# NEW COURSE DEVELOPMENT IN A DISTANCED COLLABORATIVE ENVIRONMENT

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***Abstract*** *- This paper describes improvements and innovations in the process of curriculum development in a distanced collaborative environment. The work was completed in a videoconferencing environment that enabled real-time development and capture of work products. The improvements reported were based upon lessons learned developing previous courses using interactive but text-based approaches. New technology that was developed in the interim allowed new approaches to be utilized. The paper also presents example course content and objectives. The design and development of multimedia learning activities for teaching industrial and manufacturing engineering concepts within a real-world manufacturing context is explained. Rapidly evolving computer and communication technologies are utilized to create digital objects for the delivery of video images captured from the shop floor or communicated from remote facilities in real time. These same technologies enable the packaging of digital objects in multiple delivery modes to accommodate the unique needs of individual learners.*

*Index Terms - Curriculum development, Distanced collaboration, Engineering education.*

## INTRODUCTION

The technologies available for both curriculum development and delivery have evolved rapidly over the past decade. Prior to the general availability of affordable videoconferencing systems, most curriculum development involved individual efforts. Attempts at collaboration required the physical proximity of team members or the expense of travel for face-to-face development work. The alternative was to circulate draft materials among collaborators using more traditional means such as fax or overnight delivery services. The end product was typically paper-based or compiled in a presentation format. Development times were long and the unit of production was large – generally, a complete course.

The introduction of videoconferencing facilitated the process of collaboration. Particularly for geographically dispersed teams, this technology permitted more frequent collaborative sessions while preserving much of the dynamics of human interaction. The interplay of personalities typical of face-to-face interactions was largely preserved. Development time was reduced. Often however, the work product was largely the same. Instruction was still delivered, whether face-to-face or distanced, using a static presentation format.

A next step was the introduction of authorware type software and the related development process. The resulting products were computer-based and enabled several potential improvements. They were self-paced; navigation within large blocks of material was provided; there were assessment capabilities, and supplemental materials to assist students needing additional explanation of the material could be included. This process, however, introduced additional burdens into course development. The most significant of these was the frequent need for professional programmers to encode the material, and the need for course designers to create detailed specifications to instruct the programmers. In addition, the end product often was fixed, difficult to modify incrementally or easily customize.

With respect to the approaches presented in this paper, the ultimate goal was to permit the team within the videoconferencing framework to share applications such that the design review and the editing process could occur in real time. This was to include dynamic motion examples. Team members could then create or manipulate dynamic objects that were easily integrated into the final work product. The flow of work changed from a serial to a parallel process while at the same time preserving the benefits of face-to-face interactions.

Several factors contributed to a major improvement in the productivity and efficiency of the course development process. Personal computer hardware and software capabilities advanced dramatically. Hardware processor speed, input/output capability and high-density storage capacity enabled the storage, manipulation and display of high quality multimedia objects. Software provided robust and user-friendly multimedia editing tools and the capability to integrate numerous multimedia streams into a seamless package with a sophisticated navigational framework. The creation of course materials occurred much more quickly and at lower cost as a result of these improvements.

## THE DEVELOPMENT PROCESS

For the example presented in this paper, the course development team consisted of an instructional designer,

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academic subject specialists from two universities, and industry subject experts. The collaborative sessions were typically two hours in length, meeting once a week. The videoconferencing collaboration took place at two facilities: The Enterprise Systems Center at Lehigh University in Bethlehem, PA (Figure 1) and The Center for Advanced Technology at Focus:HOPE in Detroit, MI (Figure 2). The course being developed, Manufacturing Systems I was part of the curriculum of the Bachelor's degree program offered through Focus:HOPE. The course teaches the fundamental principles of manufacturing systems and how humans interface within the process.

FIGURE 1.
GREENFIELD COALITION TEAM MEMBERS AT LEHIGH UNIVERSITY
GREG TONKAY (L), LEHIGH UNIVERSITY ACADEMIC SUBJECT SPECIALIST AND LARRY BUTLER (R), BUTLER ENGINEERING INDUSTRY SUBJECT EXPERT

FIGURE 2.
GREENFIELD COALITION TEAM MEMBERS AT FOCUS:HOPE
SOHAIL AHMED (L), WAYNE STATE UNIVERSITY ACADEMIC SUBJECT SPECIALIST, SCOTT MATTHEWS (C) FORD MOTOR CO. INDUSTRY SUBJECT EXPERT, AND NANCY BASKIN (R) GREENFIELD COALITION INSTRUCTIONAL DESIGNER

Based on the Greenfield Coalition Learning Hierarchy shown in Figure 3, the course was broken down into modules, sessions and activities. At this early stage, the industry subject experts contributed contemporaneous best industry practice of methods such as the use of TAKT time and value stream mapping. The various team members developed sessions based on their appropriate strengths and knowledge. The pedagogical approach was patterned after Robert Gagne's nine external events of instruction and their corresponding cognitive processes[1]. The value of this approach has been tested in practice and adopted as a standard for curriculum development within the Greenfield Coalition[2][3][4][5].

In the early stages of the process as sessions were developed, they were submitted via e-mail to the instructional designer. The weekly teleconferencing meetings were then used to review the progress of the team members and discuss any problems or difficulties. Early stumbling blocks included layout problems caused by unfamiliarity with the format and structure being used by the Greenfield Coalition. As the team became more familiar with the desired structure, other difficulties such as integrating the different application languages arose.

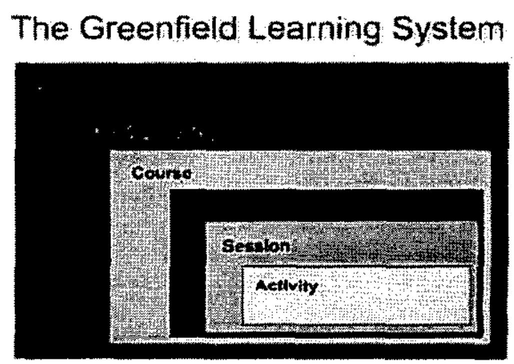


FIGURE 3.
GREENFIELD COALITION LEARNING HIERARCHY [2]

As all the developers became familiar with the process, standards, and structure of the course, the videoconferencing meetings became an instrument of real time editing and collaboration. Although real time, direct, online sharing of applications was an objective of the group and was a feature provided by the VTEL system, this was not accomplished as originally conceived.

In order to get started immediately, application sharing was initially accomplished through the use of a desktop document camera. A laptop computer was simply placed in front of the camera and the image on the display screen was transmitted to the remote site. Despite the difficulties presented by instability of the computer support devices, the type and location of the cameras at the Lehigh site made this an acceptable method of sharing information (Figure 4). Although its design was more suited to transmit hand drawn sketches and prepared slides or papers, it proved to be an adequate to the task of transferring information the Focus:HOPE site.

The location of ceiling lights made this more difficult at the Focus:HOPE site. Glare from the lights made the image unreadable. The later installation of a video projector at the Focus:HOPE site along with the location of the cameras made the use of a projector a preferable alternative because it eliminated glare as a factor (Figure 5). The projector method was not utilized at the Lehigh University site because the location of the projection screen was not entirely visible to either of the cameras.

The use of videoconferencing allowed review and modification of the sessions after they had been through the initial draft and rewrite. The academic specialists and industry experts used online editing to perform the necessary final revisions before the material was published to the web. At this point in the process, the instructional designer provided methodology discipline and managed the real-time editing process. Using the projector to display the work under consideration, team members quickly completed the online editing without the time delay that occurs using mail, fax, or electronic distribution to the reviewing parties. Online editing is shown in Figure 6.

While stumbling blocks typically occur in any collaborative effort, the use of videoconferencing reduced the lag and response time required to resolve the problem by eliminating rework or conversions.

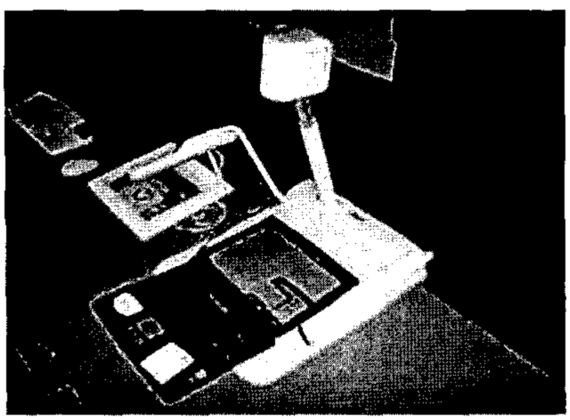

FIGURE 4.
INITIAL APPLICATION SHARING ARRANGEMENT PRIOR TO THE USE OF EMBEDDED SYSTEM SOFTWARE

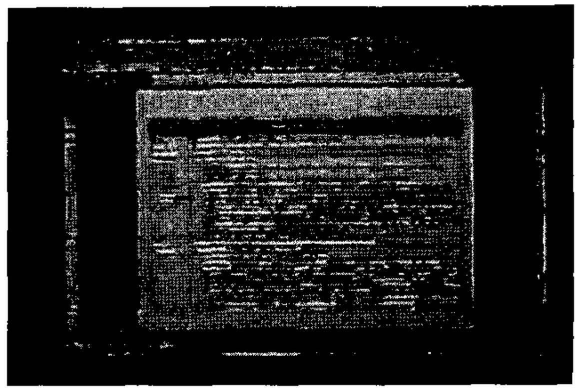

FIGURE 5.
IMPROVED APPLICATION SHARING ARRANGEMENT

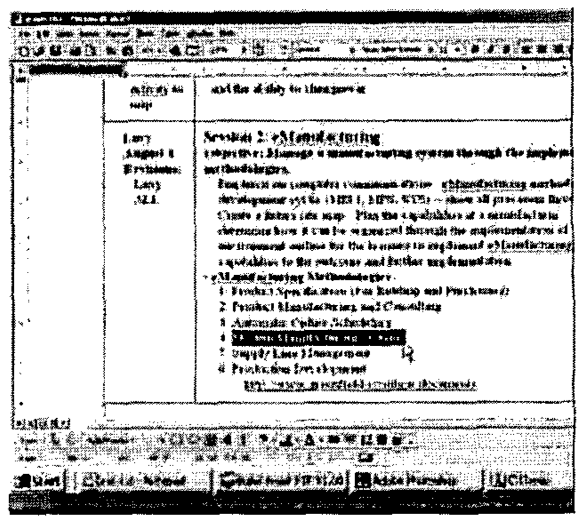

FIGURE 6.
ONLINE EDITING OF SESSION ACTIVITY

## EXAMPLE OF COURSE CONTENT AND APPROACH USED

The objective of the Manufacturing Systems I course is to have the students analyze the interaction of humans, processes, machines, and information that comprise manufacturing systems. The course is broken into four modules with approximately four sessions in each module. A brief description of modules one, two and four follows, along with a detailed explanation of module three, including individual session descriptions and objectives.

#### Module 1: Introduction to Manufacturing Systems

Four sessions, covering types of manufacturing systems including computer integrated manufacturing (CIM) and support systems.

#### Module 2: Analysis Tools (Graphical and Computer Based)

Three sessions, covering Gantt charts, flow charts, quality tools and computer simulation.

#### Module 3: Human Factors

- **Session 1.** Work Environment. Define and identify the interface between humans and the equipment they use, including the environment in which they function.
- **Session 2.** Applied Anthropometry. Define tasks, workstations, and work environments based upon ergonomic principles.
- **Session 3.** Work Measurement. Define different aspects of work and time measurement.
- **Session 4.** Classical Methods of Time Study/TAKT Time. Perform work measurement containing machine-controlled elements.

An interactive component of session 3 includes a classical time study of a broaching operation. A short video and description of the operation is presented. The student is then asked to define and analyze the operation. Refer to Figure 7 for a frame capture from the video. The digital nature of the lesson allows the student to easily repeat the sequence to become familiar with the analysis process without asking a human operator to repeat the work.

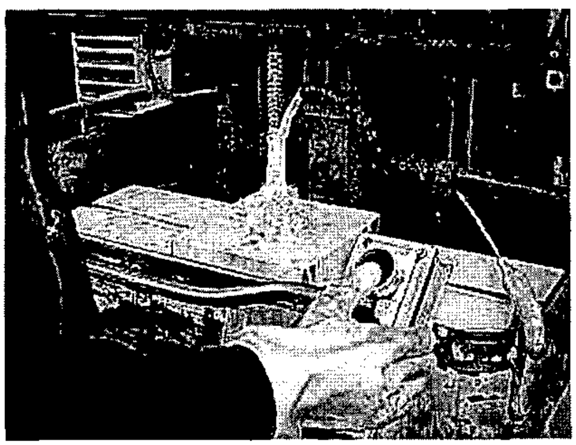

FIGURE 7.
TIME STUDY OF A BROACHING OPERATION

#### Module 4: Data Communications and Networks

Five sessions, covering distributed systems, local area networks, wide area networks, computer numerical control and ladder logic.

## EQUIPMENT USED FOR COURSE DEVELOPMENT

The videoconferencing equipment at the Lehigh University site included the following:

- **Hardware:** VTEL Enterprise Series Leadership Conferencing System, model MM-1, including ELMO EV-400AF Visual Presenter
- **Software:** Microsoft® Windows 95, Microsoft® Windows OFFICE 2000, VTEL Appsview™ version 1.10

A diagram of the system elements is shown in figure 8.

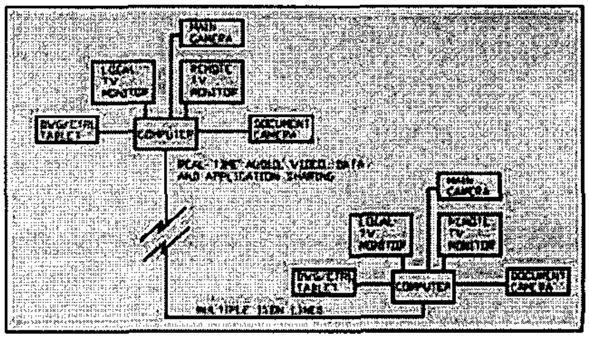

FIGURE 8.
BLOCK DIAGRAM OF VIDEOCONFERENCING NETWORK

## RELATED DEVELOPMENT ACTIVITY

The environment for related development at Lehigh University is the Enterprise Systems Center Collaboratory, shown in Figures 9 and 10. This was the location utilized for the activity previously described where distanced developers are connected. In the next part of this paper the collaboration tools and dynamic images derived largely from industrial settings are adapted for educational uses.

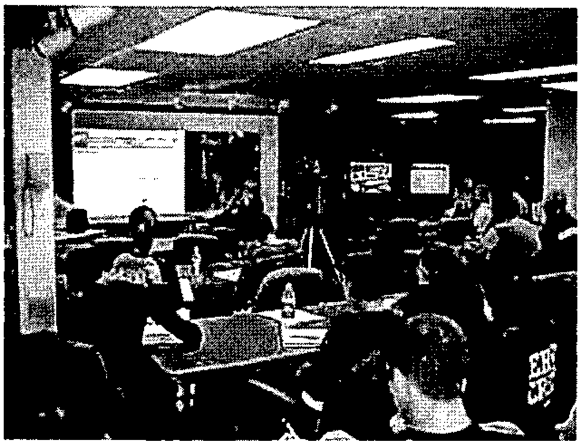

FIGURE 9.
THE ENTERPRISE SYSTEMS CENTER COLLABORATORY AT LEHIGH UNIVERSITY

The Collaboratory is designed to promote cooperation among education, industry and government partners. Its broad mission is to apply and promote the use of agility techniques in business and industry. These techniques exemplify strategic and operational processes that are flexible and adaptable to rapidly changing circumstances. The educational mission is to discover more effective ways to teach and learn in an environment dedicated to the application of advanced technologies. In addition to video and web-based conferencing capabilities, the Collaboratory contains equipment for the creation and development of experience based multimedia learning tools.

FIGURE 10.
STUDENTS UTILIZING THE VIDEOCONFERENCING SYSTEM IN THE COLLABORATORY TO CONNECT WITH AN INDUSTRIAL SITE

Additional work under development allows students to select from a variety of formats and the educational materials to assist in the learning process. This utilizes the capabilities of the current generation of desktop computers. The high speed CPU and increased capability of AGP video cards have made full animation and video available to virtually all students. The capabilities of random access, provided by CD and DVD technology and combined with the storage capacity provided by such media, makes multi-modal instruction possible.

The concept is to provide multiple learning methods to the student in an interactive format. Within the course framework there will be opportunities for both visual and audio material to be presented through multiple approaches. On specific subject matter there will be links to these various approaches. One link will direct the student to written notes; a different link will direct the student to the instructor's classroom lecture; other links will direct the student to peer explanations of the subject matter, Internet resources, and outline of the material in question.

Because the course material is stored in CD or DVD format, the student has random access to information on demand. This represents a significant advance over the VHS tape format that is essentially sequential without readily available indexes. The tape's sequential nature makes it difficult to skip material that is understood and equally difficult to repeat material that is poorly understood. It is also extremely difficult to incorporate additional information presented in a different structure or mode.

An example of a course in Instrumentation with several accompanying links is shown in Figures 11, 12 and 13.

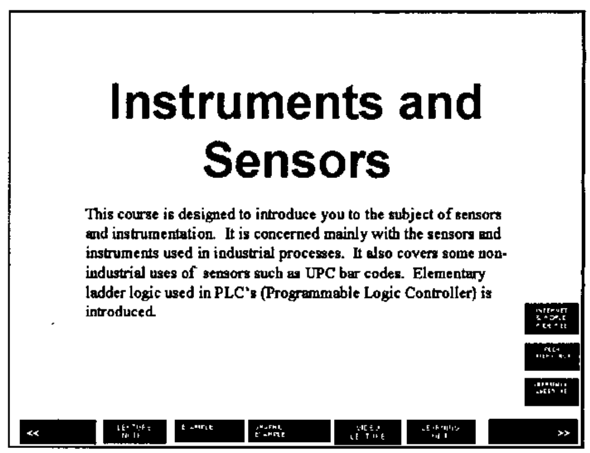


FIGURE 11.
START PAGE OF SUBJECT MATTER

The course shown is developed in Microsoft® PowerPoint format. The core of the course follows through on pages similar to Figure 11. As the student progresses through the course, supplemental material is available through the links on the bottom and right side of the page.

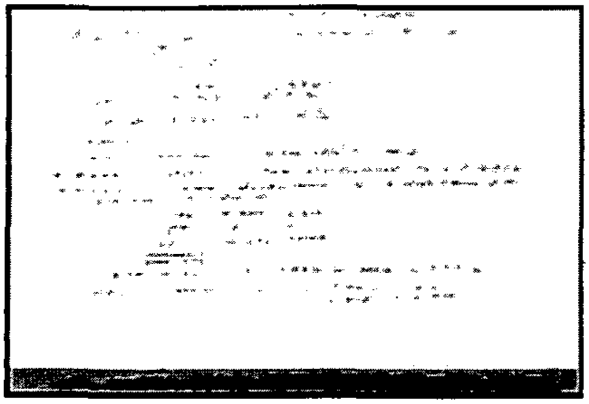

FIGURE 12.
LECTURE NOTES LINK ON WEAR ALLOWANCE

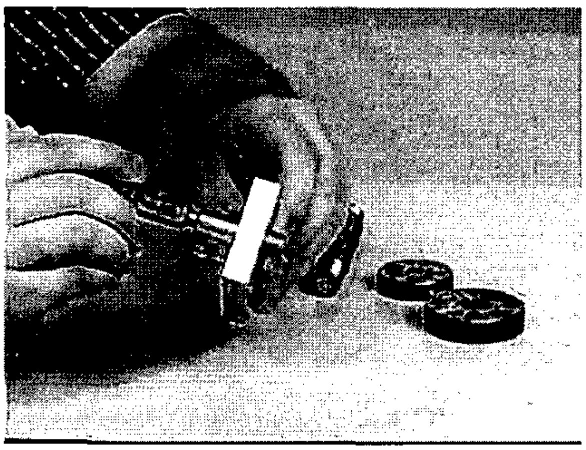

FIGURE 13.
GRAPHIC EXAMPLE LINK OF PLUG GAGE USE

The ten links shown on the page counter-clockwise from the bottom left are:

- Reverse – Go back one page.
- Lecture Notes – View the instructor notes for the information presented on that page.
- Examples – Access to real world examples or narrated sample problems that clarify the topic on that page.
- Graphic Example – Graphic display of the topic on that page.
- Video Lecture – Video images of instructor explaining this segment in a classroom setting.
- Learning Objective – A list of the items student is expected to learn during the course.
- Forward – Go ahead one page.
- Assessment Questions – Self assessment questions for evaluation of understanding and suitability for continuing.
- Peer Interaction – Material presented by other students who have mastered the relevant concept.
- Internet and World-Wide-Web – Access to additional material for research-oriented user.

Not all links will be active on all pages.

## CONCLUSION

Based on our experience, at least two components characterize the effective development of courses within a distanced collaborative environment. One is personal interaction in a face-to-face mode. Videoconferencing provides the technology that preserves the dynamics of human interaction. Coupled with this human interaction is the ability to create work in real time. Our anecdotal evidence indicates that it may be possible to enhance the effectiveness of curriculum and course development through this use of distanced learning technologies. However, complete evaluation had not been accomplished at the time of publication of this paper and will be presented in a future paper.

The current technology of shared computer applications with sufficient speed and bandwidth to incorporate both text and dynamic objects provide sufficient capability to support a parallel rather than serial, development process. Using these advanced development tools, industry subject experts, academic subject specialists, and instructional designers can overcome the obstacles of distance to create dynamic, interactive course materials that serve the needs of students with varying backgrounds and abilities.

## ACKNOWLEDGMENT

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