Northeast Meets Northwest Women in Technology Project

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Abstract

The “Northeast Meets Northwest Women in Technology Project” encourages young women to consider careers in technology and engineering by direct exposure to a complex problem in industry. The project partnered women in high school from Washington and Massachusetts, high school teachers, an engineer from Texas Instruments, and an engineering advisor from Western Washington University. The students’ objective was to solve an on-going problem for Texas Instruments at one of their manufacturing facilities. The students used concurrent engineering practices to understand the manufacturing problem. The students successfully designed, built, and tested a prototype inspection device. This device is currently used on the Texas Instruments assembly line to check for the presence of internal and external threads on four different plastic and metal assemblies. This device ensures that assemblies that do not have threads do not continue onto further, expensive processes, only to be scrapped by the final quality check. The problem-based learning project created an opportunity for students on the team to investigate engineering as a career option.

Introduction

According to the 2000 U.S. Census, women represented just 26 percent of the science, math, and engineering work force, even though women comprise 47 percent of the total work force.\(^1\) Most women who work in science are in the areas of life, physical, and social sciences (41 percent). In contrast, women have much lower representation in engineering, approximately 8 percent.\(^2\) Clearly more women need to be encouraged to enter science, technology, engineering, and math (STEM) fields.

The Women in Technology (WIT) program is an ongoing program started by Bristol Community College in Massachusetts. The purpose of the program is to encourage young women to student STEM fields as opportunities for careers in these fields. There were four different WIT projects occurring simultaneously during the 2001-2002 academic year. The “Northeast meets Northwest Women in Technology” outreach project was a problem-based learning activity designed to give high school women who had high proficiencies and interest in science, technology, and math an opportunity to explore engineering as a career. The project created an opportunity for students to gain hands-on experience in design engineering by solving an open-ended problem that was provided by Texas Instruments. The team consists of high school students from Washington and Massachusetts schools, while high school faculty and engineers from industry served as coaches and advisors. Texas Instruments has been sponsoring WIT projects since 1996, when an internal survey revealed only 8% of its engineers were women.

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Project-Based Learning

The women in the project used Project-Based Learning (PBL), a method in which students work cooperatively in small groups to seek solutions to real, complex problems. The learning objectives of project-based learning is for students to use information learned in courses to develop critical-thinking abilities, acquire lifelong learning and communication skills and develop team building and leadership skills. The instructor’s role is one as facilitator and coach.

Research indicates that students learn better and remember longer when the learning is active. In project-based learning, the students are first presented with a problem and then they seek the information they need to find solutions. As a group, the students pose questions and identify where to find answers. They learn to communicate, cooperate and collaborate with each other. The best way to learn something is to teach it to someone else. In project-based learning, everyone becomes both a teacher and a learner.

Project Summary

During the 2001-2002 academic year, the Northeast meets Northwest Women in Technology project teamed six students from Washington high schools (Anacortes and LaConner High Schools) with three high school students from the Bristol Community College TechPrep Consortium, Massachusetts (Taunton and Dighton-Rehoboth High Schools). The teams were coached and advised by an engineer from Texas instruments, as well as other engineers from industry and high school faculty.

The young women were given the title of Junior Engineer and were recruited for the team based on their individual talents and what they could contribute to the team. The following skills were desired for the team; trigonometry, algebra, and physics background, machine technology, electronics, drafting, computer-aided design, computer programming, and web site development. Additional attributes such as attitude, communication skills, and the ability to be a team player were also key to being selected for the team. The students were required to perform the following tasks to complete the design; problem identification, concept design, preliminary design, critical design, prototype, test, and acceptance. In addition to developing the designs and manufacturing and testing the prototype, the students also had to create an operations manual, give a formal oral presentation, and develop a web site.

The task assigned to these two groups of young women, was to design and prototype a real-life device for use in the assembly line of the Texas Instruments automotive parts division. The device was to perform a quality control inspection on a product called an Automotive Pressure Transducer (APT). An APT is a device that detects changes in pressure in different automotive systems. There are four different APT’s manufactured by Texas Instruments for companies such as General Motors, Ford, BMW, and Honda. The four APT’s, shown in Figure 1 and Figure 2, are used for detection of air conditioning fluid pressure, oil pressure, power steering fluid pressure, and brake fluid pressure. Because of the functions of these systems, defective APT’s are a serious safety concern. Since low defect rates are critical for these parts, many quality control inspections are necessary to ensure the safety of the APT.
APT’s are an assembly of many sub-components that are individually manufactured, assembled together, and then additional manufacturing is performed on the assembly. As each APT progresses through each of these steps on its way to completion, the total investment in that APT increases. If a defect can be identified early in the manufacturing process, the total cost of scrapping the part is reduced. Prior to the Northeast meets Northwest Women in Technology project, workers at Texas instruments were performing a visual quality control check on the APT. These workers were checking if the bottom metal component, shown in Figure 2, of the APT had been threaded. This step is occasionally omitted due to automation. The cost is significantly greater if the defective APT without threads is identified at the final inspection. If the defective APT was not identified at the final inspection, it was either returned by the customer or was a safety concern for an automobile if it was installed. Prior to this project, the defect rate was 5-10 parts per million produced. Texas Instruments wanted to reduce this defect rate closer to zero and asked the WIT team to design a device that could inspect each part to determine if threads had been properly cut on the bottom metal component.

The device had many design criteria that made the project challenging and exciting. The APT Thread Checker device had to comply with criteria listed in Table 1. The team developed six different solutions to the problem, investigated each solution, compared them to each other using the criteria in Table 1, and selected the best design. The chosen design utilized a laser and a sensor to detect the presence of threads on the four different APT assemblies. The laser was mounted in the device so that it would hit the threads of the bottom metal component. If threads were present, the laser would bounce off the thread surface to a detector. If threads were not present, the laser would bounce at a different angle and would not be detected. This design created an electrical output of the detector that would send an “accepted” versus “unaccepted” signal to a signal conditioner that could direct a pneumatic piston to push a defective APT off the conveyor and allow an accepted APT to continue to the next step in the manufacturing process.
Test both internal and external threads on four different diameters.

Be flexible enough to accept four different APT assemblies.

Perform tests without touching the threads of the APT.

Test one APT at a time.

Build prototype device at a low cost.

Fit within an 8" x 8" x 8" box.

| Table 1: Criteria for the design of the APT Thread Checker. |

### Results

1. During the course of this project, the team members further developed their technical, teamwork, communication, critical thinking, research, and problem-solving skills.

2. The students had an opportunity to explore a career in engineering by experiencing an example of a typical design project. These students are now better prepared to make informed decisions about education and career opportunities.

3. The women on the team worked via video- and tele-conferences, email and faxes to design, build, and test a successful prototype device. One of the design meetings held using tele-conferencing between the Washington students and the Massachusetts students is shown in Figure 3. The students are proud of their accomplishment and have high ownership in the results of the project. The students traveled to present their results to Texas Instruments directly.

4. The faculty who mentored the teams have applications-based experience and information that can be passed into the classroom.

5. The prototype was successful and was reproduced for use in the assembly line of a Texas Instruments automotive systems factory in Mexico.

6. Of the 134 students who have participated in Bristol Community College’s Women in Technology program since its inception in 1997, 65% have attended college with an

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engineering major. An additional 10% have attended college in another field and 25% have entered the workforce.  

7. Bristol Community Colleges entrance rate for women in engineering programs has tripled since the inception of the Women in Technology program in 1997.  

8. Bristol Community College’s Women in Technology program was awarded an $840,000 grant from the National Science Foundation to develop a two-year program in Computer-Integrated Manufacturing Systems for women and nontraditional students.

The Women in Technology program was awarded the 2002 Bellwether Award for Workforce Development. The Institute of Higher Education, University of Florida and the National Council for Occupational Education sponsor this award. The award recognizes outstanding and innovative practices that are successfully leading community colleges into the 21st century.

Conclusion

The “Northeast meets Northwest Women in Technology” project successfully exposed women in high school with a high interest in science, math, engineering, and technology to a project-based learning experience. The women were given an opportunity to work on a team to design, prototype, and test a device that solves a real-world engineering problem for Texas Instruments, a large US manufacturer. The students had an opportunity to gain experience in the career choice of engineering, develop problem-solving skills, and use concepts learned in high school classrooms to creatively develop and investigate multiple solutions to an engineering problem.


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