University/Industry Partnership: Customized Electrical Engineering Fundamentals Program For Non-Electrical Engineers at Delco Electronics

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Abstract

Engineering curriculum must stay abreast with changes taking place throughout industry in the way products are designed, developed, and manufactured. As technology advances, new and more challenging problems force manufacturing companies to adapt and overcome obstacles in order to stay competitive. This may be accomplished by emphasizing education and training. More companies are shifting much of the education and training responsibilities back to the educational institutions. The new advances in technology must be studied and understood by universities so that engineering curriculum incorporates them while maintaining the principle of coherence. Universities and industry need better communication and closer interactions. Engineering students must be exposed to the leading advances in technology, and be familiar with the latest trend in design, fabrication, and implementation of various manufacturing processes.

This paper discusses a specific university/industry partnership that uses the resources efficiently in meeting the spectrum of needs of industry. The objective of this partnership is to develop and implement a customized electrical engineering fundamentals program for non-electrical engineers at Delco Electronics in Flint, Michigan.

I. Introduction

Today's products and manufacturing systems are complex, because they are composed of integrated mechanical and electronic components, and operate with the aid of control and decision making software. The design and fabrication of such products and manufacturing systems require knowledge in all relevant areas such as manufacturing processes, materials, electrical engineering, and mechanical engineering. An integrated multidisciplinary approach to the design of products and manufacturing systems is needed, and presents a challenge for today's engineers[1]. In addition, there exist increasing problems when engineers work as a team. Since most engineers were trained in one of the traditional engineering fields (e.g., mechanical engineering, electrical engineering, and so on), they may not be able to communicate effectively among team members. For example, mechanical engineers may not understand how the mechanical components should work with the electrical and electronic components as a system. Within both the industrial and academic sectors in this country there are significant motivations for strategic alliances. One of the factors motivating these alliances is an increased appreciation of the common technical interests with a growing awareness of the significant mutual benefits. In addition to the element of collaborative research activity, consideration should also be given to the inclusion in the alliance of placement of engineering graduates in career positions, cooperative education and continuing education[2].

Students, who are the principal product of universities, should be the most effective means of transferring knowledge from universities to industry. However, in evaluating the capabilities of employees who are recent graduates from engineering schools, aerospace industry sees several prominent shortcomings: (i) New hires must serve excessively long apprenticeships before they are fully productive, (ii) Too few of our engineering graduates have any idea of how to work in teams or how to manufacture anything. Fewer still seem to understand the process of large-scale, complex system integration, which characterizes so much of what we do in industry, and (iii) Those students who are judged the "best and brightest" on the basis of grade point average are frequently those who have worked hardest in a highly competitive academic environment of separate, specialized courses, and are often least prepared to work cooperatively in teams for an integrated complex system which is economically and operationally viable[3]. With better communication and closer interactions among universities and industry, engineering graduates can be well equipped to utilize their scientific, mathematical, and analytical knowledge in the design of high-quality components, processes, and systems.

Over the past several years, technology has evolved from mathematically based clusters to microprocessor driven systems which are independent and communicate with other systems in the automotive industry. The changing technology necessitates a better understanding of electrical/electronic concepts for non-electrical engineers at Delco Electronics in Flint, Michigan. Accordingly, a partnership between University of Michigan – Flint and Delco Electronics has been established to develop and implement a series of customized training programs.
The objective of this paper is to describe the development and implementation processes for customized electrical circuit module and electronic circuit module, along with the benefits obtained from this partnership. Furthermore, this paper addresses reforming the cultures in engineering education to share information, and to encourage the flow of ideas between industry and universities so that society may benefit promptly.

II. Development and implementation phases

The customized electrical engineering fundamentals program was designed to instruct non-electrical engineers at Delco Electronics who hold a two or four year technical degree. For this program, five different modules (electrical circuit module, electronic circuit module, communication system module, computer system module, and control system module) were developed and implemented except control system module. However, this paper focuses only on electrical circuit module and electronic circuit module.

Numerous visits to the plant were made to collect the relevant information and to meet training supervisor and electrical control engineering supervisor for the development of the customized course material. Eventually, the course contents were outlined and the level of difficulty was determined. During the design and development phase, Delco's electrical control engineering supervisor regularly examined the text content for accuracy and proper process sequencing. In developing the schedule, the following factors were considered: availability of classrooms and laboratories, work schedules, and holidays. Both sides agreed to have sessions in labs at university so that the participants can concentrate on the materials covered without interruption.

A standardized evaluation method for the participants was also discussed. Both parties decided to evaluate the progress through class work and homework. Participant performance in class work and homework indicated whether or not there was a need for further explanation or review of materials covered earlier. The issues of course contents, schedule, and evaluation method were found to be similar to those of the partnerships between universities and industry[4, 5].

The course contents for electrical circuit module were identified as basic mathematics, Ohm's law, Kirchhoff's laws, elementary circuit analysis, ammeters, voltmeters, ohmmeters, phasors, power concepts, elementary sinusoidal analysis, and frequency response. The goals of electrical circuits module are: (i) to become familiar with the circuit concept using Ohm's law and Kirchhoff's laws, (ii) to become proficient with Thevenin's and Norton's theorems, mesh and nodal analyses, source transformations, and dividers, (iii) to investigate the nature of current and voltage waves with complex numbers, and (iv) to gain a practical understanding of electrical transients. The electronic circuit module includes operational amplifier, diodes, basic transistors, filters, linear and nonlinear circuits, and analog and digital electronics. And the goals of electronic circuits module are: (i) to learn to design simple amplifiers and filters using op amps and transistors, (ii) to appreciate the limitations of op amps and how they affect circuit performance, and (iii) to understand diodes with nonlinear behavior. Each module was designed to be covered in twenty hours, i.e., three hour lecture and one hour lab work in one morning for five consecutive weeks.

Three different groups (44 non-electrical engineers) completed the electrical circuits module while only one group finished with the electronic circuits module over thirteen month period (April, 1995 – May, 1996). Due to the budget problem, the customized training program was suspended in June, 1996. Based on the course evaluation conducted after the first completion of the electrical circuit module, we decided to drop the topics related to AC circuits since the main components for an automobile are DC circuits powered by 12 volt battery. It was a most challenging task to teach the first group since most of them were out of school for a long time and many topics must be covered within five weeks. The comments of the first group were extremely important in order to further customize the training to Delco Electronics' needs.

III. Benefits

One of the possible direct benefits to the industry from this partnership is that the team members for the design and/or production, regardless of their engineering fields, can communicate more effectively with a better understanding the basic electrical engineering concepts. Industrial internship for faculty is also in consideration so that the faculty can participate in the design and production processes for the real parts. Better lab projects for customized training programs could be developed through this faculty internship. Furthermore, the faculty member could become more effective educator and researcher by increasing familiarity with industrial culture and technology needs. This increased awareness can be imparted to the students as a part of their educational experience and they will be able to make the transition to their industrial careers in a seamless fashion. Engineers, who could transfer their knowledge of the latest trend in design, fabrication, and implementation of various manufacturing processes immediately after graduation, can be a distinct benefit to the industry.

IV. Reforming the cultures in engineering education

In reviewing undergraduate curricula, the National Research Council (NRC) wrote: "(University) curricula as a whole lack the essential interdisciplinary character of modern design practice and do not teach the best practices currently in use in the most competitive companies." The NRC attributed the outdated and often irrelevant nature of the undergraduate engineering experience to an academic culture that places low value on teaching in general[6]. Reforming cultures of engineering education is necessary to balance between education and research in universities. Across type of institution, research and publishing are considered to be the primary criteria in promotion and tenure decisions. It is more likely for faculty to emphasize research and publishing in response to direct rewards and incentives. When the faculty concentrates too much on the research and publishing, undergraduate students may not get the education they deserve. Providing incentives to encourage existing faculty to teach lower division undergraduates is one way to reform cultures of engineering education.

Adding experience of faculty in industry as an important criterion may be fundamental to changing the existing culture and to placing greater emphasis on teaching. The faculty without industrial experience is most likely to think of themselves as scientists first, engineers second. One consequence may be a weaker commitment to teaching and enhancing the student learning experience[7]. It has also led the universities to be isolated from the society. Universities should work better with industry since the ultimate customer of the universities is industry[8]. Methods for helping professors gain industrial experience, whether through faculty consulting or university/industry partnerships should be investigated. Faculty with a commitment to teaching and to preparing students for their future professions is fundamental to reforming the cultures in engineering education. Mechanisms for technology transfer include direct sponsorship of research, joining with other companies to form a consortium to send a timely industry voice to ensure relevant engineering curricula, exchanging faculty and engineers between universities and industry, and participating in continuing education programs. In all cases, the primary goal should be to share information, and to encourage the flow of ideas between industry and academia so that society may benefit as soon as possible.

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