The Freshmen Experience at Western Kentucky University

Mark E. Cambron
Western Kentucky University, mark.cambron@wku.edu

Abstract - **This paper describes the freshmen experience at Western Kentucky University for electrical engineering students. Students take three engineering classes in addition to math, science, and general education classes. Three engineering classes are offered to electrical engineering students during their freshmen year. Pathways into the program are presented. Suggested curriculums are given depending on math placement. The first course described is a University Experience seminar focused on introduction to the engineering profession and university survival skills. The second course is traditional course in Digital Logic. The final course teaches design through robotics. Students must design and build an autonomous robot. During this design experience, the students solder components, fabricate a frame, and program a BASIC Stamp microcontroller.**

Index Terms – Design, EE Curriculum, Pathways into Engineering.

INTRODUCTION

The Mission of the Western Kentucky University's Department of Engineering revolves around our vision of Project Based Learning. The central focus of this vision is that the faculty engage students in activities to support development of a clear understanding of engineering practice. The roles of students - as learners, as observers, as assistants, and as practitioners - should be supported by both the external project activities of the faculty as well as the implementation of the curriculum such that the practice of engineering is clearly demonstrated [1].

In the 1990's, a move towards a project-based learning model was developed and is generally supported in the American engineering education undergraduate community [2,3]. A primary focus of WKU's engineering programs is to provide a project-based experience at all levels of the curriculum [4]. WKU's goal is to provide students with relevant project experiences inside and outside the classroom. Throughout the electrical engineering program, hands-on experiences have been incorporated into the curriculum by the addition of several lab classes, design classes, and project classes. In addition, students are encouraged to be involved in industry related projects outside of the classroom.

Nationally students drop out of college at an alarming rate [5]. WKU's electrical engineering program believes it vital for freshman to experience engineering during their freshmen year. The electrical engineering program believes that students need to be motivated by experiences in their major as soon as possible. Successful engineers who enjoy classes are more likely to persist in completing an engineering program. In many engineering curriculums engineers don't have access to engineering class or faculty until their sophomore year. If a student starts lower than calculus this contact can be delayed an additional year. Suggested curriculums for different math levels are presented.

This paper describes the freshmen experience at Western Kentucky University for electrical engineering students. Students are encouraged to take three engineering classes in addition to math, science, and general education classes. The three first year engineering classes are discussed. The first course described is a University Experience seminar focused on introduction to the engineering profession and university survival skills. This course is intended for first semester engineering students. The second course is traditional course in Digital Logic Fundamentals. The digital logic course is a three hour lecture with 1 hour of lab experiences. Many hands on experiences are presented. The final course teaches design through robotics. Students design and build an autonomous robot. During this design experience, the students solder components, fabricate a frame, and program a BASIC Stamp chip.

PATHWAYS INTO THE ELECTRICAL ENGINEERING PROGRAM

Western Kentucky is a regional university primarily serving south central Kentucky. Students enter the university with a range of abilities and differing experiences from high school. In addition, many of EE students are transfer students from community colleges or other universities. The skills and experience of students have a large impact on their freshmen experience.

In order to evaluate students mathematical ability the university uses a math placement exam and the student's ACT or SAT score in math. Table 1 shows where students were placed at the time the student entered the EE program.

Almost half (~48%) of EE students are placed in Calculus I or higher. One quarter of EE students are placed in College Trigonometry and the remainder of students (~27%) are in Algebra or lower. Many of the students placed in Calculus II or above are transfer students. Proper placement of students into the correct math course increases the possibility for a successful first experience in their math course. Math courses are also used to determine when students can take science and engineering courses.

TABLE I
STARTING MATH PLACEMENT

Developmental Math	8%
College Algebra	19%
College Trigonometry	25%
Calculus I	26%
Calculus II	9%
Calculus III or higher	13%

Table 2 shows a suggested first year curriculum for students starting in Calculus I. Approximately 25% of EE students start at this level. The critical pathway is for students to take Calculus I and then Calculus II and University Physics I.

TABLE 2
SUGGESTED CURRICULUM FOR STUDENTS STARTING IN CALCULUS I

Fall Semester		**Spring Semester**	
Calculus I	4.0	Calculus II	4.0
Chemistry	4.0	University Physics I	4.0
University Experience - Engineering	1.0	EE Design I	1.0
Digital Logic	4.0	Public Speaking	3.0
English I	3.0	General Education	3.0-6.0

Table 3 shows a suggested first year curriculum for students starting in Trigonometry. Students starting at this level are able to take all suggested first year electrical engineering courses and are able to graduate in 4 years.

TABLE 3
SUGGESTED CURRICULUM FOR STUDENTS STARTING IN TRIGONOMETRY

Fall Semester		**Spring Semester**	
Trigonometry	3.0	Calculus I	4.0
University Experience – Engineering	1.0	Chemistry	4.0
Digital Logic	4.0	EE Design I	1.0
English I	3.0	Public Speaking	3.0
General Education	3.0-6.0	General Education	3.0-6.0

Table 4 shows a suggested first year curriculum for students starting in Algebra. Students starting at this level are able to take two of the three suggested first year electrical engineering courses. Students are required to take a summer course in math if they wish to graduate in 4 years.

TABLE 4
SUGGESTED CURRICULUM FOR STUDENTS STARTING IN ALGEBRA

Fall Semester		**Spring Semester**	
Algebra	3.0	Trigonometry	3.0
University Experience – Engineering	1.0	EE Design I	1.0
English I	3.0	General Education	12-15
Public Speaking	3.0		
General Education	3.0-6.0		

Electrical engineering students at WKU are accepted as EE-prep students. In order to transition to electrical engineering students must complete 10 courses consisting of core math, science, communications and introductory engineering courses. Students must earn a "C" or better in the following courses:

- Calculus I
- Calculus II
- University Physics I
- University Physics II
- Computer Science I
- EE Design I
- Digital Logic Fundamentals
- Circuits and Networks I
- English I
- Public Speaking

UNIVERSITY EXPERIENCE - ENGINEERING

All first time engineering students take University Experience for Engineers. University Experience for Engineers is a 1 hour class. The university has both departmental sections of University Experience as well as general sections of the course. The departmental section of the class is composed of the all engineering majors in the department. The engineering section of the course has two primary goals. The first goal is explore the profession of engineering and the different engineering disciplines. The second goal is help students transition into the University. The university is a difficult to understand and navigate. This course tries to give students important information to increase their chances for success. At the completion of this course, students will be able to:

- Describe engineering as a profession and how engineering functions in society.
- Explain the differences among Civil, Electrical, and Mechanical Engineering.
- Outline the academic requirements for his or her chosen major at WKU.
- Make use of the information/research facilities available at WKU.
- Use effective goal setting, time/task management, and note/test taking skills.
- Think critically about readings and presentations, especially those concerned with engineering topics.
- Use software to generate documents, and perform calculations and professional tasks.
- Communicate simple technical information effectively in both oral and written forms, in both formal and informal settings.
- Evaluate professional ethical responsibilities and dilemmas.
- Reflect on her or his own learning.

Students are given a tour of library and taught how to use the software for the library's digital assets. Students are required to research an engineering topic and find a wide range of sources.

Transfer students are not required to take this course. In order to take this course students must be in College Algebra (or higher). Students that place below College Algebra are put into developmental math are encouraged to take a general section of University Experience. Few of these students successfully transition into Engineering. If students persist and pass their developmental mathematics courses they are able to take this course if they wish.

DIGITAL LOGIC FUNDAMENTALS

Electrical Engineering Students are required to take one technical course in electrical engineering during their freshmen year. Digital Logic Fundamentals is a 4 hour course introducing digital logic. Students must be in College Trigonometry (or higher). The course has 3 hour lecture and 1 hour lab experience. WKU's EE faculty believe that it is important for students to get a traditional engineering course during the freshmen year. The goal of this is to motivate the students persist in the major. Digital logic is ideal in that Calculus and physics are not required for the majority of the topics needed in this introductory course. Upon completion of this course students should demonstrate the ability to:

- perform arithmetic in the various number systems;
- use Boolean Algebra to minimize the design of a logic circuit;
- use Karnaugh maps to minimize the design of a logic circuit;
- design combinational logic circuits;
- design synchronous sequential circuits.

The course also has a lab requirement. The lab gives students the opportunity to build circuits and see physical results of concepts presented in class. The lab component of this course allows for several hands on experiences. The lab consisted of 7 labs and a final design project.

- Lab1: Basic Skills
- Lab2: Logic Gates
- Lab 3: Design of an Alarm Circuit
- Lab 4: Flip-Flops
- Lab 5: Counters
- Lab 6: State Machines
- Lab 7: Adders
- Final Project: Digital Clock

The lab provided a practical reinforcement of concepts presented in the class room. The students were required to fabricate a digital clock on a prototype board. The final project was challenging and rewarding experience for the students.

EE DESIGN I

In the WKU's EE program, a design course is included in each year of the 4-year curriculum [6]. The role of these courses is to bring together material from various courses and form an integrated curriculum. The sequence is composed of four one hour design courses and a three hour senior capstone design experience. The first design course introduces students to the design process, problem-solving techniques, teaming skills, and oral and written communications. Students are also introduced to basic fabrication and soldering techniques. In EE Design II, students further explore the engineering design process through cost constraints and teamwork. Students discuss ethics and professionalism and complete a printed circuit board design project. EE Design III topics include: application of numerical methods, statistics, economics,

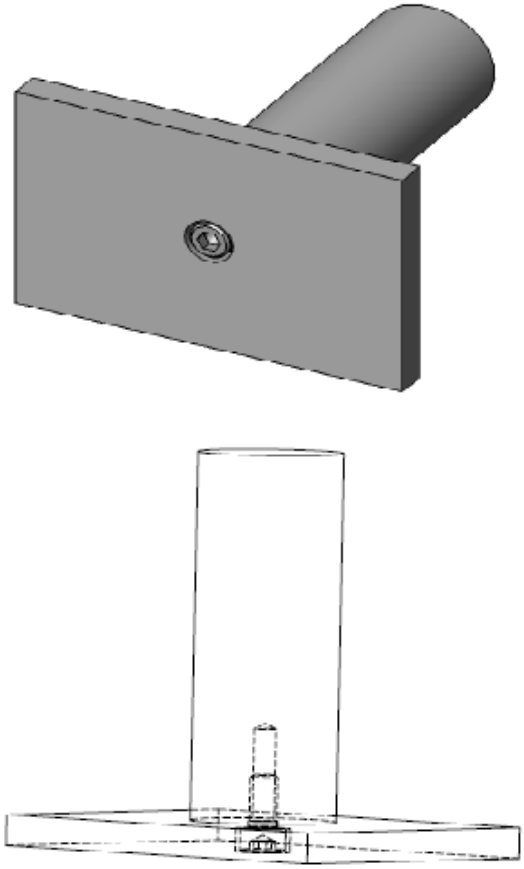

Figure 2: Fabrication Part

production techniques, and ethics. Students are put on teams and have a more intensive project. Senior EE students have Design IV and their capstone design course [7-10]. Students are assigned an industrially sponsored project. Students work with engineers from local companies on projects.

Figure 3: Robot Playing Surface

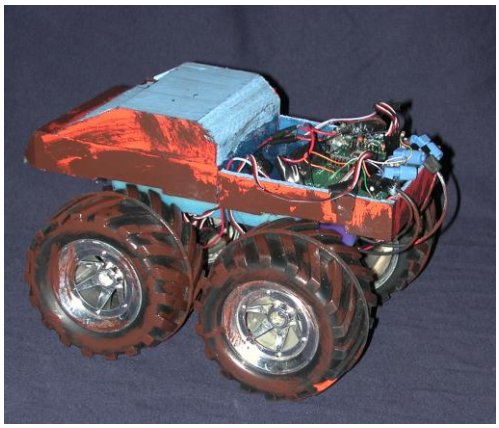

Figure 3: EE Design I Project

EE Design I introduces the field of electrical engineering to freshmen. Fabrication skills are taught with a safety training course. Students build a simple artifact (Figure 2) that requires cutting, milling, drilling, and layout. The class culminates in a team project where students design an autonomous robot. The robot must be able to navigate a simple course (shown in Figure 3). The robot project was designed so that the students would learn teamwork skills, soldering techniques, basic circuit construction, and elementary programming skills. The students were placed in teams of two and given kits from which to construct their robots. The students were also provided instructions on the construction of the robot and a simple Basic program. The students were expected to build and program their robot. Students were encouraged to enhance the design of their robot and program. Students are required to fabricate the robots body. Figures 3 and 4 show two examples of robots.

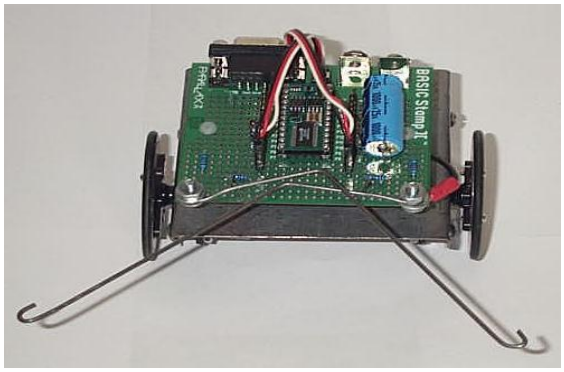

Figure. 4 EE Design I Project.

CONCLUSIONS

This paper discussed the freshmen experience at Western Kentucky University for electrical engineering students. Pathways into engineering are discussed and suggested first year curriculums are given. Three first year engineering courses were described. The first course described is a University Experience seminar focused on introduction to the engineering profession and university survival skills. The second course is traditional course in Digital Logic. The final course teaches design through robotics. Students design and build an autonomous robot.

The autonomous project forms a foundation for the students in skills such as circuit construction and elementary programming. This project provided a hands-on opportunity for the students to learn about the field of electrical engineering. The project was their first experience working with electronics and processors. This type of opportunity is invaluable for retention purposes and for aiding students who are unsure about the major.

The students were very enthusiastic about the robot. They were surveyed at the end of the project and expressed that overall this was a very positive experience. When asked what they liked about this project, their comments included: "It gave a real taste of what electrical engineering is", "It was real cool and it actually got us involved making something electronic", "I liked the fact that we got to build something and then see it work." When the students were asked what they disliked about the project, most answered they disliked nothing but some students indicated more instructions would have been helpful. Several non-traditional students felt the project was too easy.

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