Multimedia On-Demand: The Organization of Educational Systems

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Abstract

In this paper multimedia representation and dissemination technologies are discussed with emphasis on their impact on educational systems. Specific research advances in these areas are outlined. The discussion focuses on supporting the need for an education infrastructure, and a systems architecture is outlined for the purpose of more specifically describing how such an infrastructure might function. It is also suggested that university educational environments could provide the ideal test-beds for the introduction of enabling technologies and new approaches to large-scale multimedia-based educational systems.

Multimedia Technologies and Digital Libraries

Multimedia technologies hold the promise of enriching classrooms and homes with a wealth of information that is compelling, motivational and meaningful. The challenge is how to exploit these technologies to sustain large-scale educational systems.

The use of these representation technologies demand that great changes be made to the way in which educational content is organized [1] However even greater changes are needed to adapt to the way in which multimedia information sources will be delivered and disseminated. The introduction of superservers capable of delivering thousands of simultaneous video streams merit profound analysis of the way in which information is currently accessed and consumed.

A single hour of compressed digital video, for example, requires 700 megabytes, or 1.5 megabits for each second of video. A library of 1,000 hours of video alone would require 700 gigabytes of storage. Large libraries of information that are digital video intensive pose significant problems in the areas of information storage, management and delivery, but no longer a thing of the future. Research being conducted at the Thomas J. Watson Research Center indicates that a single IBM ES/9000 could support close to 2,000 simultaneous random access full-motion video streams. This corresponds to a user community numbering in the tens of thousands [2]. Because of the way in which such computers have been engineered for fast I/O, these superservers will be able to access huge libraries of multimedia content, virtually unlimited sources of information.

High-speed networks are already taking shape across the nation, and superservers exist that can provide large communities of users on-demand access to unlimited sources of information in digital libraries of text, graphics, sound and full-motion video. Clearly university environments will be among the first communities to be affected by this order of magnitude change in information processing; and, clearly universities must lead the way to innovation (by means of pioneering deployment on campus) in the emerging practices that will help bring order to this new information revolution.

Superservers and Information Highways

The term "information highways" refers to high-speed transmission networks that have existed for quite some time on a point-to-point dedicated basis to handle large volumes of communications traffic. It is expected that if employed on a massive scale these information highways will enable more than the traditional forms of communication, greatly extending the range of information sources that can be accessed on demand [3].

These information sources will be digital libraries containing the collective legacy of recorded knowledge. Superserver technologies will manage the storage and dissemination of these libraries in ways that change the way in which we think of information.

The Need for an Education Infrastructure

The challenge is to formulate the kind of infrastructure that will facilitate the use of these combined technologies (multimedia, high speed networks and superservers) for educational purposes. Such infrastructures exist in other application areas, for example entertainment and television. In education the concept of an open, recipient-targeted infrastructure must be put in place before these technologies can be meaningfully and massively applied.

While the enabling technologies exist today, the digital libraries are just starting to be formulated. It is very likely that the technology platforms will be in place and widely available much sooner than the educational communities will have an opportunity to assimilate and prepare for the changes that are forthcoming. It is not sufficient to simply bring these technologies into the classroom; it is also necessary to use these technologies to bring information into the classroom in a coherent, well-organized way. The problem of creating these digital libraries is not in engineering or computer science, it is in management and organization.

To illustrate the problem, imagine an information base of thousands of multimedia documents describing various aspects of the physical sciences. How can this knowledge be disseminated to all the school systems in the United States? How can this be done so that multiple schools can work with the same information concurrently, and at the precise times when it is needed? How can the information be kept current and evolve as human knowledge evolves? How can disparate pieces of related information from multiple sources be brought together in such a way that they can all be accessed, interpreted, and presented coherently to educational audiences? Given the amount of information that it is possible to bring on-line, how can an appreciation of the content of a large video server be effectively conveyed? How can an instructor find the appropriate six-minute video segment that is needed to reinforce a particular point in a science lesson? How does the instructor know that it is there, how can it be found, how can it be accessed, and how can it be presented to the students at the point in time when it would have the most impact?

Figure 1 is used to suggest that the measured interception of content and access will determine the impact of the education infrastructure.

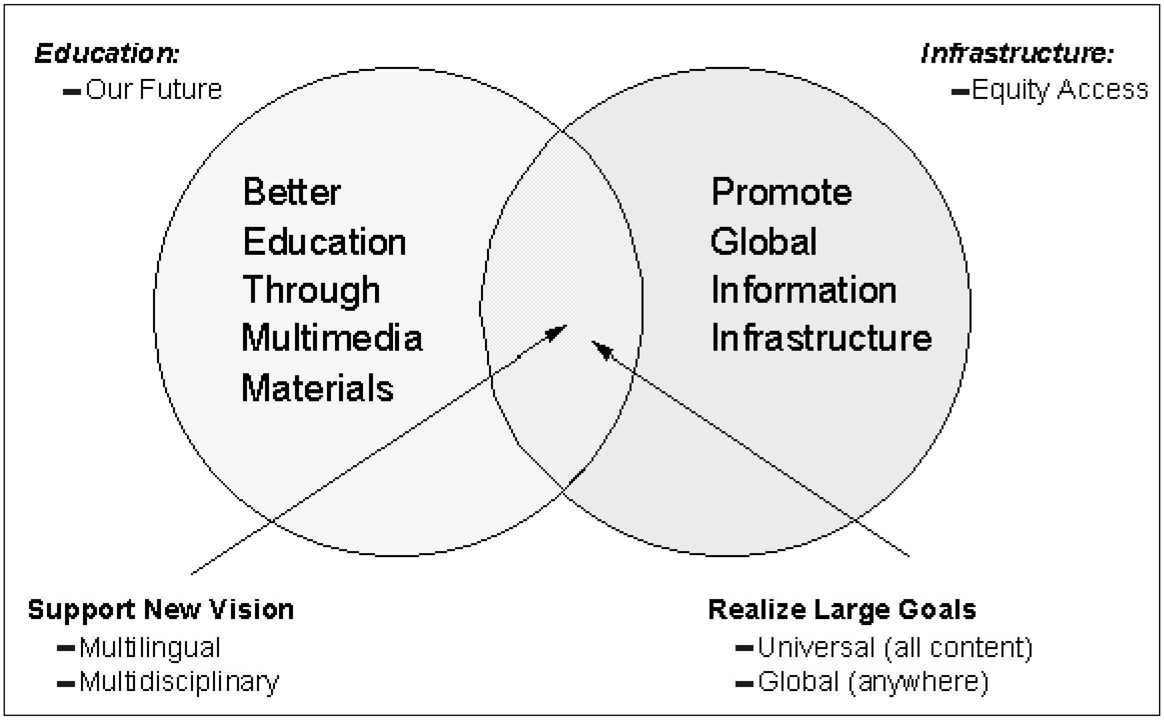

Figure 1. Impact with respect to engineering of content and access.

An Architecture for Educational Systems

A systems architecture for the application of technology to education is sorely needed, requires careful consideration, and will involve the application of powerful advanced tools and techniques. Furthermore it must be designed with Education closely in mind. Experience in this area as it relates to other domains has shown that the management of complex systems requires application dependent approaches [4].

To formulate a systems approach to Education that targets multimedia on-demand technologies, both the activities necessary to sustain educational processes and the collections of information needed to carry on those activities must be considered. Models of control and information flows need to be developed. In the domain of Education three broad classes of activities are generally recognized as fundamental. These can be designated as: organization, coordination and execution.

Curriculum development spans the organization and coordination levels. New curriculum frameworks need to be formulated, specifically based on digital repositories of information in order to provide the means for organizing that information based on sets of educational goals. The design of new curriculum models, and in general lesson plans that exploit these new open sources of information will then follow coherently. Student performance issues, scheduling and monitoring of specific activities are functions of the execution of the educational processes that derive from the organization and coordination activities.

These levels of activities can be clearly aligned with different systems requirements (data storage characteristics, access control, time sensitivity, etc.) and can be used to capture interrelated but separate collections of management tasks in terms of one common systems architecture. Figure 2 is used to suggest that the sizing of such a system is a function of content and curriculum as determined by the students that must be serviced.

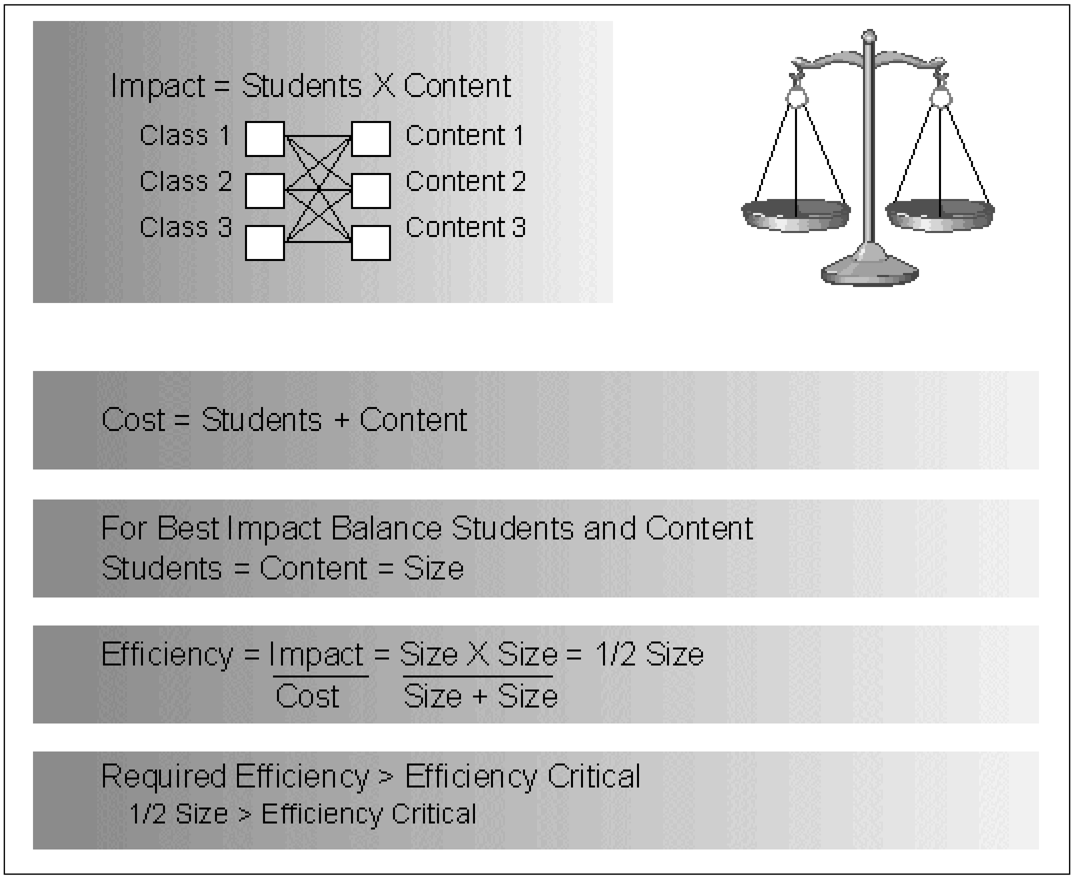

Figure 2. Sizing with respect too content and curriculum.

Conclusion

Education experiences can be enhanced with new opportunities for access to information and these opportunities can be supported in a comprehensive and structured manner. An education infrastructure to support students based on curriculum and content requirements; and, based on new multimedia technologies, can be sized and engineered using well-understood systems architecture practices. We have the tools, the knowledge and the resources to create such an infrastructure. However, this cannot happen without a sound pedagogical approach that specifically addresses the incorporation of critical technologies. The current intensity of activities in the area of educational reform provides a singular opportunity to formulate systems that reap the benefits of current technology. The confluences of new technical developments and reform movements can be used to greatly increase the capabilities of our educational systems. This coming together of inventions and events may very well be the signal that the promises of technology in education are about to become reality.

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