

**Building Engineering Achievement in Transportation
(BEAT) the Traffic**

A partnership between
**Fulton County and
Georgia Institute of Technology**

The seal of the Georgia Institute of Technology is a large, faint watermark in the background. It features a central shield with a lamp of knowledge, flanked by two figures. The shield is set within a circular border containing the text "THE GEORGIA INSTITUTE OF TECHNOLOGY" and "1885". Below the shield is a banner with the motto "PROGRESS AND SERVICE".

**BEAT the Traffic
Evaluation Report
2009-2010**

CEISMC
EVALUATION

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October 4, 2010

Table of Contents

Original Goals and Objectives.....3

GIFT Teachers ‘Beat the Traffic’ Summer Program Evaluation Results4

 GIFT Teacher 14

 GIFT Teacher 24

 GIFT Teacher 35

 GIFT Teacher 45

 Overall Evaluation of GIFT Summer Experience6

Hovercraft Professional Development Camp7

Student Summer Camps9

 Creekside High School BEAT the Traffic Camp9

 Tri-Cities High School BEAT the Traffic Camp.....11

 CEISMC Building the Future in Civil Engineering Camp13

 CEISMC Hovercraft Camp14

Freight and Airport Class (Fall 2009)16

High School Summer Camp (Airline online software).....20

Original Goals and Objectives

The goal of the BEAT the Traffic program in the K-12 setting is to increase student interest in pursuing a STEM career through the use of student enrichment programs (summer camps) and student and teacher research internships at Georgia Tech. Each program activity is focused on the field of Transportation Engineering. The specific objectives of each program will be discussed under each program evaluation. The following programs were conducted by the Center for Education Integrating Science, Mathematics, and Computing (CEISMC) in a collaboration with Fulton County Schools, Creekside High School and Tri-Cities High Schools, and the Transportation Engineering Department at Georgia Tech. The specific programs are as follows:

1. Two teachers from Westlake High school, one teacher from Creekside High school and one teacher from Eagle's Landing High School were hosted in research labs at Georgia Tech during the summer of 2010 as part of the Georgia Intern-Fellowships for Teachers (GIFT) program. These teachers, in a partnership with GT faculty and graduate students, participated in research projects and designed curriculum activities for high school math and pre-engineering courses related to traffic modeling and the civil engineering of transportation infrastructure. Three of the four teachers participated in the GIFT program with their student research group.
2. Four 1-week summer camps for middle school students were held, two at Georgia Tech (GT), one at Tri-Cities High School, and one at Creekside High school. Each camp addressed different aspects of transportation engineering.
3. A professional development summer camp was also hosted by CEISMC at Georgia Tech focusing on creating curriculum units for mathematics using hovercraft structural components
4. During a semester-long undergraduate and graduate class on airports and freight, a new curriculum was incorporated using an airline simulation software which is designed to give students hands-on experience with some of the major issues challenging the airline industry.
5. Curriculum units were developed for an Airline Simulation program during the summer, and were implemented and tested in one week-long summer institute for high school students interested in transportation engineering and the airline industry.

GIFT Teachers ‘Beat the Traffic’ Summer Program Evaluation Results

Four teachers were hosted in different research labs at Georgia Tech during the summer of 2010. These teachers worked with GT faculty and graduate students participating in research projects. Additionally, they designed curriculum units and ‘action plans’ for implementing summer experiences into the classroom or more generally applying the GIFT experience in the classroom. The action plans included a needs assessment, summer work experience, a portfolio representing key points in the learning process, a classroom implementation plan and communication plan.

The principle evaluation method employed for this report the development of aggregate narratives for each participant in the program. The following data sources are used in this study:

Online web surveys were used as a data collection tool. The greatest strengths of web-survey data collection are efficiency and flexibility. The web survey also has built-in advantages such as question skip patterns, question ordering, and easy reminders to participants. The survey was administered through an electronic survey software program called Survey Monkey, and all GIFT teachers completed the surveys. Additionally, the data were supplemented with teachers’ “Action Plans”.

The following section describes each teacher background and internship experience.

GIFT Teacher 1

The first participating teacher’s internship was with Construction Information Technology (CIT) in the Civil Engineering department. She participated in the program with a group of five students. She partnered with Dr. Ionnis Brilakis, assistant professor at CIT, to develop a scale model of a seaport and a pothole detection and positioning tracking device. The participating teacher mentored the high school students with these two scale models while working closely with graduate students. The two models required the students and the GIFT teacher to conduct comprehensive research which allowed them to incorporate math, science and technology concepts, where the scale modeling process incorporated math; and the Pothole Detection and Positioning system used technology and science concepts. The action plan this teacher developed, which can be used in any mathematics classroom, asked students to create a model of a roller coaster through the use of physics and mathematics concepts. The teacher reported that the students would continue to work on their projects during the school year. Additionally, she reported that she plans to share her action plan and GIFT experience with other teachers in her school.

GIFT Teacher 2

The second GIFT teacher’s internship was held at the Transportation Engineering department at GT. This teacher partnered with Dr. Mike Hunter and Tom Hall from Transportation Engineering and mentored a group of two research students in a transportation engineering project. He studied with Dr. Hunter also last year in the area of transportation engineering. During the project, they worked with students to create a traffic plan. This year’s project involved collecting traffic data for five intersections along the corridor on 10th street from Hemphill Avenue to Fowler Street. Students then used this data to compare the difference in travel time for coordinated versus uncoordinated traffic signals. Additionally, students spent time exploring the history of transportation engineering as well as the skills which go into

transportation engineering. This teacher also developed an action plan where students are given an opportunity to solve a traffic engineering problem: What is the most efficient way to route traffic for an event site given the context of the community and regular traffic flow in the area? His plan is to use this curriculum unit in his engineering concepts class. He reported that because of this experience, his students will be exposed to something they normally never learn about and which might have an impact on their academic achievement.

GIFT Teacher 3

This GIFT teacher's internship was with the Architecture department at GT where he was partnered with Dr. Matthew Swarts and several graduate students. This summer project included six high school students, which were split into three groups of two. They conducted several research projects. The objectives of the projects included the following:

Students were

- to determine the impact of façade shading in the interior of a building;
- to understand how various control logistics impact the effects of interior shading devices;
- to understand the relationships between interior and exterior shading devices;
- to understand how two dimensional representations could be used for viewshield analysis (GPS systems);
- to determine the impact of directionality in patrol route effectiveness.

All of the student groups used various programs and implements such as processing, AutoCAD, laser cutter, digital cameras, and Photoshop to complete their projects. This GIFT teacher feels that this experience had a great impact on his students and will stimulate them to do more scientific research and pursue college degrees. He also plans to come back next summer to continue the research.

GIFT Teacher 4

The last teacher's internship was with the Civil Engineering department at GT. He worked with Dr. Laurie Garrow and graduate students to develop curriculum units for an airline simulation program. Using the airline simulation program called "Airline Online," he developed a curriculum unit for Accelerated Math 1, Accelerated Math 2, and AP Statistics that uses real data to allow students to generate regression equations and determine probabilities. This simulation software gives students the ability to simulate real phenomena as they set up and maintain an airline. He felt that the Airline Online program is an excellent simulation for use in mathematics classes. The curriculum plan he developed during the GIFT experience is currently being used in his classroom. He had already set up the introduction to the simulation activity and this fall, his students had already begun generating data by setting up their airline. During the fall semester, the students will maintain their airline company as part of their in-class work. When they are not maintaining their airline they will be working on probability situations related to the airline industry. Maintaining the airline will generate data that will be used to write and compare regression equations. Furthermore, the teacher reported that this experience is already having an impact on the students in his classroom as they have shown a great interest in using the simulation program to help them learn mathematics in a transportation related industry.

These curriculum units were also tested with a group of nine students during the summer. The evaluation of the Airline Online software as used high school students is also presented in this report.

Overall Evaluation of GIFT Summer Experience

Teachers were asked to what extent their participation in GIFT will have an impact on their teaching. All participating teachers strongly agreed that they will be/were able to implement action plans developed through their participation in the GIFT program into their classroom. They also indicated that they are interested in using the material in their classrooms and will be able to implement the material in more than one class. Furthermore, teachers undertook more inquiry-based constructivist educational practices in their classroom. Teachers also reported a high level of positive responses from students to the use of inquiry-based student activities in their classrooms after participation in the GIFT program.

Teachers also agreed that this was a “great” experience, and they were very thankful for the opportunity. The teachers expressed that they all want to reapply next summer and continue to work with their mentors at GT. Additionally, they reported that they developed a great appreciation of the effectiveness of the partnership between GT and their schools. In fact, the GT mentors plan to visit the teachers’ classrooms in the fall. Depending on the funding availability, teachers and mentors will continue to work together on future research projects.

The following shows the program impact on teachers at the personal level.

To what extent do you agree or disagree with the following statements?	Neutral	Agree	Strongly Agree
The program was responsive to your professional development needs.	0	3	1
The program was appropriate to your knowledge, skills and interests.	0	2	2
The program provided opportunities to engage in inquiry/research activities that you will be able to adapt for classroom use.	0	2	2
The work was enjoyable and stimulating to you.	0	3	1
The program elevated my level of enthusiasm for teaching/learning.	1	2	1
The program increased my interest in integrating course curricula with other subjects or fields of study (writing/math/science).	0	0	4
The program increased my ability to incorporate “real life” examples of the subject I teach into my classroom teaching.	0	2	2

The teachers provided overwhelmingly positive responses to our survey. Here are some example quotes from the teachers' survey responses:

"I am very pleased with my GIFT experience. Dr. Garrow, Brittany Luken, and Susan Hotle provided excellent guidance and help in developing a useful unit for classroom instruction."

"As a teacher, I am always looking for ways to present the curriculum that will engage students and help them develop ownership of their learning. My GIFT experience and the unit plans I was able to develop are proving a great way to engage my students and help them find joy in learning. My students enjoy the idea of building their own airline and see how well they can maintain it over time. They understand that they are generating real data that can be used in data analysis through regression and they are looking forward to seeing what this means. It is already having an impact on the students in my classroom as they have shown a great interest in using the simulation program to help them learn mathematics in a transportation related industry."

"This was my first GIFT experience and considering the curriculum I am able to bring back to my classroom I don't know how it could have gone better."

"Dr. Michael Hunter was my mentor and he was great to work with. He had a great team of graduate students who were also extremely helpful. GIFT brought a great opportunity into my classroom last year and I hope that it does the same again this year."

"Because of this program, my students got a head start on college level research. When they get to college they won't be totally lost on how to do a science or math project."

"Thanks to this wonderful experience, my students will have great exposure to something they would not normally be exposed to."

"Professor Matthew Swarts. He was excellent. I enjoyed the lectures and hands on activities he offered the kids. He stayed late on most days to assist the kids. He was awesome. I was very inspired by him. Awesome job!"

"This program is already having an impact on the students in my classroom as they have shown a great interest in using the simulation program to help them learn mathematics in a transportation related industry."

Hovercraft Professional Development Camp

A total of five teachers attended the hovercraft professional development (PD) camp, which was organized into two sections. Three of the five teachers were from Bear Creek Middle School, other two are from Benjamin Banneker High School, and Creekside High School. The first section of the camp was one week long, from June 14 through June 18, 2010. During the first camp, the instructor, Mr. Jeff Rosen, focused on theoretical aspects of building a hovercraft. Two graduate students also assisted Mr. Rosen during the course. Teacher participants learned essentials of engineering design and the physics that keeps hovercraft aloft and moving, and worked as a team in designing a hovercraft. Further, participants learned how they can use the concept of building a hovercraft to teach mathematics in their classroom. In that regard, they created lesson plans which can be incorporated within the curriculum. In addition to creating

lesson plans, teacher participants also visited several different engineering programs around the GT campus and listened to motivational speakers that provided insights about transportation. The instructor encouraged the teachers to engage in daily discussions about classroom practices and ways to motivate students to learn by discovering. The second section of the camp was three days long, from June 29 to July 1, 2010. During the second part of the Professional Development camp, teacher participants built their own hovercraft and tested it in various environments.

The teacher-designed hovercraft consisted of what appeared to be an air mattress attached underneath a broad, flat board. Inflation was achieved by way of multiple leaf blowers mounted to the top of the board concurrently blasting air through holes cut in the platform directly into the mattress below. The bottom of the mattress was punctured in various places in order to allow some air to escape, thus allowing for the creation of an air cushion between the bottom of the mattress and the ground. Much duct tape was used to plug gaps and to cover up various holes on the bottom of the mattress until an ideal equilibrium was established.

Teachers described the camp experience as *“a unique multidisciplinary endeavor that will help them to increase students’ interest in engineering and technology, and especially in transportation engineering.”* Teachers also described building a hovercraft as an activity that will enhance their curriculum. Participants were also asked to describe the camp experience, and here is a sample of the comments:

“Outstanding training and I cannot wait to pass the information on to my students.”

“Very informative, I hope that CEISMC continues to offer this kind of PD, it is so valuable for my professional development. Thank you very much for the great and valuable two weeks”

“I enjoyed being on the Georgia Tech campus to study with graduate students and hear insights from professors to bring real world problems back to the classroom for my students to solve.”

“It was a positive and fun learning experience. I think I have a better way of implementing project-based learning in my classroom now. Thank you!”

“A rewarding experience, which will be very useful in my classroom.”

We also asked the participants the reasons for attending the camp. They reported that learning more about engineering projects will potentially help their students to learn mathematics in a new and more interesting way. Further, they believe that new, innovative hands-on activities will help students’ motivation and engagement in their classroom. Teacher participants also reported briefly their plans about using the knowledge and skills they learned during the camp:

“I plan on working with our engineering teacher and our Banneker students to build and participate in this year’s hovercraft competition.”

“Designing the craft is a good way to introduce measurement and proportion my group.”

“My students will work as a team to construct a Hovercraft for this year's event.”

“Using inquiry based approach towards teaching and learning this school year.”

The following table also shows that the camp experience was very positive for teachers:

<i>To what extent to you agree with the following statements?</i>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The Hovercraft camp was appropriate to my knowledge, skills, and interests.	0	0	0	2	3
The Hovercraft camp provided me new/alternative methods to teach my students.	0	0	0	2	3
The Hovercraft camp provided me with learning activities that were effective and useful.	0	0	0	1	3
The Hovercraft camp met my expectations.	0	0	0	1	4
The Hovercraft camp increased my content knowledge about the subject matter.	0	0	1	1	3
The instructor(s) were very knowledgeable about the subject matter.	0	0	0	2	3

Student Summer Camps

A total of four student camps was held during summer 2010. Two of those camps were at GA Tech and were organized by CEISMC. The other two camps were held in Creekside and Tricities high schools. After completion of each camp, the participants were asked to fill out a survey. Surveys were used to evaluate: (1) STEM and transportation engineering interest of high school students; (2) the camp experience; (3) student understanding of science concepts.

Creekside High School BEAT the Traffic Camp

A total of thirty (30) 8th and 9th grade students attended the camp, which was held in Creekside High School. The camp was held the week of June 1st, 2010. The camp enrolled middle school students, all of whom were African-American. The goals of the camp were to:

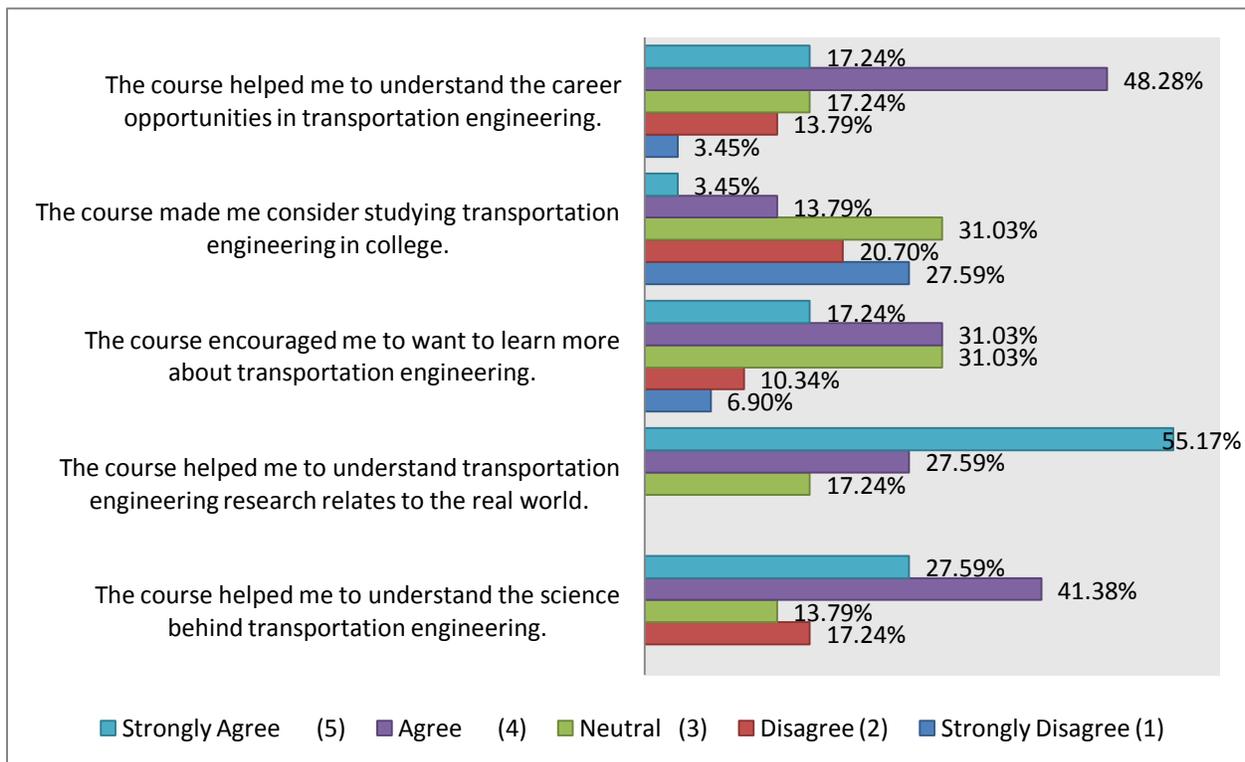
- Increase student interest in pursuing a math or science based career;
- Provide research and instructional opportunities in civil engineering related to earthquake liquefaction and traffic design;
- Provide research and instructional opportunities in forensics;
- Design a solution to an integrated real world problem.

The participating teachers were Derrick Washington, Kaleah Lambert, Chris Hill, and Douglas Edwards. The camp was structured using problem-based learning. This camp provided an interdisciplinary experience that involved physical science, biology, forensics, algebra, engineering design, and project management. By researching causes of road collapses directly related to earthquakes, in conjunction with designing a conceptual traffic problem related to

stopping distance to reduce the possibility of an accident, as well as the forensics of identifying someone if an accident should occur, the students experienced the application of math and science to solve road design, traffic design, and forensic problems. Students were placed in teams of three (civil engineer/road designer, traffic engineer, forensic specialist) to develop and test their road design, traffic solution and forensic investigation. In order to evaluate their effectiveness, a mini-competition was held at the end of the program, and an awards ceremony was held to conclude the camp.

After completion of the camp, the participants were asked to answer a short survey about their experiences. A total of twenty-nine (29) camp participants responded to the questionnaire. Of those twenty-nine, seventeen (17) were male and twelve (12) were female. Students were drawn from local middle schools: eight (8) attendees from Sandtown Middle School, five (5) from Bear Creek Middle School, four (4) from KIPP South Fulton Academy, three (3) from Renaissance Middle School, two (2) each from Westlake and Hapeville Charter Middle School, and one (1) each from Fulton Science Academy, Sandy Creek High School, Southwest Atlanta Christian Academy, Woodland Middle school, and Woodward Academy.

The camp was very effective in increasing students' awareness of transportation engineering (means before and after the camp increased from 2.31 to 4.1), helping students understand how transportation engineering research relates to the real world (mean=4.53), and helping students understand career opportunities in transportation engineering (mean=3.72).



There are several points of note from the table above. Only half the camp participants considered the camp effective in stimulating interest in studying transportation engineering in college. This factor is explained by the correlation between the reason for participating in the

camp and the desire to study transportation engineering. The students who chose “*learn more about transportation engineering*” as their primary reason for attending the camp also wanted to study transportation engineering in the college. Students who chose “my parents signed me up” were more likely not to consider studying engineering in college.

After completing the summer camp, the majority (68%) of student participants agreed that they had a more positive attitude towards engineering, followed by 21% who were neutral and 7% who disagreed that they had gained a more positive attitude. Approximately 75% of the students agreed that they like studying science in school. When asked if they felt bored while attending the summer camp, 75% disagreed with this question and 25% were neutral.

We also asked for students’ impressions of the faculty/graduate students/instructors they met during the camp. Their overall impression of these individuals was that they were nice people and good teachers.

“They were all nice and friendly and helped me to learn more about transportation engineering.”

“They actually taught us better than some teachers at my school.”

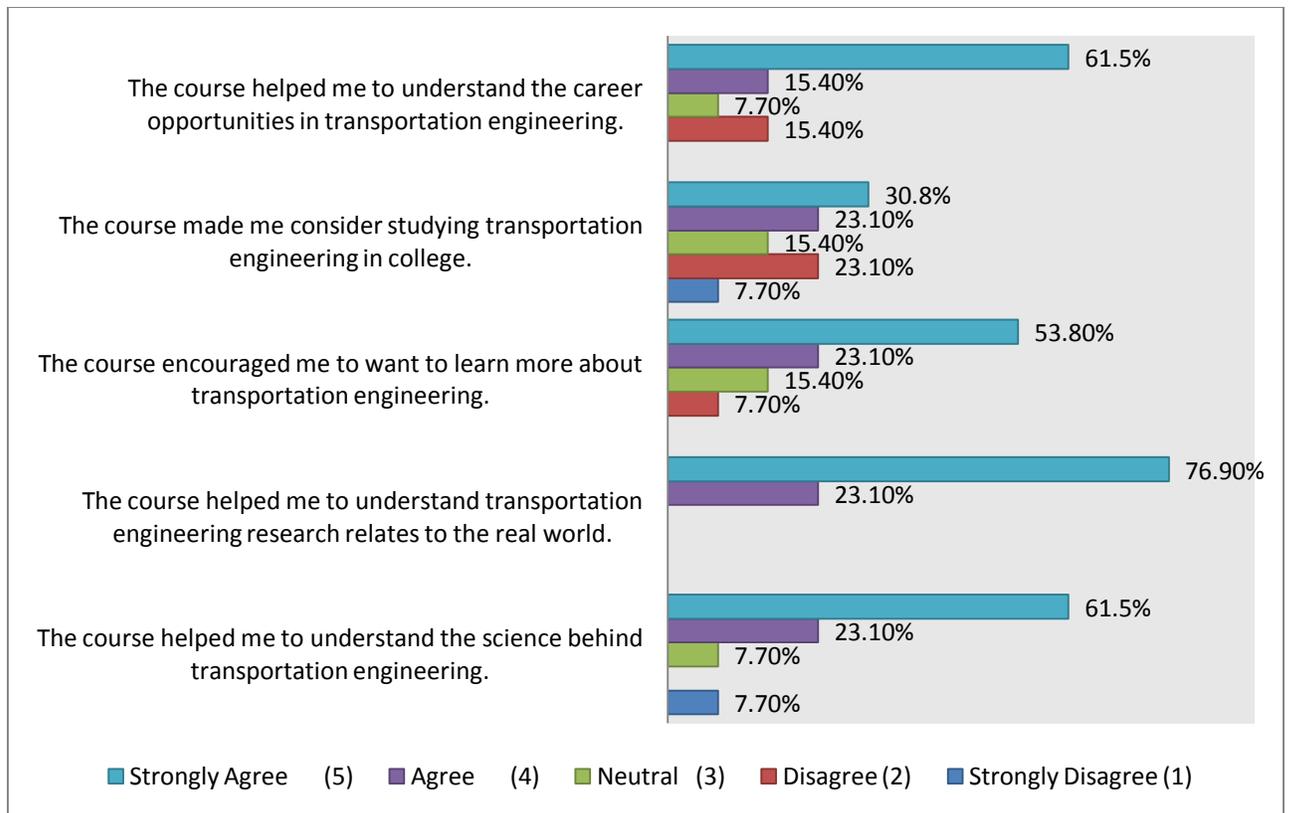
Finally, when students were asked if they had any suggestions for improving the camp, the most popular answer was “*to go on more field trips*” and “*spend more time on GA Tech campus.*”

Tri-Cities High School BEAT the Traffic Camp

A total of fifteen (15) students attended this camp, which was held at Creekside High School during the week of June 7th, 2010. The camp enrolled local middle school students, all of whom were African-American. The camp’s objectives were similar to those of the Creekside camp, discussed previously.

A total of thirteen (13) camp participants responded to the survey questionnaire. Of those thirteen, nine (9) were male and four (4) were female. The majority of the participants were African-American with only one individual claiming “other” as race. The schools in attendance were fairly evenly distributed, with Hapeville Charter Middle, McNair Middle and North Fayette Elementary all leading with two (2) students, respectively. Approximately 30.8% of the students were 7th graders, followed by 4th grade with 23.1% and the remaining students in the 5th and 6th grades.

The camp was very effective in increasing students’ awareness of transportation engineering (means before and after the camp increased from 2.08 to 4.2), helping students understand how transportation engineering research relates to the real world (mean=4.72), and helping students understand career opportunities in transportation engineering (mean=4.32). High marks were received when asked if the course helped them to understand the relationship of transportation engineering to the real world. The final question in this section asked the participants why they attended the program. The most common reason was to “*learn more about transportation engineering.*”



The second section of this questionnaire asked for open-ended responses to five questions. The first question asked for students’ impressions of the faculty/graduate students/instructors they met during the camp. Their overall impression of these individuals was that they were nice. The second question asked if the participants could see themselves doing this type of work, and nine (9) of them responded yes and four (4) responded no. When students were asked to report the three most interesting things they learned during the camp, practically all of the activities were mentioned except building a road. The most notable answer when asked what was their least favorite activity, it was going to Georgia Tech, with 23.1%. The final question asked how one might improve the Beat the Traffic Summer Camp and the most popular answer was “to go on more field trips”.

After completing the summer camp the majority (61.5%) of participants agreed that they have a more positive attitude towards engineering, followed by 23.1% who were neutral and 15.4% who did not know how they felt. Approximately 46.2% of the respondents were either neutral or agreed that they like science in school. When asked if they felt bored while attending the summer camp, 84.6% disagreed with this question and 15.6% were neutral. Conversely, when asked if they got excited about these types of camps the respondents stated that they agreed (69.2%) or were neutral (30.8%). The responses to the final two questions, regarding whether becoming an engineer was important and whether students’ focus in school is primarily math and science, were inconclusive with an even distribution of responses.

CEISMC Building the Future in Civil Engineering Camp

This camp was held during the week of July 12, 2010, at Georgia Tech. The application process and the organization of the camp were handled by CEISMC. A total of twenty-one rising 8th and 9th grade students attended the camp. Of those 21, sixteen (16) were male and five (5) were female. The main goal of the camp was to increase student interest in pursuing a math or science based career. Specifically, the camp focused on the science behind building a bridge and the role of civil engineers in the process. Additionally, students learned that when many forces interact with the structure of a building, the design is the last defense against failure. Students also examined many bridge designs and then built their own structure and tested to see how well it holds up to the stresses of transportation. They also visited engineering labs on campus and used Georgia Tech testing equipment.

This camp was very effective in increasing students' awareness of transportation engineering (means before and after the camp increased from 2.15 to 3.86), helping students understand how transportation engineering research relates to the real world (mean=4.00), and helping students understand career opportunities in civil engineering (mean=4.1). High marks were received when asked if the course helped students to understand civil engineering in relation to the real world. The final question in this section asked the participants why they attended the program. The most common reasons were to *"learn more about civil engineering and ...to spend a week at a Georgia Tech camp."* This was also stated in responses to the open ended questions. A majority reported that they wanted to attend Georgia Tech and become a civil engineer.

	Mean	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The course helped me to understand the science behind designing a bridge.	4.10	0%	0%	30%	35%	35%
The course helped me to understand how career in civil engineering relates to the real world.	4.14	0%	5%	15%	35%	45%
The course encouraged me to want to learn more career opportunities in Science, Engineering or Technology.	3.90	0%	15%	15.00%	35%	35%
The camp made me consider studying civil engineering in college.	4.10	0%	10%	5%	50%	35%

After completing the summer camp the majority (62%) of participants agreed that they have a more positive attitude towards engineering, followed by 33% who were neutral and 5%

who disagreed. Approximately 74% of the respondents agreed that they like science in school. When asked if they felt bored while attending the summer camp, 80% disagreed with this question and 15.6% were neutral.

The second section of this questionnaire asked for open-ended responses to several questions. The first question asked students for their impression of the faculty/graduate students/instructors they met during the camp. Students' overall impression of these individuals was good.

"The volunteer students/instructors were all great at helping/teaching us about bridge building."

"The instructors were quite helpful and gave us the tools we needed to know how to design and construct a successful bridge."

"They were very helpful, and explained everything until every student understood it. The graduate students seemed to know a lot about what they were teaching."

The second question asked if the participants could see themselves doing this type of work. Twelve (12) students responded yes to this question. When asked to report three of the most interesting things they learned during the camp, practically all of the activities were mentioned except building a column underwater. Building wood bridges mentioned most frequently as one of the most interesting things studied at the camp. The most notable answer to the question assessing students' least favorite activity was *"waking up early."* The final survey question asked how one might improve the camp, and the most popular answer was: *"allow more types of building material for bridges."* Several students indicated there was no need to change anything.

CEISMC Hovercraft Camp

This camp was held during the week of June 28, 2010, at Georgia Tech. The application process and the organization of the camp were handled by CEISMC. A total of twenty-four (24) rising 11th and 12th grade students attended the camp. Of those twenty-four, sixteen (16) were male and eight (8) were female. Similar to the hovercraft camp, student participants learned essentials of engineering design and the physics that keeps hovercraft aloft and moving. Students worked as a team to design and build their own hovercraft and tested it in various environments.

Similar to other camp results, the camp was effective in increasing students' awareness of transportation engineering (means before and after the camp increased from 1.78 to 4.14), helping students understand how transportation engineering research relates to the real world (mean=3.96), and helping students understand career opportunities in transportation engineering (mean=4.0). The final question in this section asked the participants why they attended the program. The most common reason given was: *"learn more about transportation engineering."* This was also stated in responses to open ended questions, i.e.: *"after this experience I want to come back to GT and study here."*

Eighty-seven percent (87%) of the students remarked that after attending this camp, they are more likely to pursue a career in a STEM field. This trend was followed in response to the open ended questions:

"Yes, before coming to this camp, I did not know what an engineer can do. After this camp, I understand the engineering process and still want to become an engineer. "

“I enjoy this kind of engineering design, and I think it would make an exciting career. Hopefully, I can be a Tech student one day.”

	Mean	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The course helped me to understand the science behind designing a hovercraft.	3.83	0%	0%	34.78%	47.83%	17.39%
The course helped me to understand how a career in hovercraft engineering relates to the real world.	3.96	0%	0%	17.39%	69.57%	13.04%
The course encouraged me to want to learn about more career opportunities in Science, Engineering or Technology.	4.00	0%	0%	30.43%	39.13%	30.43%

After completing the summer camp, the majority (87%) of participants agreed that they gained a better understanding of engineering design and the physics that keeps hovercraft aloft and moving.

The second section of this questionnaire asked for open-ended responses to several questions. The first question asked for their impression of the faculty/graduate students/instructor they met during the camp. Their overall impression of these individuals was good:

“All of the instructors and graduates were cheerful, encouraging, and knew quite a bit about hovercrafts. They guided the camp perfectly. “

“They were good at explaining how the hovercraft works but they let us have freedom in how we could design something that works.”

When asked to report three of the most interesting things they learned during the camp, practically all of the activities were mentioned. However, the response *“learned the physics behind hovercraft”* was reported by a majority of camp participants. Almost all participating students rated the overall camp experience as excellent.

Freight and Airport Class (Fall 2009)

A total of seventy (70) undergraduate and graduate students took a class on freight transportation and airport management. Students were organized in groups and each group was asked to complete an assignment using the simulation program “AIRLINE Online.” The primary purpose of this assignment was to provide a hands-on experience designing and operating an airline company. The assignment was comprised of a simulation effort to model the financial and operational decisions as though students were the operators of an airline company. Specifically, students were in charge of determining the airport locations, buying aircraft, providing services, scheduling, staffing, advertising, determining airfares and maintenance within constraints for a simulated “airline” business plan, and then to simulate the yearly operation of the airline in competition with other user-defined simulated airlines. At the end of the simulation period, various economic, financial, and operational data were outputted to quantify and compare the performance of the simulated airlines as they competed with one another. Towards the end of the semester, each student team critiqued and analyzed their progress and reported their findings. The following evaluation findings were derived from the “lessons learned and conclusion” sections of the students’ reports. The principle evaluation method employed for this program was to develop aggregate narratives for each student group. The narratives describe the effectiveness of the AIRLINE simulation assignment from the perspective of each group. The evaluation consisted of using mixed methods (qualitative and quantitative) to maximize the validity of the findings. We were also able to triangulate the findings from student group reports with an online survey for greater accuracy.

A majority of the student groups reported that this was “*a very interesting learning experience.*” The most valuable lesson students learned from the simulation was that the theory and reality of operating an airline are two very different things. Students reported that the simulation helped them to apply the theory to a real life setting, thereby providing a better understanding of the concepts involved in managing an airline. Furthermore, they felt that learning from a simulation setting was a good way of understanding the cause and effect relationship of each variable that is related to an airline operation. Students also stated in their reports that being involved with the entire process of managing an airline was a valuable lesson that they can apply to future “real life” situations. They also gained knowledge and an understanding of how such modeling techniques can be useful in real life experiences. As one group reported: “*We came to understand that a model simulation is a representation of reality based on a computer program. We felt that this simulation is an excellent tool that can be used by stakeholders in the planning process of an airport system.*” Another group reported a similar sentiment: “*Our experience with the Airline Online simulation has shown that it can be a powerful tool in helping airlines develop business and operation plans by better understanding the competitive element of the airline industry.*” Lastly, the groups also reported that this project was very accurate in projecting today’s airline industry trends. “*This airline simulation exercise did help us get an inside view of the everyday operations that are involved in the airline industry. The exercise was a very accurate representation of today’s industry also.*”

Students also emphasized that they had a deeper understanding and appreciation of the complexities involved in managing an airline after participating in the AIRLINE Online

program. Students felt that they learned about the intricate details of running an airline and what actually happens in the process. It was a “worthwhile” experience as the simulation could be easily related to other business models. Here are some significant quotes from the group reports:

“This exercise gave us a solid exposure and better understanding of the complexities in the airline industry. There are many factors that must be combined to construct a solid operation plan, many of which are not immediately apparent at the beginning of the project; however, during the project we developed a good sense of different factors that might have an impact on the results”

“After the conclusion of this simulation we learned of the complexity of the airline industry. This complexity is not limited to those that are seen by the average passenger. They are embedded within every decision that is made throughout the entire process. With this in mind, we learned that complex system of dynamic integrated sub systems.”

Students felt that the complexities of scheduling aircraft service and maintenance; the amount of capital investments that needed to be made; and the difficulty in designing a profitable airline business were the critical challenges involved in running an airline. Furthermore, according to group reports, the most time consuming aspect of the simulation was scheduling aircraft arrivals and departures and making sure that aircraft maintenance was up-to-date. Students also learned that external events also might have an impact on the decision making process. For example, *“the problems caused by the rising price of fuel became apparent to our group after the first year simulation. The only way to combat the rise in fuel price is to raise the ticket prices, lower the services offered in flight, which helped us understand that today’s economy plays a big role in operating an airline.”*

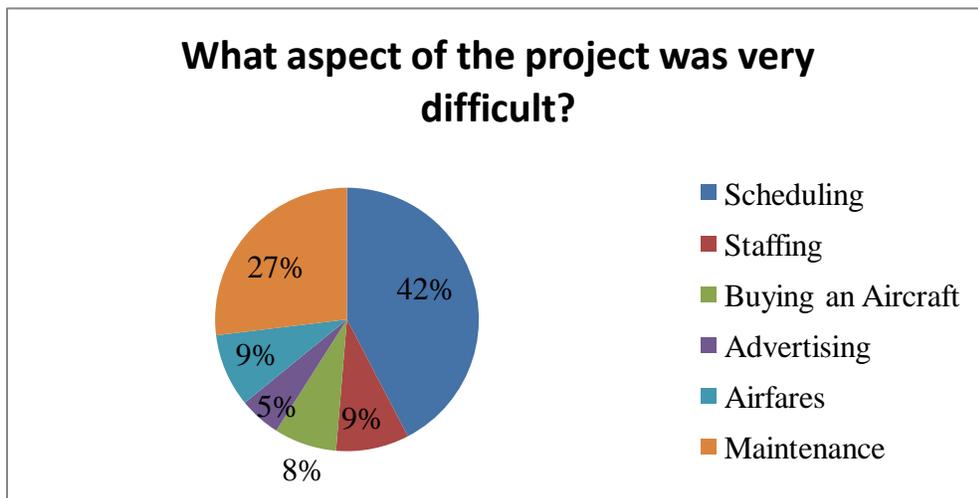
In conclusion, the reports also showed that students were deeply engaged with the simulation project, learned to interpret and respond to many aspects of their airline’s operation, made collaborative decisions in dealing with a variety of challenges, and developed a range of decision making skills.

An online survey was also used to obtain more information about the effectiveness of the AIRLINE Online simulation program. The survey was administered using a survey software program called Survey Monkey. The response rate within a few weeks of the initial e-mailing was 75%. This survey was used to evaluate three (3) components of the simulation project: 1) the overall effectiveness of the airline simulation project; 2) the most difficult task in the project; and 3) the future implications of students’ involvement in the airline simulation project. A total of fifty-four (54) students completed our survey; 74% were male and 26% were female. The following tables summarize the students’ responses to the survey:

Evaluation of Airline Simulation Assignment

<i>To what extent do you agree with following statements?</i>	Mean	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
The airline simulation project helped me to understand the real-world decision making process involved in building an airline.	4.20	1.85% (1)	1.85% (1)	5.56% (3)	55.56% (30)	35.19% (19)
After completing the airline simulation project, I had a deeper understanding and appreciation of the complexities involved in managing an airline.	4.18	1.85% (1)	3.70% (2)	7.41% (4)	48.15% (26)	38.89% (21)
The airline simulation project was a very positive learning experience.	4.07	1.85% (1)	0%	12.96% (7)	59.26% (32)	25.93% (14)
I have learned to interpret and respond to many aspects of an airline’s operation.	3.78	3.70% (2)	1.85% (1)	25.93% (14)	50% (27)	18.52% (10)
During the airline simulation project, I enjoyed making collaborative decisions in dealing with a variety of challenges.	3.94	1.85% (1)	5.56% (3)	14.81% (8)	51.85% (28)	25.93% (14)
Active simulation applications are the best way to learn in engineering.	4.03	3.70% (2)	5.56% (3)	12.96% (7)	38.89% (21)	38.89% (21)
The airline simulation project felt “real” in the sense that it simulates as closely as possible real world situations.	3.80	7.41% (4)	1.85% (1)	25.93% (14)	33.33% (18)	31.48% (17)

* Parenthesis indicates the number of responses



Our survey results highlight very important points. Eighty-five percent (85%) of the participants agreed or strongly agreed that the airline simulation project was a very positive learning experience. Additionally, a majority (91%) of the students agreed that the simulation project helped them to understand the real-world decision making process involved in building airlines. A similar distribution of responses was observed when asked if they had a deeper understanding and appreciation of the complexities involved in managing an airline. The results indicated that approximately 87% of the students answered this question affirmatively. When asked if they enjoyed making collaborative decisions in dealing with a variety of challenges, 78% agreed with this question, and 15% were neutral. However, 68% of students felt that they learned how to interpret and respond to many aspects of the airline's operation. This is also revealed in comments from the students: *"This exercise would have been more useful if we could run the simulations every week, then students can interpret and respond to different components of the airline operation. We can learn better from the mistakes and different settings of the simulation."* Additionally, 78% of the students agreed that active simulation applications are the best way to learn in the field of engineering. One student commented, *"this was the most enjoyable part of the class. A great activity in an engineering class, I think other engineering courses can use a similar approach."* Another student reported, *"It can be a worthwhile exercise as the simulation could be related to other engineering business models in the future."* Lastly, when students were asked if they could see themselves managing and operating an airline, 67% responded affirmatively. In that regard, one student commented that *"after this exercise, I feel that this is what I would enjoy doing after completing my degree."*

Scheduling arrivals/departures and maintenance of the airplanes were ranked as the most difficult aspects of the simulation study, with 62% and 39% responses respectively. One student commented: *"The major obstacle we encountered in scheduling is the difficulty in scheduling multi-point destinations. However, given the current user-interface of the program, it was hard to manage."* Several students also commented about the interface of the software:

"It was impossible to find where you went wrong. The simulation could use a better interface."

"I found the user interface less straight forward than I would have liked. The progression of steps necessary in setting up the simulation was not obvious or readily apparent."

Overall, the comments and responses to survey questions showed that student experience with the airline simulation was very positive, and that the simulation is a powerful tool in helping students to understand the challenges involved in developing an airline business and operation plan. Students gained a much better understanding of the competitive element of the airline industry.

High School Summer Camp (Airline online software)

We also adapted the simulation program into a summer camp for high school students (10-12th grade) interested in transportation engineering and the airline industry. At the end of three sections, nine students completed our survey: six (6) were male and three (3) were female. The following survey summarizes the students' thoughts about using the AIRLINE Online software.

Evaluation of Airline Simulation Assignment

<i>To what extent do you agree with following statements?</i>	Mean	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
The simulation project helped me to understand the real-world decision making process involved in building an airline.	4.88	0%	0%	0%	11.1% (1)	89% (8)
It was <u>challenging</u> working as a group.	3.22	22.2% (2)	11.1% (1)	11.1% (1)	33.3% (3)	22.2% (2)
I enjoyed the Airline Simulation project.	4.55	0%	0%	0%	44.4% (4)	55.56% (5)
I liked investigating real-world airline issues in a group setting.	3.88	0%	0%	33.3% (3)	44.4% (4)	22.2% (2)
The simulation helped me to understand better the consequences decisions have in the real world.	4.00	0%	0%	33.3% (3)	33.3% (3)	33.3% (3)
Active simulation applications are the best way to learn.	3.22	11.1% (1)	0%	44.4% (4)	44.4% (4)	0%
Navigating the software was <u>hard</u> .	2.88	11.1% (1)	44.4% (4)	11.1% (1)	11.1% (1)	22.2% (2)
This activity felt “real” in the sense that it simulates as closely as possible real world situations.	3.55	11.1% (1)	0%	11.1% (1)	77.78% (7)	0%

** Parenthesis indicates the number of responses*

All students agreed that the simulation project helped them to understand the real-world decision making processes involved in building and managing airlines (mean=4.88). Additionally, they enjoyed the airline simulation project (mean=4.55). Since the AIRLINE Online simulation software offers interactive learning opportunities for students and requires ongoing decision making skills, we asked students if it was challenging working as a group. Approximately 56% of the students agreed that working as a group was difficult. Furthermore, 67% agreed that this

simulation activity helped them to understand better the consequences decisions have in the real world sense (mean=4.0). Only a few students (33%) reported that the navigation of the software was difficult.

Students were also asked to rate the level of difficulty when making a decision for each aspect of the simulation project: scheduling, staffing, buying an aircraft, advertising, airfares, and aircraft maintenance. Students reported that scheduling arrivals and departures was the most difficult task because they were unable to completely understand consequences that their decisions had on scheduling. It was also challenging to decide when to schedule a given flight. Advertising was also a moderately difficult challenge during the project because of a disagreement between an advisor and an advertising manager.

Several students also reported that they learned that “*the decision process is very important.*” The context of this airline simulation provided an environment in which students learned to interpret and respond to many different challenges involved in an airline’s operation; made collaborative decisions in order to deal with these challenges; and developed a range of critical thinking skills. The feedback in the surveys showed that students enjoyed working collaboratively and making complex decisions in which they realized that they needed to consider a range of complex factors. They also indicated that more time was needed to complete and understand the simulation procedure. Lastly, when students were asked if this simulation study increased their interest in this kind of work, 4 of 9 students answered affirmatively.