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Contents

Computer and telecommunications technologies are having profound effects on higher education. They influence whom we teach as well as how we teach. Indeed, the appearance of 'virtual universities' reflects new developments with respect to who is doing the teaching. This special issue of the International Journal of Engineering Education examines the role of virtual universities in engineering education. In this introduction to the issue, we first consider two challenges to traditional higher education and suggest that 'virtualization' is one way to respond to these challenges. We then define and describe what we mean by 'virtual university'. We outline the many issues raised by this form of education for engineers and other learners and provide an overview of the papers incorporated in this journal. Finally, drawing some conclusions from the papers and from our own experience, we express some thoughts on what the future might hold for the 'traditional' engineering schools and for learners seeking access to engineering education.

The National Technological University was created in 1984 as a cooperative effort by many major engineering and management colleges in the United States for the graduate and continuing education needs of busy engineers, technical professionals and managers. Today, 52 university campuses are linked by 16 channels of new MPEG2/DVB compressed digital video technology to workplaces in North America, and since 1995, to nine countries in the Asia Pacific region. NTU's vision is to enable working professionals and managers to share premier educational resources globally via telecommunications. NTU is a private, non-profit, accredited university although it has no direct faculty or campus student facilities. Today, NTU offers thirteen MS degrees and a MBA, nearly 500 academic courses each year, and more than 450 non-credit continuing education courses to a customer list of more than 250 business and government organizations. NTU's brief history is punctuated with a number of innovations. These involve delivery technology, and more recently, the creation of a for-profit subsidiary for many support functions. This paper describes the organizational relationships with the 52 participating universities and their faculties. Academic program outcome measures are reviewed in depth. Current trends in continuing education service are described. The increasing role of the Internet and World Wide Web in all aspects of the operation is reviewed. NTU's latest delivery technology strategy is also highlighted.

This paper reports on a project which was carried out by the Faculty of Electrical Engineering, University of Hagen, Germany. The goal of this project was to develop a Virtual University with all its essential features. The paper describes experiences with electronic multimedia courses, Internet-based tutoring and communication laboratories as well as the underlying technical platform which was developed for the administration of students and courses. Furthermore, a concept is presented how electronic payment systems can be used for the dissemination of learning material for further education.

Georgia Tech is currently developing twenty-two three-semester credit hour courses, to be delivered in an asynchronous mode via the Internet, which will allow remote students to earn a Master of Science in Mechanical Engineering (MSME) degree completely online. We are using several innovations in online course delivery to produce a better product than currently offered by other US institutions delivering courses and degrees via the Internet. We expect to spend $670,000 to develop the twenty-two online courses. The MSME degree is the first in a series of graduate degrees Georgia Tech will develop and offer completely online.

Technological innovation and socio-economic change have been leading to a reconfiguration of educational systems worldwide. The buzz-words are 'virtual teaching' and 'learning anytime, anywhere', and they are having an especially large affect on universities. Four universities in Baden, in South-West Germany, are gaining experience in this area thanks to an extensive interdisciplinary pilot project. The main part of the paper focuses on the means and methods used and developed within the project. Moreover, we point out some observations we have made attempting to take the first steps towards a structural change in the universities.

Distance educators are relying increasingly upon telematic solutions to connect with remote students. The authors argue that educators should have a sound knowledge of the pedagogical applications of telematic technology and how it impacts upon the distance learner. This paper uses a construction analogy to outline the basic building blocks of telematic learning delivery, and examines three key areas of implementation: theoretical frameworks, integrative approaches, and benefits analysis. Current practice and research into distributed learning networks in rural South-West England are described and a range of telematic technologies are examined. The paper offers benefits analysis and evaluation of the effectiveness of these applications to different learning and teaching contexts.

In this article we investigate the role of recommender systems and their potential in the educational and scientific environment of a Virtual University. The key idea is to use the information aggregation capabilities of a recommender system to improve the tutoring and consulting services of a Virtual University in an automated way and thus scale tutoring and consulting in a personalized way to a mass audience. We describe the recommender services of myVU, the collection of the personalized services of the Virtual University (VU) of the Vienna University of Economics and Business Administration which are based on observed user behavior and self-assignment of experience which are currently field-tested. We show how the usual mechanism design problems inherent to recommender systems are addressed in this prototype.

TELD is an on-line courseware engine over the World-Wide-Web. Firstly, TELD represents a method of 'teaching by examples and learning by doing' that unifies a number of contemporary methods such as problem-based learning (PBL), project-based learning (PBL) and case method (CM) in medical, engineering and business education respectively. Secondly, TELD serves as a web server for hosting teaching and learning materials especially based on the TELD method. Thirdly, TELD is a courseware search engine where educators are able to register their course materials and search for materials suitable for a particular course. Finally, TELD is an on-line virtual classroom for electronic delivery of electronic curriculum materials and for on-line conduct of many class activities. This last TELD feature is the subject matter of this paper. Like most commercial on-line course tools, TELD provides typical facilities such as syllabus tool, calendar of events, e-mail and live chat boxes, threaded forums, etc. However, what is unique with TELD is that it combines the above three features into one courseware engine. This paper focuses on explaining how TELD is used as a virtual classroom for active and collaborative teaching and learning. The TELD web site is currently at http://www.teld.net/

This paper sets out to present a comprehensive and integrated approach to teaching a Thermodynamics and Heat Transfer course using the World Wide Web. Existing WWW-based teaching structures and their shortcomings are first discussed. Then the concept and contents of a course portal following the comprehensive and integrated approach are presented. Different aspects of the portal, namely, the Main Page, the Multimedia Page, the Courseware Page, the Contact Page and the Search Page, are described. Future directions to improve the portal are discussed.

As course provision is expanding in the emerging virtual universities, the majority of Internet-based education revolves around online course materials and asynchronous discussion forums. One of the less exploited aspects of the Internet however is its ability to enable students to work together at a distance on collaborative design projects. A wealth of new technologies enables high levels of communication between students working at a distance. Sometimes, though, communication breaks down. Some of the technologies are still unreliable and many are not easy to use. Students are faced with working together in new ways and must develop effective means to collaborate using the technologies available to them. At the University of Strathclyde's Faculty of Engineering students have been working on collaborative online design projects since 1997. Building on the original ICON project, developed under the Clyde Virtual University initiative, a number of projects have identified barriers to communication between students. In describing the educational and technical environment for these design projects, this paper highlights the difficulties and shows ways in which students and staff have developed strategies to overcome them.

This paper outlines the development of a working model of a manufacturing enterprise, consisting of a manufacturing system, a warehouse and a customer. A model train is used to ship the goods between the three stages. The model can be viewed and controlled interactively on the Internet. This means that the user can explore different operating strategies to optimise the performance of individual components or the manufacturing enterprise as a whole, in terms of delivery time and total cost. The manufacturing enterprise model is built using LEGO and controlled by LabVIEW. The complete model and its controlling software was developed by a group of engineering students as an undergraduate project. The paper also discusses the educational advantages of developing and using such a system.

Given that modeling, simulation and computer-aided design are an integral component of the modern practice of science and engineering, virtual universities are faced with the problem of providing students with access to simulation programs required for their education. This paper describes the Purdue University Network Computing Hubs (PUNCH), an extensively-used Web-based computing portal that allows geographically distributed users to share and run unmodified tools via standard web browsers. The PUNCH infrastructure has been operational for five years, and has been successfully used to share and disseminate specialized tools and educational materials, and to offer simulation-intensive classes in distance education environments.