DOCUMENT RESUME

ED 417 706 IR 018 773

TITLE	Conference on Information Technology in Education and Training, Session 4.
INSTITUTION	Northwest Regional Educational Lab., Portland, OR.
PUB DATE	1998-00-00
NOTE	53p.; For entire Proceedings, of which this is one untitled session, see IR 018 769. For Sessions 1-6, see IR 018 770-775.
PUB TYPE	Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Change; *Computer Science; Distance Education; *Educational Technology; Foreign Countries; *Higher Education; *Information Technology; Technological Advancement; World Wide Web

ABSTRACT

The fourth session of IT@EDU98 consisted of five papers and was chaired by Dao Huu Chi (Van Lang University, Ho Chi Minh City, Vietnam). "Impacts of Information Technology in Education and Training" (Son Thanh Vuong) examines issues related to reengineering education infrastructure in the information society, including elements of effective computer science, how to partner with industry, the need for making educational structure more flexible, new possibilities in distance education, and some Web-based education experiences. "Management Changes in the Information Age" (Pattrick Tantribeau) looks at the effects on management of viewing information as a resource. "Restructuring the University for Technological Change" (Antony Bates) outlines 12 strategies for change and argues that if the new information technologies are to play a central role in university teaching, each institution needs to develop a set of strategies for change which will amount to no less than restructuring the university. "Interactive Multimedia Technology Contributing in Solving the Problem of National Education" (Tran Ha Nam) is abstracted, but the full text is not included in this proceedings volume. "Information Technology Will Transform the University" (Wm. A. Wulf) discusses changes that will occur in the university in scholarship, textbooks, libraries, teaching, the importance of place, and uncertainties. (Some papers contain references.) (SWC)

SESSION 4

Friday, 16 January 1998

Session 4: Keynote address

Chair:
Dr. Dao Huu Chi ,Van Lang University, HCMC, Vietnam

4-1.Impacts of Information Technology in education and training
Prof. Vuong Thanh Son, UBC, Canada

4-2.Management changes in the information age
Dr. Pattrick Tantribeau, FutureCom Intl Holdings Ltd, Canada

4-3.Restructuring the University for technology change
Prof. Tony Bates, UBC, Canada

4-4.Interactive Multimedia Technology contributing in solving the problem of national education
Dr. Tran Ha Nam, SCITEC, Vietnam

4-5.Information Technology will transform the university
Dr. Wm. A. Wulf, University of Virginia, USA

IMPACTS OF INFORMATION TECHNOLOGY IN EDUCATION AND TRAINING

Son Thanh Vuong
Computer Science Department
University of British Columbia
Vancouver, B.C. CANADA

Abstract

In the past, educators asked themselves if they needed to change. Today, the question is not IF but HOW education will reengineer itself. In this talk we will examine a range of issues related to reengineering education infrastructure in the information society, including elements of effective computer science, how to partner with industry, the need for making educational structure more flexible, new possibilities in distance education and some Web-based education experiences.

Introduction

Information technology (IT) revolution at the turn of the century has shaped our society in many important ways, especially in the domain of education and training. Even the strongest proponents of traditional teaching methods now find themselves using email to supplement office hours. Desktop computers are showing up in faculty office and become indispensable to both teachers and students, class sessions are held in computer labs, software packages and simulators accompany textbooks, and homework often consists of Web searches.

However, simply being caught up in technology and merely using advanced techniques and tools for education and training would not be adequate to meet the demands of an information society. We must do much more. We must aggressively go after the skills and methods needed to produce designers of the complex information systems our society requires. A range of important issues must be examined in a proactive approach to reengineering our education infrastructure in the information society: "Are we ready to scale up information technology?", "Can our current infrastructure support the demands of the information society?", "To what degree must we reengineer it?", "What stays, what goes?", "How much should industry be involved in our reengineering process?". If we do not address these issues properly, we jeopardize not only the future of our graduates, but also our ability to produce systems with increasing complexity, and thus our intellectual wellness and our ability to cope with the information society.

1. How Will the Program Change?

1.1. Elements of Effective Computer Science

In 1995, Peter Freeman suggested the concept of effective computer science (CS) consisting of a strong core computer science coupled with emphasis (application) areas that focus on interactions with other disciplines. The "emphasis areas" element require that we seek ways to work on problems and provide educational experiences in which computer science is an effective element of some larger, often real-world, context. If we compromise the core of computing science, we risk losing long-term, foundational skills. If we fail to take into account the concerns of the computing professional, we risk becoming obsolete. The key is to achieve the right balance - but there are more than one way to get there. This is actually an individual decision; at least for the foreseeable future, each faculty must decide for itself what aspects of CS are fundamental in the context of their particular educational programs and chosen emphasis, or application, areas.

What we can and should work out is some way to characterize the applications we choose so that we can measure how effectively they are contributing to the evolution of the computer science program. To fulfill this goal, future educational program should provide the following three components:

- Broader understanding of information technology (IT). How is IT used in other disciplines and activities? We professors must be familiar with some of the most ubiquitous computer applications (e.g. email, WWW). Otherwise, how can we expect our students to be well prepared to go out into the world and help create new generation of applications and the scientific basis on which they are built?
- Ability to understand an application's essence. As computer science increasingly interacts with other disciplines in a variety of ways, it is important to have coherent means of characterizing these applications so as to enhance our understanding of computer science and application relationship. Students should be led to a more generalized ability to understand an application's key aspects.
- Ability to interact effectively with others. The CS students' communication skills are increasingly required in at least two ways. First, students must be able to communicate with a much broader range of people and in different ways; effective communication skill has become critical to their career's success. Second, students must be able to communicate deeply with experts in other fields to achieve effectively the computer science vision outlined earlier.

An important and exciting challenge is how to educate those who will create future generations of technology-intensive applications and their underlying technologies.

1.2. A New Educational Focus: Information Systems Engineering

The development and maturity of the three disciplines, computer engineering, computer science and information systems with their increasing interrelations have led to an additional educational focus, so-called *information systems engineering* [Stokes97]. This new focus is necessary if we are to create the large, complex, integrated information systems we will need in the next few decades.

Information systems engineering does not radically change existing disciplines. It simply adds a role to the development and implementation of an information system. The computer engineer provides the hardware innovations. The computer scientist adds the cooperating software elements and creates a viable user environment. The information system engineer collects the enterprise's information needs and designs and develops and enterprise information system that comprises hardware, software, and an enterprise-operating environment. The information system specialist assists in the development, then manages and operates the information system to carry out the design intent and meet the user need. But this new focus poses several problems for educators because it requires a systems approach performed in a team environment and it is characterized by complex problem environments with uncertain routes toward the goal – several people can contribute to the success of the problem solution without a clear assignment of domains to individuals. Four fundamental changes in our educational approach are deemed essential:

- *Adopt a student-centered approach.* As the available computing power and our ability to use technical tools increase, we instructors can move from being the "sage on the stage," dispensing information, to the "guide by the side," managing the learning experience.
- *Add a system view of problem solving.* The student must understand the need to integrate components into a comprehensive whole. Software must be developed that let students participate in complete systems, not just selected components of a project.
- *Emphasize skills in cooperative problem solving.* We need to promote teamwork through systems-oriented problem-solving environments, e.g. using proven components or code from others' information systems or class libraries.
- *Organize joint projects.* We must provide the opportunity for students and enterprise professionals to work together to solve real information systems problems. Distance learning and related technology would be an effective mechanism for this kind of cooperation.

A conscious effort to change our educational approaches and incorporate systems and teaming into our educational processes is essential in letting us move forward and provide people who can design and implement complex information systems of the future.

2. How Will Curricula and Methods Change?

2.2. Whom Are We Teaching?

Adult education is evolving rapidly. As organizations continue to want updated skills and technical expertise, the typical university student is less likely to be 20 years old, living and working on campus, but a mature worker who may live anywhere in the world, pursuing a course of study through tele-technology. All this presents opportunities and challenges for our universities, particularly in computing and information technology where principle and practice change more rapidly than in other disciplines. How do we teach these mature worker-students?

What are the requirements of these new students? For one, they tend to approach their studies as consumers and will demand value and relevance of the study material and teaching methods delivered to them. They will also expect a "professional" relationship with the university. This has several implications for the institutions. It may involve setting standards for the presentation of the course material; it may mean ensuring that student feedback is properly evaluated and incorporated into course development.

The implications for the academic staff are considerable: Not only they must know how to use new technologies (multimedia, Web, email) as part of their teaching armory, but they must also understand the (actual or potential) working environments of their students to provide relevance.

We need to find new ways to assess students' performance, define work-based projects and evolve course validation criteria. There must be a balance between technology and principles so that the students can relate their academic study to the needs of their work environment. This, in turn, means making the education process an integration of academic methods, technical skills, and context setting. Change is thus inevitable. Those who continue to prove theorems on a chalky board are likely to find themselves among the extinct academic species!

Blend of Old and New

A truly effective solution to rapid advances in IT and changes in education methods should carefully consider the potential value of old methods as well as embracing the obvious benefits of the new ones.

As we consider the implications of new technologies for education and for careers our students will pursue, it would be easy to forget the most basic characteristic of an educated person: the ability to communicate well. The new technologies, which are affording us the opportunity to change education, make communications skill even more critical. That's one part of the old system we should keep.

What we should throw away is the current grading system. Both independence and collaboration figure in the essential characteristics of modern workers. As professionals, out students will have to make judgement calls, independently gather information and analyze it, and exercise an enormous amount of creativity. Rarely does one person oversee an entire project. Instead, each individual is accountable and responsible for part of a project that must be combined with other parts to make the whole thing work. How can we possibly evaluate this kind of collaborative responsibility and creativity with an A, a 92 percent or a point on the bell curve? Why not make the "grades" comprise a list of the course's learning objectives and the level of learning each student has achieved for each objective? Forget about one grade per a course.

If we are to effectively educate the new generation of students, we must carefully think through our options. The methods we use should comprise both old and new methods so as to accurately reflect stated needs.

3. Ethical Behavior in the Curriculum.

As the computing sciences move rapidly toward "professionalization," we must begin to incorporate new topics into the curriculum. One of these is ethics or professional ethical behavior. For example, professionals are responsible for designing and developing products, which avoid failures that might lead to losses, cause physical harm, or compromise national or company security. With so much information flowing across the Internet and the Web and because of the rising popularity of Java applets and similar modular applications, it is vital to teach our students their responsibility in maintaining high standards for the products they will develop as professionals.

Some institutions require undergraduates to participate in a non-credit seminar, which typically covers topics like current computing applications, resume writing, and opportunities in the field. It may be straightforward to include ethics here. Regardless whether ethics is taught as a separate course or lumped with other topics in a course or seminar, we should emphasize ethics by the way we teach it. In an operating system course, we can point out ethical issues dealing with hacking into systems and systems security. In database courses, data security and privacy are natural topics. We can set ethical examples by making it clear that we obey the IEEE Computer Society's and ACM's codes of ethics, e.g. when we copy class materials, we abide the copyright rules and when use software, we do so ethically.

4. What Can We Expect From Technology?

4.1. Are We Ready to Scale up Information Technology

Large-scale use of information technology in education has been talked about with great excitement. Advanced telematics services, like the Internet and the Web, can provide innovative teaching tools such as rapid and pervasive access to multimedia and mechanism for collaborative learning. However, are we prepared for the change? Can our current infrastructure adequately meet the challenges?

First, how exactly do we make computing and information technologies accessible to everyone when even in modern countries, computer use in elementary and high schools is far from common practice? Our goal should be to provide everyone with basic concepts and skills on the use of information technology and to keep pace with the rapid developments in this field. We should begin to deal with these issues in elementary schools, laying the foundation for more complex topics in much the same way as in other curricula.

Second, how do we teach responsibility when we pay little attention to computing ethics and related issues in our current curricula? Computers and information systems have already become crucial in commerce, business, science and entertainment.

Technology is neither good nor bad until it is applied. Then a range of psychological and ethical implications arises. The Web is a perfect example. There is also the danger of substituting virtual contact for human interaction, through excessive surfing on the Web, for example, or to mistake the distorted use of technology portrayed in movies and televisions as acceptable.

Third, how exactly do we scale the use of information technology to systematic use at any educational level and in every field when we cannot successfully integrate it into a computing science curriculum on a small scale? For example, to locate relevant resources in the maze of information on the Web may be difficult or impossible. Even if we did not have technological limitations, we must still face methodological problems.

We are not clear on how to adapt teaching and learning activities to computer-based technologies. Most people still teach, learn and interact in the same traditional way. We must clearly refine infrastructures and create tools to make the information available for the real benefit of teachers and learners, and we must develop new approaches to education that take these tools into account. The Renaissance project in Europe is experimenting with the integration of technologies for user and network services in higher level of education (colleges, universities and vocational institution), specifically, learning support environments, multimedia courseware authoring, and networking infrastructure. These technologies have great potential for local and distance vocational training.

We must be careful to lay the foundation for a wide-scale use of information technology. We still have a long way to shift from a stage where mainly universities pioneers and lead the introduction of new tools and techniques to the stage where they are made available to any kind of education and related institutions, e.g. libraries.

4.2. New Possibilities for Distance Learning

It is interesting to note that the concepts behind buzzwords such as network learning environments, teletraining, and virtual university are identical to those we had for distance learning nearly 20 years ago. The traditional distance education model however is not without shortcomings. Personal communication via phone, fax, and email are no substitute for eye-to-eye discourse. But with the Web, affordable multimedia equipment, and an increase in networked personal computers, we now have the possibilities to overcome these limitations, as demonstrated in a number of ambitious research projects,e.g. the University of British Columbia's WebCT, the University of Simon Fraser's VirtualU and Fern University's Virtual University System.

The first is electronic materials catalogs. These catalogs contain fragment of education materials that are both reusable and platform independent. We can seamlessly integrate different forms of asynchronous and synchronous communication with the development, delivery, collaborative revision, and storage of course and working materials. Teaching units, for example, can now be downloaded or remotely accessed interactively. Teachers can also correct and enhance these units continuously.

Another improvement area is learner-controlled interactivity. Researchers are discovering how to tailor navigation to the student's pace and knowledge and to persistently record the structure of individual learning processes.

The third improvement area is increasing integration with physical systems, e.g. linking educational material to real-world components (like a robot cart) to understand and explore real-world phenomena (e.g. tract control) from a distance.

We are gradually replacing much paper-based study material with multimedia courses, using hyperlinked interactive animation, simulation package, video and software for experimentation.

Finally, research is finding ways to increase connectivity with the information Web, including digital library projects and video teleconferencing systems.

Despite progresses in the above areas, two problems remain: mainly because the interoperability of tools, operating systems, and vendor platforms is poorly developed and Internet solutions, like HTML and Java, are constantly changing: (i) scaling up (to support a large number of students) and (ii) evaluation mechanisms (for acceptance and measurable learning effectiveness); technical and didactic standards and guidelines related to teaching over the Internet need to be developed, tested and disseminated.

5. How Do We Partner With Industry to Achieve Change?

5.1. More Relevant Computing Skills

There is a considerable shortage of computing personnel with adequate skills in systematic thinking, problem solving, communicating (both written and oral), teaming with the project stakeholders, and assessing schedule, cost, risk and potential impediments. Industries must work closely with academic institutions to address these skill deficiencies through a new curriculum focus. Such a curriculum is long overdue, in part because collaborative relationships between industry and academic institutions have been lacking. This prevents computing graduates from smoothly transitioning to the industrial work force.

5.2. Making the Structure More Flexible

Computing education faces pressures to adapt not only to the rapid changes in information technology, but also to changes in the way businesses operate. But keeping educational programs current in both technology and business practices is no easy task. Traditional educational structure does not support rapid changes. So, how do we design programs that can keep pace with rapidly changing needs? To evolve a framework to replace the traditional education structure, we need the several things: stronger ties with industries, shorter time to adapt to changes, new reward structure for educational improvement, greater focus on continuing education, and more attention to pedagogy.

6. Conclusions

As educators, we are in exiting times. The need for complex information systems to support all aspects of business, industry, and government has exploded during the last decade. What we do now has the potential to enrich or impede the growth of the information society. As in any reengineering effort, we need to thoroughly understand our goals and requirements. We can begin by being proactive with industry in a partnership that cooperates not only in student training, but also in curriculum reform and resource sharing. Together, we can prepare those who will endure the next technology explosion.

References

[1] L. Cassel, "Blend of Old and New," IEEE Computer, Vol 30, N0. 11, pp. 50- 51, Nov. 1997.

[2] H. El-Rewini, "Keeping Pace with an Information Society," IEEE Computer, Vol 30, N0. 11, pp. 46-47, Nov. 1997.

[3] P. Freeman, "Effective Computer Science," Computing Survey, March 1995, pp. 27-29.

[4] P. Freeman, "Elements of Effective Computer Science," IEEE Computer, Vol 30, N0. 11, pp. 47-48, Nov. 1997.

[5] J. Haines, "The Case for More Relevant Computing Skills," IEEE Computer, Vol 30, N0. 11, pp. 55-56, Nov. 1997.

[6] I. Jelly, "Who Are We Teaching," IEEE Computer, Vol 30, N0. 11, pp. 49-50, Nov. 1997.

[7] B. Kraemer, "New Possibilities for Distance Education," IEEE Computer, Vol 30, N0. 11, pp. 53-55, Nov. 1997.

[8] D. Lidtke, "Ethical Behavior in the Curriculum," IEEE Computer, Vol 30, N0. 11, pp. 51-52, Nov. 1997.

[9] S. Russo, "Are We Ready to Scale Up Information Technology," IEEE Computer, Vol 30, N0. 11, pp. 52-53, Nov. 1997.

[10] E. Soloway and R. Wallace, "Does the Internet Support Student Enquiry? Don't Ask," Comm. ACM, May 1997.

[11] G. Stokes, " Rethinking the Current Formula," IEEE Computer, Vol 30, N0. 11, pp.46-47, Nov. 1997.

[12] J. Turner, "Making the Structure More Flexible," IEEE Computer, Vol 30, N0. 11, pp. 56-57, Nov. 1997.

MANAGEMENT CHANGES IN THE INFORMATION AGE

Patrick Tantribeau
Fututre Com International Holdings Ltd.
Vancouver, British Columbia, Canada

Abstract

Our existing concept of management is going out of date. Information is the new resource to be considered in most of our businesses. All companies are information related companies, and all managers also become information managers. Information is now the energy of enterprise, generating new products and services and enabling new ways of managing. A technology strategy, application plan and policies must ensure that information is not used up wastefully. In the next decade, the business strategy and the information strategy will be interrelated. The managers will have to become skilled at managing information as at managing conventional resources. As a need in the future new economy, academic curriculum should include training of information technology management in most programs.

Introduction

Up to date, our models of management was designed from and for the industrial era. From now on, in the post-industrial era, we are clearly on our way toward the *Information Era*. We are already moving more into the transition from the old to the new economy.

The fundamental difference is how we manage business resources. In the industrial era, business resources are based upon 4-Ms – Men, Machine, Material, and Money. From now on, we must add a 5th resource, that is Information.

In the next century, the business manager must understand information as a resource. He has to be able to manage information as an asset, both for business development and for managing the entire organization. In brief, every business becomes an information related business, and every manager also becomes an information manager.

The Information Resource

The main resource of the post-industrial era is information, which also is the energy of the entire organization, generating new products and services and creating new ways of managing. But what is information? To define the real meaning of information for every individual to understand is not easy. It kept many universities around the world occupied for years, and their conclusions are often conditioned by their base disciplines. Engineers, Political Scientists, Sociologists and Economists see information in different ways.

Engineers and Technologists often see information as signals. They handle information as a matter of code, transmission and reception. Sociologists and Psychologists frequent see information as a way of communication. They are concerned with cognition, interpretation and meaning. Political scientists tend to connect information with power. They are concerned with its distribution and manipulation. Economists seem to have trouble dealing with the information. As a commodity, information is different from other resources. Information exchange does not necessary the same as value exchange in the conventional models.

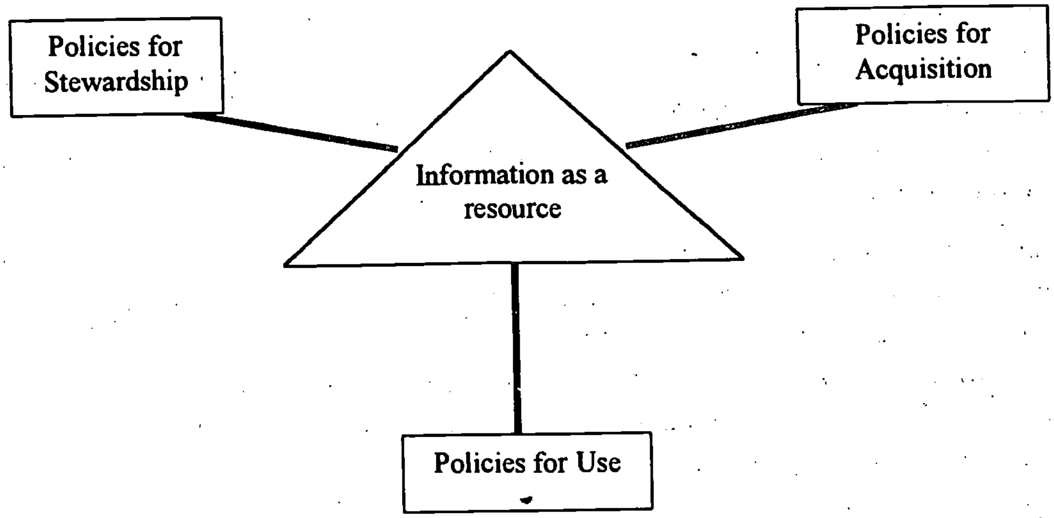
We, in the Information management, try to make a distinction between data, information and knowledge, often linking information value to decision-making. If we pass on an information to someone else, the receiver may gain value but we do not automatically lose value. Information can be communicated at minimal cost. In addition, the potential uses and the value added of information are unlimited.

These characteristics tend to destroy the traditional theories of the Economics of Trade and Organization. They pose threats and opportunities for business. The creative use of information can widely destroy the rules of competition and marketplace.

If you want to grow a business in the future, you have to see information as a resource and understand it as best you can. Implicitly, you will need policies for acquisition, stewardship and use of information. In any case, since the information is intangible, it is not easy to do. For instance:

1. Since we can never know the full scope of available information, and since one person sees information in a data or message that another does not, how can we know what information to collect? And how to collect? It is not just stored on paper or electronically; it is stored in actual form in our individual minds. Then what does stewardship of information mean?

2. Since the use of information is unpredictable and it can be good or bad depending upon the circumstances. What is the balance between information freedom and information control? These may depend upon a business context. However, when you realize that every business is an information business, and every manager an information manager, they becomes ever more important issue for management in the future. We will need policies as described in Figure 1.



Every Business is an Information Related Business

During the past decade, we have made distinction between the information-intensive sectors and the traditional ones. Financial services, airlines and retailers are a few examples.

Financial service businesses are the centers of information transactions where new products and services are developed by the collected databases of customer events and financial flows. The business is traded through electronic markets. In airlines industry, it is substantially based upon the command of electronic distribution via reservation systems and upon the aggressive sales and marketing by analysis of customer databases. Many retailers investing in customer "V.I.P." cards not just to offer discounts due to frequent and volume purchasing, but to capture individual consumer behavior in order to customize offerings and develop newly targeted services. As the media and telecommunication converge, businesses are stepping toward an information-driven market place by creating home pages, virtual shopping centers and information services on the internet, by buying information content and so on.

Recently, we often see the media, entertainment and network companies work together to create the so-called *Infotainment* sector such as MS-NBC (Microsoft and NBC News Network in the USA.) New sectors are emerging and conventional sectors are being eroded. The new businesses of tomorrow are founded on information. All these businesses are information businesses – they see information as the main support of their business, and information communication as their distribution channel.

Many entrepreneurs and MBA graduates are building business plans for information-based businesses – multimedia form of retailing, database analysis, marketing ventures and electronic trading systems. Today's entrepreneurs of the industrial age are now being replaced by tomorrow's *infopreneurs* of information age.

Every Manager also is an Information Manager

Clearly, business executives need an information strategy that ensures an appropriate infrastructure to run business in the information age. They need so-called Application Plans that guide investment decisions on the information systems required to support the business.

As mentioned earlier, they also need the information policies to ensure that the main resource of tomorrow is not used wastefully by losing information, by disputing about who owns and has access to a particular information, by configuring technology that impede information exchange, by developing managers and employees who do not have information skills, or by not thinking about information acquisition, stewardship and use in all the strategies that companies take years to put together.

By the end of this century, the questions about information policies will have to be addressed in strategy making for marketing, manufacturing, human resources, and research & development.

In fact, there is a bigger strategic question. In the information age, you simply cannot build business strategy as a whole without first considering information as an asset. That is why we can see the current wave of mergers and acquisitions, among the big companies, around ownership of both information content and information distribution. We can also see why today's information-intensive businesses have to consider threats from the new comers from other sectors – Insurers particularly Life Insurers offering banking, retailers offering insurance, software companies offering money transmission, and so on. The intermediaries are wiping out by many direct selling electronic systems.

Not only the information-intensive sectors have a changing face. Conventional sectors that were not seen to be information-intensive are changing their strategies as well. Pharmaceuticals companies are predicted to buy health management and prescription-processing organizations for their information contents, or acquire informatics businesses in order to create a new technology-based health care services. Food companies acquire many smaller distributors in order to capture more direct information from the market place. Recently, Oil companies are also planning different strategies to improve a better profit and to capture a bigger market share. In short, every sector will be an information-intensive.

Up to date, we often see information technology strategies to support the business strategy. More recently, we have understood that information technology (IT) creates opportunities to do business differently. Thus, information strategy and business strategy are more interrelated.

In the future, we cannot divide the two. The future business strategy has to consider information strategy as a factor in order to be positioned for the information age. Thus, IT technology and business strategy become one. A business strategy cannot be completed if the information resource is omitted. Information and IT can create (or destroy) a business.

That is why the requirement of strategic management in the future is to create an information business strategy. This idea can be summarized as indicated in Figure 2.

The Past	IT supports Business Strategy	Business Strategy --> Information Strategy
Present	IT supports Business Strategy & Presents Opportunities	Business Strategy <---> Information Strategy
Future (information age)	IT & Business Strategy are ONE.	Information Business Strategy

Figure 2 : IT and Business Strategy in the Information Age

In our pervasive IT environment, Managers have to think information in their strategy making, they have to analyze and manipulate information in their daily decision making as managing the information resource. However, many managerial works always have been seen to be concerned with information processing. And organization design has been seen as a matter of creating an effective information and communication flows. Usually, Information processing occupies a substantial proportion of management and organizational time. So, it is not surprising that a mix of data processing, executive information systems and groupware can enhance the productivity within a department.

Organizations can be centralized or decentralized by adopting more advanced forms of information management systems. With the progress of telecommunication industry, the communication from enterprise to home have made many virtual offices and organizations a possibility.

One result of all these trends, together with the business changes described above, is that every manager also becomes an information manager. Managers are not only skilled at using IT, but they should be able to analyze, explore, and play with information. They are expected to collect, to add value to and share information. They will have to become as skilled at managing information resources as at managing conventional resources. Today's managers are experiencing a shift where the challenging questions are such as "If my business is an information business, does it have a future and is it being mapped out?" or better "Since I am an information manager, do I have a future and am I re-educating myself in order to survive?" The organizational architecture of tomorrow is being created today (Figure 3.)

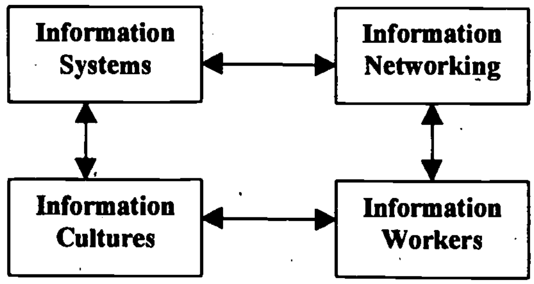


Figure 3 : Organizational Architecture of Tomorrow

Information systems are designed to support managers in creativity, decision making and control. Information network is configured to collect, and share information. Employees will be skilled at IT use and analysis. Organization will have to create culture where it is easy to share information, and where management processes are about adding value to information more than disputing "facts" and seeking data. Today, many manufacturing and service sector companies are working through these challenges already and are demonstrating a characteristic of the information age.

New Models for the Information Age

New manager and new business can be described by extrapolating today's trends. We, in the Technology & Business Consulting, are doing this and can help prepare managers for the next century. We have studied much management in our industrial age as being concerned with planning, organization and control. The scenarios of how these activities are practiced in the information age are definitely to be very different from the past. They include a shift from organizational hierarchies to multi-level networks, from physically bounded to virtual organizations, from decision-making by data analysis to decision-making by exploration and creativity, from work based on physical action to time spending on intellectual reflection, from programmed endeavor to business rapid change, from national and local context to global and cyberspace.

Our models of management are evolving but they need to have further research and development on the management in the information age. To master management in the next century, business schools or academic curriculum in most universities around the world need to study more closely with the enterprises to build better theories required for the information age - where it becomes more and more difficult to control information.

RESTRUCTING THE UNIVERSITY FOR TECHNOLOGICAL CHANGE

Antony Bates
UBC, Canada

Abstract

This paper forms the basis of a multimedia presentation (see http:// bates.cstudies. ubc.ca/). The paper argues that if the new information technologies are to play a central role in university teaching, each institution needs to develop a set of strategies for change which will amount to no less than restructuring the university.

Twelve strategies for change are outlined. While these and possibly other strategies are all essential, timing is critical. Such strategies require institutional leadership and a process that leads to widespread support for such strategies from a majority of staff within an organization through an inclusive process of involvement and participation in technology applications and policy making.

The paper concludes that the widespread introduction of technology - based teaching will require such fundamental changes to an institution that its use should not be embarked upon lightly, nor will it necessarily lead to any significant cost savings, but nevertheless such an investment will still be necessary if universities are to meet the needs of its students and society at large in the 21st century.

The challenge for universities

Many universities are making substantial investments in new technologies for teaching purposes. The increasing ease of use and improved presentational and interactive features of technologies such as the World Wide Web are leading many academics to use technology for teaching for the first time in a significant manner.

However, although there has been widespread adoption of new technologies for teaching in the last few years, they have yet to bring about major changes in the way teaching is organized and delivered. Without such changes, though, technology - based teaching will remain a marginalized activity, while at the same time leading to increased unit costs.

For technological change to be effective, it usually needs to be accompanied by major structural and organizational changes for its full potential to be realized. This paper attempts to indicate some of the strategies that universities may need to adopt in order to use technology effectively for teaching and learning.

Why use technology ?

Politicians, university presidents, keynote speakers at conferences from government and industry, and teachers themselves offer a number of different reasons to justify the use of technology for teaching and learning.

Here are four of the most frequent reasons given for using technology (there are probably many more) :

- to improve access to education and training
- to improve the quality of learning
- to reduce the costs of education
- to improve the cost-effectiveness of education.

Different people in different positions tend to place different emphasis on each of there rationales. For instance, what has really set fire to many university professors is the possibility of improving the quality of learning through the use of multimedia. The same professor though who is a startling innovator in the use of the technology for teaching can at the same time violently oppose any suggestion that more students might be served by the institution through using technology : more means worse - or at least more work for faculty.

Other professors are fired up by the idea that all the world can access their ideas, their research, their wisdom through the World Wide Web - a passion to widen access to their teaching. This is not always accompanied though by a similar passion to improve the quality of their teaching, as can be witnessed very easily by surfing their Wed pages.

Some politicians and business people see technology simply as a replacement for labor, and therefore anticipate that technology when applied properly will reduce the costs of education. Unfortunately, this is to misunderstand the nature of the educational process. While labor costs can be reduced by applying technology, unless done sensitively and carefully it can also lead to a large decline in the quality of learning, which in turn will eventually to a less skilled workforce.

Lastly others look to technology to improve the cost - effectiveness of education. This is not the same as reducing costs. The argument is that for the same dollar expenditure learning effectiveness can be increased, or more students can be taught to the same standard for the same level of investment.

While then technology is unlikely to reduce substantially the costs of education without a parallel loss in quality, the wise use of technology can simultaneously widen access, improve the quality of teaching, and improve the cost - effectiveness of education. That is not a bad goal to strive for.

This paper does not challenge the core functions of a university: teaching, research and public service. Nor does it assume that universities should convert to becoming businesses, using technology to become financially independent of government. The paper assumes that public universities still have important social and public goals to serve.

However those core values need to be served in a rapidly changing world, not the least of which is the central role that technologies now play in everyone's life. Using technology for teaching can help universities serve the public more cost - effectively, and in particular can prepare students better for a technologically based society. There are also many things that are valuable in education, as in life, that technology cannot do, and we need to recognize that, but that is another topic. Given then that technology has an increasingly important role in teaching and learning, what do universities need to do to ensure that it is used to greatest effect

Selecting technologies

There is an increasing range of technologies from which to choose. Some of the criteria that have to be taken into consideration when choosing and using different technologies, and a strategy for decision - making, are discussed more fully elsewhere (Bates, 1995). In brief, these criteria are reflected in the **ACTIONSS** model:

A ccess

C osts

T eaching functions

I nteraction and user - friendliness

O rganizational issues

N ovelty

S peed of course development/adaptation

This paper is concerned primarily with the relationship between teaching, learning and organizational issues.

Technology and post-modernist organizations

Before putting forward 12 strategies for institutional change to exploit fully the potential of new technologies for teaching, it is important to understand the relationship between technology and the organizational structure of institutions using technology (for a full discussion of this issue, see Peters, 1973, Campion and Renner, 1992, Peters, 1994, Capion, 1995, Renner, 1995, Rumble, 1995).

Most manufacturing companies producing physical goods have until recently adopted a 'Fordist' organizational model. This is characterized by the production of uniform products ('you can have any colour you like, so long as it's black'), economies of scale (initial set - up costs are high, but large volume results in each extra unit having increasingly lower marginal costs), a division of labour (work is broken down into different elements conducted by different classes of worker), hierarchical management (decisions are made at the top, and passed down the line of command), and organization of people and processes into discrete, large units which themselves are hierarchically managed (e.g. production, payroll, personnel, marketing, sales).

The best examples of this kind of manufacturing organization and structure in education are the large, national autonomous open universities in countries such as the United Kingdom, Netherlands, Thailand, Indonesia, India, etc., many of which have over 100,000 students (see Daniel, 199). The nearest examples in Canada are Athabasca University and Tele-Universite, although because of their provincial base they do not really reach the scale and hence 'purity' of the industrial model.

However, the rapid increase in the size and scale of 'conventional' universities in Canada, the USA, and many other industrialized countries since the 1960s has led to many elements of the industrial model being found in today's universities, such as division of labour and increasingly large classes. Nevertheless the core activity of teaching in conventional universities has been relatively untouched by the industrial process.

Information technology though has led to the growth of many knowledge based and service industries which have a very different structure from the industrial or 'Fordist' model. These newer forms of organization have been labeled as 'post-modern' or 'post - Fordist' in structure (see, for example, Farnes, 1993) and are characterized by the following :

- heavy dependence on information technologies (telecommunications, computers)
- customized products and services tailored and adapted to needs of individual clients.
- creators and developers of new knowledge/new ways of doing things, or transmitters and modifiers of existing information.
- directly networked to clients : rapid and immediate feedback used to modify products and services.
- rapid development and change : organizations are dynamic and move very fast.
- often small-scale and specialist; dependent on partnerships and alliances with other organizations with related but different competencies.
- decentralized, empowered, creative workers, often working in teams.
- strong leadership characterized by clear but broad vision and objectives, playing an integrating, co-ordinating and facilitating management role.
- global operations.
- post - modern industry sectors are often chaotic and characterized by new players, new amalgamations and unpredictable emergence of dominant technology - linked organizations.

Examples of post - modernist organizations are Apple Computers, started originally in a garage in California by two research graduates from Xerox Park, but now suffering from the pains of growth and the failure to stay sufficiently dynamic and innovative; Microsoft Computers, which has the same revenues as Sony and Honda combined, but whose direct workforce is one hundred times smaller than each of those companies; and Netscape Communications Corporation, which did not exist five years ago, but now dominates the Internet market.

The post - modernist university?

Where does this leave the post-modern university ? The move in the 1960s to a mass higher education system has forced universities to adopt many features of an industrialized or Fordist organizational model :

- large class sizes for first and second year student (economies of scale),
- a differentiation between tenured (research) professors and graduate teaching assistants, and between academic (professors), management (deans and vice - presidents), and administrative staff (division of labour),
- large, hierarchical and distinctly separate core organizational structures (faculties).

Nevertheless, even modern universities still display many examples of pre-industrial or agrarian organizations, i.e. they are not post - Fordist but pre-Wattist. For instance the semester system with the long summer break reflects the origin of the land grant universities, where students had to return home for harvesting and to tend the crops. Teaching, at least in upper undergraduate and graduate levels, is craft-based with little or no division of labour, and is based on an apprenticeship model of handing down knowledge and teaching methods from one generation to the next.

In other words, university teaching is not professionalized, in the sense of being based on skills resulting from research into and analysis of the teaching process. For instance, most university teaching has not been influenced to any extent by recent research into the psychology of learning, organizational management research, communications theories or research into human-machine interaction, all of which have been critical for the development of post-modern knowledge-based organizations.

The new technologies will be exploited best by those that establish post-modernist forms of organization. We have not yet seen any advanced and sustainable form of such an organization in higher education, but elements are already visible in organizations such as the University of Phoenix's online programs, Nova South - Eastern University in Florida, the National Technological University, and the proposed Western Governors' Virtual University in the USA.

Nevertheless, there are certain features of a traditional university that lend themselves to the new post-Fordist environment. First of all, a university is an extremely decentralized organization. It has a large and highly creative 'core' of staff, faculty, who when they apply themselves are capable of creating new applications software, developing expert systems, and adapting or even inventing new forms of teaching and learning. Furthermore they have one valuable commodity or quality that is lacking in many dedicated open universities : they have a research capability that enables them to generate new knowledge in a wide range of subject areas that can be assembled and marketed through the use of technology. Lastly, conventional universities have the advantage of what the marketing people call a strong brand image.

There are signs that some conventional universities, with good leadership and a shared vision, and sometimes goaded by strong external pressure from government, are re-generating and re-structuring themselves to meet the technological challenge. Whether they can do this fast and deep enough to need the growing competition from the private sector remains to be seen.

Universities in transition

The ease of use or 'transparency' of technologies such as the World Wide Wed and video-conferencing makes it much easier than in the past for faculty to develop technology - based learning materials and delivery.

The World Wide Web for instance allows a teacher easily to adapt materials created for lecture or classroom use and present them as attractive colour graphics and text. Once the materials are created as Web pages, it is a simple matter to make them available for off - campus as well as on - campus students. This means that innovation in teaching, which has traditionally been associated with more fringe areas of the university, such as the distance education units or specialist R & D educational technology units, is now coming from the 'core' : original and exciting technology - based materials initiated and developed by faculty themselves, through what I call the Lone Ranger and Tonto approach : the professor with their trusty computer - skilled graduate student, who does the HTML mark up and scanning.

There are however dangers in this approach. In an increasingly competitive environment, and where technology - based teaching is increasingly open to public inspection, the organizations that will survive, as with any of the other new knowledge-based industries, will be those that provide services that the public values, at a better price and quality than the competition.

However, on most Canadian university campuses, amateurism rules in the design and production of educational multimedia. A feature of many Lone Ranger projects is that technology applications end up as a costly supplement to conventional teaching, merely increasing the students' (and faculty) workload, and the institution's overall unit costs, because teaching with new technologies is rarely accompanied by the substitution of multimedia for face to face teaching. For the extra cost of using technology to be justified, it needs to be accompanied by the re-organization of the teaching process, moving away from fixed, scheduled group instruction to more flexible and individualized modes of learning.

Another common problem with the Lone Ranger approach is that often there is never a final product that can be used on a regular basis in a teaching context. This is because the project drags on, being constantly up - graded or improved, or has to be re-designed as a result of inappropriate technology decisions in the early stages of development. Often the graphics and the interface are poor, compared with commercial games with which students are familiar, and the potential for high quality learner interaction with the multimedia materials is often missed. Products when finished have limited applicability because they are not of high enough standard in terms of graphics and interface, or sufficient in volume, to become a commercial product. In other words, Lone Ranger materials usually lack quality in the final product.

There are several components of quality in technology - based educational materials. The first is the quality of the content, which is where the brand image and the research capability becomes critical. Is this unique or valuable teaching material for which there is a need or demand ? this is not usually an issue in most research universities.

However, the second component of quality is the standard of media production. Are the graphics clear ? are the screens easy to read ? Is the sound and video easy to hear and see ? Are the unique features of each medium (video, audio, text, computing) fully exploited ? Is the material well assembled ? Is the screen designed in such a way that students intuitively understand the range of activities open to them and how to accomplish them (interface design) ?

The third component of quality is instructional design. Are the learning objectives clear ? Does the material result in the desired learning outcomes ? Does it have the appropriate mix of media to achieve the learning outcomes in the most efficient manner ? What is the quality of the interaction between student and learning materials ? What is the role of the tutor / instructor relative to the technology - based learning ? Is it well structured ? Can the students easily find all the material they need and move around the teaching materials easily ?

The fourth is the quality of delivery. Are the materials easily for the student to access ? Can learners ask questions or discuss materials with other students ? Who gives feedback ? What happens if they have technical problems ? At what times is help available ?

Fifth, there is the issue of project management (see Strategy 9, p.21). Timelines and budgets need to be established, teams created, meetings organized, materials produced, distributed and maintained, deadlines met. All these five factors contribute to quality in multimedia teaching and learning materials.

New technologies the are likely to remain marginal, despite high levels of capital investment, and will merely add costs to the system, if we do not at the same time deal with structural changes in our institutions, and in particular if we do not make fundamental changes to the ways we organize teaching.

Twelve organizational strategies for change

If we assume that the intelligent application of technology can improve learning, then what do we have to do to re-organize, re-structure or reengineer the university to ensure that we achieve cost - effectiveness from the application of new technologies to teaching ?

From the basis of experience at UBC I am going to suggest 12 strategies for change. These are not my strategies; I am merely the chronicler. Some individual strategies have been developed deliberately and thoughtfully by the senior management at UBC, particularly the Committee of Deans, and the Media Resources Network and its successor, the Centre for Educational Technology. Others have been developed as a result of experience, or have emerged as issues to be addressed. While collectively they reflect an overall strategy for change, they have not been developed or promoted within UBC as a formal plan. Some have not been implemented at all, or where they have been implemented, not on any consistent basis. This list certainly does not represent the full range of possible strategies. Lastly, it is too soon to indicate whether these are in fact useful or validated strategies for change.

Nevertheless, they do constitute a useful range of options for consideration by management.

1. A vision for teaching and learning

I use vision in a specific sense : that of creating a concrete description of how teaching should take place in the future, given the current knowledge we have about the goals and purpose of the university, and the potential of new technologies for furthering those goals. Vision describes what we would really like to see or to happen.

It is difficult enough for an individual to identify and describe accurately a personal vision for the future; it is even more difficult to create one for an organization as complex and diverse as a large research university. However, the journey or the process is as important as the goal (Fritz, 1989, Senge, 1990). 'Visioning' is indeed a technique that allows those working in an organization to understand the full range of possibilities for teaching and learning that technology can facilitate, and the possible outcomes, acceptable or otherwise, that might result from its implementation (see Bates, 1995b). It helps people working in an organization to identify and share certain goals. Even more importantly, a shared vision is necessary as a benchmark against which to assess different strategies and actions regarding the development of technology - based teaching.

In particular, an institution needs to define what balance it wants between face - to - face and technology - based teaching. An institution could for very good reasons decide not to go down the technology - based teaching route and place special emphasis on face - to - face and personalized teaching. It is likely though to be a very elite and high cost institution. Alternatively, an institution might wish to vary within its structure the degree of dependency on technology-based teaching, giving more emphasis for instance to face - to - face teaching at the graduate level, and more to technology - based teaching at the undergraduate level. Lastly, other institutions may make a clear decision to emphasize technology - based learning throughout all its teaching.

Another issue that should be covered in a vision statement is the extent to which an organization sees itself operating on a local, regional, national, or international basis, and the implications of that for courses offered and student services. This is important because technology - based teaching does not respect political geographical boundaries. For instance, regional colleges may need to redefine their role if students are capable of accessing the college's standard courses from other, perhaps more prestigious institutions, anywhere in the world.

In 1996, the Centre for Educational Technology at UBC developed a vision for technology - based teaching (UBC, 1996 : http ://www.cet.ubc.ca/about/vision.html). The vision included several detailed scenarios of teaching and learning for different types of learners. There were several key features in the vision :

- a mix of teaching models, from programs delivered entirely in a face - to - face mode to courses available entirely at a distance; it was envisaged though that most students would take a mix of face-to-face and technology - based teaching over the life of a full degree program;
- an in crease in the provision of technology - based non - credit, certificate and diploma programs, aimed particularly at mature students;
- learning materials developed as discrete modules for multiple uses, i.e. the same CD-DOM might be used for on - campus and distance undergraduate students, as part of a certificate program, as continuing professional education for individuals, and as a stand - alone CD - DOM for employers / companies;
- more flexible admission and access, particularly for mature students, through the use of technology - based learning, allowing more students to be admitted to the university.

This vision statement has yet to go out to Faculties and departments for discussion and comment, partly because the CET Steering Committee felt that the statement may be too controversial or provocative, and that it might thus slow down the adoption of new technologies. It is clearly a judgement call whether to approach the introduction of technology - based teaching on a slow, incremental, ad hoc basis, or whether to have clear long - term objectives and goals driving the use of new technologies.

2. Funding re - allocation

The re-allocation of funds is another critical strategy. Too often technology implementation is driven by external grant funding or by 'special' funding arrangements, such as student technology fees. If the university sees the use of technology for teaching as critical for its development, then funds for implementing this must come from the base operating grant. Since most universities in Canada are receiving less rather than more government funding on an annual basis, this means re-allocating funds.

Figure 1 (below) is a theoretical or idealized strategy for funding re-allocations at a university - wide level. Between years two to five, despite cuts in overall levels of funding, an increasing proportion of the general operating budget is allocated to the development of technology - based teaching. However, also in year five we see a small increase in funding due to a combination of increased enrolments and sales of learning materials as a result of earlier investments in technology - based teaching. This return on earlier investment continues and increases in years six and seven, until by year seven funds are almost back to year 1 levels, despite continues government funding cuts. Also in year six the university decides to stabilize the level of funding for face - to - face teaching, deciding that any further decrease would be out of balance with its overall teaching goals.

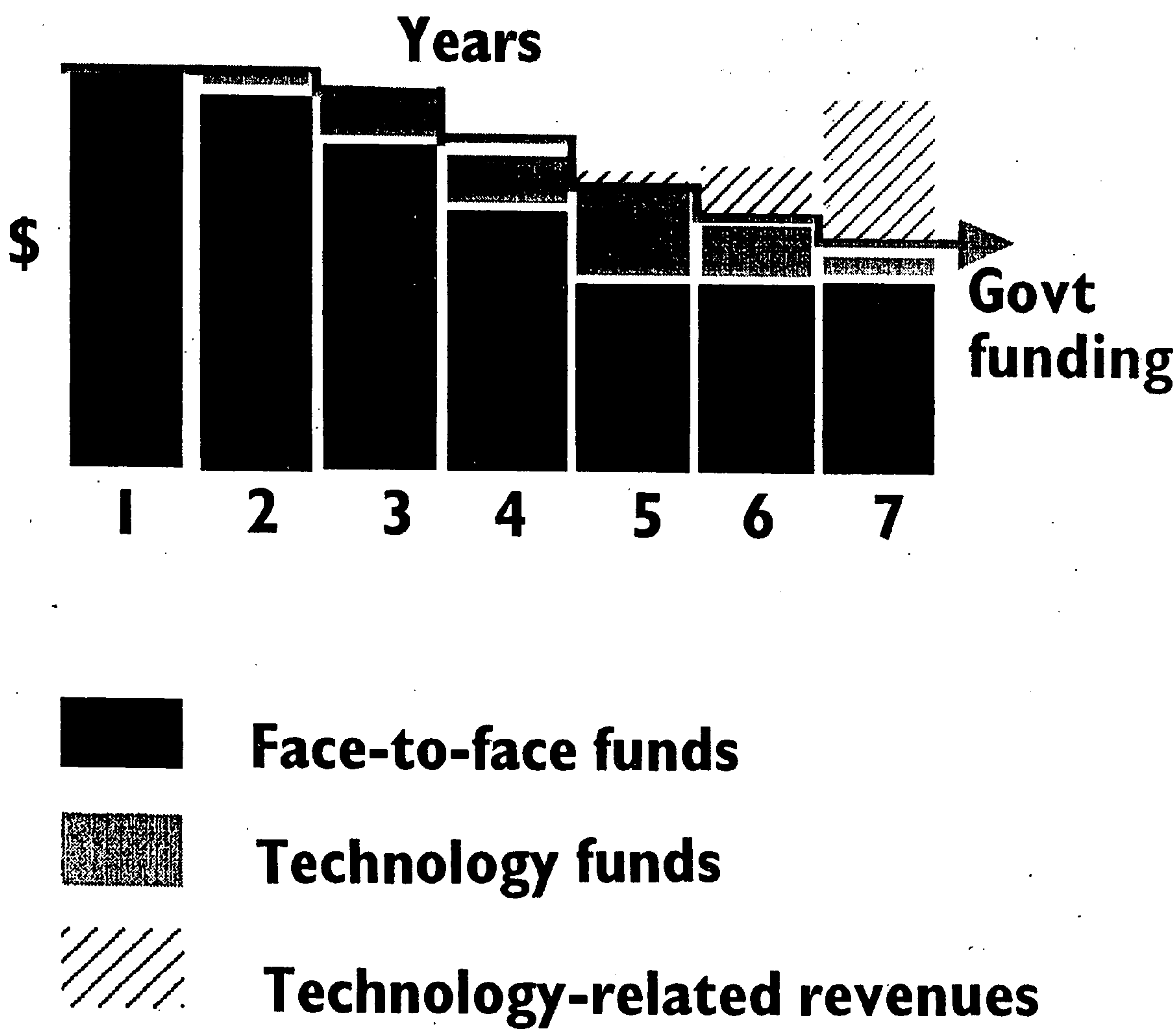


Figure 1: A model for re-allocating funds to support technology - based teaching.

The graph in Figure 1 does not indicate the organizational level at which these re-allocations are made. In 1994/95 the British Columbian government with - held 1% of all post - secondary institutions' operating budgets, and 0,5% in 1995/96, to be reclaimed by an institution if it came up with proposals for innovative teaching. In UBC's case this came to approximately $4 million over the two years. UBC decided to use half this fund for campus technology infrastructure improvements, and the other half for technology - based teaching applications, with a small amount held back for establishing a small Centre for Educational Technology.

For 1996/97, when the government discontinued its innovation fund strategy, the university itself increased the level of funding for its own Teaching and Learning Enhancement Fund to $2.2 million, to which individual faculty members could apply.

Eventually, funding re-allocation will need to be made at a Faculty or oven departmental level. Thus in 1997/98 the Faculty of Science has re-allocated $500,000 of its own budget to support technology - based teaching initiatives. The willingness to re-allocate funds is not only a necessary strategy if technology - based teaching is to become a core part of a university's operation, it is also a measure of the level of commitment to the concept by different organizational units.

3. Strategies for inclusion

One of the main challenges of making technology - based teaching a core function is to extend its implementation from a relatively small number of enthusiasts and early adopters to the main body of the teaching force. This means introducing a strategy for inclusion, to ensure that all faculty are encouraged and supported in their use of technology for teaching.

Either deliberately or accidentally this is exactly what UBC has done with the Innovation Fund and the Teaching and Learning Enhancement Fund. Because initially the funding for innovation was held back from general operating grant, the university applied the same principle as the government : faculties' operating budgets were reduced proportionally, then they were encouraged to put forward ideas as to how to spend 'their' proportion of the operating grant held back by the university for applications of technology. Thus instead of grants being awarded on a competitive bases across the university, each Dean made an assessment of the priority for funding for particular projects within his or her own faculty.

This had two consequences. Innovation grants had relatively weak criteria, in terms of conditions required; and secondly the money was spread right across the university roughly in proportion to the size of each faculty or department. This meant that between 1994 and the present, a relatively large number of academics in every faculty has had some hands - on experience of developing technology - based materials.

Another strategy that has increased participation in technology and its management was the creation of two sets of committees. The Advisory Committee on Information Technology was established, with the Vice-President, Student and Academic Services (which includes the library and computer and telecommunications services) as chair, with a remit to advise on technology infrastructure and student and staff access issues.

The Media Resources Network (later Centre for Educational Technology), originally with the Associate Vice President, Computing and Communications, then later (as CET), with the Dean of Science as the Chair, was also established, with a remit to identify academic issues arising from the use of technology for teaching.

Both these committees set up a number of sub-committees, to cover such issues as campus connectivity, student access to computers, copyright, electronic library issues, distributed learning, faculty development, implications for research and evaluation. Between them, these committees involve well over 200 faculty in addressing issues arising from the use of technology.

4. Technology infrastructure

It is absolutely essential of course to have a strategy for developing the technology infrastructure of a university. Priorities must be set on both the level of investment and the areas of investment.

Large research universities such as UBC may need to spend up to $20 million to develop the necessary campus technology infrastructure : high speed networks that will link every building, and within every building, every classroom and office. Many universities have old buildings without adequate conduits for wiring, or asbestos fillings within walls that need to be removed before modern cabling can be installed. Many faculty and staff will not have a computer or know how to use one. Servers will need to be installed within each department, and networked to other servers on campus. Internet connections with the outside world will need to be established, and ports and other communications facilities installed to enable to enable students in residences or off - campus to access the main university campus, or satellite campuses and other institutions to be linked.

While such a technology infrastructure strategy is absolutely essential, unfortunately it is often the first - and sometimes the only - strategy adopted by universities : build it and they will come. However the technology infrastructure plan should be driven by, not lead, the university's overall vision and strategy for its teaching.

5. People infrastructure

Just as important as the physical infrastructure are the people required to make the physical infrastructure work.

There are in fact three levels of support required to fully exploit technology. The most obvious is the technical support, the people who make the networks operate and service the computers and telecommunications. At the second level are media production and services, those who produce educational products or supply educational technology services, such as interface designers, graphics designers, video - conferencing managers, or graduate students who do HTML mark - up. At the third level are those that provide educational services, such as instructional design, faculty development, project management, and evaluation.

The major part of physical infrastructure, such as networks and major equipment purchases, is usually funded from capital budgets, and as such is less likely to compete for funds that impact directly on teaching, such as general operating budget. The cost of the human support though does compete directly with funds for teaching and research.

Furthermore the human cost of infrastructure support is recurrent, i.e. has to be found each year, whereas physical infrastructure is often seen as a once only investment, although rapid advances in technology and hence the need continually to replace or update networks and equipment make this a dangerous assumption.

As a consequence, the human support side is often under-funded. Probably the most consistent complaint across universities from those responsible for technology applications is the inadequacy of resources for technical support. Even so, the further down the chain, from technological support to educational support, the more difficult it becomes to secure adequate resources. If the network crashes, its impact is obvious; the value of an instructional designer is much harder to sell when funds are tight.

Nevertheless, from a teaching and learning perspective, it is critical that faculty receive the training and educational support needed, an issue discussed more fully in strategies 8 and 10.

6. Student computer access

Particularly for distance education students, but also for on - campus students, access to computer technology is a major issue. Approximately 40% of households in Canada have a computer, and about 10% have access to the Internet. Access amongst university students is higher. A recent IBM survey found 60% of USA university and college students had convenient computer access. At UBC, 70% of all undergraduates already have Internet accounts.

However, while access continues to grow, it is strongly related to income, gender and profession. Many of those that do have computers have machines that are not suitable for multimedia or Internet access. There is also a chicken and egg issue here. If students are not required to have a computer for their studies, they are less likely to purchase one. If students who are thinking of purchasing a computer are not given clear specifications as to what is needed, they are more likely to purchase a less powerful model.

Nevertheless, it would be a reasonable assumption to assume that within five years, at least in North America, most university students, both on and off campus, will have convenient access to a computer and Internet access. Universities though will need to put in place strategies to help students acquire the most appropriate kind of computer for their studies, and to help those students who do not have and cannot afford to purchase their own computer and network access.

There are several strategies that can be used to provide support for student access to computers (see Resmer, Mingle, and Oblinger (1995) for an excellent review). One is to provide computer labs on campus for students. Once again this is a useful start-up strategy, but in the long run it becomes unsustainable as the primary source of student support. There are several drawbacks to relying on computer labs for access. The first is that as the need to use computers for learning increases, either capital investment costs get out of control, or students' lining up for access reaches unacceptable levels. Secondly, given the rate of technological change, computers in labs quickly get out of date. More importantly, it requires students to access learning from a specific place, often at a specific time, if they have to book, thus removing one of the main advantages of using technology, its flexibility.

There will always be a need for specialist computer labs, for those subject areas requiring exceptionally high end or specialized machines and software. There will also always be a need for on - campus access through plug - in ports or drop in labs for casual use. However, in the long run the most flexible and most cost - effective approach is to encourage students to provide their own computers and Internet access.

Such a policy though cannot be implemented unless it is clear that students will need a computer, and that means ensuring that there are sufficient courses designed to exploit fully the instructional benefits of using a computer. Will access to a computer be compulsory for certain courses ? Will a whole program require computer access ? Which courses or programs should be the first to implement such a policy ? will there be common technical standards for computers for all the courses to these questions. This requires each department to develop a clear strategy for the use (or deliberate non - use) of computers, and this strategy needs to be clearly communicated to potential students. These departmental strategies need to be coordinated at a faculty and institutional level, so that students do not continually have to change machines, operating systems, Internet service providers, etc.

Sonoma State University, California, spent two and a half years preparing for the implementation of a policy requiring all freshmen students to have a computer. They made sure that there were sufficient courses developed in a way that exploited the use of a computer, and therefore made it essential and valuable to use one. This required a major investment in faculty development.

Sonoma State put in a place a whole range of strategies to help students who could not afford a computer : a work - on - campus scheme whereby students could get a computer then work to pay it off; relatively few students at Sonoma qualified for some form of supplementary State or federal grant that would enable them to purchase a computer, as those eligible for a grant were usually already 'mixed - out', i.e. were already receiving maximum allowable benefit, so for these students, there was a low - cost rental scheme and for some free loans of computers from a pool donated by IBM and Apple. There was an additional 'technology fee' imposed on all students. This was used to provide technical help support for students, improving the local area network, providing docking ports for portables, and making available easy access to public computers in public places on campus. Students themselves play a large role in managing this fund and in approving the level the fee.

Sonoma State found that there was very high compliance for its policy of requiring all its freshman students to have a computer, it was well received by parents and by employers, who praised the university for making higher education more relevant, and also most students seemed to be pleased with the policy. The important point here is that it was a total strategy. Implementing only part of it - such as a technology fee when many students clearly don't need to use a computer for their studies - can lead to considerable student and faculty resistance.

Other strategies increase the accessibility of computers and networks for learners are the development of government - funded educational networks, through contract leasing or bulk buying of telecommunications services, teas breaks for students on computer purchase, and the development of local community learning centres equipped with advanced technologies.

Lastly, while technology may open up access to some and deny it to others, computer ownership is not the main obstacle to university access at the University of British Columbia. Many more potential students are decide access by restrictive grade point average entrance requirements, arbitrary prerequisites, residency or attendance requirements, and barriers to credit transfer from other institutions, If a primary purpose of introducing technology - based learning is to increase access, these admission policy issues need to be addressed as well.

7. New teaching models

In just the same way that the steam engine changed the forms of transportation, and the microchip, satellites and fibre optics are changing the forms of communication, so will technology change the forms of teaching and learning.

There is a synergistic relationship between different technologies and different approaches to teaching. This is a subject that deserves several books to itself (see for instance, Laurillard, 1993, Bates, 1995, Harasim 1995). However I want to make three general points that indicate the complexity of this issue.

First, the newer technologies are quite flexible in that they can be used in a variety of different ways for teaching. Secondly, humans vary enormously between their wish or requirement to follow tried and tested processes, and their ability to be imaginative and inventive. Thus technologies can be used to replicate traditional forms of teaching; at the same time, they can be used in quite new and different ways, depending on the imagination, skills and resources available to the teacher or learner. Thirdly, media such as video, audio, text and computing are all converging into single multimedia technologies such as the Wed or CD - ROM. This is making it increasingly difficult to identify educational applications with a particular technology.

Nevertheless, despite this variability, certain trends in the use of technology are evident. It appears that some technologies lend themselves more easily to certain approaches to teaching and learning, while other technologies lend themselves to others (see Bates, 1995, for a full discussion of this). So far there is no super technology that can meet to be mixed and matched to the educational purpose.

Thus we find that instructional television and video - conferencing (one - or tow - way television from one site to a class in another site) and certain applications of the World Wide Wed (for instance, where information is posted for students to read) tend to be used primarily for information transmission in a didactic style, very close to the classroom lecture model.

Other technologies, such as computer mediated communication using software such as Soft Arc's First Class, Simon Fraser University's Virtual-U, and Netscape's Hypernews, allow for more collaborative learning models. These technologies encourage or require a high level of discussion and participation by the learner, and very much resemble the seminar model of classroom teaching.

Although CD - ROM technology is often used merely to replicate a book (ie. a didactic style), but with better graphics, animation, audio and video, a number of applications that more fully exploit the technology are emerging. Thus CD-ROMs are increasingly being used to simulate human interaction (for language teaching), for representing expert systems, such as forestry management, and for problem - solving approaches based on scientific methodology, through for example the use of virtual laboratories. These approaches to learning enable students to apply their learning to para - realistic situations, to test their own ideas and use their own experience, and as a result to make and test decisions drawing on their previous learning, or even learning facts and principles during the process of decision - making.

The Web is a particularly interesting technology in the way that it is evolving. It has the ability to combine all these various approaches to learning. For instance, Web CT, designed at the University of British Columbia by Murray Golberg (see Goldberg, Salari, and Swoboda, 1996), is a Wed authoring system that combines deductive and collaborative learning tools, as well as a student learning management system, allowing subject experts without any specialist computer skills to construct their own courses. The limitation of the Web at the moment is bandwidth and the power of desk-top machines, which make it difficult or impossible to run the more powerful applications needed for expert systems, complex simulations and problem solving. However this will change quite rapidly.

It could be said with some justification that what I have described are not new ways of teaching, merely the application of well - tries teaching methods to delivery by technology. While that may be true, these technologies enable more powerful applications of such teaching methods in more flexible and accessible forms for students, with also the potential for economies of scale. Furthermore, what all these technologies have in common is that, when well designed, they enable learners, irrespective of the subject matter, to develop skills of information navigation, acquisition, and analysis, application of knowledge to new situations, new knowledge creation, and decision - making, all skills essential for survival in an information society.

In terms of change strategies, these new approaches need to be tested and developed not just in a narrow setting of a particular class or course, but in a system of teaching as a whole, where appropriate replacing, not adding to, conventional teaching methods. Thus technology - based teaching needs to be built into the mainstream teaching, and not offered as peripheral or optional learning for students.

8. Faculty agreements and training

It should apparent by now that the use of technology needs to be accompanied by some major changes in the way faculty are trained and rewarded. Teaching with technology is not something that can easily be picked up along the way, as something to be done off the side of the desk while engaged in more important or time - consuming activities such as research.

The most common form of training given to faculty is to show them how to use the technology. This though is starting at the wrong place. Many faculty need to understand why it is important to use technology for teaching in the first place. It has to be related to the changing environment in which universities find themselves, and in particular to the changing needs of learners.

Secondly, some basic understanding of the teaching and learning process, and in particular the different kinds of teaching approaches, and the goals they are meant to achieve, need to be understood.

Thirdly, faculty need to understand the different roles that technology can play in teaching, and how this alters the way that teaching needs to be organized. Only then does it make much sense to train faculty in how to use a particular piece of technology.

While this sequence may be logical, it is unlikely to be the most effective way to help faculty develop skills in using technology; 'show and tell' and hands on experience are most likely to lead to this full range of understanding, Nevertheless all four aspects need to be deliberately targeted in faculty development (see Holt and Thompson, 1995, for a good discussion of this issue).

University teaching is probably the last craft - or guild - based profession. However, the changing nature and variety of learners, the growing complexity and volume of knowledge, and the impact of technology on teaching now really require that university teachers should have formal training and qualifications in instructional methods. This should eventually become a condition for tenure.

Even more fundamental than faculty training is the need to change the reward system for faculty. While many universities have statements that equate teaching with research for tenure and promotion, the reality in most research universities is quite different : the only criterion that really matters is research.

Thus there is no point in pouring millions of dollars into infrastructure and computers and multimedia unless the faculty reward system is changed. Teaching ability must become in practice at least equal to research for promotion and tenure. The good news though is that technology - based teaching is usually more public, more observable, and hence more easily evaluated than conventional classroom methods. Furthermore, multimedia technologies provide an excellent means to convert research knowledge directly into teaching and into promotional material for the research itself.

Another way to reward faculty is to ensure that revenues generated by the use of technology by a department flow back into that department, and do not get swallowed by the central bureaucracy. Innovative mechanisms need to be developed for faculty (and other creative staff) to share in rights and royalties from the development of generic educational software and learning materials.

Lastly the very sensitive issue of faculty agreements needs to be addressed. There are short - term advantages in leaving things loose, but technological innovation will become unsustainable as faculty become more experienced, suffer from increased work-loads, and find that they are still unrewarded.

9. Project management

It has already been argued that there is a great deal to be learned about how to exploit fully the new technologies for teaching and learning. At the same time there is growing evidence that there is a major difference between 'experimenting' (R&D) and delivering cost - effective technology - based teaching (operations). The challenge is to encourage faculty to be innovative while at the same time maintaining quality control and cost - effectiveness in the delivery of teaching.

However, while new technologies require new applications, a great deal is already known about the process of producing high quality, cost - effective multimedia learning materials. This knowledge has been developed both in the large autonomous distance teaching universities, and also in private sector multimedia companies in areas such as advertising and film and television making.

The answer is project management. This means establishing each course or teaching module as a project, with the following elements :

- a fully costed proposal, which identifies
  - the number and type of learners to be targeted (and in particular their likely access to technology),
  - clear definition of teaching objectives,
  - choice of technologies,
  - a carefully estimated budget allocation (including staff time, copyright clearance, use of 'fixed' media production resources, such as video - compression, as well as actual cash),

- a team approach, involving any combination of the following :
  - subject experts / faculty,
  - project manager, instructional designer,
  - graphics designer,
  - computer interface designer,
  - text editor,
  - Internet specialist,
  - media producer,
  - depending on the design of the project,
- an unambiguous definition of intellectual property rights and a clear agreement on revenue sharing,
- a plan for integration with or substitution for face - to - face teaching,
- a production schedule with clearly defined 'milestones' or deadlines, and a targeted start date,
- an agreed process for evaluation and course revision and maintenance,
- a defined length of project before redesign or withdrawal of the course.

A project is not defined in one step. In the Distance Education and Technology unit, we have a five - stage approach to project definition. Following an invitation to all faculties to bid for funds, a department or individual academic is invited to submit a short proposal (usually two to four pages) requesting funds or assistance. We provide a short questionnaire to help faculty at this stage.

One of our senior managers then works with the lead academic to develop a fully costed proposal. This is a critical stage of the process, where objectives are clarified, alternative modes of delivery are explored, and resources are identified.

The project proposal then goes in competition with all the others to a university - wide committee of academics for adjudication. A set of criteria for selection has been developed, including the number of students to be served, strategic positioning in terms of technology applications, innovativeness, potential for revenue generation, etc.

Following allocation of funds, a detailed letter of agreement is drawn up between the academic department and the Distance Education and Technology unit, which clearly sets out responsibilities on both sides, and ties down production schedules, intellectual property, sharing of revenues, etc.

Once the project is funded, DET managers track progress, schedules are rearranged to take account of changing circumstances, budgets are sometimes changed (but more likely re-arranged) as a result, all by mutual agreement.

Funds for distance education then are allocated differently from the Teaching and Learning Enhancement Fund. The differences are really a matter of timing and purpose. To encourage staff who are 'novices' in using technology, and to encourage research and development in the use of new technologies, a 'weak' criteria approach may be best for TLEF. Often faculty with little experience of using technology prefer the privacy and control of the Lone Ranger approach. However, as one moves to regular teaching with new technologies, as more experience is gained by faculty, and the more independent the targeted learners, the more important it becomes to move to a project management model.

Faculty experienced in using technology soon learn that there are things they do not need to do, and that while a good graduate student is invaluable, there are other skills needed too. In the Distance Education and Technology unit we have found that most faculty welcome a structured approach to the development of multimedia courses, provided it does not interfere with their creativity in teaching, which it should not do.

10. New organizational structures

The challenge with regard to organizational structures is to develop a system that encourages teaching units to be flexible, innovative and able to respond quickly to changes in subject matter, student needs and technology, while at the same time avoiding duplication, redundancy and conflicting standards and policies.

There has been a long history in universities of setting up large central technology units. In the 1960s and 70s many universities invested in expensive, centrally managed television studios. More recently universities have established large central computing organizations. Too often these central services have had little impact on the core teaching activities of an institution, partly because faculties have felt that they do not control them. Such units are often subjected to attempts by Deans to break them up and reallocate their funding back to the faculties.

Although often dependent on centrally provided networks, new technologies such as the Web are more decentralized. The power is often (or appears to be) on the desktop. This provides considerable empowerment for the individual faculty member. However we have seen that high quality educational multimedia requires a range of specialist skills that go beyond the capability of any single individual. Furthermore the appearance of decentralization in the new technologies is deceptive. They depend on agreed standards and networks for communication and inter-operation, and they depend on human and technical support infrastructures that require policy making across the university.

The initial strategy at UBC in responding to the challenge of the Innovation Fund was not to centralise all the new technology support services into an existing unit such as Computers and Communications or Media Services, nor to set up a large New Media Centre, as many other universities have done, but to establish a very small co-ordinating unit, originally called the Media Resources Network and later the Centre for Educational Technology. This had a project director, a multimedia graphics designer, an interface designer, and later a part - time secretary. These provided services that could be called on by faculty to help them if they wished.

This now means that UBC has several small - sized organizational units with somewhat linked activities : Media Services, which provides printing, photography, audio and video production and videoconferencing facilities, the Centre for Educational Technology, the Distance Education and Technology unit, which has project managers, instructional designers and more recently an Internet specialist, the Centre for Faculty Development and Instructional Services, and Computer and Communications, which provides network services across campuses and a somewhat decentralized computing support service for faculties. Health Sciences has its own media services unit and educational support units. Each of the directors of these units have different reporting relationships. Lastly, as well as individual faculty members or departments hiring graduate assistants to provide educational technology support, at least one Faculty has now appointed its own Director of Information Technology and Instructional Support.

This sound like recipe for chaos, but it works surprisingly well. For large projects, teams can be called together from across the various groups. Thus a project to put the whole of an introductory microbiology program on to CD - DOM and the Web has funding from the Faculty of Science, the Teaching and Learning Enhancement Fund, and the Distance Education fund, faculty and a project manager from Science, an instructional developer from Health Sciences, graphics and interface design from CET, media production from Media Services, and an Internet specialist from Distance Education and Technology. Figure 2 below indicates the kind of arrangement just described.

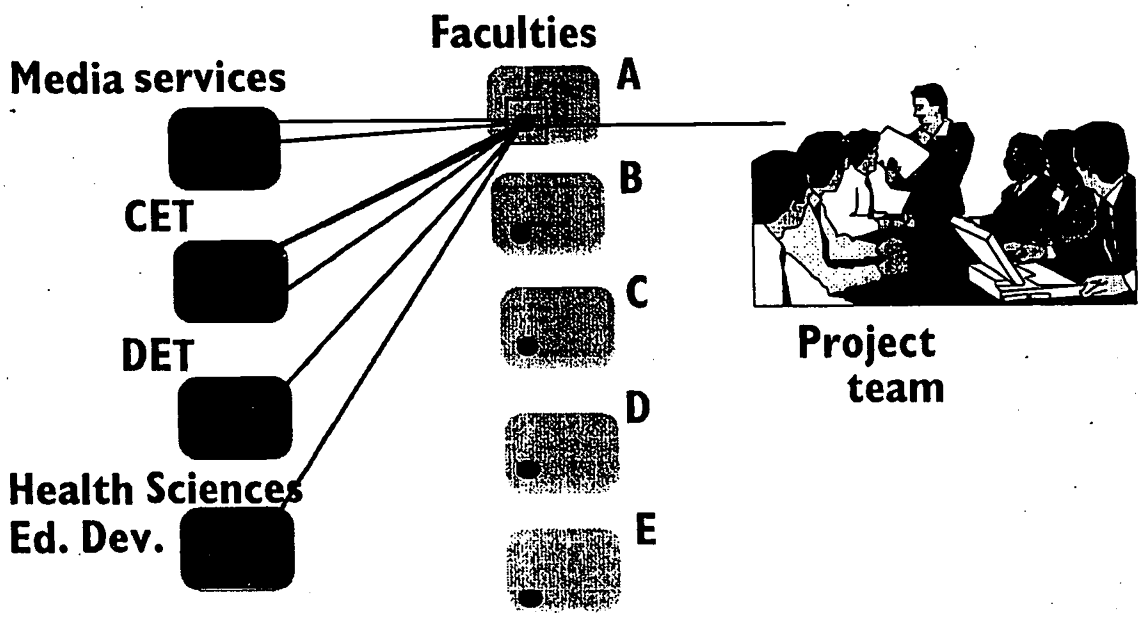


Figure 2: A decentralized model of multimedia course design and production.

At the other extreme, an individual faculty member can still work alone, or draw on any one the services, on a project - funded or fee for service basic.

Some institutions, especially in Australia (e.g. the University of Wollongong, and Griffith University), have integrated their professional development, distance education and media services units into a single multimedia department. The establishment of six co-operative multimedia centres in Australia, with university partners, suggests that multimedia production and services may even be shared between several neighbouring universities and private sector organizations.

However a major study of managing technology for teaching and administration in Australian higher universities (Australian Graduate School of Management, 1996) classified universities into three different groups : old, divisional and new. The study argued that while centralization of services is appropriate in a new institution with a major commitment to make IT a centre of its vision and strategy, this is less likely to be appropriate for large, well - established 'divisional' universities with a strong Faculty structure. It is certainly true that at UBC there has been concern not to weaken the control of Faculties over the teaching process, and to avoid setting up a large central unit that might develop its own autonomy.

With regard to the establishment of university - wide policies and strategies to support the use of educational technologies, we saw under strategy 3 that UBC has established two different reporting lines for policy initiatives, one through the Academic Vice - President and Provost, and the other through the Vice - President Student and Academic Services.

In the private sector a number of organizations have recognized the strategic importance of information technology by appointing a single Chief Information Officer at a Vice - President level, who has a full - time responsibility for information technology policy.

This person is not necessarily someone who has come from a career in computing or communications; in a university environment, it would be someone with a strong academic background, but who has a good understanding of the management and policy issues surrounding information technology, and commands respect and has at least equal status with the other Vice - Presidents and with Deans (see Bates and Mingle, 1997, for a more detailed discussion of this issue).

These are not the only structures for setting and co-ordinating information technology policy at a university level; a small committee consisting of the President, two Vice-Chancellors and two Deans could provide the same role.

While there are advantages and disadvantages of these various approaches, what is essential is that there is a mechanism in place by which university - wide policies and priorities for information technology can be set and implemented throughout the organization.

11. Collaboration and consortia

New technologies are resulting in global competition for universities. Already three Canadian universities (Queens, Western Ontaria, and Athabasca) are vigorously promoting and offering distance MBA's in British Columbia. In 1995 43% of all Masters in Education awarded to British Columbia teachers were from institutions in the USA. This competition is going to increase and will be impossible to regulate.

UBC's competitors are less likely to be our neighbours, such as Simon Fraser or the University of Victoria. There is a good deal of complementarity in programming within British Columbia; UBC offers courses not available from other BC universities, and vice - versa. For more than 10 years there has been collaboration and co-ordination in the offering of undergraduate distance education programs and a system of credit transfer between institutions, through the Open University Planning Council of British Columbia. Where such structures within a state or provincial jurisdiction do not exist, they will needed to prevent duplication and 'body snatching' (recruiting students from other institutions through distance education programs).

Our competition is more likely to come from universities such as the University of New South Wales, Strathclyde University, UK, and Penn State University. Even more of a threat is likely to come from multinational corporations in the areas of telecommunications, entertainment and information technology, such as Microsoft, IBM's Global Networks, and the Disney Corporation, who are all targeting education as a natural growth area for value added services and products.

As a consequence, we are beginning to see strategic alliances emerging between universities, and between universities and the private sector. UBC is developing a strategic partnership with the Monterrey Institute of Technology in Mexico, for staff and student interchange, and more significantly for the development of joint programs that can be delivered by technology throughout Latin America.

With the private sector, UBC and BCTel are entering into a partnership agreement that will provide improved connectivity on and off campus for the university, investment in program areas critical to the telecommunications industry, and the development of joint educational initiatives that provide benefits for both partners.

At a national level, a consortium of universities, colleges and private sector companies, called Oui. Can. Learn, is working towards establishing a national marketing strategy for Canadia distance education products and services. At a provincial level, UBC, Simon Fraser University, British Columbia Institute of Technology, the Open Learning Agency, BCTel, the IBM Pacific Development Centre, and Mobius are tentatively working towards the establishment of Distance Learning BC, to identify market needs for technology - based learning, as well as to market internationally.

These strategies enable universities to reduce risk, share the costs of new developments, and reach wider markets for their products and services.

12. Research and evaluation

The need for systematic research and evaluation into the use of new technologies should be obvious. However it is important that the right kind of research should be done. The wrong kind of research is to compare the learning effectiveness of technology - based teaching with the learning effectiveness of classroom based teaching, using the classroom based model as the baseline. Many hundreds of thousands of such comparative studies have been made in the past, and the usual result when the comparisons have been done using sound research methodology is that there is no significant difference (see, for instance, Clark, 1983).

As long ago as 1974, Wilbur Schramm pointed to the flaw in this kind of approach : technologies allow the achievement of new or different learning outcomes to those of the classroom lecture method, but if the classroom 'event' is the base, then the new learning outcomes that could be achieved are not usually measured. For instance, if a lecture is used primarily for transmitting information, but a CD - ROM is used for applying that knowledge to solving a problem, then the measure of success for the CD - ROM has to be different from the classroom lecture. The aim then should be to measure the success or otherwise of new technologies in extending the range of learning skills, as well as content acquisition.

Even more important than research into learning outcomes is research into learners' response to using technologies, and in particular what learners and teachers believe may be lost or gained in using such approaches to learning. These results are likely to vary considerably from individual to individual, so benefit more than others from technology - based teaching. This kind of research should also help identify the critical aspects of face - to - face teaching, which are likely to be as much social as instructional.

Another area of research that has so far been neglected is around the organization of technology - based teaching : which organizational arrangements seem to work best for different kinds of university ?

Yet another area where research and development is needed is into new interfaces and applications software that facilitate different kinds of skills, or the development of technology - based teaching. These are generic tools that could be used for the development of a wide range of courses.

Lastly and perhaps most important of all, there is a need for studies into the cost - benefits of technology - based teaching. As well as looking at the costs and benefits of a particular technology, it is also important to look at the social and economic impacts of moving to technology - based teaching (see Cukier, 1997).

Fortunately, at this point in time it is not too difficult to find external funds for this kind of research. For instance we have a grant through the Canadian government's National Centres of Excellence in Tele-learning program to conduct a cost - benefit analysis of on - line teaching and learning. We also have another grant from Human Resources Development Canada's Office of Learning Technologies to study the impact of technology - based learning on different kinds of adult learners, in conjunction with Simon Fraser University, the University of Victoria, the Open Learning Agency, and community skills centres in British Columbia.

Conclusions

By this time you may well have asked the question : is it work it ? I must confess that I get tired merely thinking about what needs to be done. The implementation of these strategies will present a major challenge to any university administration. Are they all necessary ? If technology is to used to improve significantly the quality of learning in a cost-effective manner, I believe they are. Indeed there are probably many other strategies that are also necessary to facilitate the achievement of such a goal.

Furthermore, timing is critical. There is a stage for instance where an institution needs to move from a 'weak' criteria approach to a 'strong' criteria approach to funding. Organizational changes may have to take place later than funding re-allocations. Nevertheless these strategies are all inter-related. There is no point in making major technological investments without a parallel development of a vision of how the institution wishes to teach over the next 10 years. 'Build it and they will come' without the other strategies is a very high risk.

Then there is the cost of change. It takes time to design effective learning materials, to put technology systems in place, while at the same time the flow of conventional students and the necessity to conduct research does not stop.

Nevertheless Rome wan't built in a day. It took more than 100 years from the invention of the steam engine to Henry Ford's first production line. Such revolutionary changes have to progress at a rate that can be absorbed by faculty and students. What I am suggesting is more like a 10 year strategy than a strategy to be completed within one year.

There is also the options of not going down this road, of having a token or limited use of technology for very specific purpose, of using technology mainly as an additional activity to face-to-face teaching (and being prepared to live with the extra costs of so doing), or deciding to focus entirely on more traditional approaches. However all these approaches contain high risk as well.

Lastly the question needs to be asked : can this be done ? It could be argued that the 12 strategies require such fundamental changes within a university that the whole enterprise is unsustainable; it may be 'better' to create new institutions from scratch.

My own view is that this underestimates the ability of some of the most intelligent and well-educated people in the world to learn, to change, and to take control of their own destinies. It also underestimates the pressure that is likely to be exerted on universities to change, by governments, by competition, and from within. Lastly, I ask sceptical professors: 'Who is having the most fun in teaching : those struggling to serve increasingly large classes within the conventional system, or those who have embraced technology as a possible solution to increasing demands and reduced resources ?

So while I predict that quite a number of universities will not survive, while others will find alternative routes to survival, many will protect their core activities by improving the quality of learning and the institution's cost effectiveness, and will do this through the intelligent use of technology.

References

[1] Australian Graduate School of Management (1996) Managing the Introduction of Technology in the Delivery and Administration of Higher Education Sydney, Australia : Fujitsu Centre, Australian Graduate School of Management, University of New South Wales.

[2] Bates, A. (1995) Technology, Open Learning and Distance Education London/New York : routledge.

[3] Bates, A. (1995b) 'Creating the future : developing vision in open and distance learning' in Lockwood, F. (ed.) Open and Distance Learning Today London : Routledge.

[4] Bates, A. W. and Mingle, J. (1997) Distance Education in the University of Maine System : Consultants' Report Bangor, Maine : Chancellor's Office, University of Maine System.

[5] Campion, M. (1995) 'The supposed demise of bureaucracy : implications for distance education and open learning - more on the post - Fordism debate' Distance Education Vol.16, No.2

[6] Campion, M. and Renner, W. (1992) 'The supposed demise of Fordism : implications for distance education and higher education' Distance Education Vol. 13, No.1

[7] Clark, R. (1983) 'Reconsidering research on learning from media' Review of Educational Research Vol. 53, No. 4

[8] Cukier, J. (1997) 'Cost - benefit analysis of telelearning : developing a methodology framework' Distance Education (in press)

[9] Daniel, J. (1997) The Mega - Universities and the Knowledge Media London : Kogan Page

[10] Farnes, N. (1993) 'Modes of production : Fordism and distance education' Open Learning Vol. 8, No. 1

[11] Fritz, R. (1989) The Path of Least Resistance New Yeork : Ballantine

[12] Goldberg, M., Salari, S., and Swoboda, P. (1996) World Wide Wed - Course Tool : An Environment for Building WWW - Based Courses Paris, France : Fifth International WWW Conference (url : http : // homebrew. cs. ubc. ca/ wevct/papers)

[13] Holt, D. anf Thompson, D. (1995) 'Responding to the technological imperative : the experience of an open and distance- education institution' Distance Education Vol. 16, No. 1

[14] Harasin, L. (1995) Learning Networks : a Field Guide to Teaching and Learning Online Cambridge, Ma : MIT Press

[15] Laurillard, D. (1993) Rethinking University Teaching London : Routledge

[16] Peters, O. (2973) Die didaktische Struktur des Fernunterrichts.

[17] Untersuchungen xu einer industrialisierten From des Lehrens und Lernens, Weinheim : Beltz.

[18] Peters, O. (1994) 'Distance education in a postindustrial society' in Keegan, D. (ed.) Otto Peters on Distance Education : The Industrialization of Teaching and Learning, London / New York : Routledge

[19] Renner, W. (1995) 'Post - Fordist visions and technological solutions : educational technology and the labour process' Distance Education Vol. 16, No. 2

[20] Resmer, M., Mingle, J. and Oblinger, D. (1995) Computers for All Students : A Strategy for Universal Access to Information Resources Denver, Co.: State Higher Education Executive Officers

[21] Rumble, G. (1995) 'Labour market theories and distance education : 1. Industrialization and distance education' Open Learning Vol. 10, No. 1

[22] Schramm, W. (1974) Bih Media, Little Media San Francisco : sage

[23] Senge, P. (1990) The Fifth Discipline : The Art and Discipline of the Learning Organization New York / London : Doubleday Currency

[24] University of British Columbia (1996) A Vision Statement for Distributed Learning at UBC Vancouver, B.C.: University of British Columbia, Centre for Educational Technology (http: //www. cet.ubc.ca/about/vision.html)

INTERACTIVE MULTIMEDIA TECHNOLOGY CONTRIBUTING IN SOLVING THE PROBLEM OF NATIONAL EDUCATION

Tran Ha Nam
SCITEC, Vietnam.

Abstract

This paper contains three parts : First, the pedagogical advantages of CD-ROM based interactive Multimedia .Second , the comparison of Multimedia and the other public media , such as Internet/Intranet , broadcasting , television.. Last, after determining the demand of the Education-training, the role of CD-ROM, A proposal of national strategy for developing the use of CD-ROM in Education will be suggested.

The report will be concentrated in the following issues:

- *PC based Interactive Multimedia.*
- *Interactive Multimedia and Learning.*
- *Comparison of Multimedia and other Media.*
- *CD-ROM and the application in Distance Education :CD-ROM in class, CD-ROM and Television, CD-ROM and books, CD-ROM and Internet, CD-ROM and Videotape.*
- *The urgent demand of a national program for developing Multimedia application in Education.*

INFORMATION TECHNOLOGY WILL TRANSFORM THE UNIVERSITY

Wm. A. Wulf
University of Virginia, USA

Universities are in the information business , and technological developments are transforming that industry. University professors from a variety of disciplines have helped create of disciples creates the technology that are forcing many U.S. industries to reinvent themselves, have advised industry leaders on how to adapt, and have analyzed the importance of the changes for society . But it's harder to look inward at the university and to think about whether it might change in dramatic ways. We should remember that although its roots are millennium old, the university has changed before. In the early 19th century it embraced the notation of secular "liberal" education. In the late 19th century it included scholarship as an integral part of its mission. After World War II it accepted an implied responsibility for national security, economic prosperity, and public health in return for federal funding of research. Although the effects of these changes have been assimilated and now seen " natural", at the time they involved profound reassessment of the mission and structure of the university as institution.

Outside forces are always acting on universities. Some of them, notably the political ones, have great immediately and hence get a good deal of attention. For example, university administrators are acutely aware of the current reassessment of the rationale for federal funding of research and the desire for greater " productivity" from the faculty, and so on. As important as these changes may be, I believe that information technology has a far greater potential to provoke fundamental change in our system of higher education. Moreover, I am certain that these changes are much closer than most people realize.

Let me be clear. Higher education will flourish. If anything, the need for advanced education is increasing. A greater percentage of the world's population needs to be educated to be productive in an increasingly technological workspace. The period during which particular skills are relevant is shortening, so the need for lifelong learning are growing. The knowledge and skills necessary to function at the frontier of knowledge are expanding as well, increasing the need for advanced degrees.

Higher education is not in danger. But we would be wise to ask whether the particular quaint way in which universities now do their work will survive the transformation of information technology. It ma , but I don't think so. I expect to see major changes - changes not only in the execution of the mission of universities but in our perception of the mission itself.

Universities historically have changed slowly, but there are times that are more propitious than others for change. The next decade is one such. Because of the speed with which information technology is advancing , decisions are being made now(or more likely, make by default) that will have a material effect on the real and perceived quality of institutions of higher education. In my experience, almost none of the current generation of senior university administrators understand what is happening . They should be confronting two central questions: Are universities like businesses they must adapt to technological change and is the capability of technology used for higher education really going to change all that much?

Universities share many of the attributes of traditional handcraft industries. They are highly labor intensive and depend on the skill of their master craftsmen. They have been regional, requiring collocation of the producer and customer, and have contributed to the prestige of their locales .They have a long tradition. They have evolves powerful guilds to protect the masters. And now they face the prospect of a technology that can perform many of the specialized tasks that have made their work valuable.

Universities also share at least some of the attributes of others vertically integrated industries . They manufacture information (scholarship) and occasionally "reprocess" it into knowledge or even wisdom, they warehouse it (libraries, they distributes it (articles and books).Information technology has already changed each of these processes and future. Like industries that have been overtaken by technology, they need to understand its individual and collective impact on their basic functions. Its not a comfortable thought, but we must at least consider that a change in technology- a change that will facilitate the flow of the university 's essential commodity, information- might provoke a change in the nature of the enterprise.

As for the rate of technological progress, most people still fail to understand the dimensions of the exponential rate of improvement in information technology. For the past four decades, the speed and storage capacity of computers have double every 18 to 24 months; their cost, size and power consumption have diminished at about the same rate. The bandwidth of computer networks has increased a thousandfoul in just the past decade, and the traffic on the network continues to grow at 300 to 500 percent annually. For the foreseeable future, all of these trends will continue; the basic technology to support them exists now.

For a concrete example of what this rate of change means, consider ENIAC the first fully electronic digital computer. A 1949 article in Popular Mechanics raved about what could be expected from computer design: "ENIAC" contains about 18,000 vacuum tubes and weighs 30 tons , but in the future computers will contain only about 1,000 tubes and weigh only one and a half tons."

Thirty-five years later , a typical microprocessor is about 100,000 times more powerful, contains the equivalent of 10 million tubes, and weighs substantially less than an ounce. Imagine the nonoprocesssor of a few decade hence.

To my knowledge, there has never been a similarly rapid, sustained change in technpology, especially one with such broad social application. By comparison, even the industrial revolution seems modest in scope and leisurely in space. Lacking a precedent, we need to work harder to imagine the impact of future computers and networks. Thinking about the current ones, in fact , can be misleading; it's all too easy to assume that something won't change just because just because today's technology doesn't support that change . Instead, it's almost better to hypothesize a change and then ask how soon the technology will support the answer how soon

Don't think about today's teleconferencing technology. But about one whose fidelity is photographic and possibly three dimensional. Don't think about the awkward way in which we access information on the network, but about a system in which the entire world's library is as accessible as my desktop files. Don't think about the clumsy interface with computers, but one that literally listens and talks in your jargon, not mine. Don't think about the storage on today's personal computer, but on one with millions of megabytes, we can 't afford it now, of course but that is the power of the equipment affordable in a decade or so. That is the equipment that will shape the future of the university.

Tapping new capabilities

How we will use this equipment to change education and scholarship? That seems like a simple question, but as both an academic and a computer scientist, I don't know. The ability to process information, the raw stuff of knowledge , sits at the heart of the university mission. A technology that will alter by orders of magnitude our ability to create, store, and communication knowledge will have an impact on how to we fulfill our mission, and possibly on the mission itself. Perhaps as a start we might look at several functions of our vertically integrated information business and note how they have been and might be changed.

Scholarship.

The impact of information technology on science is apparent and pervasive. Scientists now routinely talk of computation as the "third modality" of scientific investigation, on a par with theory and experimentation.

The easy examples are those that simply automate what have been done manually, such as the reduction of data and control of instruments, The profound applications, however are those that lead to whole new areas of research and new methods that lead to whole investigation and thus to science that was not and could not be done before: analyzing molecules that have not been synthesized, measuring the properties of a single neuron by "growing" it on a silicon chip, watching a model of galaxies colliding and letting a scientist feel and the forces as drug docks in a protein . These applications have transformed the nature of scientific investigation ; they have led to question that would not even have been asked before.

Science, however, will not be where we see the most dramatic impact. I say that despite a recent study (in which I participated) by the National Research Council that paints an expansive image of the transformation of scientific research. I believe. I that a more dramatic transformation is about to shake the foundation of scholarship in the liberal arts. Humanists will lead the way to innovative application of the information technology in the university.

The comfortable stereotype of humanists as technophobic is no longer accurate. The availability of text and images in electronic form, coupled with the processing power of modern computers, allow the humanist to explore hypotheses and visualize relation that were previously lost in the mass of information sources. The presentation of humanists' scholarly results in electronic form is moving even faster. Precisely because of the complexities of the relationships they next to present, electronic "hypertext" books and journals are emerging. Indeed, they are emerging faster, with more vigor, and with more effect on their disciplines than are their counterparts in the sciences.

We all expect scientists and engineers to use computer in their research, but the notion that information technology could be central to humanistic scholarship is a bit more startling, at least to me. In large measure, it was talking about the application of computer to historiography and theory of text that opened my eyes to the larger issues that I am trying to raise here.

Textbooks.

I don't know anyone who prefers to read from a computer screen, and besides you can't take a computer to the beach, or so say the nostalgic. They are right, and yet so profoundly wrong.

There are two fallacies here. They first is the assumption that electronic books will contain only text and hence be essentially the same as paper books but in a different package. In reality, it will not be possible to reproduce electronic books on paper . They will not be a simple linear presentation of static information, but will contain animation and sound. They will let you "see the data" behind a graph by clicking on it. They will contain multidimensional links so that you cant navigate through the information in ways that suit your purpose rather than the author's. They won't contain references to sources, but the source material itself; for example, the critique of a play will include its script and performance. They will have tolls that let you manipulate equations, trying them on your own data or modifying them to test scientific hypotheses. They will let you annotate and augment documents for use by later readers, thus making a book a "living document".

They second fallacy is presuming today's technology. We should not be talking about reading these electronic books from to day's screen. Screens with a resolution about the same as good laser printer already exist in the laboratory. Why would anyone lug around several heavy books when something the size, clarity, and weight of a single one contains them all? I mean all: all the ones in the Library of Congress. I will talk my computer to beach!

Libraries

For thousands of years, the focus of libraries has been on the containers of information: books. The information itself was the domain of the library's user, not the library. Information technology turns that premise on its head and with many of the deepest unstated assumptions about the function or library.

Looking back to Alexandria and before, the principal objective of librarians has been to build the collection. But in the future a library will not collect. Electronic information can be communicated virtually instantaneously, so its source location is irrelevant. Instead of a hoarder of containers, the library must either become the facilitator of retrieval and dissemination or be relegated to the role of a museum.

If we project far enough into the future, it's not clear whether there is a distinction between the library and the book. They technology of the bibliographic citation pales by comparison with the hyper-textual link: the ability to gain immediate access to the full referenced source and hence to browse through the context of the referenced. It will take a long time to build the web and especially to incorporate the paper legacy, but the value of a seamless mesh will doom the discrete isolated volume.

As the library and the book merge, it seems clear to me that another merger will accompany it, a merger precipitated by devolving disciplinary boundaries. Knowledge isn't inherently compartmentalized; there is only one nature, only one human record. The division of the sciences into disciplines and sub-disciplines is human imposition, as is the division of the humanities into disciplines such as history, English, and anthropology. For very practical reasons, paper texts have mirrored this artificial division, but those reasons evaporate in the electronic world. Clearly, the "long pole in the tent" will be human rather than technological; disciplines are complex and idiosyncratic social structures that will not easily dissolve. However (and here I can only speak with smallest authority technological disciplines), much of the most interesting work already happening at the boundary of traditional disciplines. That is not new news; Albert Einstein maintained that most of the important science lay at the intersection of the traditional disciplines. What is new is that we have technology that facilitates incremental accretion of knowledge at these intersections.

Finally, books are passive, sitting on shelves waiting for us to read and interpret them. Although there is an intellectual thrill in discovery and interpretation, passivity of the text is not required for that. As MIT's Marvin Minsky said "Can you imagine that they used to have libraries where the books didn't talk to each other?" One of the profound changes in the store for the libraries is that parts of their collection will be software agent collecting, organizing, relating, and summarizing on the behalf of their human authors. They will "spontaneously" become deeper, richer, and more useful.

Teaching.

The notion of computer-aided instruction has been touted for 30 year. Frankly, it has had relatively litter impact, especially at the university level. The reason is obvious: Chalk and overhead projectors have been perfectly adequate technology given the current nature of the scholarship and texts.

If, however, the professors are using information technology in their scholarship and the results of that scholarship can only be exhibited using the technology: the classroom will follow rapidly. How will it follow? Not, I think, by "automated drill" scenario we have come to associate with computer-aided instruction.

These are interesting but mundane applications, mundane in the sense that they do not change the educational process in a deep way. More fundamental is the opportunity to involve students in the process of scholarship rather than merely its results. We like to say that we teach students to think, not merely to learn rote facts, but in truth we mostly limit them to thinking about what has been thought before.

We can't ask them to explore new hypotheses because of the practicalities of access to source and the sheer grunt work of collecting and analyzing data. Information technology eliminates those impediments.

A hint of this kind of change can be detected in a report in the Chronicle of Higher Education about the impact of the release of the Thesaurus Lingure Groece on the scholarship and education in the classics. The report noted that the release of this database, which includes virtually all Greek literature from Homer through the fall of the Byzantium, has enabled undergraduate participation in research.

One cannot leave the subject of teaching without at least mentioning the issue of "productivity," the current code word to capture the public's frustration with the rising cost of college education and the perceived emphasis on the research over teaching. The simplistic solution is to have professors spend more time in the classroom and the less in the laboratory. Particularly given the wrenching restructuring that industry has undergone, the public has ample cause to ask why an elitist academe should be exempt from a reorientation toward greater customer satisfaction.

The irony, of course, is that one of the oldest figures of merit for any school - a low/teacher ratio-is diametrically opposed to the strict definition of productivity as output per worker. Information technology is not going to resolve this tension; for our own children, we want relatively individual attention from the most qualified, intellectual alive professorate possible. Information technology can however, shift the focus on the discussion to the effectiveness and quality of the student/teacher interaction rather than just the number of contact hours.

Indeed, in most modest ways is already has shifted that focus. By removing the barriers of space and time for example, e-mail has given my students much greater access to me than ever before. Involving students in the process of scholarship and giving them greater access to international authorities are more profound shifts, but I suspect that these are still just pale precursors of what we can do. Part and parcel of rethinking the impact of technology on the university is addressing precisely the issue.

The importance of place

Technological change will even force us to reconsider some of the fundamental assumptions about what a university is. For example, historically a university has been a place. The stone walls of St. Benedict's cloister at Monte Cassino were the bastion that provided defense against the physical and intellectual vandals of the Dark Ages. In colonical times, Jefferson 's Academical Village provides access to scholarly materials as well as collegial interaction by collocation. In contemporary times, scholars flock to scientific instruments and library collections. And , where the scholars assembled, the students followed.

In his influential 19th-century essays on the university, John Cardinal Newman wrote:" If I were asked to describe .. what a university was, I should draw my answer from its ancient designation of a stadium Generale.. This description implies the assemblage of strangers from all parts in one spot. "

Newman then goes on at some length to emphasize that books are an inadequate source of true education and must be buttressed with discourse, which is obviously only feasible if the discussants are collocated. Thus the notion of being in one spot is, to him, essential to the very definition of the university; as he says. "else, how can there be any school at all ?"

But with the possible exception of teaching, to which I'll return in a moment, I believe that information technology obviates the need for the university to be a place. With powerful ubiquitous computing and networking, I believe that each of the university's functions can be distributed in space, and possibly in time. Remote scholarship is the direct analog of telecommuting in the business world, and every bit as appealing. Academics tend to identify more closely with their disciplinary and intellectual colleagues than with their university. Freed from the need to be physically present in classroom, laboratory, or library, grouping by intellectual affinity may be more useful. But even then, physical grouping may be unnecessary.

There are some disciplines that need shared physical facilities, such as a telescope, that suggest the need of a place. But many large scientific instruments such as telescope and accelerators are already run by consortia and shared by the faculty from many universities, and many of these facilities do not require the physical presence of investigator, who could be on-line and have access through the network. Indeed, some instruments , such as those for space physics at Sondre Stomfjord in Greenland, are already accessed on the Internet. The university as place is already irrelevant to at least some scientific scholarship.

As with instruments in the sciences, direct access to archival materials is necessary for some humanistic scholarship but hardly all , and certainly not all of the time. If anything, the information infrastructure will provide greater access for a much larger set of scholars to archival materials of a quality that's "good enough". Consider the excitement caused by the recent release of the images of the Dead Sea Scrolls, even though the scrolls themselves are not accessible to most scholars.

As for teaching, we don' t really know whether it can be distributed or not . I do know that even asking the question is considered heretical by some good teachers who contend that eyeball-to-eyeball contact is necessary. Others including me, contend that although they need feedback to teach well , there is a threshold of fidelity beyond which one does not need to go; student and teacher probably don't need to smell one another, for example. Thus, there is some finite amount of information required to produce an adequate representation of the parties. If true, when that threshold of fidelity is reached electronically, high-quality teaching will be distributed. The fallacy in Newman's reasoning was only that he could not imagine quality discourse at a distance, but that is precisely what technology will enable.

Uncertainties

Can an institution such as the university, which has existed for a millennium and become and icon of our social fabric, disappear in a few decades because of technology? Of course. If you doubt it, check on the state of the family farm. Will the university as place in particular disappear? I expect not; the reduced importance of place does not imply no place. However, just as farming has been transformed, so will the university be. The everyday life of both faculty and students will be very different

I have more questions than answers as to the shape of the new university. Having now laid the groundwork, let me pose a few of them:

Will universities become mass-market manufacturers or distributors of information or will they be niche tutors to the privileged?

Does it really make sense for every university to support the full complement of disciplines, or should they specialize and share course in cyberspace? This might be a natural consequence of aggregation by disciplinary affinity.

Might professors affiliate with several institutions or become freelance tutors to telepresent students? Indeed, might "tele-itinerant" scholars and tutors give new life to an ancient practice ?

Might some employers (and hence students) prefer a transcript that lists with whom certain courses have been taken rather than where?

What about alumni and sports? Surely the allegiance of alumni to their alma mater has a great deal to do with place. Because the support of alumni is essential to universities, isn't that very human need sufficient to perpetuate university as place? Perhaps. But broad alumni support has become essential to university only in relatively recent times. Moreover, alumni associations and large sports programs were created to support the university as place, not the other war around.

Will university merge into larger units as cooperate world has done or will the opposite happen? I can argue either side of this question. On the one hand, if a university isn't (just) a place, its major remaining function is certification: If certifies the competence of the faculty, programs, and graduates. We don't need thousands of organizations to do that. On the other hand, I can envision many small colleges being empowered to provide a broad curriculum through telelocation while retaining the intimacy so valued in our small liberal arts institution. I don't know anyone that really wants the impersonal ambiance of a mega - university. The current size of these universities seems optimized for the physical infrastructure, not for either education or scholarship.

Might the technology revive the talented amateur participation in the scientific community? Except in a few disciplines such as astronomy, the talented amateur has largely disappeared from scholarly discourse in science and engineering. Surely such individuals still exist, but they isolated from the community of scholars. How can or should the university re-engage them ?

What about the various businesses such as the universitypress that have affiliated with universities: My guess is that each of these will be forced to rethink its principal mission and many will be irrelevant.

Will more (most?) universities serve a global clientele, and how does that square with the publicly supported university in the United States? In particular, will private universities have greater flexibility to adapt to globalization, thus dooming the public universities

Does the function of socializing young adults, which perhaps remains a reason for "place" need to be coupled with the educational function or could it be done better by some form of social service?

Some will interpret these questions as threatening; I don't. That there will be a change seems inevitable. But change always implies opportunity; in this case, the opportunity to improve all facets of what we do in the academy. The challenge is to anticipate and exploit the changes.

Recommended reading

To see how much the academic world is already changing, sample these on-line sites in the humanities:

http://jefferson.village.virginia.edu/

http://tuna.uchicago.edu/ARTFL.html

http://dmf.culture.fr.files/imaginary_exhibition.html

http://scalett.libs.uga.edu.darchive/hargrett/mapss/colamer.html

http://sunsite.unc.edu/expo/deadse.scrolls.exhibit/intro.html

U.S. DEPARTMENT OF EDUCATION

OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT (OERI)

EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

REPRODUCTION RELEASE (Specific Document)

I. DOCUMENT IDENTIFICATION

Title: IT@EDU98: INFORMATION TECHNOLOGY IN EDUCATION TRAINING. PROCEEDINGS. JANUARY 15-16, 1998, HO CHI MINH CITY, VIETNAM

Author(s): Dr. Thomas Owens and others

Corporate Source (If appropriate): Northwest Regional Educational Laboratory

Publication Date: 1998

II. REPRODUCTION RELEASE

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources In Education (RIE), are usually made available to users in microfiche and paper copy (or microfiche only) and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the options and sign the release below.

HECK ERE [XX] Microfiche (4" x 6" film) and paper copy (8½" x 11") reproduction

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY Northwest Regional Educational Laboratory TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

OR

[ ] Microfiche (4" x 6" film) reproduction only

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY _____ TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed in both microfiche and paper copy.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction of microfiche by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

IGN ERE

Signature: Jerry D. Kirkpatrick
Printed Name: Jerry D. Kirkpatrick
Organization: Director, Institutional Development and Communications
Northwest Regional Educational Laboratory
Position:
Address: 101 S.W. Main St., Suite 500
Portland, OR
Zip Code: 97204
Tel. No.: (503) 275-9517
Date: 3/13/98

III. DOCUMENT AVAILABILITY INFORMATION (Non-ERIC Source)

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents which cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price Per Copy:
Quantity Price:

IV. REFERRAL TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER

If the right to grant reproduction release is held by someone other than the addressee, please provide the appropriate name and address: