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RESTRUCTURING THE UNIVERSITY FOR TECHNOLOGICAL CHANGE

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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.

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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 realised. 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 these 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 Web pages.

Some politicians and business people see technology simply as a replacement for labour, 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 labour 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 lead 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 recognise 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

A C T I O N S 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, Campion, 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 larger, 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, 1997). The nearest examples in Canada are Athabasca University and Télé-Université, 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 labelled 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 students (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 on-line 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 meet 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 Web and video-conferencing makes it much easier than in the past for faculty to develop technology-based learning materials and course 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 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 easy 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 then 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 re-engineer 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 thoughfully 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 emphasise 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 or 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 increase 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-ROM 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-ROM 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 continued 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.

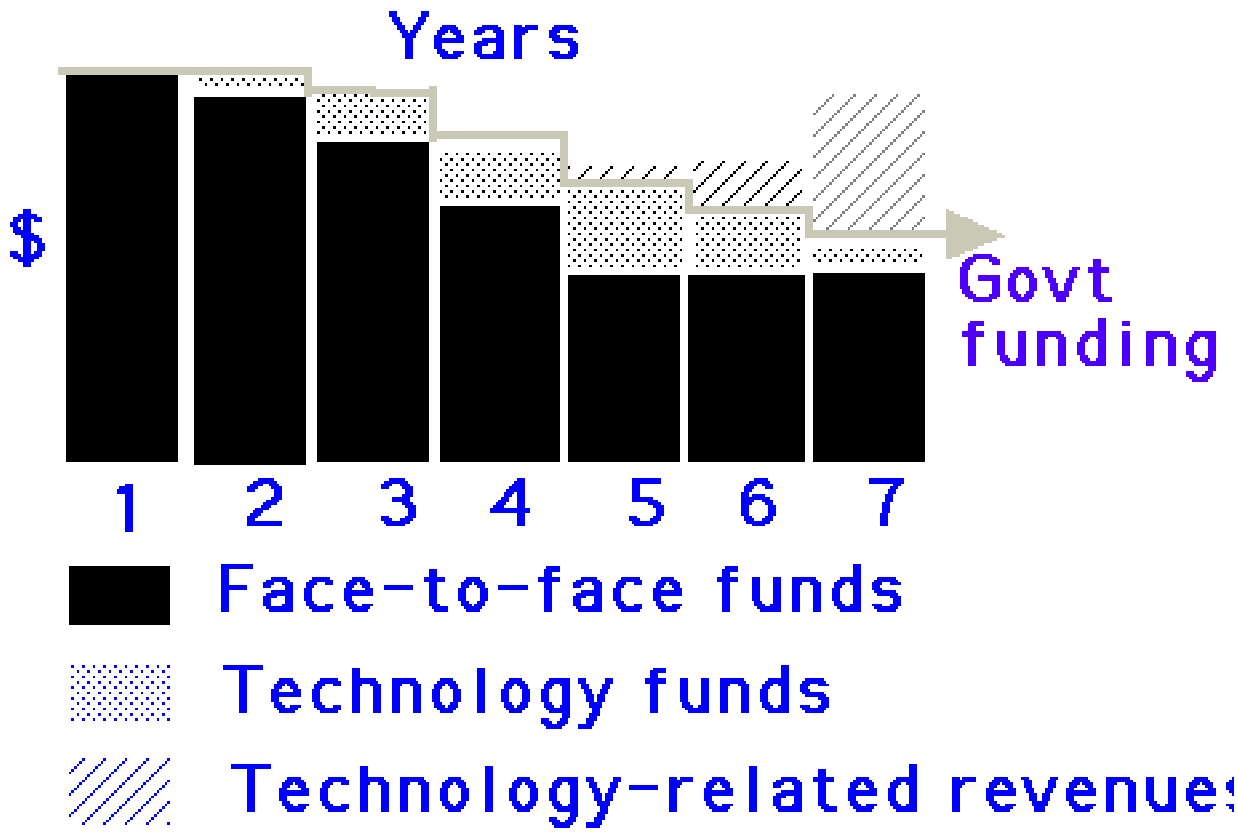

Figure 1: A model for re-allocating funds to support technology-based teaching

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 even 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 accidently 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 basis 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 the 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 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 underfunded. 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 in a program requiring the use of a computer? Students will need answers 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 co-ordinated at a faculty and institutional level, so that students do not coninually 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 'maxed-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 of 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 to 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, tax 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 denied 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 Web or CD-ROM. This is making it increasingly difficult to identify educational applications with a particular technology.

Nevertheless, despite this variablility, 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 all teaching and learning requirements, so technologies need to be mixed and matched to the educational purpose.

Thus we find that instructional television and video-conferencing (one- or two-way television from one site to a class in another site) and certain applications of the World Wide Web (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 (i.e. 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, WebCT, designed at the University of British Columbia by Murray Goldberg (see Goldberg, Salari, and Swoboda, 1996), is a Web authoring system that combines didactive 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-tried 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.

The second implication, and one that will be addressed more fully below, is the need for professional development of faculty, to help them understand not just the technology, but its relationship to teaching and learning.

8. Faculty agreements and training

It should be apparent by now that the use of technology needs to be accompanied by some major changes in the 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 re-arranged 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 re-allocate 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 sounds like a 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-ROM 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.

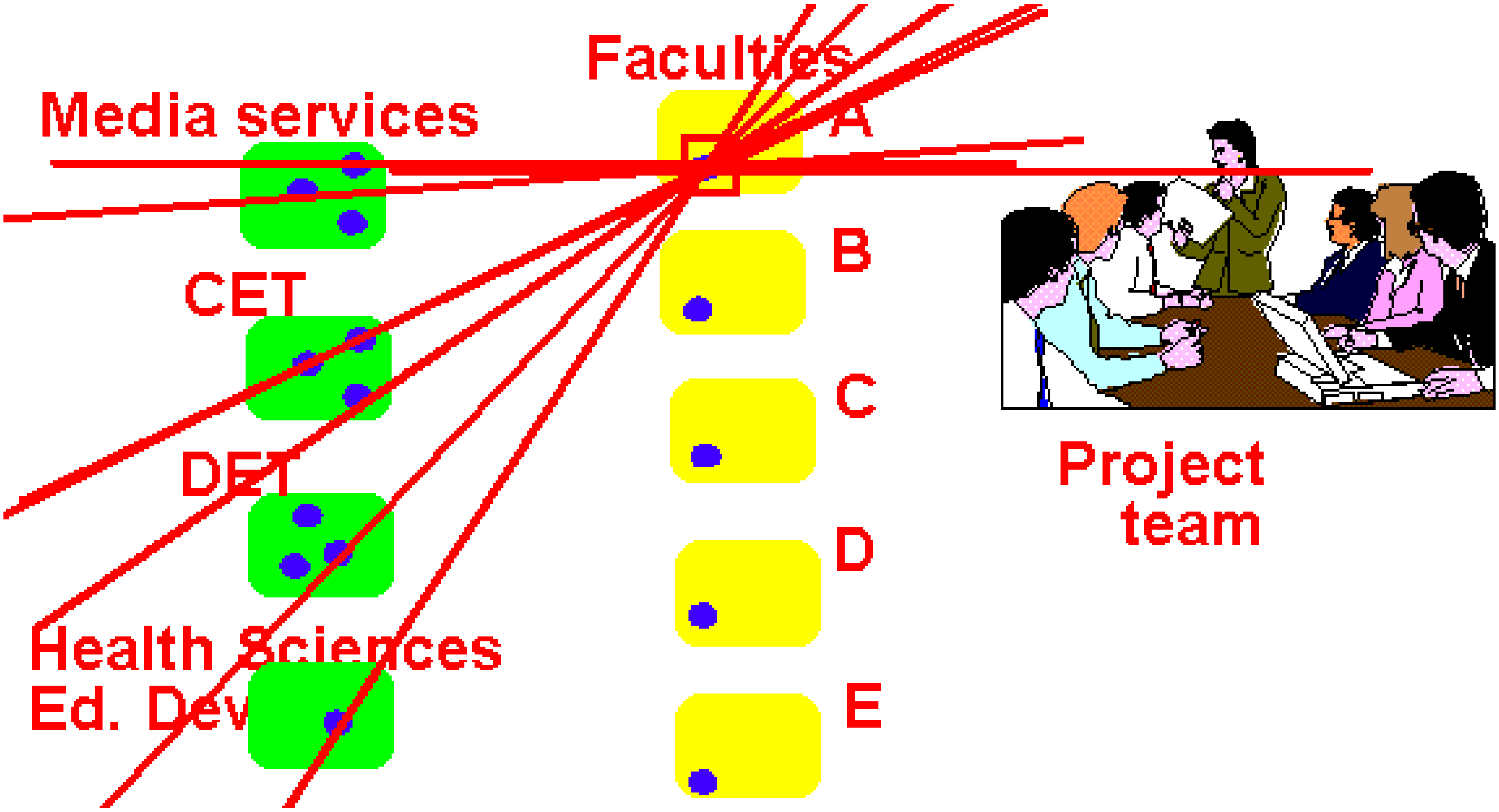

Figure 2: A decentralized model of multimedia course design and production

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

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 Ontario, 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 be 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 tele-communications 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 Canadian 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 it is important to see whether there are groups or types of learners who 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

Telelearning 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 worth 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 be 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 purposes, 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.

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