A Multi-media Network for First-Year Engineering

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Abstract

First-year engineering courses at The Pennsylvania State University can be completed at any one of the University's 19 campuses. Over the years the first-year engineering curriculum at Penn State Campuses has deviated significantly from the established criteria, and the course content varied significantly from campus to campus. This is primarily due to inefficient communication media, difficulties in sharing course material, and challenges involved in mapping course requirements to the local resources available at each campus. This paper outlines the project underway to build an efficient multi-media network with the 19 campuses via Internet to communicate, distribute, and acquire curriculum related multimedia information for the first-year design course. This network would provide access to course material currently used at the campuses as well as to resources that will enhance the future course content. The network will also provide video-conferencing capabilities and on-line “chat” capabilities to collaborate with industrial partners.

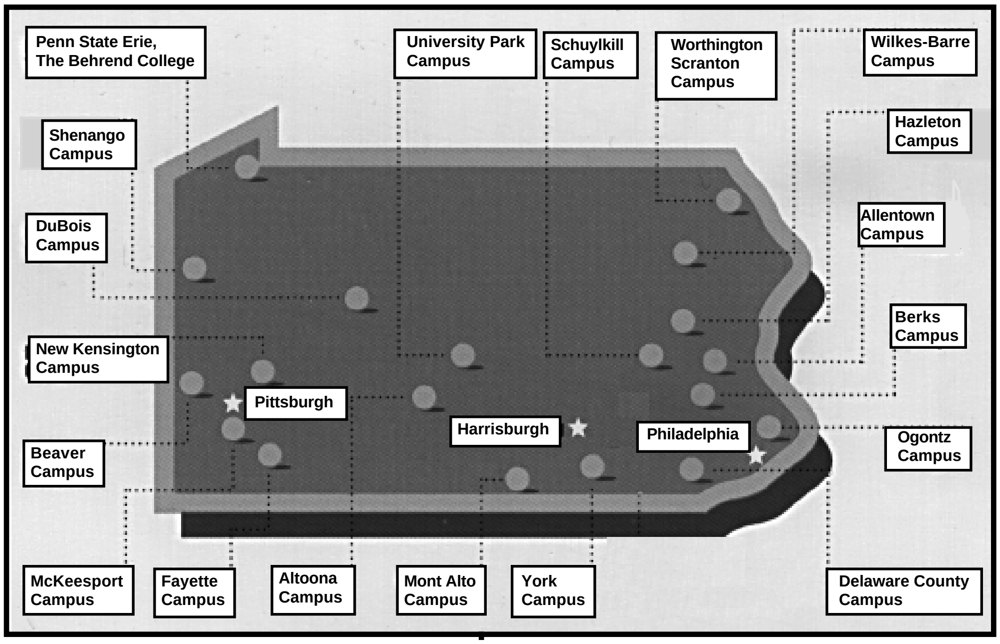
Introduction

The 19 campuses of the Penn State Commonwealth Education System provide an accessible alternative for 1800 students per year across the state who plan to eventually complete their undergraduate degree at Penn State's University Park, Behrend, or Altoona campuses. At the same time, it presents a serious challenge in terms of ensuring consistency in course expectations, competencies met, content covered, and types of learning experiences offered at the various locations.

Earning design credits at the first-year level is the first step in integrating design throughout the undergraduate curriculum. Several of the colleges in the NSF sponsored Engineering Education Coalition have efforts underway to redesign the first-year engineering course as a design course. This is also one of the missions of the ECSEL (Engineering Coalition of Schools for Excellence in Education and Leadership), where Penn State plays a significant role in integrating design in the first-year. Satisfying design credits means defining competencies for the course, establishing prerequisites, defining design project content, establishing grading policy, and spending sufficient class time on the design activities[1].

To provide a uniform design experience to all students, a new first-year design curriculum was implemented at all the campuses. In developing and instituting the curriculum, there were unique challenges involved. First, how do we implement a design curriculum that is uniform across all the campuses when the resources available to each campus are dramatically different from one to the another? Second, when a design curriculum is implemented at all the campuses, how can we be assured that the design experience is of appropriate quality that it will be recognized for its design content? These are some of the challenges that need to be addressed, especially if the course will be designated to receive ABET approved design credit.

The curriculum was coordinated by identifying a contact person at each campus who is responsible for local implementation at the campus level. The campus contacts meet several times a year to coordinate the effort. The key to successful implementation is that the faculty teaching the courses must have “ownership” of the course. This can only be achieved if the faculty is allowed to tailor the course according to her or his interest, expertise, and resources available[2]. This concept of ownership of the course is specially important when



The Location of 19 Penn State Commonwealth Campuses in Pennsylvania

teaching design courses, where the success of the course is heavily dependent on the faculty's enthusiasm for the course. This is a dramatic shift from the old model, where faculty were told exactly what topics and chapters to cover by their predecessors. The new curriculum model allows for continuous improvement.

The new curriculum has the following features:

- Competencies and goals for the course are defined, which were developed by the campus contacts under the leadership of the coordinating team.
- Faculty have the freedom to teach the course in their areas of interest using the resources available to them, as long as the competencies are satisfied.
- The course content is evaluated by the course outline and the assigned design projects. The course outline is treated as a contract between the students and the faculty. The course outline is required to show that the course meets the defined competencies. The outlines are evaluated annually by a team of faculty from the campuses.
- Course material, such as workbooks, notes, design projects, developed at each campus are shared through internal publications.
- Student evaluations are performed to monitor the quality of the course.

Challenges in Maintaining a Coordinated Curriculum

The course has been tested at all the campuses and the course is officially approved to be offered starting Summer 1996. The new course is a design driven curriculum with emphasis placed on skills such as: team work, communication skills (graphical, oral, and written), and computer-aided analysis tools. The curriculum is an introduction to an engineering approach to problem solving with strong references to basic science and math skills, as well as testing and evaluating design ideas by building working prototypes. The design projects total at least 30 hours of in-class work (one third of the course). Industrial participation is a valuable component of the curriculum.

The implementation of the new curriculum was a momentous task involving 25 full-time faculty, dispersed across 19 campus locations. The entire project took approximately 4 years to complete with a price tag of approximately $300K, mainly funded by the NSF sponsored ECSEL coalition. The implementation involved following tasks:

- Curriculum development
- Course material development
- Pilot testing
- Evaluation & assessment
- Full-scale implementation
- Faculty re-tooling workshops
- Teaching assistant training workshops
- Funding for improvement of lab facilities

The early course development efforts are documented in articles by Sathianathan et al.[3] Some of the course material developed for the new course are available as workbooks by Sathianathan and Sayeed[4], and Kallas and Sathianathan[5]. Assessment of the new course material on student learning is documented Devon et al.[6]

As we plan for the future, we clearly face new challenges in maintaining coordination of the curriculum and sustaining continuous curriculum improvements. These challenges are obviously burdened by the geographical dispersion of the campuses. Furthermore, the new design curriculum calls for active industrial participation, and considering the number of campuses involved, this is difficult to sustain especially for campuses that are not in close proximity to industrial sites. A detailed discussion of these issues are presented below:

Geographical Dispersion of Campuses - Implementation of the new curriculum was feasible through funded projects involving significant travel. Although meetings are necessary to enhance coordination, this mode of coordination is very costly on faculty time. In the long term this type of coordination will be difficult to maintain.

Mechanism for coordinating the curriculum with effective dissemination of developed materials - Currently, the course material used at each campus is collected centrally, duplicated, and mailed to the campus contacts. This cycle usually takes 8 to 12 weeks, and very often there are significant number of changes made by the time the campus contacts receive a copy of the course content. Therefore, significant effort is placed on a medium which becomes out-dated in a short time.

Continuous Curriculum Improvement - Maintaining a working mechanism to implement proactive incremental curriculum changes is essential to sustaining the value of the curriculum. Most of the current changes in the curriculum are reactive to the changing needs by industry in a globally competitive environment. For example, a new curricular module on the social and environmental context of design has already been tested. The future curriculum must anticipate the needs of engineers and meet these demands before these needs become issues. To be successful in operating in this mode, the curriculum must be able to make continuous incremental changes in a short time frame.

Active Industrial Participation - Currently there is some modest, but valuable, industrial participation in the curriculum. However, bringing in active industry involvement is the obvious next step. This is rather challenging to campuses that are not strategically located close to industrial sites. Also, the current form of industrial participation involves significant commitment by industry, which may involve traveling and one or two days away from work. Considering the number of campuses involved we must establish a very large resource of kind industrial partners. This is certainly not feasible at a time when the industries are operating on lean budgets.

Use of Multimedia Network

In consideration of these challenges, an integrated system of networked technologies and digital resources is under development to support the redesigned first-year engineering curriculum. Many leaders in higher education agree that the structure of information technology is centrally important to strategic change, and that while there are many examples of high quality digital applications that improve education, these programs typically stand alone without the accessibility offered by an appropriate delivery network or learning infrastructure[7,8].

Over the past ten years there has been explosive growth in the design and delivery of computer-based instructional solutions in higher education[9]. Digital curricula and networked delivery systems are not only able to extend learning opportunities beyond the walls of the classroom, but also meet the increasing student demand for greater control over the time, place and pace of their learning[10]. When properly implemented, computer-based instructional materials are shown to have positive effects on learning[11,12,13] and are rated favorably by both instructors and students[9, 14]. Fundamentally speaking, networked delivery of instructional materials provides an efficient, convenient way for faculty and students to exchange information and ideas regarding course expectations, projects and assignments, and specific course topics.

Penn State's College of Engineering and Center for Academic Computing identified specific technologies that would comprise the engineering curriculum network. The technologies were identified based on the ability to facilitate the program objectives described earlier. Below we describe each objective and how it will be facilitated via the network.

Any time, any where access - Providing course materials and resources that can be accessed any time and anywhere allows students greater flexibility in conducting work outside of class, and enables instructors to view and select materials from a comprehensive resource database to which all faculty contribute. The World Wide Web is currently the best medium for quick development and dissemination of multimedia materials. Development of these resources is being carried out by instructional and graphic designers, with engineering faculty playing a critical role as experts in the subject matter. Some of the on-line resources that can be accessed include course calendars, descriptions of weekly assignments and semester projects, technical diagrams illustrating complex concepts, up-to-date grade information, and a project database with video clips and still images illustrating sample projects. In addition, by using the WWW, secondary curriculum resources are virtually limitless, and can be linked where appropriate. For example, a course topic related to fluid systems might be linked to the homepage of a municipal water authority, a pump manufacturer, or a company specializing in irrigation systems.

Computer terminal demonstrating the video linkup software, CU-SeeMe, via the Internet

Faculty collaboration - Because of the geographic dispersion of campuses in Penn State's Commonwealth Education System, the current project seeks to make faculty collaboration easier through the use of desk-top video-conferencing with shared electronic white board features. For a relatively small investment, this technology will allow instructors (who teach the same course in different locations) to hold informal meetings, discuss course ideas and resources, collaborate on curriculum development or divide course development responsibilities based on areas of expertise and interest.

Industry partnerships - Input from industry managers and practicing engineers was critical in the development of program competencies, and will continue to be important in course delivery. Video-conferencing will enable frequent "virtual field trips" --hosted by industry sponsors-- through factories, plants, and test labs. Internet communication tools will also be used to encourage mentoring of student work. For example, practicing engineers will participate in class listservs set up to discuss course topics and design projects. All participants on the list can generate discussion topics, post queries, get feedback on design ideas, and trouble-shoot problems. As part of the project-centered focus of the program, participants from industry will also provide engineering "problems" which become the basis for student projects.

Current Status of the Project

Currently, a prototype of WWW course materials has been completed and will be implemented at Penn State's main University Park campus in Spring of '96. This prototype is the basis for the materials now under development for the other 19 campuses. During the Spring semester, feedback on the prototype will be gathered electronically (including data on use as well as descriptive feedback on the various features) and be used to revise and improve the materials that are delivered.

A positive finding during this developmental work was that there were many highly innovative curriculum activities being developed and implemented in isolation at various campuses. Thus, the collection of content resources grew very rapidly as innovative project descriptions, ideas for interactive WWW searches, and multimedia resources were collected and shared. Thus, the pool of curriculum resources available to engineering faculty has increased significantly.

Through the support of AT&T Foundation, funds will be made available for faculty to acquire necessary hardware and software to have to access to current technologies via the Internet. This will ensure that all faculty have the necessary technology to support the use of the multimedia network and contribute to its development.

Video-conferencing for faculty collaboration and classroom use will be piloted at several sites in the Spring, as will industry involvement in class design projects. Full on-line participation of practicing engineers will be implemented in Fall of '96.

Conclusions

The use of information technology with an appropriate delivery network, and an integrated learning infrastructure will continue to be a priority for future engineering curriculum. The technologies we use to access to information, the volume of this information, and the format of this information will rapidly change the pure nature of engineering education. To keep up with this change we must provide faculty incentives to take “ownership” of the course and nurture faculty collaboration. Providing “ownership” for the course would mean breaking down the course requirements to competencies, which will be met by the interest, expertise, and resources available to the faculty. This type of flexibility is an essential ingredient for continuous curriculum improvement, and only though such incremental changes can we meet the demands of the future engineering curriculum.

The systemic changes incorporated in the first-year design curriculum at Penn State will meet the demands the information age will place on the curriculum. The planned network will allow faculty to collaborate more efficiently and have access to on-line course materials and other resources. The flexibility provided by working with competency would drive continuous curriculum improvements. The valuable access to our industrial partners through digital network will keep our curriculum within the context of our society’s needs.

Acknowledgments

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