Distanced Delivery and Multiple Teaching Methods for Manufacturing Engineering Education

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Abstract

This paper describes a partnership among business, academia and student learners that is being developed to meet educational challenges posed by the changing global marketplace. The paper discusses several teaching methods used at the Focus: HOPE Center for Advanced Technologies, an innovative factory in Detroit, MI, and Lehigh University. Much of this work is being conducted as a part of the National Science foundation sponsored Greenfield Coalition. The paper emphasizes the role which technology will play in these new learning partnerships, especially in terms of the way in which advances will enhance distanced delivery of course materials.

Introduction

As the manufacturing environment evolves, so should the educational community. Indeed, it is desirable that academia operate in partnership with the dynamic global marketplace, responding to its changing directions and demands, rather than operating in isolation. However, in order to accomplish this, both industry and academia must undergo a fundamental change in thinking with respect to their individual roles in the education process and the potential spheres for united efforts through learning partnerships. Clearly, the multitude of new technologies available today make such joint activity more viable in that they provide a vast range of potential learning models outside the traditional classroom setting. Moreover, it should also be noted that although the issues explored in this paper are centered on the manufacturing environment and the engineering academic discipline, they may be applicable to other industries and fields of study as well.

Learning Partnerships

A major part of the rethinking that is occurring to meet new demands on the educational system centers on the need for academia to better understand the role of the business community as one of its primary customers. As this is accomplished, appropriate steps can be taken to gear learning activities toward the long-term competency requirements of business and industry. Clearly, such a shift in paradigm is healthy and to the benefit of all involved. It enables companies to function more effectively by supplying them with a strong, knowledgeable workforce. The likelihood of students securing a vital and satisfying position in the business world upon graduation is increased.

This rethinking and restructuring of the educational process is being approached as a give-and-take situation. The academic community can not be expected to blindly direct its activities toward the demands of industry without the enlightened help and guidance of the corporate sector. Colleges and universities must be willing to respond to the suggestions and concerns of business. In a complementary manner, industry leaders must be willing to devote their time and energy to improving the overall educational process. By providing their input at the front-end of the hiring process, while their future employees are still in school, companies can better allocate the time and money often spent retraining and reeducating the workforce after graduation. The implementation of multiple teaching methods and distanced delivery, as piloted in this program, recognizes that students can be viewed as customers of their institutions. A primary belief is that education is an interactive process conducted in partnership with the student, rather than a one-sided activity done to the student.

Initial evidence based on Lehigh University’s curriculum development activities with Focus: HOPE
indicate that students benefit from this interactive approach to learning. They are often more motivated in their overall academic endeavors as a result. Moreover, such joint effort is beneficial as it enables the instructor to be fully aware of potential student problems in understanding the course material early on in the educational process. This insight allows the teacher to modify lesson plans rapidly and helps to assure that few, if any, students are left behind as the course progresses. Clearly, this is especially helpful in engineering-oriented classes in which much of the material tends to be sequential and misunderstanding a fundamental concept at the onset of the class hinders future progress and success.

**Multiple Teaching Methods**

**Industry Practitioner Input.** Pilot program experience indicates that engineering concepts can become more valuable and understandable from a student perspective. This occurs when the traditional classroom point of view on a topic is coupled with the anecdotal experiences of an individual putting those ideas into practice in a real-world setting on a daily basis. In the past the knowledge and expertise of corporate leaders has been drawn into the classroom through scheduled guest lectures during class time and on-site company visits by the students. However, these encounters are severely limited by time factors and physical constraints and even when such meetings do occur they are typically a one-time interaction.

Advances in technology such as that used for picture phone operation, enable the concept of learning partnerships between industry and academia to be raised to new levels. By capitalizing on these recently mass marketed technologies, the scope of industry involvement in educational activities can be greatly increased with relative ease. For example, a case study on scheduling issues could be infused with new energy and insight by simply obtaining the suggestions and feedback of a plant manager who deals with such matters every day. On a broader scale, the traditional classroom lecture explaining a machining process can be improved by incorporating a video conference between a factory worker and a manufacturing engineer into the normal lecture flow. These four to six minute additions to the traditional presentation add the perspective of how such regulations effect their work experiences to the regular academic view.

In addition, Lehigh University and Focus: HOPE are enhancing their learning partnership through technology by incorporating real-time video teleconferencing with the Detroit-based Focus: HOPE factory into a senior-level industrial engineering course taught at Lehigh in Pennsylvania. At this time the distance delivery linkage is being accomplished via a picture phone optically coupled to large-screen T.V. displays. Initial feedback from the Lehigh students has been positive. Descriptions of the structure and functioning of the automotive manifold line delivered by a plant manufacturing engineer from the factory during a pilot hookup were made more relevant to the students when he actually showed them the partially machined manifold as he was speaking to them. He was also able to answer student questions on a real-time basis which served to further enhance the learning experience.

**Integrated Curriculum Development.** Many academic subject areas can be taught in an integrated manner. Preliminary feedback from students and industry personnel indicates that a more integrated, holistic approach to course development is highly motivational to the students and recognized as beneficial by the companies that hire them. For example, in the industrial engineering department course material is being linked across fields and disciplines that have traditionally operated in separate spheres. This is being done based on techniques employed by Lehigh University during the development and implementation of the manufacturing systems and communications knowledge areas for Focus: HOPE and the Greenfield Coalition. The industrial engineering department at Lehigh University is currently incorporating fundamental aspects of oral and written communications theory into a mandatory senior engineering course. This effort is in direct response to industry feedback which indicates that at times engineering graduates tend to have difficulty in the area of communications.

It should be noted that the development activities at Lehigh were carried out concurrently to the benefit and enhancement of both knowledge areas. Initial pilots utilized assignments such as case study analyses comparing current factory operations to more automated processes. Anecdotal evidence indicated that improvements in learning occur when the technical direction of an experienced manufacturing engineer is coupled with the guidance of faculty schooled in the methods of effective written and oral communication.

In terms of the communications knowledge area, it is logical that technically oriented people derive more benefit and satisfaction in reporting on the capabilities
of a new piece of equipment than the more typical essay assigned in a traditional communications course. Thus, when examining the structure of the Focus: HOPE manufacturing systems curriculum it is readily apparent that the interest of the students is more easily captured and maintained and retention is increased, as the classroom material is immediately relevant and meaningful to them.

**Partnering through technology.** For this work some of the traditional multimedia technology tools are used to simply facilitate cataloging and presenting different teaching methods. Cooperative development of today's engineering courseware is essential to the successful incorporation of computer-based lessons into the overall curriculum structure. In light of this fact, Lehigh University is developing and incorporating computer-based techniques into the general flow and structure of these programs which help to capture user commentary and suggestions. Thus, industry reviewers and the students themselves provide frequent feedback in the development of the lesson material. It is believed that this partnership and interaction during the preliminary development process enhances the quality and usefulness of the final educational products. Moreover, in subsequent years the ability to obtain on-going user feedback ensures that the computer-based educational tools remain flexible and dynamic, continuously changing in response to the needs of the students and industry, as well as further technological advances.

The concept of a learning partnership between academia, industry and the students is further supported by the use of multimedia type tools. Provisions have been made to capture dynamic video vignettes presenting various approaches to the explanation of the mainstream course material. It is believed that this approach improves the effectiveness of the computer-based format as an educational tool. It takes into account the fact that different people learn in different ways. In addition, it enables the user to focus on the particular method or style of explanation that best suits his individual learning style. Furthermore, the student also receives a more well-rounded educational experience by being exposed to diverse perspectives, rather than merely absorbing only the traditional academic outlook. For example, the typical classroom explanation of queuing theory is being strengthened via the computer-based format by presenting video footage of an employee on the factory floor describing how bottlenecks affect his work performance. Also presented is an industry executive explaining the consequences of such buildups on the overall functioning of his organization. Thus, the learner gains exposure to a fuller scope of the material since the academic concept is coupled with the real-world applications of the theory.

In addition, multimedia development has further worked to satisfy the diverse learning styles of its potential users by building multiple interactive on-screen icons which serve to support and complement the mainstream sequential information flow of the computer-based lesson into the standard multimedia layout. These buttons offer the user a vast array of support and reinforcement for the mainstream body of knowledge and range from lecture notes, to real-life examples to video illustrations. Thus, the user can focus on the particular method of explanation that best suits his individual learning style. Furthermore, the student also receives a more well-rounded educational experience, especially being exposed to global perspectives of the issue at hand through linkages to state-of-the-art information banks such as Mosaic/World-Wide-Web.

A brief summary of the interactive on-screen icons is as follows. These icons can be invoked by the student as he or she moves through the sequential presentation of the course material.

**Lecture Notes**
This icon will provide access to actual lecture notes generated by the instructor and will contain detailed information about the topic. Notes are generated in ASCII text format and incorporated in the computerized lesson via script written for displaying the text. These notes can be modified by the lecturer to update or meet new requirements.

**Examples**
Clicking on this button will allow students to access real-world examples that clarify and reinforce the topic at hand. In the case of Focus: HOPE multimedia development activities, examples were derived from the Focus: HOPE factory due to their immediate relevance to the students.

**Graphic Examples**
In cases where a topic can be explained with the help of graphic examples, this button can be activated. Examples of this usage include displaying a graphical solution for a linear programming problem, a flow chart of product movement or a man-machine simulation for workplace design.

**Assessment Questions**
Clicking this icon will allow the student to perform a self-assessment on the current material and then make a decision about whether to proceed to the next topic.

**Factory Floor**

Where appropriate, links to the factory floor will be established to further reinforce the real-world applicability of the mainstream course material.

**Learning Objective**

This button will list the items the student is expected to learn during the course.

**Video Lecture**

This icon will allow the user to view a video segment of the lecturer explaining this topic in a classroom setting. In most cases these are keyed to the text or other arrangement of course material appearing on the main screen.

**Outline Text**

Through this icon students will gain access to course outlines from other institutions that could be relevant to their current subject area through MOSAIC and Internet.

**Internet and World-Wide-Web**

This button will allow students to access institutions connected to the Internet. The more research-oriented user will be able to obtain a wide range of information in this fashion.

**Peer Interaction**

This button provides course material presented by the students who have mastered the relevant concepts. It is explained using terms and references common to the student audience.

Finally, realizing that the technological supports to computer-based learning are changing and improving almost daily, development at Lehigh University to date has been guided by looking toward what is technically achievable now or likely to be available in a one to two year time period. Developers have been working within current technology constraints to create an educationally viable support for the traditional courseware. They have also been building mechanisms into the structure of their efforts to facilitate the incorporation of new approaches to multimedia. For example, current networking, storage and processor restrictions make the use of real-time, full-screen video somewhat difficult. Consequently, at this time students are being directed to an external video source until the technology can better support a fully integrated presentation.

**Practical applications of course material.**

Many academic disciplines throughout Lehigh University and other institutions have been encouraging their students to pursue internships in areas related to their coursework as a means of enhancing their overall educational experience. Such real-world work experience clearly benefits the student by enabling him to test potential career paths before actually accepting a full-time position in that area. At the same time, students who receive such practical training have a marked advantage in today's difficult job market, as business and industry leaders have repeatedly indicated that individuals who pursue this dual learning path are more productive and successful in the corporate world and therefore more desirable recruits.

However, these internship experiences are perhaps not as beneficial as they could be, because quite often the students are sent out into the business world without faculty support of guidance and simply told to write a paper about their experience when the internship is complete. Any problems or questions that arise through the internship activities are uncovered when the work is finished, if at all, and as a result potential educational benefits may be lost.

To this end, the industrial engineering department at Lehigh University has incorporated a more structured approach to the practical learning experience into its undergraduate engineering curriculum through a required senior project course. As part of this course, students are assigned to local manufacturing or service organizations as part of a small project team and work to solve real-world problems using industrial engineering techniques, having had the appropriate academic coursework to support such endeavors. These activities are coupled with a classroom component in which problems and conflicts are analyzed and discussed in an interactive group setting, enabling other students to assist with and learn from the experiences of their classmates. At the same time, a qualifies instructor is also available to offer input and guidance when necessary on a real-time basis as the students are actively involved with the project, rather than after-the-fact, as with more traditional internships.

**Concluding Comments**

It is the author's belief that as the requirements of an increasingly technologically advanced global marketplace continue to grow and change, academia must strive to redefine its activities and approaches.
By utilizing some of the same technological advances creating these new demands a greater variety of teaching methods can be utilized. Anecdotal evidence based on pilot studies indicates that learning efficiency improves.

Using a learning partnership approach new methods can be tested out. It is our belief that concepts such as industry practitioner input, integrated curriculum development, partnering through technology and practical applications of course material show promise as they are being piloted in the Focus: HOPE and Lehigh University settings.