Internet-Ready Instruction Modules in Engineering Education

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Abstract

The primary objective of Internet-Ready Instruction Modules (IRIMs) is to utilize the global accessibility of the Internet to aid and enhance traditional classroom instruction. Recent advances in Internet technology offer a myriad of possibilities for IRIMs. In this paper, we outline how IRIMs can be used to promote multidisciplinary learning, to illustrate difficult concepts through audio-visual aids, for the development of virtual/real experiments that can be conducted via the Internet and to integrate faculty research into undergraduate/graduate education.

I. Introduction

Engineering education must keep in pace with progress in science and technology in order to help engineers fulfill societal demands and expectations. Therefore, educational and professional goals have to be redefined and adapted from time to time to accommodate the changes in these variables. The national focus on higher education [1], as we approach the new millennium, offers educators an opportunity to rethink educational objectives and to modify traditional tools and create new ones.

Computers and the Internet have influenced engineering practice significantly. Use of Information Technology (IT) in information/data management, communication, advertising, commerce and trade has created a global market place in which "the traditional engineer" should redefine her vital role. In addition, many of the emerging technologies require engineers to function efficiently in multidisciplinary environments and team projects. IT offers great potential for the development of new education tools that transcend the limitations of traditional classroom instruction. The vision behind the IRIMs project is to use advances in IT to develop a "global" learning culture that promotes education through multidisciplinary, team-oriented, computer aided learning. Principal elements of our present efforts are outlined below.

2. IRIMs in Education and Outreach

Use of animations and movies to aid assimilation of difficult concepts: Classical movies, such as the ones by G.I. Taylor and S. Corrsin, can be reformatted and placed as computer resources that can be accessed through the Internet. A number of efforts, supported by National Science Foundation, has recently resulted in the generation of multi-media modules in areas such as fluid mechanics and process technology [2-3].

Incorporation of virtual and real experiments that can be performed through the Internet: Virtual experiments are possible with today's technology. For instance, consider the illustration of self-diffusion through random walk through IRIM. A computer program to simulate random walk will be linked to the IRIM. The student can "click" on the appropriate icon to run this program with the parameters she specifies and see the results in real time. Physical limitations exists for real experiments. Currently, this idea is sought for selected process-control experiments that can be entirely computer-controlled.

Introduce cutting-edge technology and multidisciplinary applications: Examples for chemical engineering students include biomedical, environmental and materials processing such as site-specific drug delivery, placental transport, contaminant transport in soil, Chemical Vapor Deposition (CVD), composites manufacturing etc. For instance, if the application is Chemical Vapor Deposition, Internet links can be placed to the MEMC Inc., St. Peters, web site and to the academic research laboratories that work on silicon manufacturing through CVD and non-CVD processes. This will enhance professional awareness and improve career prospects.

Introduce experimental and software tools**:** Software tools will include Maple/Mathematica/Matlab and special purpose software such as FIDAP, Fluent, POLYFLOW etc. This could complement the introductory course on computing (CS 265 at Washington University). Similar introduction to applications of flow visualization [4] digital particle imaging velocimetry (DPIV), infrared thermal imaging (IRTI), Rheometry etc. could also be given through the IRIMs.

K-12 Education: IRIMs developed based on simpler illustrations of engineering target high school students to enhance K-12 education and undergraduate recruiting. These IRIMs can be developed by freshmen during Freshman Seminar (E60-120 at Washington University) course. E60-120 is aimed at providing students with a taste for the various engineering disciplines. It is taught by seniors with outstanding academic records under the supervision of a faculty member. Students are divided into groups and undertake a team project. Ideas pursued in the past include demonstration of viscosity to sixth graders, concrete canoe that floats in water, sticky polymer that climbs the rod and the suitability of pregnant women to undergo chemotherapy. Freshmen's work on these projects could be integrated into IRIMs and made available to high school students through the Internet.

3. An Example

An IRIM that illustrates transition to turbulence in a wavy channel flow may be found at http://wuche.wustl.edu/~sato/flowtrans/flowtrans.html. Transition to turbulence is a key concept that finds applications in chemical/mechanical/aerospace/civil engineering. This IRIM presents the results of a sequence of flow visualization experiments where the flow rate is increased in steps. Students can easily visualize the qualitative difference between the steady, streamlined laminar flow and the chaotic turbulence. The student is also asked a number of questions along the way dealing with flow separation, velocity profiles, Bernoulli's principle etc. The wavy channel geometry can also be used to motivate discussion on modeling porous media flow and its applications in industrially relevant processes such as oil recovery, materials processing and filtration. The development phase of this IRIM involved undergraduate students, thereby providing them exposure to the use of IT tools. There is also potential for improvement, i.e., results of more quantitative measurements using digital particle imaging velocimetry (DPIV) can be incorporated to complement the qualitative flow visualization videos. This will create the capability to include exercises in Reynolds averaging and construction of friction factor vs. flow rate curve from "real" data.

Bibliography

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