is still a relatively small percentage drawn to the field of civil and transportation engineering. As a consequence, there is a need to educate young people about the profession to encourage under-represented individuals to become engineers and contribute to transportation technology.

Approach

The major goal of this program was to introduce middle school students from under-represented groups to basic engineering and transportation-related concepts. A novel approach of the project was to draft local minority and female engineers to act as team instructors and mentors. Participants used real world examples and new technologies in their hands-on activities to reinforce the concepts presented by the engineering mentors. A final comprehensive team project was used to tie all the knowledge together in a design competition.

Section 2 Background

In past years, The University of Alabama in Huntsville (UAH) and the American Society of Civil Engineers (ASCE) worked with local schools in the Huntsville, Madison County and Morgan County area and became aware that local public schools do not have any formal relationship with the engineering academic and technical community. In addition, all those school systems have a high ratio of minority students, approximately 25 percent of total enrollment. As a consequence, local county middle and “science magnet” school principals and teachers were asked to nominate students for this Summer Institute. Under-represented students, female and minorities, were especially targeted. This year a week was dedicated to “Girls Incorporated” to encourage females to attend the program. A committee consisting of representatives from each of the participating groups selected twenty participants based on potential rather than classroom grades.

The Summer Institute project consisted of bringing selected middle school students to the UAH campus to learn about various aspects of engineering and to experience transportation-related design and safety topics. This opportunity may encourage them to consider civil and transportation engineering as a career option and increase diversity of the workforce, a problem in some areas of the country (U.S. DOT, 2000).

Section 3 Methodology

Science Teaching Method

Recent efforts to reform science education in schools have led to the development of the Science/Technology/Society (STS) teaching method. Some important aspects of the STS method are that students must feel a concept is personally useful for solving specific problems, and students who learn through an experience will retain information and will be better able to apply the information later to new situations. Instructional and interactive experiences were developed with this grant to motivate interest in transportation engineering and related science topics. The program was initiated in the Gearing Up for Transportation Engineering Program (GUTEP) Summer Institute in 2000, and the current year's program refined the laboratory activities and put the manual on the UAH University Transportation Center for Alabama (UTCA) Web site as a teacher resource.

The strategy of this program was aimed at producing students who know “how to find out” and “how to examine and evaluate evidence.” As discussed in last year's UTCA final report [Leonard, et al., 2000], the following criteria were used in designing the hands-on experiments:

- The activities were designed so that the students could complete them by themselves; they were not demonstrations performed by the instructors for the class.
- The students had to be able to read, perform and document the experiments themselves with limited adult supervision.
- Each experiment was designed so that the results were sufficiently dramatic to keep the student's attention with a high probability of success.
- Experience has shown that middle school students work best in teams, so the activities and equipment were appropriately structured.
- In general, each experiment took approximately 1-1.5 hour including set-up and clean-up, and follow-up discussions were held to highlight concepts and results.
- Safety and good lab protocol were practiced and stressed throughout.

To accomplish these goals, students were encouraged to use the following design heuristic in their team transportation problem:

1. Define the problem;
2. Generate possible solutions, using brainstorming and other creative thinking techniques;
3. Decide on a course of action;
4. Integrate the solution; and
5. Evaluate the solution.

The following list of national science education standards' topics (National Research Council, 1998) and skills was used as a template for the GUTEP activities. Attention to appropriate skill level was a major factor in the preparation of these activities, which were tailored to fit the GUTEP.

Physical Science

- Motions and forces
- Transfer of energy

History and Nature of Science

- Science as human endeavor
- Nature of science
- History of science

Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
- Develop descriptions, explanations, predictions, and models using evidence

Science and Technology

- Abilities of technological design
- Design a solution or product
- Implement a proposed design
- Evaluate completed technological designs
- Abilities of technological design
- Understanding about science and technology or products

Science in Personal and Social Perspectives

- Science and technology in society
- Populations, resources, and environments

Unifying Concepts and Processes

- Evidence, models, and explanation
- Form and function

Science Process Skills

- ◆ Collecting data
- ◆ Constructing
- ◆ Inferring
- ◆ Measuring
- ◆ Communicating
- ◆ Making models
- ◆ Interpreting data

- ◆ Controlling variables
- ◆ Investigating

The GUTEP goals and activities were designed to meet the UTCA goal of increasing diversity in the transportation field. The project provided technology transfer through focused activities to provide an educational and stimulating experience for the students that will affect Alabama's future human resource population that can address transportation needs.

Section 4

Project Results

Tasks Completed

This project had a one-year duration, commencing in January of 2002. The following tasks were completed to achieve the desired goal of transportation education through technology transfer.

Recruiting

Letters were sent to schools, phone calls were made to science teachers, and follow-up contacts were made as needed. The North Alabama Girls, Inc. manager was instrumental in contacting parents and helping to select candidates for the GUTEP program. The program committee met and selected 40 students based on potential and interest levels.

Scheduling Mentors

The project Principal Investigator contacted professional organizations (National Society of Black Engineers, Society of Women Engineers, American Society of Civil Engineers), college chapters of the societies, the NASA Marshall Space Flight Center, local companies (Boeing and Sverdrup), and the Huntsville Center of US Army Corps of Engineers to seek professional mentors.

Setting-up the schedule and lab experiences

The schedule of activities and the laboratory experiences were designed through a sequence of events:

- a) The principal investigator met several times with instructors to discuss the objectives of each lab experience.
- b) Professors were asked to update individual experiments in the light of last year's survey results.
- c) Instructors ran through labs with several middle school students prior to GUTEP, to gather feedback..
- d) Finalized laboratory instructions were received from the Co-Principle Instructors.
- e) Supplies were obtained and student manuals were assembled.
- f) Rooms (on campus) and field trips were scheduled.

Conducting the Summer Institute

The first week's session was conducted June 24-28, 2002, and the second week's session was conducted July 8-12, 2002. Each session:

- a) Divided students into five teams of four students to run concurrently in labs/
- b) Followed schedule shown in Appendix A.
- c) On the last day of the session – secured judges to which participants gave demonstrations and design reports on their future transportation modes.

Deliverables

This project developed a manual for students and for use as a teacher resource (including lab sheets – All four investigators were responsible for completing their laboratory experiments). The team members completed the evaluation of the final manual for teachers and students. The manual was posted on the UAH UTCA Web site (<http://coeweb.eb.uah.edu/cee/utca.htm>.) in HTML format. The Principal Investigator was responsible for quarterly reports to UTCA. The final report was completed and sent to UTCA in December of 2002.

Synopsis of Student Hands-On Experiments

GUTEP was scheduled and ran for two one-week sessions on the UAH campus. The mornings were scheduled for informative sessions, followed by lunch. The afternoon activities were characterized as "hands on" experiences, such as design projects and laboratories. The last day concentrated on team building and a "vehicle of the future" design project. A summary of each laboratory experience follows and the two new experiments are included in Appendix B. Photos from GUTEP are also included in Appendix C

Lab 1. Traffic Simulation

Objective: To learn about the traffic engineering concept, level-of-service, and how traffic engineers use micro-simulation to analyze roadway intersections and design city streets.

Description: In this activity, students explore traffic micro-simulation and determine existing and future levels of service for different roadways systems. The students will learn about highway design principles related to intersections and traffic signal control.

Lab 2. Space Transportation

Objective: To demonstrate how rocket liftoff is an application of Newton's Laws of Motion. Students also will learn about the history and future of space transportation in the USA (NASA, 2000).

Description: Students construct a rocket powered by the pressure generated from an effervescent antacid tablet reacting with water. Students also use the NASA disk "Space Transportation: Past, Present and Future" to learn about space applications.

3. Construction Materials

Objective: To learn about different types of materials used for roads, bridges, parking lots, dams, and buildings.

Description: In this activity, students learn about engineering materials used in transportation, such as wood, metals, concrete, pavements and composite materials. They will prepare and test some of these materials.

4. Engineering Shapes (New this year)

Objective: To learn how to enhance the strength and stability of simple structures.

Description: In this activity, students will build and test a column, dome and truss and make predictions on loads.

5. Alternative Energy (changed this year)

Objective: To explore alternative energy sources, other than fossil fuels, for future transportation modes. Also, this lab stresses the importance and effectiveness of alternative energy sources.

Description: In this activity, students perform experiments using a solar cell. They will observe the physical power of light/heat absorption through a small free moving device with black and white panels. Each student constructs a battery powered fan boat.

6. Bridges

Objective: To learn about different types of bridges by building simple models.

Description: In this activity, students construct a simple span bridge. They use an interactive computer simulation model to design a suspension bridge to carry the load of a truck. They also build a scale model of their bridge design.

7. Strength of Materials

Objective: To understand how forces and moments create stresses and strains in materials and structures.

Description: Students will perform simple experiments in the UAH Mechanics of Materials Laboratory to demonstrate how forces and moments are created, and balanced to achieve equilibrium.

8. Transportation Safety (updated for this year)

Objective: To explore issues related to automobile safety. Also, to learn ways to design safety into cars.

Description: In this activity, students learn about bike, bus and auto restraint safety. They also perform experiments illustrating safety features using eggs.

9. Future Transportation Design Problem

Objective: To design and build a working model of the team's vision of a future transportation vehicle.

Description: In this activity, students design a prototype of a vehicle of the future. They construct a working model with motorized K'nex kit. It must meet energy, safety, and infrastructure constraints.

Field Trips

- Past Modes of Transportation - North Alabama Railroad Museum, Big Spring Canal
- Current Modes of Transportation – Huntsville Shuttle (mass transit system) and Huntsville Hospital tram
- Transportation Engineering -- City of Huntsville Engineering and Sign Shop
- Future Modes of Transportation --NASA Marshall Space Flight Center's ANVIL research center. This introduced students to virtual reality and space station mock-ups.

Seminars

- History of Transportation Engineering
- Team Building Skills

Goals Met

The major goal of this program was to introduce middle school students from under-represented groups to basic scientific and engineering concepts. These groups have potential for science and engineering, but might lack role models and motivation to pursue a career in transportation engineering. The selection committee used the teacher references to rate the students (criteria were student statements of interest, teacher comments and ethnicity). Through the UTCA summer program, we were successful in recruiting 100% African American females the first week, and an overall of 72% ethnic minority students for the program. The ethnicity breakdown is given in Table 4-1.

Table 4.1 Participant's Ethnicity Information

Week 1			
Ethnicity	Female	Male	Percent
Total attendees	18	0	
African American	18	0	100.0%
Asian	0	0	
Caucasian	0	0	
Hispanic	0	0	
Week 2			
Ethnicity	Female	Male	Percent
Total attendees	12	6	100.0%
African A merican	2	4	33.3%
Asian	1	0	5.6%
Caucasian	8	2	55.6%
Hispanic	1	0	5.5%

Significance and Benefits of the Program to Participants

The participants gained knowledge about the role of transportation planning, management, safety, and design in modern society. The emphasis was on how engineers use their knowledge in design applications. The last day of the Summer Institute concentrated on team design in transportation engineering, where students combined the knowledge acquired in laboratory experiences. A faculty member or professional acted as each team's mentor and helped them to prepare an electronic and oral presentation of their design. Students in the winning design team were awarded K'nex kits and all participants received certificates of accomplishment from UAH at the closing ceremony. All the students received a prize of some kind, from the safety challenge, bridge design, rocket launch, etc., which helped to instill a sense of accomplishment and pride.

Since the middle school curriculum contains hard science and algebra, which are directly related to engineering, this program enhanced classroom instruction with "hands on" experience. In addition, the principal investigators and professionals that acted as team mentors functioned as role models for minority and female students. This may help to increase the number of these students that will go on to become transportation professionals. The use of UAH minority and women engineering students as lab assistants encouraged them to become involved in the community as professionals.

The program was intended to be a fun learning experience with a lot of basic information, team building skills, and hands-on laboratory experience of the latest transportation safety and management technology. On the last afternoon of the program, the students were asked to complete a program survey form. Table 4.2 shows the results. The "favorite" experiment was the alternative energy units (they built a battery powered fan boat), which will remain unchanged in next year's program. The least favorite, mechanics of materials (which was the favorite last year) will be updated with more "fun" dynamic activities.

The students were also asked about their enjoyment of the program and all of them answered affirmatively to questions regarding recommending this program to a friend (100% said they will

attend a similar program next year (question 6) and the fact that the field trips and experiments increased their knowledge of engineering (question 7). The last question indicated their own views about engineering as a future career for them. Approximately 80% thought that they might choose engineering as a profession (the first week was 60% and the second week was 100%)

Table 4-2 Participants' Survey Results

<u>Survey Questions</u>	<u>Students' Responses</u>	
1. What was your favorite experiment?	Question 8 (73%) Alt. Energy , Questions 2, 4, and 6 tied at 5%	
2. What was your least favorite experiment?	Question 7 (36%) Mech. Of Mat'ls	
3. What was your favorite field trip?	Railroad Museum (80%)	
4. What was your least favorite field trip?	NASA Virtual reality lab (36%)	
	<u>Yes</u>	<u>No</u>
5. Would you recommend this program to a friend?	100%	0
6. Would you attend a similar program again	100%	0
7. Do you feel like the field trips and experiments contributed to your learning experience?	95%	5
8. Did the program increase your knowledge of what transportation engineers do?	95%	5%
9. Would you consider becoming an engineer?	80%	20%

This year the construction materials, bridges and mechanics of materials labs were also used for a group of high school students visiting UAH in late July. They were successful for the older participants with the addition of cost constraints on their bridge designs.

Advantages for participants

The GUTEP provide wonderful learning experiences, which had the following advantages:

- fun and enjoyable exposure to science, engineering and transportation technology topics
- development of thinking and problem-solving skills
- participants learn what civil engineers do and their contributions to society
- meaningful and immediate experiential learning
- fuel for their natural curiosity
- self-directed learning opportunities in team design
- increased self-esteem from completion of institute
- multiple exposure to difficult topics and interrelationships to transportation issues
- opportunity to learn within academic facilities – may take away fear of technology
- diversity of mentors help students feel comfortable at institute

Student Involvement

The project employed four undergraduate student assistants and two graduate students (both minorities and females) to help in designing the projects, documenting the plans, setting up the laboratory sessions, and assisting the participating middle-school students at the Institute. Other university students acted as laboratory volunteers through their SWE, ASCE and NSBE student chapters.

Section 5. Project Conclusions

Education and Technology Transfer Activities

The team members completed the lab activities' manual (both teacher instruction and student activity guides) for implementation at school visits and for next year's program. A Web page was posted through UAH - UTCA home pages to allow on-line access.

Research relevance and impacts to Alabama

This project addressed the mission and several of the major goals of the UTCA. It provided educational experiences for minority students within Alabama, and thus addressed diversity issues. This program has the potential to affect the future workplace (human resources issues). The students may wish to become involved in working on transportation-related safety research at an early age and thus may gravitate towards the profession as they mature. The project also addresses the technology transfer goal of the UTCA since student assistants, mentors, and participants were exposed to state of the art technology within the university curriculum.

After the program was finished the students completed a survey and all thought that the program was fun and educational. Most of them did not know what transportation engineers did prior to coming to UAH and were surprised at all the variations. Finally they would all recommend the program to their friends.

Recommendations for Next Program

The survey results will be helpful in composing next years' summer program. The two least favorite labs will be updated with new material and an additional lab will be added. Otherwise the program will be similar to the 2002 GUTEP.

Section 6.0 References

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APPENDIX A
Sample of Program Schedule

“GEARING UP FOR TRANSPORTATION ENGINEERING SUMMER INSTITUTE”

SUMMER 2002

Field Trips

Past Modes of Transportation

North Alabama Railroad Museum - Chase, AL
Big Spring Canal

Current Modes of Transportation

Transportation Engineering - City of Huntsville Engineering and Sign Shop (Tim Barnett)
Huntsville Hospital tram

Future Modes of Transportation

NASA-MSFC virtual reality lab

Hands-On Sessions (Groups of four students each)

Title (coordinator)

Room

- | | |
|---|---------------|
| 1. Traffic Simulation - (Mike A) | TH S239 |
| 2. Space transportation -- (SWE: Mary Anne, Yvonne) | TH S208 & 206 |
| 3. Construction Materials -- (HT) | TH S228 & 230 |
| 4. Engineering Shapes - (KL) | Outside |
| 5. Alternative Energy/Battery Boats (KL) | TH S201 |
| 6. Bridges - (Norb) | TH S208 |
| 7. Strength of Materials --(Salvi) | TH N278 |
| 8. Safety Concerns/egg container - (Ranjan) | TH S205 |
| 9. Designing the Car of the Future | TH S105 |

General Schedule of Sessions

	Monday	Tuesday	Wednesday	Thursday	Friday
9:00-10:00	Introduction- History	Huntsville Shuttle ride	RR museum	Future trans. MSFC - NASA virtual reality tour	Team Design Project
10:00-11:00	Team building	Big Spring	City of HSV Engineering		
11:00-12:00	<i>Lunch - Pizza</i>	<i>Lunch - Hamburgers</i>	<i>Lunch - Picnic</i>	<i>Lunch - UC</i>	<i>Lunch -</i>
12:00 -1:45	Exp 1,2,3,4	Exp 1, 2, 3, 4	Exp 5,6,7,8	Exp 5,6,7,8	9. Design Competition
1:45- 2:00	break	break	break	break	
2:00-3:45	Exp 1,2,3,4	Exp 1, 2, 3, 4	Exp 5,6,7,8	5,6,7,8	Awards

APPENDIX B

Copies of New Experiments 4 and 5

Note: The versions of the experiments in this appendix are simplified for display purposes. The full experiment instructions are posted on the UAH UTCA web site, and may be viewed at <http://coeweb.eb.uah.edu/cee/utca.htm>

4. Engineering Shapes: Columns, Trusses and Domes

Believe me this one is so much fun! You are going to learn how to enhance the strength and stability of simple structures. You will build and test the structures and make predictions on loads.

Now let's see what **Truss, Column and Dome** mean.

Truss

Some shapes are more stable when put under a load. When a compression (pushing) force is applied to the structure it should not bend or change shape. It is difficult to distort a triangle: compression at one joint is balanced by tension along the opposite sides.

Column

Columns (long tubes) are used to hold up heavy loads, such as roofs of buildings. The heavy load pushes on the column, setting it up in compression. So a good column should be very strong in compression.

Dome

A dome is a series of trusses that must support its own dead weight as well as the live load of wind, rain, snow, or ice. A **geodesic dome** is a dome formed by joining triangles together. You can build a giant geodesic dome out of paper. The geodesic dome's strength is due to the fact that triangles are very stable shapes. The geodesic dome's design distributes loads over all the different triangles that compose it.

Materials and Tools

Straws, Paper clips, Cardboard tubes, Sand Tray, Masking tape, Funnel, Newspapers, Measuring tape, Pens and decorations.

4a Columns

Make a prediction: Can a toilet paper tube withstand the compression caused by your foot?

1. Place an empty tray on the floor. Stand an empty toilet paper tube (column) on one end in the pan.
2. While holding on to the back of a chair with both hands, gradually press straight down on top of the column with one foot. Continue increasing your weight on the column until it collapses. Use this scale to rate the column's strength:

a. very weak - it crumbles or breaks with hardly any force.

b. Only fair - it can't withstand much force

c. pretty strong - it takes a lot of force to break it

d. super strong - We can't break it!

1. Observe the collapsed tube to see where it failed. How can you make the column stronger, using only sand and tape? Repeat step 2 using the second column and your new design.

Compare the ratings

4b. Trusses

Make a prediction: Which shape: triangle or square will be more stable? Why?

2. With your partner, build a triangle and a square from straws and paper clips. To connect two straws, slip the wide end of a paper clip into the end of a straw. Hook a second paper clip to the first. Now insert the wide end of the second clip into a second straw.
3. Compare the stability of the shapes. Stand each shape up and press down on the top corner. What happens? How much does each one bend and twist? How hard can you press down on each shape before it collapses?
4. Use 11 gum drops and 25 toothpicks to make a dome. Connect 5 of the toothpicks into a ring using 5 gum drops.
5. Use 2 toothpicks and 1 gum drop to make a triangle on one side of the base
6. Repeat all the way around the base until you have 5 triangles sticking up.
7. Use toothpicks to connect the gumdrops at the tops of the triangles.
8. Push 1 toothpick into each of the top gumdrops.
9. Use 1 last gumdrop to connect these toothpicks at the top.

4c Domes

Make a prediction: Predict how many magazines you think your paper dome will be able to support

1. Using a sheet of colored paper and starting in one corner, roll the sheet as tightly as you can to form a tube. When you reach the other corner, tape the tube to keep it from unrolling. Repeat for 34 of one color and another 30 of a second color.
2. Now cut the tubes to make 35 longs out of the first color (23.5 cm) and 30 shorts out of the second color (22 cm).
3. Flatten the ends and punch holes in each end for connectors.
4. First connect 10 longs together to make the base of the dome.
5. Next connect a long and short to each joint. Arrange then so that there are 2 longs next to each other, followed by 2 shorts. (See picture)
6. Connect the tops of 2 adjacent shorts together to make a triangle. Connect the next 2 longs together and so on all the way around.
7. Connect the tops of these new triangles with a row of shorts. (The dome will start inward).
8. At each joint where 4 shorts come together, connect another short sticking straight up. Connect this short to the joints on either side with longs, forming new triangles.
9. Connect the tops of these new triangles with a row of longs.
10. Finally add the last 5 shorts so that they meet at a single point in the center of the dome. To test your dome's strength, see how many magazines you can load on top.

How can you make your dome stronger without interrupting the space underneath it?

Additional Information:

"Web sites" for more information:

<http://www.pbs.org/wgbh/buildingbig/>

<http://www.eweek.org/2002/Engineers/zoomB.shtml>

4. Shapes Report Sheet

Group Name: _____

Explain It!

4a. Trusses -

Compare the results of your tests on the triangle and square.

- Which shape was more stable?
- What do you think made it more stable?
- How might this shape be used in large structures?

4 b. Columns

- How did the strength ratings for the 2 columns compare?
- Explain what you think accounted for any difference.
- What was the hardest part about creating the dome?
- Were you surprised by the results of this activity? Why or why not?

4c. Geodesic Dome

- How strong was your dome?
- Did the results surprise you?
- What was the hardest part about creating the dome?

5. Alternative Energy

Just take your time and see what is going on here. I guess that you will like this one!

In this activity, you are going to perform experiments using a solar cell and test a small solar powered car. You will observe the physical power of light/heat absorption through a small free moving device with black and white panels. Then you will construct a battery-fan powered boat.

As the world's supply of fossil fuels is being used up, there is a need for new energy sources. Adding to this need is the fact that the current use of fossil fuels causes pollution in the form of carbon monoxide, unburned hydrocarbons, nitrogen oxides, soot, and particulates. Some of the alternatives that have been suggested are batteries (electricity), hydrogen fuel (fuel cells), solar panels (photovoltaic), ethanol, methanol, natural gas, geothermal, biomass, hydroelectric, and electric wind generators. Methanol is made from natural gas, while ethanol is made by fermenting crop (primarily corn) starches and sugars.

Geothermal energy is created when we force hot steam from the earth. Scientists can also harness the energy from the ocean and its thermal changes; this type of energy is classified as a biomass energy source. Other, more common types of energy sources are electric wind and hydroelectric generators.

All of these various types of fuels are in the form of either liquid, gas or electric energy. Any of the alternatives listed above are much cleaner and healthier for us and our environment because they do not emit harmful gases or use valuable non-renewable resources.

Electric cars have been around a lot longer than one would think – since the 1830s. In fact, there were more electric cars being used at the end of the 1800s than there are in use today. Electric cars have improved a lot since then; now, some cars can travel over 150 miles before having to be recharged.

Fuel cells, which act similar to a battery, are also being considered. The cells are filled with hydrogen, methanol, phosphoric acid or molten carbonate salts and can store energy until it is needed.

The more popular option today for car manufacturers is a hybrid type of vehicle. This car is powered by an electric motor and another form of energy (gas, fuel cell, solar, etc.)

Solar powered cars have also been researched and manufactured to a very limited extent. This type of car would transfer the sun's energy trapped on a solar cell to an electrical battery used to power the automobile.

More than ever before, auto manufacturers are spending a lot of time and money researching the alternative energy sources listed above. Soon, this new technology will replace the use of non-renewable energy sources.

5a. Energy

Materials and Tools:

Solar Panels, small Electronic motor, Various wooden parts, Light source, Eye protection, Notebook, motor(1), propeller (1), film canister(1), velcro or sticky backs (2), Battery holder(1), Batteries, AA(2 paper clip (1), Paper fasteners (2), Rubber bands (4), Dowel (1), Empty water bottles (2)

1. Show mechanical energy and potential energy using the happy meal toy.
2. Look at the potato clock – what makes it work?

5b. Power of Light

1. Demonstrate the power of light with the radiometer. Why does it spin?
2. Solar cell and motor with blade “What can this be used for?”
3. Count the rotations per minute with several distances of light sources. (note distances and rpms on data report sheet)

5c. Battery Fan Boat

1. Take a plastic deck and attach 2 empty water bottles with rubber bands for ballast.
2. Use a sticky mount to attach a motor to the film canister.

3. Attach battery holder to the deck and attach 1 end of the wire lead to the motor wire (see figure on next page).
4. Attach the other end to a paper clip
5. Attach 2nd wire from motor to a paper fastener for a switch that will complete a circuit when touching. Put 2 AA batteries in holder and test motor
6. Mount the propeller on the motor shaft. Note that the motor can turn either direction
7. Test your electrical/propeller system.
8. You may want to include a rudder with your boat, to ensure steering. A rudder can be a piece of dowel, and plastic, mounted through a hole in the deck,
9. Operate the boat in the tub.
10. Answer the discussion questions

DISCUSSION:

1. Can your ship carry a cargo?
2. Can you control its direction?
3. How sturdy is it?

Additional Information:

(This experiment taken from www.web.net/~sunwind/technology)

Several additional Web sites are available for more information on alternative energy:

- Office of Transportation Technologies Kids' Page
<http://www.ott.doe.gov/kids.html>
- Clean Cities Web Site
<http://www.ccities.doe.gov>
- Alter Fuels Data Center
<http://www.afdc.doe.gov>
- AFV Resources
<http://www3.cerritos.edu/atc/resources.htm>
- San Diego Clean Cities
<http://www.sdrafvc.org>
- Miramar College
<http://www.miramar.sdccd.cc.ca.us>

5. Alternative Energy Report Sheet

Group Name _____

5b. Power of Light

1. Using the radiometer bulb. Write your data in the spaces below.

2. Answer the following questions:

Why does it spin?

What makes it spin?

• *Gravity?*

• *Magnets?*

• *Heat?*

• *Magic?*

• *What?*

APPENDIX C
Photos from GUTEP 2002



Figure C1. Rockets (Experiment 2)



Figure C2. Mixing concrete (Experiment 3)

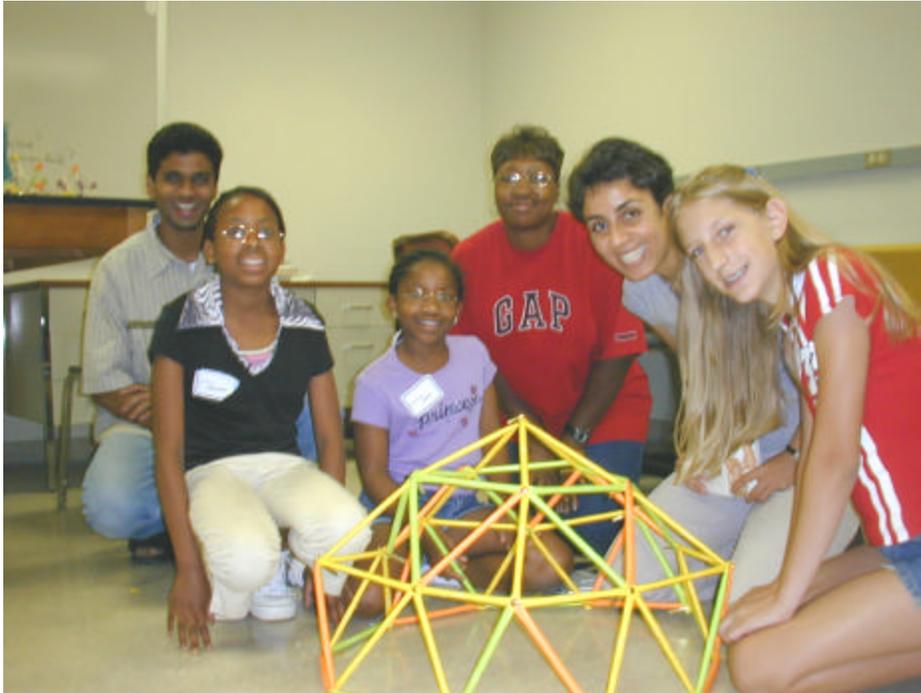


Figure C3. Construction of geodesic dome (Experiment 4)



Figure C4. Battery boat races (Experiment 5)



Figure C5. Bridge building (Experiment 6)

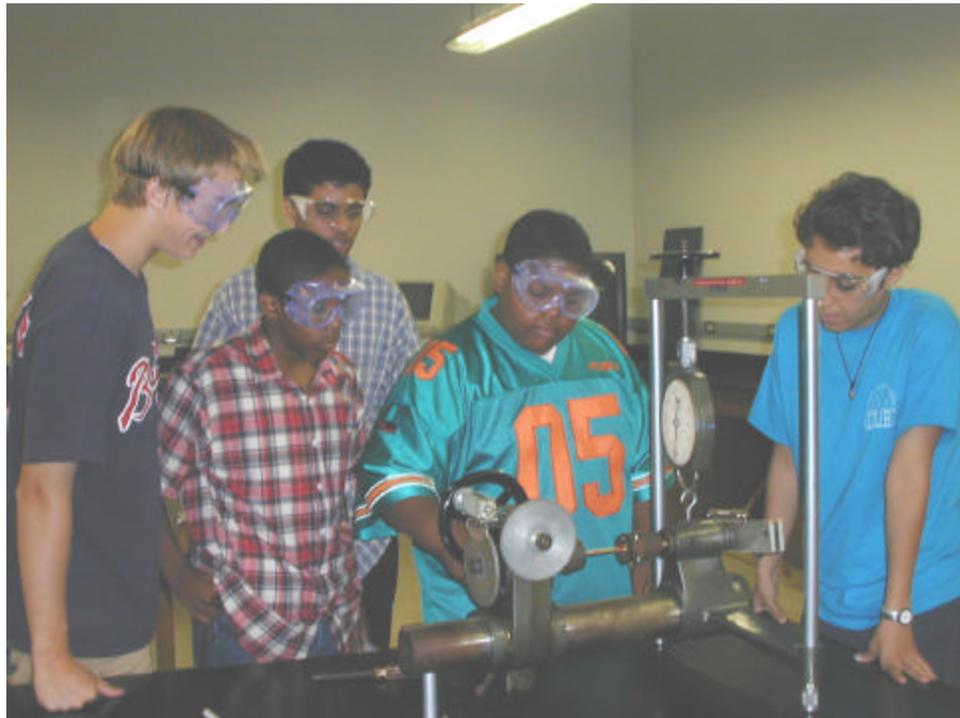


Figure C6. Torsion testing (Experiment 7)



Figure C7. Car of the future (Experiment 9)



Figure C8. North Alabama Railroad Museum field trip



Figure C9. GUTEP participants, Girls, Inc. week



Figure C10. GUTEP participants, Coed week