A Networked Education Infrastructure

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Breaking the Barriers of the National Information Infrastructure
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Introduction

This paper describes EduPort [1], a project designed to demonstrate the use of digital libraries and high speed communications in education and to explore what roles these technologies might play in shaping the teaching and learning environments of the future. The project was first demonstrated in the spring of 1994 in Lincoln, Nebraska, as part of an educational technology conference, in the words of Senator Robert Kerrey (D-Nebraska) "to show what could be done with imagination and training if money and infrastructure were not obstacles", and to illustrate "the work to be done building infrastructure and human capacity".

The demonstration went beyond planning for the one-day conference and became the coalescing force behind an active collaborative to produce a model of technology-based infrastructure for education that could play a role in the building of a National Information Infrastructure (NII). This paper documents the project and reports on the issue of implementation hurdles.

Brief History of the Project

On May 21, 1994, an IBM Research project that allows students and teachers to interact with electronic educational media in real-time on-demand was demonstrated at an education and communications technology conference in Lincoln, Nebraska. EduPort, developed at the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., is intended to explore the issues relating to the application of digital libraries and high-speed networks to enhance K-12 education. EduPort was installed and first used during National Science and Technology Week at Lincoln High School. The system uses mostly digital video from an electronic library at the University of Nebraska, and then sends it, via fiber-optic to the high school where teachers and students can access it in real-time, on-demand.

Media from a variety of sources is available to the students through EduPort. A history class studying World War II can hear the speech that Franklin Delano Roosevelt delivered to the American people immediately following the attack on Pearl Harbor. This is made possible through an electronic field trip to a digital subset of the FDR Library, installed at the University of Nebraska. An English teacher covering composition can simultaneously take her class on the same field trip to view handwritten drafts of FDR speeches. All the media is available to the teachers, in real-time on-demand.

For example, a science teacher in addition to drawing upon textbooks and other materials to interact with the students, might use EduPort to access NASA video footage previewing the 1994 space shuttle mission which replaced the solar panels on the Hubble telescope, when discussing solar energy and other alternative sources of power.

Other sources include the Smithsonian National Museum of American Art, the National Gallery of Art, and the Kennedy Center for the Performing Arts, which provided art and cultural material; the North Central and Mid-Central Regional Educational laboratories, which provided teacher training materials; and The American Chemical Society, which contributed science videos prepared specially for educational purposes. Research materials from the T. J. Watson Research Center are also part of the digital library.

On May 25th EduPort was demonstrated to the United States Senate Subcommittee on Commerce, Science and Transportation. The demonstration was part of Senator Kerrey's testimony before this subcommittee that is working on information superhighway legislation. Kathryn Piller, the principal of Lincoln High School, showed the committee how a digital library was being used to bring information to her students. Digital video and other media stored in the central EduPort repository at the University of Nebraska were accessed in real-time, on-demand, from the Senate conference room over a T-1 facility.

A plan is being formulated for a National EduPort initiative, starting by linking Rensselaer Polytechnic Institute (RPI) and California Polytechnic State University (CalPoly) to the University of Nebraska. All three of these institutions are networked and currently distribute multimedia across the campuses, but only the University of Nebraska provides those services to local K-12 schools. As part of this planned collaboration, schools in those geographic areas will have access to EduPort immediately. Interconnectivity is essential for national impact, and this new aspect of the project further promotes the development of an NII component that specifically targets a K-12 education infrastructure at the national level.

Overview of the Project

EduPort is introduced as *a conceptual link between the information of the world in digital form, as it will become increasingly available, and its use in education within a physical testbed for the application of digital media, on-demand, in education.*

An infrastructure that provides such a link and testbed, as a function of information and communications, has no intrinsic value except for how it is used, and, ultimately only if its use serves to enhance the quality of life. Therefore, in reporting the hurdles of realizing EduPort, the issue is its potential for improving opportunities for education; and this issue should be viewed from the perspective of equity of access to educational opportunities, which a well-thought out, dedicated education infrastructure can provide.

The aspects of EduPort that will help to understand how to overcome the hurdles of implementation are:

- ✓ The intellectual concept behind it
- ✓ The underlying technology platform to enable it
- ✓ The collaborative that must be formed to realize it

The combination of these aspects gives value to EduPort as a model NII component to enhance educational opportunities for all, and, therefore, in examining these aspects, the implementation hurdles that must be overcome are identified.

Background

By the end of this century large-scale digital libraries containing the collective legacy of human knowledge and information will be accessed in real-time, on-demand, over gigabit networks. The use of these technologies in education holds great promise for both students and educators. Digital libraries will provide access to information currently available in books, videos, and other traditional forms, while digital museums will provide access to content that is not currently available in these media. The potential to be able to interact with limitless sources of educational content, on-demand, both from classrooms and homes will change the way in which our teaching and learning environments are organized.

But embracing these technologies cannot be undertaken without serious consideration of all the possibilities that it opens. The technical changes that are taking place today in the area of information use and control are order-of-magnitude changes that will affect culture and be global in scale. Demonstration projects are extremely important at a time when critical decisions must be made [2], because they give parents, educators, and policy makers the ability to envision the kinds of things that we want to get out these technologies and the kinds of things that we must avoid. It is simply not possible to clearly envision the possibilities without demonstration projects, because the technologies are too complex, and it is not possible to acquire even a fundamental understanding of the issues without special training.

Issues to Consider When Defining the Hurdles

The technologies that will promote the NII are predominantly in the areas of systems and communications. The use of these technologies is expected to remove the physical and temporal boundaries that currently dictate access to all forms of information. This will in turn have profound impact on the social and economic factors that currently regulate how and for what purposes we use technology and information. We are about to become an information society.

Education systems are profoundly affected by social and economic changes. The radical changes that affected our education system during the Agriculture Age and the Industrial Age have not yet happened during the Information Age. The one room schoolhouse of the agrarian society gave way to the factory-like schools of an industrial society. Driven by an information-rich society, the role of education will be to teach students to organize, interpret and harness information. For that to happen there must exist an infrastructure inside and outside the school that makes information available in a consistent, manageable form. Education is now awaiting the fundamental change without which it cannot move forward, and this change may depend on how the NII handles its education component.

It has been pointed out, by well-known writers and children alike, that there is a discrepancy between the kinds of technologies that students are exposed to before entering school and, in general, outside the classrooms, and those which are in the classrooms. We have not been able to determine yet how to equalize those arenas, but neither have we been able to try.

One problem is that the technologies that have the most potential for equalizing exposure to technology and information access in education, and to compete with other less altruistic uses of technology, are the most difficult to implement, because there is no current infrastructure in place for their use. Therefore, we use alternatives that cannot compete. It is estimated that K-12 students spend an average of 24 to 27 hours watching television every week of the year. These

students have no systematic access to educational media, but they have organized access to all sorts of other media through a very efficient media infrastructure put in place for purposes that have nothing to do with education.

Video on-demand technologies are about to make those differences wider and more difficult to bridge. Video on-demand coupled with broadband communications technologies, the "information highways" of the future, will have an extremely differential effect on populations of students, enhancing the current systems of access to information that are available to them now, not relating to education. While we struggle to determine if those new technologies will bring any added value to the process of learning, or if we can incorporate them into the learning process at all, the enabling technologies will continue to flourish and penetrate deeper outside the learning environments.

Defining the Hurdles

Instead of hopelessly attacking the existing infrastructures we must set out to build an education infrastructure based upon the most advanced technologies that are available, and in such a way that it can evolve as the technologies evolve and thus serve as stable platform for change. The NII must contain this strong education component in order to neutralize the dividing effect that the "information highways" may have on the population. The education component of the NII must provide those missing alternatives without which the new communications infrastructures will provide only choices from among applications without educational merit for our students (e.g., entertainment, home shopping, etc.). Indeed the building of the communications infrastructure is being advocated without understanding how this will affect people.

The Intellectual Concept

Implementing demonstration projects that are so important for raising public awareness of the issues is very difficult in a climate of controversy regarding the use of the technologies. Market forces have presented confusing versions of what the information and communications infrastructures of the future might be like. Access to the Internet, for instance, has been made as an analog to the existence of an NII, and the appearance of 500 channels has been equated to video on-demand. Access to these alternative infrastructures is advocated because there are market opportunities, and sometimes in the name of education. Fortunately some of the misconceptions are beginning to disappear, but the educational communities are still left with no clear definitions.

Unfortunately, definitions and explanations of how and why the new technologies will play a role in the national initiatives are not forthcoming, and there is a danger that the classrooms may yet be left out. In implementing EduPort, the biggest hurdle was accepting that we must first explore, and that the exploration will require reaching out to industry and academia. The educational community alone will find it very difficult to participate in the national initiatives. For industry and academia, the formulation of a K-12 education infrastructure presents an unprecedented opportunity to participate in an area that is of critical importance to our society and that has important economic implications. Having an effective NII-based education infrastructure is a matter of survival for industry and academia, since both depend on the products of our K-12 school system. The educational community need not be left to do this alone, and should not be left out.

The concept of an NII by definition has as its premise collaboration, because it calls for the creation of a collective entity of information that is made nationally available electronically. If schools have no electronic access to information, and if the information to be accessed has no educational content, then schools are left out. If the form of access proposed for the schools is limited (e.g., text and images, download vs. real-time) the schools are again left out (because teachers have no time to search for, retrieve, and download media). Those are not effective forms of participation in the NII.

The underlying technology platform, technologies that were used to enable EduPort were not those that are available to schools, nor those that are affordable for schools. The most advanced technologies that could be offered were used in the project, the technologies that will advance the goals of the NII. A networked information infrastructure for education must have as its fundamental goal to make available resources and media to teachers in such a way that they can be integrated with classroom instruction when they would be most useful, when they are needed. But this requires complex and powerful computer systems not available to schools. Another hurdle that had to be overcome was how to make existing technical platforms that could support those requirements available to the school in Lincoln.

For the EduPort demonstration, a superserver located at the University of Nebraska supporting a LAN server and token ring-network of clients at Lincoln High School was used to deliver multimedia materials on-demand over a high-speed fiber optic cable. The high speed link between the university and the school did not exist prior to the demonstration (connectivity of this kind requires participation and support from the communications industry) Finding servers to connect to and planning for this kind of connectivity will be a hurdle, but one that can be overcome by means of collaboration with academia.

The Collaborative That Must Be Formed

Without a doubt what made this project a reality was the collaboration among the school, the university, and the computer and communications industries involved. The common goals that these partners shared were:

1. To explore new ways in which to enrich the classrooms, and
2. To better understand how to use the new technologies in general.

Figure 1. Extensions of the collaborative effort.
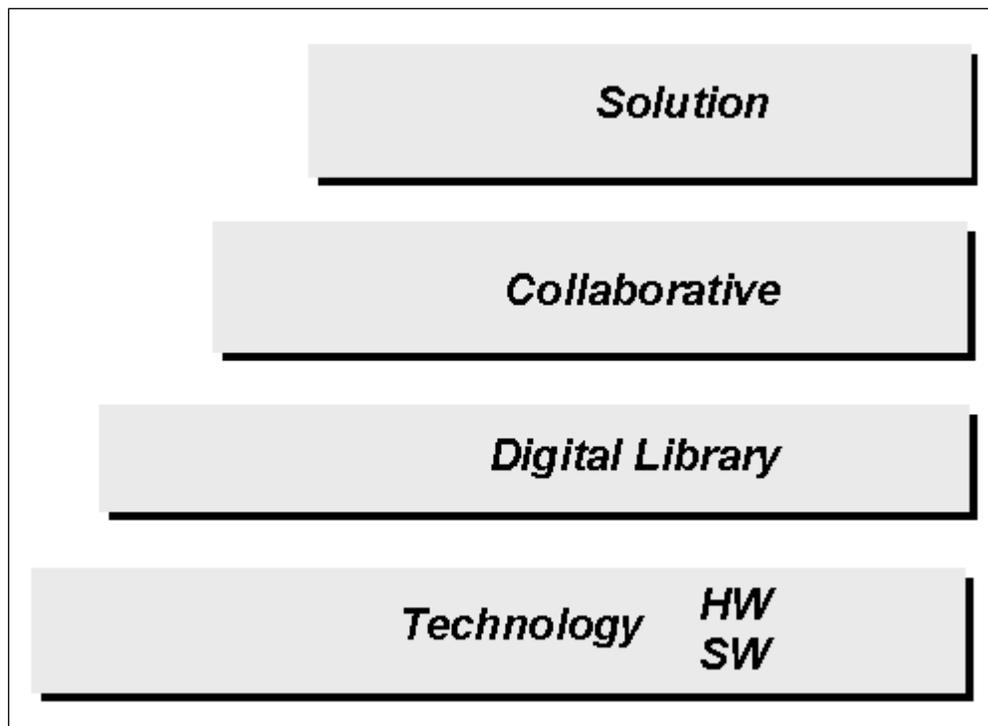
More collaborative efforts like this one can be expected, as long as those two goals are present. Hopefully the first goal will always be present, but once the new technologies are tested and their application well understood, the second goal will disappear, and it will become difficult to sustain projects like this one over time. Government funding alone will neither launch these projects nor perpetuate them. In the absence of mandates or commitments to have the NII reach the schools systematically, access will become a matter of luck.

Another very important aspect of the collaborative has to do with content. The materials for EduPort came from organizations that have large inventories of content in the public domain and that are seeking ways to make their content-base more widely available to people. Opportunities to explore new ways in which technology might be used to disseminate their content are both appealing and consistent with their goals of enriching the national community. Given the opportunity to do so more efficiently, these organizations will be eager to participate in similar projects.

Conclusion

EduPort is a research project that explores and defines some of the needed functions of the NII. It demonstrates a way in which to systematically and automatically bring media into the classrooms using the advanced technologies that will shape the future direction of the NII. Use of these advanced technologies is the only way for truly extending the role of the school in the community, when we are able to reach the NII from schools and home. Thus, it exemplifies the potential of integrating the two learning environments and coordinating learning across the home and the school, for students and for families. In this respect, it defines a needed function of the NII, the role it must play in lifelong learning to prepare individuals for work in a world constantly shaped by science and technology, the only reasonable way to maintain a prepared workforce.

It is also an approach for filtering the vast collection of materials that will become available in digital form into one education infrastructure that can be managed, studied, enhanced, and used by all. In that respect, it defines the need for another function of the NII, responsible provision of information, and protection of our youth. Finally, in helping to identify the hurdles that will have to be faced if the NII is to become a reality, this project hopes to inform the direction of policies that need to be formulated.

Realistically, in the process of building the NII, it is possible to overcome the hurdles of understanding the potential best application of the concept, and of having access to the appropriate technologies for implementing it. But in the case of education it will require commitment to the value that we place in education, to make it happen. Unless laws are designed that elevate the provision of education for all to a fundamental right to be achieved at all cost, and one that can no longer be achieved without the benefit of an education component in the NII, the schools will never achieve the full benefit of the NII.

Acknowledgements

This work is the result of collaboration among many individuals with different expertise and one common goal, having to do with the future of our schools, upon which the future of our society is dependent. We name just a few of the groups that came together to realize the EduPort collaborative effort:

✓ The teachers of Lincoln High School in Lincoln, Nebraska, with excitement, gave much thought and many hours of labor to make EduPort a rewarding experience for their students.

✓ The Lincoln Public Schools Foundation patiently coordinated every aspect of this activity.

✓ The contribution of content by many organizations, never before available in this fashion is a very special contribution to this project.

✓ The University of Nebraska, taking what may be an unprecedented action, put their powerful computing resources to work for the delivery of educational materials to Lincoln High School, even before they made use of the new technology for their own purposes.

✓ The demonstration would not have been possible without the participation of Lincoln Telephone and Telegraph in Lincoln, Nebraska; not only because of the donated use of fiber optics cables, but because they did this with a sense of community service.

✓ Many individuals in IBM Research, and in many other areas of the IBM Corporation contributed expertise, resources, and a lot of hard work of every sort.

✓ Finally it was through the leadership of Senator Robert Kerrey (D-Nebraska) that this demonstration came to be, as a challenge for Nebraska to explore.

Thanks to all!

References

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