Partnering with Industry to Provide Continuing and Distance Education Programs in Engineering & Technology: A Case Study

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Abstract

This paper provides a description of continuing education programs developed and implemented by Penn State Altoona Office of Continuing & Distance Education for engineers and technicians in the Central Pennsylvania region. These programs are offered in the areas of process control, CAD, project management, information technology, and quality management. The paper also lists assessment methods used by the Continuing and Distance Education Office to evaluate the effectiveness of the training programs.

I. Introduction

Over the last several decades, the expectations of the American worker have changed dramatically to include better employee preparation and increased work skills. New technology, teamwork, quality management, and just-in-time production have become the norms of the current and future workplace .[1] To keep up with the changing technology, the USA and the world as a whole need employees with increasingly sophisticated skills. For this reason the issue of workforce education, training, and retraining is becoming increasingly important all over the world. All organizations, regardless of their nature, face the challenge of providing professional training to their employees. Many organizations are addressing the professional training needs of their members by joining forces with academia.

Through partnership with regional business and industry, Penn State Altoona Office of Continuing & Distance Education provides customized services such as:

1. Training needs assessment
2. Job profiling
3. Organization assessment

Programs that can be customized to meet the training needs of a customer include:

- Supervisory management and leadership development
- Front-line employee skill development
- Quality and process improvement
- Computer/information technology training
- Programs on selected topics in engineering
- Graduate course work for educators
- Training for healthcare professionals

This paper focuses on development and implementation of continuing engineering education programs of Penn State Altoona.

II. Institutional Background

Penn State Altoona is one of 24 campuses making up the Pennsylvania State University system. It is the second largest of the 24 campuses and is a full-service residential campus located 42 miles from the research campus at University Park. Penn State Altoona became a four-year college within the Pennsylvania State University system in 1997 and offers baccalaureate degrees in eight majors. Penn State Altoona also offers associate (two-year) degrees in nine majors. Additionally, Penn State Altoona provides two years of course work for more than 160 Penn State majors. More than 3800 students attended Penn State Altoona during Fall 1999. During the 1999-2000 academic year, 239 minority students attended Penn State Altoona.

III. An Overview of Continuing Engineering Education Program

The Penn State Altoona Office of Continuing and Distance Education offers engineering education programs on the following topics:

1. Basic CAD (Computer Aided Drafting)
2. Intermediate CAD
3. Programmable Logic Controllers (PLCs)
4. Engineer-in-Training (EIT)
5. Fundamentals of Mechanical Drawing
6. Pneumatics and Hydraulics
7. Finite Element Analysis
8. Metallurgy
9. Industrial Math
10. Project Management
11. Industrial Motor Control
12. Functional Gauging & Inspection

All the training programs listed above are based on regularly conducted training needs assessments. However, some of these programs have been developed as a direct result of a close partnership between a specific company/companies and the Penn State Altoona Office of Continuing & Distance Education. Such programs are customized to the training needs of specific organizations.

IV. Customized Training Programs

As mentioned above, certain training programs offered by the Penn State Altoona Office of Continuing & Distance Education are customized to the training needs of specific industrial organizations. Examples of such programs are:

- Programmable Logic Controllers (PLCs)
- Industrial Motor Control
- Fundamentals of Mechanical Drawing

The training programs on PLCs and industrial motor control were developed as a result of a large scale assessment of the training needs of IBEW (International Brotherhood of Electrical

Workers). The development process for these programs is described by Anwar[2]. This training development process follows an eight-step sequence explained by Gunter[3]. The steps are: (1) determine customer needs; (2) determine the behavioral objectives of the training program; (3) determine content to meet the program objectives; (4) choose training methods tailored to the content; (5) determine instructor qualifications; (6) determine logistics; (7) develop a marketing and follow-up strategy; and (8) plan for evaluation and feedback.

Course descriptions for the training programs in PLCs and industrial motor control are given below:

Programmable Logic Controllers (PLCs)

Duration of Training Program

This 24-hour training program will be conducted on four Saturdays; 9:00 a.m. – 3:30 p.m.(half hour for lunch) every Saturday. However, it can be conducted in any other format as needed by IBEW.

Topics Covered

1. Basics of a PLC
    a. Parts of a PLC
    b. Principles of Operation of a PLC
    c. Modifying the Operation
2. PLC Hardware Components
    a. The Input/Output Section
    b. Input/Output Modules
    c. The CPU
    d. The Processor-Memory Module
    e. Memory Design and Types
    f. Programming Devices
    g. Program Loaders
3. Basics of PLC Programming
    a. Processor Memory Organization
    b. Program Scan
    c. Relay-type
    d. Entering the Ladder Diagram
    e. Modes of PLC Operation
4. PLC Installation Practices, Editing, and Troubleshooting
    a. PLC Installation
    b. PLC Preventive Maintenance
    c. PLC Troubleshooting

Industrial Motor Control

Eight weeks, 6-9 p.m.

This 24-hour course is designed to provide participants with knowledge needed for controlling industrial motors. Practical applications of motor control are presented. Topics covered include solid state devices, motor control circuits, DC motor control, AC motor control, motor drives and solid state motor control. Concepts, tools, and techniques learned in this course are reinforced

through lab exercises and a practical application project. Equipment to be used will include solid state devices, relays and contractors, pushbuttons and switches, motors, and motor starters. A basic knowledge of AC and DC electricity is required.

Figure 1 provides information regarding the enrollment in these training programs in the past few years. All the program participants were IBEW members working in regional business and industrial organizations. The course instructor (Sohail Anwar) for the above mentioned customized training programs is a full-time faculty member in the Business and Engineering Division of Penn State Altoona. He is assisted by personnel from Sheehan Electronics and Huntingdon Electric Motor Service for the delivery of customized training programs.

V. Engineering Training Programs and Workshops for the General Public

The Penn State Altoona Office of Continuing and Distance Education regularly offers the following engineering training programs and workshops for the general public:

Geometric Tolerancing Applications
This advanced course sharpens your Geometric Tolerancing skills, and makes the tool even more useful. Drawing from the real world of industry, the instructor introduces you to functional dimensioning; shows you how Geometric Tolerancing reduced product costs; teaches you how to select part datums; discusses profile tolerancing and gauging in-depth; and provides dozens of time- and cost-saving tips.

Functional Gauging and Inspection
This workshop will provide guidelines for selecting the most appropriate inspection method for a part feature; low-cost functional gauge design principles; method of practical datum selection; guidelines for using modifiers; criteria for selecting company/division gauging policy; and an overview of gauging equipment capabilities.

Programmable Logic Controllers (PLC): Programming, Maintenance, and Networking
Eight weeks, 6:00-9:00 p.m.
This program emphasizes plan floor applications of PLCs. Topics covered include PLC programming, maintenance, troubleshooting, and networking. Allen Bradley PLCs, electrical/electronic test equipment, input/output devices, and personal computers will be used. A basic understanding of DC electricity, AC electricity, and electrical test equipment is required. participants will use new state-of-the-art equipment.

Intermediate Computer-Aided Drafting (CAD)
Three days, 9:00 a.m.-3:30 p.m.
This course is designed for participants who have completed basic CAD or those who would like to enhance their skills. More advanced use of standard editing and entity creation commands will be covered along with design drafting philosophies, use of grips, xref, three dimensional techniques and user coordinate systems. Those having specific learning goals will also have a chance to customize their time in the course. (Notebook and lunches included)

Introduction to Computer-Aided Drafting (CAD)
Three days, 9:00 a.m. – 3:30 p.m.
This hands-on-course is designed to give each participant a working knowledge of AutoCAD as it applies to his/her working environment. (Notebook and lunches are included.)

Advanced Computer Aided Drafting (CAD)
Three days, 9 a.m. – 3:30 p.m.
This course has been developed to familiarize the participants with the major concepts of parametric-based Solid Modeling. The course is designed to provide students with "hands-on" experience using AutoCAD software. Materials to be covered; Understanding menus, dialogues, and terminology; sketching and profile; parametric dimensioning; constraints; extrusions; creating a three-dimensional solid model from a two-dimensional profile; Chamfer and Fillet; edit features.

Developing an ISO 14000 Environment Management System
Eight Days, 6:00 – 8:00 p.m.
ISO 14000 environment management system standards are a series of voluntary standards developed by ISO to provide business management disciplines, including the basic management system auditing, performance evaluation and life cycle assessment. This program provides an understanding of environmental management systems elements and their applications. The business reasons for environmental management are discussed. The ISO 14000 standards and associated guidelines are thoroughly explained.

Basic Project Management and Applications
Three Days, 6:00 – 9:00 p.m.
This hands-on course will introduce the principles of project management, including projects and planning, resources, and project plans and controls. Participants will be introduced to a major project management software application, Microsoft Project 98. In addition to fundamental training in the use of this particular software package, the software will be used as a tool by the course participants to explore and clarify management principles outlined through the course. One class will be conducted entirely in the computer lab.

Project Management and Microsoft Project
Eight Days, 6:00 – 9:00 p.m.
This class will help you be a better project manager or project team member. In this seminar which will be laced with humor, real-life experiences and participatory class exercises we'll explore the four phases of a project (need identification, proposals, execution and termination) and the roles of the individuals on the project team. The seminar will also provide basic training in the use of the leading project management software and construction and tracking of a project plan. The Theory of Constraints, a modern view of multivariable processes, which have uncertainty involved, will also be applied to project management. Find out why your projects are often overbudget and overschedule and loaded with stress, and what to do about it!

Fundamentals of Engineering Review Course
This course is designed to provide a review of the topics included in the Fundamentals of Engineering quality examination. The goal of this examination is to test an individual's level of

knowledge, skill and ability in basic science, mathematics, engineering science and economics. Because of the breadth of topics to be covered in the review, only brief lectures of fundamentals are possible in order to maximize the time devoted to solving a wide variety of problems, typical of those included in recent examinations.

Geometric Tolerancing Fundamentals Workshop
This workshop is designed for quality, manufacturing, & design engineers, drafters, blueprint readers, machinists, supervisors, and anyone dealing with machine parts or interpreting drawings. Discover major pitfalls of traditional machine parts or interpreting drawings; major pitfalls of traditional coordinating tolerancing and how Geometric Tolerancing overcomes them. Then, starting with your basic blueprint knowledge, learn the symbols, terminology and rules of Geometric Tolerancing as prescribed in the current standard (ANSI Y14.5).

The enrollment in some of these programs and workshops is shown in Figure 2.

VI. Facilities and Personnel

The Continuing and Distance Education Office of Penn State Altoona is blessed to have outstanding facilities to conduct programming. Cypress Building houses the administrative offices and includes five state-of-the-art technology classrooms. Each room has flexible seating and can hold up to 45 persons. The rooms are wired for computer based instruction, sound, and satellite down-link.

Additionally, the Office operates a Conference Center in downtown Altoona. This facility is comprised of a 300 seat auditorium, a 100 seat mini-auditorium, two 40 seat meeting rooms and a technology room designed to deliver lap-top computing.

The Continuing Education and Training staff includes a Director, three Continuing Education Representatives (one of which manages the Conference Center), a Program Aide, three full-time staff assistants, a part-time staff assistant and evening supervisor at the Conference Center, and several student workers.

VII. Evaluation of Training Programs and Workshops.

One of the axioms of quality improvement is that one must measure to improve. Without a yardstick, all we have is subjective opinion, and disagreement and indirection result. Training is subject to the same axioms. Therefore, it is important to evaluate training. There are at least two contexts in which evaluation must occur: short-term and long-term [4]. Short –term evaluation is the usual framework of course evaluation. The purpose is to provide feedback from course participants on the effectiveness of the training process. Training developers would want to know about the course design. Was the content relevant? Did the ideas flow together smoothly? Were the right things being emphasized to the correct degree? Analysis of the ratings from such evaluations usually give a surprisingly accurate assessment of the strengths and weaknesses of the training.

While short-term course evaluations provide much useful information to help improve the dynamics of the training process, they cannot tell how well the training succeeded in changing participants' behavior. Since this is the primary objective of training, this important information must be obtained on a long-term follow-up basis. Two key questions of long-term evaluation are: Have you used what you learned? How or why not?

At present, the Penn State Altoona Office of Continuing and Distance Education does conduct short-term evaluation. This evaluation usually takes the form of a survey instrument. Figure 3 provides an example of the evaluative instrument used by the Continuing & Distance Education Office of Penn State Altoona to evaluate the training programs conducted by Penn State.

VIII. Problems Confronting the Penn State Altoona Office of Continuing & Distance Education.

1. The Penn State Altoona Office of Continuing & Distance Education has no mechanism in place to conduct long-term evaluation of its continuing education and training programs.

2. At present, the Penn State Altoona Office of Continuing & Distance Education does not conduct distance education programming due to regional industry's lack of interest in distance education programs.

IX. Conclusions

This paper describes the continuing education programs developed and implemented by Penn State Altoona Office of Continuing & Distance Education for engineers and technicians in the Central Pennsylvania region. The assessment methods used by the Continuing & Distance Education Office to evaluate the effectiveness of training programs are also listed. Finally, the problems encountered by Penn State Altoona in implementing continuing and distance education programs are described.

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Sohail Anwar obtained a Ph.D. in Industrial and Vocational Education from the Pennsylvania State University in December 1995 and an M.S. degree in Electrical Engineering from the University of Texas at Arlington in May 1982. He completed additional graduate coursework in control theory and applied mathematical sciences at the University of Texas at Arlington during 1982 – 1984. Since August 1992, Sohail has been working as an assistant professor of engineering and Department Coordinator of Electrical Engineering Technology at Penn State Altoona. Since 1996, he has also been serving as an invited professor of electrical engineering at IUT Bethune, France. He is the Subscriptions Editor of the *Journal of Engineering Technology (JET)* and an associate editor of the *Journal of Pennsylvania Academy of Science.*

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Semester	***Course Title***	***Enrollment***
Fall 1995	Industrial Motor and Controls	22
Spring 1996	Industrial Motor and Controls	21
	Programmable Logic Controllers(PLCs)	16
Spring 1999	Programmable Logic Controllers(PLCs)	11

Figure 1: Enrollments in Courses for IBEW Members.

Semester	***Course Title***	***Enrollment***
Spring 1994	Basic Level PLC	16
Spring 1994	Basic Level PLC	17
Summer 1994	Basic Level PLC	16
Spring 1995	Industrial Mathematics	18
	Electrical Blueprint Reading	12
	Mechanical Blueprint Reading	22
Fall 1994	Intermediate Level PLC	16
Fall 1995	Basic Level PLC	17
	Fiber Optics	16
Fall 1996	Electrical Blueprint Reading	15

Figure 2: Enrollments in selected Continuing & Distance Education Courses, Spring 1994 to Fall 1996.

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1. CLARITY OF COURSE OBJECTIVES.	_____ Unsatisfactory _____ Below Average _____ Average _____ Above Average _____ Very Good _____ Excellent _____ Exceptional
2. COURSE ACHIEVED STATED OBJECTIVE.	_____ Unsatisfactory _____ Below Average _____ Average _____ Above Average _____ Very Good _____ Excellent _____ Exceptional
3. PACE OF THE COURSE.	_____ Unsatisfactory _____ Below Average _____ Average _____ Above Average _____ Very Good _____ Excellent _____ Exceptional
4. SUITABILITY OF HANDOUTS AND/OR MATERIALS	_____ Unsatisfactory _____ Below Average _____ Average _____ Above Average _____ Very Good _____ Excellent _____ Exceptional
5. OVERALL RATING OF COURSE.	_____ Unsatisfactory _____ Below Average _____ Average _____ Above Average _____ Very Good _____ Excellent _____ Exceptional

Figure 3:Evaluative instrument used by Penn State Altoona
Office of Continuing & Distance Education