
AC 2012-3288: CAPSTONE PROJECT: ELECTRONIC NAME TAG SYSTEM

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Capstone Project: Electronic Name Tag System

Abstract

Concept of Capstone projects provides the students with a challenging interdisciplinary engineering and technology problems that requires them to integrate the core concepts from engineering technology courses. The interdisciplinary project provides the students with a better perspective of real world engineering and technology projects. This paper outlines a general framework for project planning that can be used by students and faculty advisors to outline goals and objectives of senior design Capstone projects that requires team members to organize and design/build the project with limited resources. This paper also describes a capstone project which served as a pilot study for the capstone project course which will be implemented in the Department of Engineering Technology in spring 2012 for the Civil and Electronics Engineering Technology majors. Electronic Name Tag System project was carried out by the Summer Undergraduate Research Training (SURT) program student during the summer of 2011. The basic project requirement was to design and build an Electronic Name Tag using the PIC16C57 microcontroller. The main objective of the project was to familiarize students with Embedded Systems which is a combination of computer hardware and software, and perhaps additional mechanical or electronics parts, designed to perform a dedicated function. In some cases, embedded systems are part of a larger system or product, as in case of microwave oven, cell phones, GPS, cruise missiles and etc. The 3D modeling software called Autodesk Inventor was also used to design and assemble the case for the Electronic Name Tag. Student was presented with the opportunity to conduct tests with a Stamp Microcontroller, PBASIC compiler and other interfacing devices.

I. Introduction

Teaching engineering design through senior project or capstone oriented courses has amplified in recent years. The trend to increase the design component in engineering technology is not only part of the ABET recommendation but is essential to prepare graduates for engineering practice. Senior design Capstone project implements the skills required in Electronics Engineering Technology, Civil Engineering Technology and Computer Science Technology to solve real world engineering/technology problems and to develop/implement a feasible project. The Capstone project proposal was initiated by the Department of Engineering Technology based on recommendation of ABET.

Capstone senior design project will be a of part degree requirement from fall of 2012. In some programs, the capstone senior design project is accomplished in one semester. Others require two semesters to design and implement the project. At this institution, the capstone senior design project is accomplished during the senior year in one semester. The senior design course is of three semester credit hours. Students are divided into several interdisciplinary teams based on their interest. Each team will form a company and write a proposal to the instructor in their area of interest. Students who worked on special projects during their internship can submit a proposal to continue working on that project given that they have a mentor from the industry. Once the proposal is approved by the instructor, students are set to do the technical design of the project. Each team is required to present their project orally as well as submit documents to

support their design work. Students are evaluated by a team that consists of instructors as well as engineers from the industrial advisory board committee.

During the first few weeks of the semester the problem statement is formulated and basic conceptual designs are generated and then evaluated. The conceptual design that solves the problem best is then selected and a complete and detailed design is generated by the end of the eight weeks. In the final eight weeks of the semester, a prototype of the finished design is built, tested and evaluated. Whenever it is possible, the students are exposed to real life design problem experience by getting them involved to work on design projects provided and supported by the local industry and professional societies such as IEEE and ASCE. Types of the design projects that the local industry is interested in include: completely new design to perform specific task(s), modify or improve existing design, and solving problems in some industrial operations. Teaming skills can be improved through the use of a structured framework using a Team Process Document (TPD), which is a general document that can be used by students and faculty advisors to outline goals and objectives and to facilitate communication among team members. When used properly it provides a method that facilitates good teamwork and organization. It is not a stand-alone method for developing good teamwork, but assists in developing the well-established and essential components of a successful team.

II. Course Information

A propagation of capstone design courses has occurred in an attempt to satisfy the ABET requirements. While the format of capstone design courses varies significantly among different engineering technology departments, the objectives of such courses generally include at least some of the aspects of the ABET requirements. The ABET design requirements provide the common thread that links capstone design courses for all engineering technology disciplines. Important aspects of capstone design courses include course description, student design teams, faculty involvement, industrial involvement and the evaluation of student performance.

A. Course Description

This course will require students to undertake team projects, by applying knowledge acquired from classroom/lab activities in program courses and core courses. The student will create or construct a product, a circuit or mechanism using circuit building, troubleshooting and other engineering skills developed through previous course work. The project activity includes conceptualization, detailed planning and design, project construction, cost and production considerations, quality assurance and project presentation. The objective of this course is to provide students with experience working on real life engineering and technology projects. Following are expected student learning outcomes.

Expected Student Learning Outcomes:

Upon the completion of this course students will be able to:

1. Form a company and a team to write proposals to win engineering design projects
2. Present their design orally as well as in writing using necessary engineering documentation.

B. Student Design Teams

Another important aspect of capstone design course is the way in which students interact while completing their design projects. The ability to function as a member of a team is considered by many educators to be an essential skill of today's engineers. Many educators provide team oriented capstone projects to help students learn how to function effectively as a team member before entering the work force. Other reasons for using team oriented capstone projects include better simulation of industrial conditions and an ability to tackle larger projects. Students can also improve interpersonal and leadership skills from team related projects. Student teams are formed based on the concept of equal weighing with respect student capabilities and interests. A proper balance of skills and interests should give each student team an equal chance of successfully completing the design project.

C. Faculty Involvement

Coordination of capstone design courses is done by a team of instructors. Having a team of instructors coordinate the course places a greater emphasis on the importance of teamwork. It also allows for a way to meet the increased faculty demands that are often required to offer such a course successfully. The role played by the faculty coordinator(s) of capstone courses often act as advisor for one design group and as technical consultant in his/her area of expertise for the other groups. Instructors also act as the client for student design groups when industrial clients are not involved with the course.

D. Industrial Involvement

Industrial involvement in capstone design course includes support in form of equipment, software, and technical consulting. The industrial sponsors have a mentor engineer who assists the students and who follows the progress of the project. The involvement of a mentor engineer is often one of the most important factors determining the success of industrial-sponsored projects. Research shows that projects that were funded by industry and then turned completely over to the students were invariably less successful than those that had an interested mentor engineer involved with the project. Having students feel responsible and accountable to an industrial "customer" seems to be an important factor in their learning the practice of engineering.

E. Evaluation of student Performance

Individual students will be evaluated by their team members. Each member is required to write a confidential percentage of the individual member's contributions to the project. The grade will be based on the average of the team member's evaluation. For Example: Team 1 has gained 400 points in their project. One member was evaluated by his peers as contributing 50% effort. The grade of that member will be $50\% \times 400 = 200$ point which means a "D" grade in the course

III. Project Planning

The Capstone senior design project requires that from the initial introduction to final presentation students must complete all tasks for design, fabrication, documentation, and presentation of the project within one semester. Therefore, to ensure that all projects are achieved in a timely fashion, students are guided to prepare a detailed plan after the selection of the project. Following are the stages of the project along with scoring guidelines:

Project Stages:

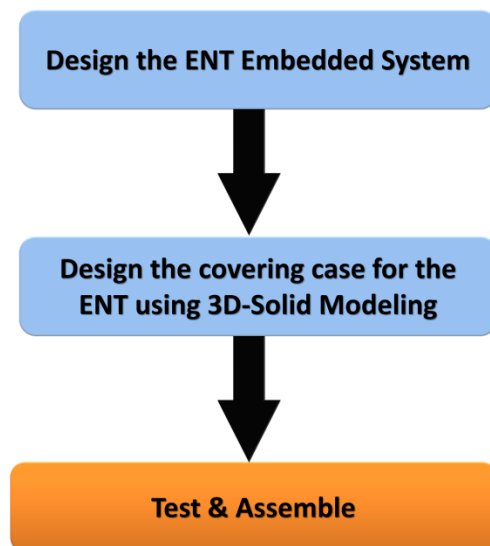
<i>Stage Activities</i>	<i>Due Date</i>	<i>Points</i>
1. <i>Team Selection; each team should have at least three students and designate a team leader and give the information to the instructor. Team leaders will keep a journal of all activities including meetings, interviews, information researched. and must be included in the submission of the final report</i>	**/**/**	10
2. <i>Each Team form a company and decide on a name for their company; Design a letter head for your company and give to instructor</i>	**/**/**	20
3. <i>Each team will meet with the instructor/practitioner of their field of interest</i>	**/**/**	20
4. <i>Each Team writes a proposal to the instructor/practitioner to indicate their top two projects of interest. The proposal is a document describing the company, its personnel and expertise, and the approach it will take to the engineering design problem You should submit the:</i> <ul style="list-style-type: none"> a. <i>Initial Draft reviewed by the Rewrite Connection, Whiting Hall, RM 125, and</i> b. <i>Final Proposal</i> 	**/**/**	50
5. <i>Team plan: a document that outlines how the team intends to execute its work.</i>	**/**/**	10
6. <i>Instructor review of proposals and inform team leaders of the approved project</i>	**/**/**	-
7. <i>Technical design will start</i>	**/**/**	-
8. <i>Mid-term progress due: an oral presentation summarizing the company's progress on the project to date</i>	**/**/**	90
9. <i>Final report is due</i>	**/**/**	100
10. <i>Presentation of the project*</i> * See Presentation Evaluation Form	**/**/**	100

IV. Project Design

The focus of this pilot study project was to develop a prototype of an Electronic Name Tag (ENT) system. This project focuses on creating an ENT that can be used for conferences, visitors' badges etc. The development of the ENT will help the world become more environmentally friendly. The ENT consists of a microcontroller, the brain of the system, which is a programmable electronic integrated circuit with built in processor memory and peripherals. The microcontroller is programmed using the Basic Stamp Editor program. The microcontroller uses this program to display the information on the liquid crystal display (LCD).

The electronic equipment is housed in a case. The case is designed using 3D modeling software, Autodesk inventor. After the design is complete, the manufacturing process (rapid prototyping) came next. Files must be formatted in sterolithography (STL) to be compatible with the printer software (Catalyst EX) for rapid prototyping. The Dimension SST 1200es (3D printer) was used to create the three dimensional physical model to test the design of the case. The case is made from a durable acrylonitrile butadiene styrene (ABS) plastic. Once the parts have been manufactured, they are then assembled into the ENT. It is expected that this concept will save money in the long run since the ENTs' can be reused. Following is the focus of design:

1. Develop the embedded System:
 - Program the parallax BS2 Rev J microcontroller
 - Interface the parallax 4x20 Serial LCD (Backlit) display to the microcontroller
2. Designing and manufacture (Rapid Prototyping) a covering case including the design of the On/Off and Reset Buttons (Figure 3) for the ENT using 3D Solid Modeling software package
3. Assemble parts



V. Physical Overview of ENT System

Over the past few years, we have seen numerous changes in the microprocessor and microcontroller market. Motorola stopped the development of its popular 8-bit 68HC11 microcontroller for approximately 10 years. With these advancements in technology, modern system design requires the use of advanced microcontroller chips and tools. Several new companies have emerged in the microcontroller market to meet the complex design requirements. To fulfill the demands of the new technology, universities and colleges have shifted from teaching the traditional 68HC11 microcontroller to teaching the PIC microcontroller. A PIC microcontroller is a single chip computer that is commonly found in everyday products such as microwave ovens, cell phones, alarm clocks, etc. If the device consists of push buttons and displays, chances are it also contains a programmable microcontroller. The PIC is a popular, inexpensive single chip microcontroller for a low powered, complex embedded system.

A design project by enlarge is focused on developing a product that is robust, reliable, and economical. Keeping this in mind, our project team decided to incorporate Parallax Inc.'s BASIC Stamp2 module (shown in figure 1.0) in the Electronic Name Tag project. This compact BASIC Stamp2 module plugs into Parallax Inc.'s board of education carrier board, shown in figure 2.0.



Figure 1.0: Basic Stamp2 Module

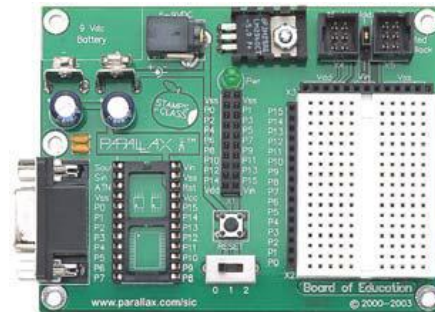


Figure 2.0: Board of Education

The major physical feature of the Electronic Name Tag case is made from a durable acrylonitrile butadiene styrene (ABS) plastic, which was hollowed out to make room for the LCD Display, and the microcontroller. Figure 3.0 shows the physical layout of the components.

The electronic name tag is controlled by a pre-programmed, embedded microcontroller that controls the LCD display.

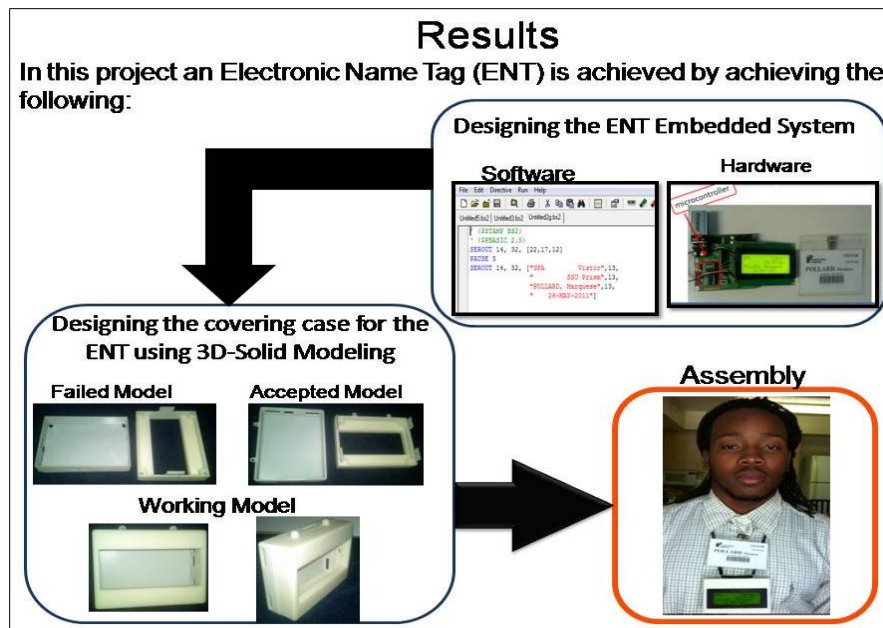


Figure 3.0: Physical Layout of Electronic Name Tag

The 3D modeling software called Autodesk Inventor was used to design and assemble the cover case for the electronic assembly of the ENT product. Autodesk Inventor is 3D parametric solid modeling design software. Its purpose is to create 3D mechanical design, simulation, tooling creation, and design communication that help the designer cost-effectively take advantage of a Digital Prototyping workflow to design and build better products in less time.

In this Stage five task were identified. Figure 4.0 shows the 3D-Solid Modeling Design and Manufacturing Process.

1. Learn Autodesk Inventor Software and in particular parametric design.
2. Determine dimensions of discovery board and LCD to constrain the parametric design of the case.
3. Design locking mechanism of the case.
4. Manufacture a sample of the constrained parametric design for testing purpose.
5. If unsatisfactory results are obtained go back to step 2

VI. Hardware and Software Design of ENT

Typically, development tools needed for the microcontroller can be divided into two different groups: software and hardware. Software tools include assemblers, compilers, program editors, debuggers, simulators, communication programs, and systems integration environments to implement solutions. In the electronic name project, the BASIC Stamp2 microcontroller is interfaced to the BASIC Stamp2 Editor software, which is used to write programs that the BASIC Stamp2 module will run. The software is also used to display messages sent by the BASIC Stamp2. The BASIC Stamp2 Editor is free software, and the two easiest ways to get it are:

- Download from the Internet. Search for “BASIC Stamp2 Windows Editor Version 2.0”
- Included on the Parallax CD.

Hardware and software control architectures were designed to control the Electronic Name Tag. During the early execution stage, the students handled the mechanical design portion of the project. The electronic concepts, which included interfacing and programming of the microcontroller, were faculty led and the student was trained to program the electronic name tag in BASIC Stamp2 programming language. Student also kept a record of project progress in his individual notebooks, including design ideas and sketches, along with issues faced and their solutions. The hardware section of the electronic name tag uses the PIC16C57 microcontroller. The microcontroller is programmed in BASIC Stamp2 programming language to control the electronics name tag system.

Several hardware development tools are available for the PIC microcontrollers. Parallax provides the following hardware development tools to support the hardware development of the PIC based products:

- BASIC Stamp2 module
- Board of Education
- 9V battery
- Serial cable
- Strip of 4 adhesive rubber feet

3D-Solid Modeling Design and Manufacturing Process

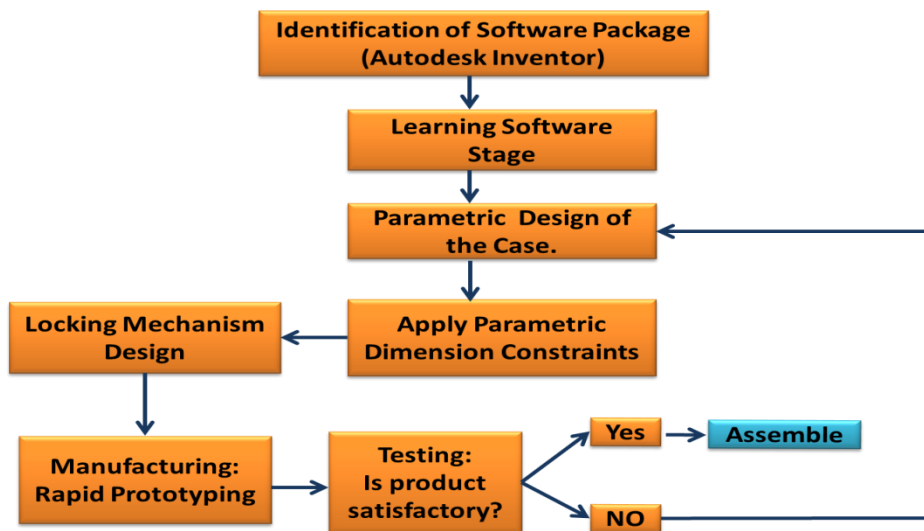


Figure 4.0: 3D-Solid Modeling Design and Manufacturing Process

The role of control electronics was to create a clean interface between the electronic name tag and the BASIC Stamp2 programming language to control the LCD display.

The electronic name tag circuit is built by plugging the components into small holes called sockets on the prototyping area. This prototyping area has black sockets along the top left. The black sockets along the top have these labels above them: Vdd, Vin, and Vss. These are called power terminals, and they are used to supply power to the electronic name tag. The black sockets on the left have labels like P0, P1, up through P15. These sockets are connected to the BASIC Stamp2 module's input and output pins. The software developed is downloaded to the board of

education via a serial or USB cable. The integration of the hardware and the software produces an integrated embedded system, which controls the electronic name tag.

The electronic name tag focused on important learning concepts such as physical layout, electronics, programming, and cross disciplinary interaction. The physical layout symbolizes the interrelationship between various substructures of the electronic name tag. This includes an understanding of components and the manner in which all these components function together as a deterministic whole system. Basic components, such as LCD, 3D modeling with Autodesk inventor and electronics, which include microcontrollers, and LCD digital display, are the major components of the electronic name tag system. Integrating these components offered an opportunity for the student to understand the design/development of electronic name tag system.

VII. Project Outcomes and Benefits

The curriculum in any specific area of study tends to narrowly focus students on that area, whereas real-world multifaceted systems tend to incorporate components from multiple disciplines. The development of such systems has shifted from designing individual components in segregation to working in cross-functional teams that include the variety of proficiencies needed to design an entire system⁹. The parking garage provides an opportunity for students to integrate the mechanics and electronics to build a real-life application.

The goal of this summer training program was to exemplify the impact of hardware and software design in embedded system products. Significant trends were measured from the electronic name tag project, which included 3D modeling, electronics, programming, and student interaction with the faculty. The results show that the student learned tangible lessons from each topic.

Conclusion

Research shows that the senior level capstone design course is being implemented nationwide to improve the design skills of engineering and technology disciplines. Although the individual outlines of capstone design courses are diverse. However, the objective of nearly all such courses is to provide students with real world engineering and technology design experience. Other objectives of the course include the development of interpersonal and communication skills, enhancement of student confidence, and improved academic relationship with industry.

This paper described the design and implementation of electronic name project. This activity has served as a reference for providing student with challenging and exciting hardware and software design experiences that involved various fields of 3D modeling, electrical, and physical layout design concepts. The electronic name tag provided an excellent opportunity for both the faculty and students to work in an application-oriented environment. The use of the ENT product will help us to become more environmental conscious users. The design methodology will assist the designers to also become involved in producing green products.

Although the ENT prototype is functional, it is not the final product. It is bulky in size (due to the size of the electronic boards) and the LCD used cannot handle graphical images. Further research is needed to miniaturize the electronic parts which will allow us to design a much thinner case. In addition, the LCD displays needs to be replaced with an LCD that is capable of displaying images to produce companies' logos.

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