Summer Engineering Experience (SEE) Program

The Summer Engineering Experiences, SEE Program is designed with an objective to enhance students' hands-on, computational, programming, communication, and problem solving skills. The SEE program is offered during the summer to the first year engineering students and cover topics related to engineering computation using MATLAB and C++, robotics, bridge truss design & analysis, and technical writing.

The following learning outcomes have been established to assess student performance in Summer Engineering Experience program. These student outcomes are as follows:

(a) Students will demonstrate an ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
(b) Students will demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data with the use of computer applications current to industry;
(c) Students will demonstrate an ability to design and apply creativity in the design of engineering systems, components and process;
(d) Students will demonstrate an ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty;
(e) Students will demonstrate an ability to communicate effectively with a range of audiences
(f) Students will demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools used in the engineering field;

Attainment of these outcomes prepares students in the SEE program for the core courses within engineering disciplines and provides them with an ability to be successful in their professional career path.

Mapping of student outcomes vs Topics in SEE Program: The mapping of student outcomes vs topics offered in SEE program were discussed and developed by the involved faculty members and is presented in Table 2.

Table 2: Relationship of Topics to Student Outcomes

Topics	a. Math, Science, Solve Engineering	b. Experiments, Computer	c. System Design, Components,	d. Function Effectively on	e. Communication	f. Techniques, skills, and modern tools
Truss Bridge Design and Analysis	●	●	●			
Computational Method with MATLAB	●	●				●
Computational Method with C++	●	●				●
Statics	●					
Robotics		●	●	●		
Technical Writing and Presentation				●	●	

Computational Method with MATLAB and C++ Application

This topic in the SEE program provided students with some fundamental knowledge of engineering analysis and programming using both MATLAB and C++. Students were introduced to topics such as Taylor Series, finite difference, root determination, and numerical integration with application to engineering problems. Both MATLAB and C++ were introduced to students as a computing tool to generate results and facilitate the process of investigating behavior in an engineering system. Through both computational and programming (MATLAB and C++) sessions, students were introduced to the following computational processes

- Mathematical or governing equation of an engineering system
- Development process of an analytical and numerical formulation
- MATLAB and C++ Programming
  - How to work in MATLAB and C++ environment?
  - How to use logical control loops?
  - How to write a MATLAB and C++ program?
- Development process of closed-form and numerical solution of an engineering system

Figure 1 is a graphical representation of this computational project based learning.

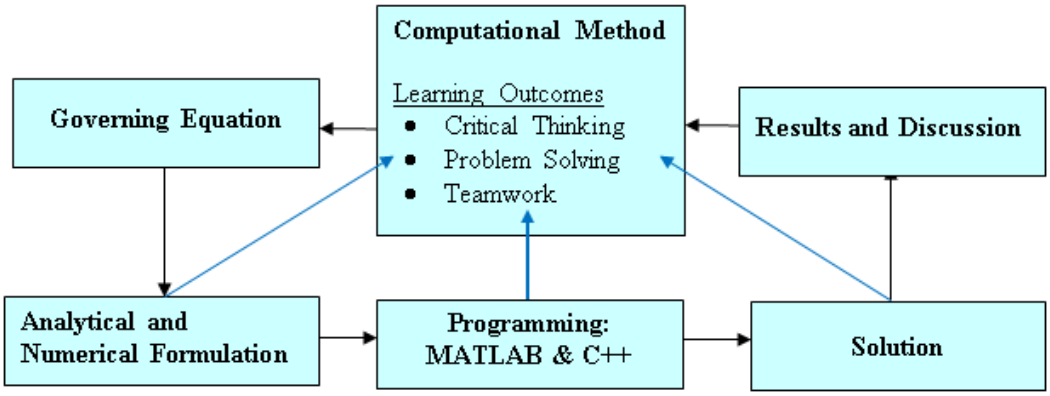

Figure 1: A graphical model of computational project-based learning

In the first two weeks (Two hours per day for four days per week) students were introduced to both MATLAB and C++ programming and how to use logical control loops such as for loop, while loop, conditional loop, switch, and function to develop programs for specific application. In the third and fourth weeks students learned how to write a program with application to engineering problems related to root determination, numerical integration, beam deformation analysis, impulsive vibration, and numerical analysis of a governing engineering equation. In the last week, students worked with faculty mentors and developed a project titled "Computational Methods of Analysis Using C++ and MATLAB" and presented their work to faculty and the Vaughn community on the last day of the summer session. Their projects were assessed by faculty members according to the following learning outcomes

- Students will demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools used in the engineering field – Both MATLAB and C++ are used as a programming and computational tool to solve analytical and numerical solution of an engineering system.

- Students will demonstrate an ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics – Both the analytical and the numerical form of an engineering governing equation require knowledge of mathematics and engineering principles.
- Students will demonstrate an ability to communicate effectively with a range of audiences – Projects require both report writing and presentation.

Robotics and autonomies programming

In order to enhance freshman students' engineering experience, the robot design and implementation were considered as an important part of the summer program. The course objectives were to help students understand engineering design, implementation and troubleshooting process using the practical platform -- VEX Educational Robots (EDR).

Students for this session were involved with engineering design and development, understanding DC motors with the relationship between the speed, power and torque, and learning to use concurrently a variety of sensors in robot programming using RobotC and VEX Cortex controller. Upon the completion of the class, students demonstrated knowledge of the engineering design process and had the ability to complete a project. They were, for example, able to build and to program a mobile robot using VEX robotic parts, different types of sensors as well as 3D printing parts. The activities of the course covered the following topics:

1. Introduction to engineering, team work, design process and design documents.
2. Discussion of DC motors as well as speed, power and torque limitations under the requirements of load and speed.
3. VEX Cortex controller as well as programming DC motors and sensors.
4. Program structure review and existing program analysis.
5. Robotic project design, implementation and trouble shooting.
6. Presentation of the robotic project.

During their five weeks of classes with four days per week and one hour per day, students learned step by step about the above subjects. In the first five weeks, their homework assignments included the development of engineering design concepts as well as robot programming to complete a sequence of tasks using a variety of sensors. In addition, three quizzes were given to examine students' learning outcomes.

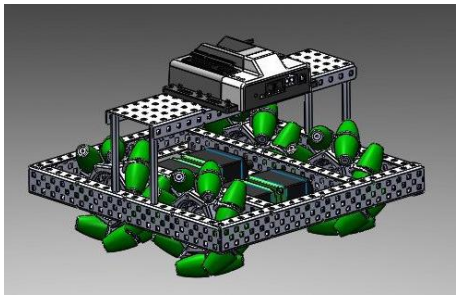

Figure 2: Robotic Chassis with Motor Mecanum Drive

By the end of the class, students selected a project titled Robotics and SEE Program. In the project, students built a robotic chassis with four motor mecanum drives as shown in Figure 2. On the chassis, six different sensors were installed. They are one encoder, one ultrasonic sensor, two line tracking sensors, one limit switch, five bump sensors and one potentiometer. A speaker module is also installed. The VEX Cortex controller was programmed to explore the possibility of developing sensor redundancy, i.e. when an object is captured, the correct result will be derived from the measured results from a number of sensors and the speaker will remind the designer which sensor(s) may have a problem.

Bridge Truss Design and Analysis

This session of SEE program introduced students to some basic concepts used in solid mechanics along with simple design and hands-on application.

During this session, students were given an introduction to basic concepts such as stress, strain, deformation, and Hooke's law. Applications of these concepts were then introduced to students in which they studied and analyzed a basic Warren truss bridge. Students were given an opportunity to design and build a simple Warren truss bridge which was required to support the load of a truck driving over it. During this design process, students used software such as excel and CATIA. As part of the class, students were also required to write a short report explaining their design process and build a small bridge based on their design. Figure 3 shows the bridge designed by students using CATIA.

Figure 3: CATIA design of a Warren truss bridge

In the last day of summer session, students presented their project titled "Bridge Design and Analysis – A hands-on project-based learning" to faculty. Their project was assessed according to specific student learning outcomes.

Technical Writing and Presentation

This program addressed the technical writing needs of students in engineering, such as using plain language and clear word order and reducing ambiguous terminology. Students completed daily exercises covering many stylistic aspects of engineering writing, and they practiced the expression of technical knowledge in a concise and effective manner.

The program culminated with several group presentations, and in preparation for these public talks, students learned how to tell effectively the story of their work. After practicing their presentations in front of their classmates, they then made adjustments to their exhibitions based on the observations and comments they received.

Assessment: Students' Evaluation of SEE Program

As an indirect measure, a rubric survey based on contents of SEE programs has been given to students to assess the effectiveness of the SEE programs. Table 3 below provides the results of these evaluations.

TABLE 3: SURVEY'S RESULT AND ANALYSIS

Questions	Response in percent of participants (Number of participants: 5)			
	Poor	Fair	Good	Excellent
1. Rate SEE program in preparing you with the applied computational, design, & programming.			40%	60%
2. Professor's ability in introducing you to MATLAB programing and application				100%
3. Professor's ability in introducing you to C++ programing and application				100%
4. Professor's ability in introducing you to robotics and autonomous programing		20%	20%	60%
5. Professor's ability in introducing you to bridge design and analysis			20%	80%
6. Professor's ability in introducing you to technical writing and presentation		20%	40%	40%
7. Rate SEE program in providing you with skills in problem solving, communication, and teamwork.			20%	80%
8. Rate SEE program in providing you with adequate knowledge and skills for your program of study.			40%	60%
Overall average Learning Outcome Attainment		**8%**	**36%**	**56%**

The survey results and student comments are an indication that the SEE program has been satisfactory and provided students with a profound appreciation for engineering education. Overall, 56 percent of the survey participants rated the SEE program as excellent and 36 percent rated their instruction as good.

Below are students' comments regarding SEE program

- The SEE Program was an excellent opportunity for me to gain some insight as to what I can expect when working post-graduation. I learned the practical applications of things, as well as how to apply them. I would recommend the SEE Program to all freshman students, as it also prepares them for future classes.
- This program helped me to understand applications of engineering principles in bridge design, robotics as well as engineering computation. Also, the programming skills that I learned through the SEE program provided me with the knowledge in analyzing behavior of an engineering system. Certainly, I do recommend this program for all freshmen who are entering in an engineering program.
- The SEE program was very rewarding; it gave me a background of what I will be studying in the upcoming future. I do recommend it for all freshman students.
- I felt that the program was very beneficial for me personally, because it offered experience in classes that I had not taken yet that were critical for engineering. As a graduate of the program I would recommend that the program be offered to freshman students who are interested.

Friday's Seminars and Workshops

Friday's session of SEE program is designated for technical seminars and workshops. This session is designed to enhance students' learning outcomes related to critical thinking, problem solving, and life-long learning. Given the rapid pace of technological change, the Friday's seminar series and workshop will help our students in SEE program to develop a mind-set to adopt changes in technology and prepare them for future challenges.

Seminar #1
Date: Friday, June 3, 2016, 10 am -12 pm
Presenter: Mr. Johnathan Sypeck, Ph.D. Student at City College, CUNY
Topic: Academic Success

In this session, Mr. Jonathan Sypeck, an outstanding Vaughn alumnus and a current Ph.D. student at City College of New York, addressed students in SEE program about educational determination, willingness, and ethic as prerequisites for the academic success.

He expressed, education is an extremely important part of your lives, but it is a two-way street: it is not only the job of the professors to teach you, but you yourselves to keep and maintain a healthy academic ethic. This is why so many students move from school to school; they feel that the professors in one school are better than the other, or the facilities are under par. If you don't put in a relevant amount of effort into your education, then it doesn't matter if Richard Feynman was your professor or your school had the largest library in the world. Education starts with you, and it takes serious determination to make it in the field of Engineering. If you put your entire mind and body into your work and you never cease to strive for the best, then being an Engineer has limitless rewards. Just think: in a few years, you will be counted among the likes of Nikola Tesla and Alexander Graham Bell; maybe one day, you'll be as famous as them!

Seminar #2
Date: Friday, June 3, 2016, 12 pm – 2 pm
Presenter: Mr. Waseem Hussain, Student in Mechatronic Engineering
Topic: Union Crate Start-up Company

In the afternoon session of SEE program, Mr. Waseem Hussain, an outstanding senior student in Mechatronic Engineering program and Co-Founder & VP of Union Crate talked about his start-up company.

He expressed, Union Crate is the first real-time management platform food service operating system that bridges the gap between supply and demand by analyzing customer behavior and predicting demand for every product. He explained how his company will reduce waste and increase revenue by moving excessive food.

Mr. Hussain shared his expertise by providing insight on how to balance his academic career with his start-up dream as well as discovering how the right support services from both academia and business expertise sources helped him successfully launch his idea.

Waseem Hussain Co-Founder & VP of Union Crate Start-up Company

Seminar #3
Date: Friday, June 17, 2016, 10 am – 2 pm
Presenter: Mr. Marvin Blackman, Control Systems Engineer at Wunderlich-Malec
Topic: Efficient Engineering

In the morning seminar session, Mr. Marvin Blackman a Vaughn alumnus and a control systems engineer at Wunderlich-Malec talked about efficient engineering and required process to be an efficient engineer at the workplace. He mentioned engineering is a process, it is ever evolving and engineers must realize that there is more to engineering than what is documented in our textbooks, taught by our professors and observed in a school setting. He emphasized several key items as building blocks for being an efficient engineer

- Attitude vs Aptitude - Having the right attitude is the key to being successful in much more than just your professional career. Your attitude impacts more than the task at hand, it impacts the people around you, the project and the company you represent.
- Dedication - What does it really mean to be dedicated? It's more than just working long hours. Dedication means being committed to yourself, your coworker, your project and your company.
- Embrace Technology - Technology is all around us. But how do engineers embrace it when technology shows up at their company door.
- Be Resourceful - Remember that 90% of everything you see once you get out of school is going to be 'new'. You're going to hear terms like 'sink or swim', 'learning on the fly', 'on the job training' and much more that will imply we don't expect you to know it but we're sure you can figure it out. Being resourceful will work best if it is also coupled with your dedication.

- Take Ownership - Engineering if it had to be a sport would be a team sport. Your aim is to be the individual that looks out the window for someone to praise and into the mirror for someone to blame. By using your window and mirror appropriately you are preparing yourself to be more than just an engineer but a leader.
- Control Engineer - He also talked about his career and responsibility as control engineer for designing a solution to controlling a system, process or task to a specification or user defined requirement. His presentation followed with 20 minutes open discussion session with students.

The afternoon session included a workshop that was based on the Honeywell's Experion LX platform and Matrikon OPC Server. Experion is used in a distributed control system (DCS) for process control. While Matrikon OPC server is used to take a number of propriety communication protocols and serve as the supervisory control and data acquisition (SCADA) system using the standard OPC protocol. The lab involved a hands-on demonstration of how points are configured in hardware and presented to the end-user by a human machine interface (HMI) in software. Students worked in groups of 3-4 and were able to practice some of the key elements that were discussed in the morning presentation. This workshop included labs that were designed to simulate real world scenarios and encourage teamwork.

Control System Workshop - The Honeywell's Experion LX platform and Matrikon OPC Server

Seminar #4

Date: Friday, June 24, 2016, 10 am – 1 pm, Room W143

Presenter: Mr. Derry Crymble, Academic Solutions Advisor at Quanser

Topic: Engineering product and feedback control system designs

Mr. Derry Crymble, Academic Solutions Advisor at Quanser, addressed students in SEE program and talked about Quanser's engineering product and feedback control system designs in the workshop.

He began his discussion on three-year design procedure for the autonomous unmanned aerial vehicle - QBall system. The engineering design process had gone through need analysis, brainstorm for innovative ideas, computer simulation, repeated modification of the design, and implementation and testing.

After the introduction, Mr. Crymble took a rotary servo unit with the QFLEX 2 USB interfacing panel and MATLAB/Simulink software as an example to explain the working principle of a real-time feedback control system. He started from the open-loop system: control of the servo motor without a feedback signal from the encoder. The motor position was easily disturbed by external force. Once a feedback loop with P control was added, the motor position was stable due to an applied external force. However, the motor position response showed a large overshoot and steady-state error. With a PI control, the large overshoot disappeared. Finally with present of a PID control, both overshoot and steady-state errors were eliminated.

The workshop successfully provided students first-hand experience for engineering project and control system designs, which aroused great interests of students.