Confronting the Technology Challenge in Universities and Colleges

Carol Twigg (quoted in Marchese, 1998) dramatically but accurately illustrated the unprecedented challenge to universities and colleges resulting from the impact of new technology: "What was once a competitive advantage [for universities and colleges]'-the physical concentration of intellectual resources on a residential campus-is no longer a critical differentiator. Newer information age models, which are distributed and ultimately network-based, eliminate many of the advantages of vertical integration, making it easy for many different types of competitors to enter the marketplace rapidly."
Daryl Le Grew, the former academic vice president of Deakin University, Australia, has pointed out that many postsecondary institutions "are moving to reconstruct their infrastructure, redesign 'policy, and realign external relationships to gain comparative advantage in the information superhighway environment" (Le Grew, 1995). He argues that there is a transformations "paradigm shift"-taking place in postsecondary education, characterized by the following trends:

From	*To*
Industrial society	Information society
Technology peripheral	Multimedia central
Once-only education	Lifelong learning
Fixed curriculum	Flexible, open curriculum
Institutional focus	Learner focus
Self-contained organization	Partnerships
Local focus	Global networking

In particular, Le Grew argues that the new technological environment "opens access to study across sectoral, disciplinary, and cultural boundaries," and that this "will quickly erode traditional ideas of the course of study." Le Grew is not alone in his predictions. Recent publications by Dolence and Norris (1995), Mason (1998), Rowley, Lujan, and Dolence (1998), Marchese (1998), and Katz and Associates (1 999) all present similar conclusions.

Why the Need for Change?

There are many interrelated reasons for this pressure on higher education institutions to change. I have chosen three that are of particular significance as the themes of this book:

- The need to do more with less
- The changing learning needs of society
- The impact of new technologies on teaching and learning

Doing More with Less

Since the late 1960s, the number of students in postsecondary public education around the world has steadily expanded. Many more postsecondary institutions have been created over the last ten years.

In general, this expansion has not been accompanied by a pro rata increase in funding. In the United States, the cost of higher education has steadily increased year by year. It has increased not merely as a gross amount but also in average cost per student and cost of tuition paid by students or their parents. For instance, tuition fees at public higher education institutions in the United States have nearly doubled in the last twenty years after adjustment for inflation (Institute for Higher Education Policy, 1999).

There are several reasons for this situation. Following the rapid expansion of higher education in the 1960s, the professoriate has been steadily aging, leading to salary creep. As governments try to eliminate public debt and deficits, there has been increasing fiscal restraint. Last, there has been growing public disenchantment with higher education institutions, whose preoccupations and methods of operation often seem to the public to be increasingly divorced from the needs and expectations of the wider society. As one British vice chancellor put it, "Universities now operate in a low-trust environment." Consequently, in the United States, contributions from state and federal government to public higher education institutions have dropped from 59 percent in 1980-81 to 47 percent in 1994-95 (Institute for Higher Education Policy, 1999).

In Canada, most provincial governments have required universities and colleges to take on more students while maintaining or even reducing levels of funding. In Australia and some parts of Canada (Ontario and Alberta), some universities have had their operating grants from government reduced by up to 25 percent over a two- or three-year period.

The impact on the classroom has been severe. The increase in students has been handled by increases in class size, which inevitably Means less individual interaction with senior tenured faculty and less individual attention for students. Young teaching assistants have been hired, often only a few years ahead in their studies of those they are teaching. Sometimes these teaching assistants are international graduate students whose English is poor. Teaching assistants are often assigned mainly to teach large undergraduate classes so that more senior research professors can teach smaller classes of higher-level undergraduate or graduate students. But with the increase in associate degree programs and transfers from two-year colleges, even third- and fourth-level classes have grown to a large size in many institutions.

Finally, many faculty members-whose own experience was formed as students attending university when doing so was reserved for a relatively small elite-have never come to terms with the implications of "mass" higher education. They view with genuine distress the lack of interaction and communication that results from large class size and the impact on their research time of increasingly demanding administrative and teaching duties.

Many faculty members now recognize that these unpleasant circumstances are unlikely to go away. Unless significant changes are made, universities and colleges will find themselves in a downward spiral, as costs and class sizes continue to rise and the students, the public, and the politicians become increasingly reluctant to support what rightly or wrongly are seen as increasingly self-serving and inefficient institutions.

Changing Learning Needs

While coping with a deteriorating instructor-student ratio, universities and colleges are being asked to meet new needs. One is the need for a much more highly skilled workforce to enable a nation to remain economically competitive and to sustain a prosperous society based on high wages (Porter, 1991).

The sources of employment have rapidly changed because of increased automation and the growth of new industries and services, such as telecommunications, information technology, and financial services. Although traditional manufacturing industries and government services are shedding labor, most new jobs are being created in private sector service industries and in companies employing fewer than twenty people. Where jobs are being created in the larger manufacturing industries, they often require highly skilled specialists, each new employee often replacing many existing lesser-skilled staff.

Many of the new jobs are on a part-time or contract basis - with at least two-thirds of the new jobs going to women-and a majority of new jobs are relatively low paid (Kunin, 1988). Nevertheless, nearly half the new jobs created require graduates or people with the equivalent of seventeen years of full-time education (Canadian Labour Market Productivity Center, 1989).

Thus the traditional picture of work as a lifetime commitment to a particular trade or institution with a secure pension at the end applies to an increasingly smaller proportion of the population. In particular, secure middle management jobs of a general kind, requiring little or no professional or technical expertise, are disappearing rapidly. A very small proportion of the young men and women leaving school will find

employment in the traditional resource-based or manufacturing industries as unskilled or semiskilled workers. Most of those already unemployed, and a good proportion of those already working in large companies or in manufacturing or resource-based industries, will need to be retrained every few years.

The most significant development is that many of the new jobs being created require a much higher skill level than the jobs they are replacing, especially in management and manufacturing industries. People will retain existing jobs only if they are reeducate to higher standards; even for the majority of new jobs that are low paid and require generally low skill levels, training or retraining will be necessary, especially in basic skills, just in order to keep the job.

With respect to the new skills needed in the workforce, the Conference Board of Canada (1991) has defined them well:

- Good communication skills (reading, writing, speaking, listening)
- Ability to learn independently
- Social skills (ethics, positive attitude, responsibility)
- Teamwork skills
- Ability to adapt to changing circumstances
- Thinking skills (problem solving; critical, logical, numerical skills)
- Knowledge navigation (knowing where to get and how to process information)

Thus the education and training of the workforce is now a high priority for governments, and this education and training must be continued throughout a person's lifetime because of the continuing pressure to remain competitive. It has been argued that investment in education and training is now as essential for company survival in a knowledge-based economy as capital or plant investment (Reich, 1991).

It is hard to quantify the need, for workforce education and training. However, if we assume that a person will need to retrain at least five times in a working lifetime and that such retraining requires the equivalent of three months of full-time learning (probably a gross underestimate), then the current capacity of the Canadian education and training market, public and private, probably needs to be at least doubled (Open Learning Agency, 1992).

The need for this increased capacity results from increased demand from two sources. The first is from young people continuing into postsecondary education. This demand will continue to increase slightly in most developed countries (between 2 percent and 5 percent per annum for another ten years at least) as more .and more young people realize the importance of further education for their future prosperity. Many professors also feel that with the widening of access, the range of academic ability of freshmen students has widened. Professors are now teaching many students who would have not entered higher education in the past. Many campuses are witnessing a significant increase in students from minority populations and from different cultures. This challenges professors to deal with wide differences in prior learning, language and communication abilities, and cultural assumptions.

At the same time, universities and colleges are facing an important increase in demand from all those in the workforce who need to continue learning if they are to stay employed and if their employers are to remain economically competitive. This new market's requirements for learning are very different from those of the young people the higher education system has traditionally served.

Learning in the workplace will be initiated by individuals as part and parcel of their working and leisure lives. It will be informal (that is, not leading to any formal qualification), self-directed, and piecemeal (broken into small chunks of learning, some as small as a few minutes a day). It will be driven as much by short term needs as by any conscious plan of study. Thus, it will not be determined by some master instructor but rather by the task at hand (Weimer, 1992).

To understand just how prevalent this kind of learning is already, just ask yourself how you have learned to use a computer. How much of it was the result of formal training with an instructor, and how much was picked up piecemeal by trial and error, with a poor manual, and with help from colleagues? This is not to say that the learning would not have been much more effective if it had been structured and

directed all through by a skilled tutor, but what drives such learning is not the control of an instructor but the needs and the motivation of the learner.

Traditionally, large companies have provided training for their employees by establishing their own training centers and programs; small- and medium-size companies have relied more on outsourcing the training to private training companies or to public sector institutions. All of these methods, however, are labor-intensive, and any increase in such activities would lead to proportional increases in cost at a time when companies are under pressure to be more cost-competitive.

Furthermore, in the new economy, modern workers are much more mobile, moving from employer to employer or increasingly working for themselves. Therefore, they want "portable" qualifications, that is, qualifications that have some independent validity, either for their own satisfaction, if they are self-employed, or for their new employer.

Finally, many employers and members of the public are growing increasingly critical of the quality of education being provided through the public sector. There seems to be a mismatch between the skills taught and the requirements of the labor market (see, for example, -the British Columbia Labor Force Development Board, 1995).

In some ways, this is an unfair criticism. Educational attainment of students in public schools has increased over the last twenty years; the problem is that the demands on the workforce have increased at an even faster rate (Drouin, 1990). For instance, production line workers need greater literacy skills today to deal with written instructions, manuals, and so forth. They now need more than just an arm and a leg to operate the production machinery; they need intellectual skills as well. Similarly, with greater emphasis on teamwork and worker involvement and motivation, the level of communication and social skills required from managers and supervisors has increased.

Although a great deal of attention is being paid to the gap between the skills of those entering the workplace and the needs of employers, less attention is being paid to the much wider gap between the skills of those already in the workforce and the demands of the workplace. For instance, the older the worker, the lower the functional literacy level in most developed countries.

Impact of New Technologies on Learning

Modern learning theory sees learning as an individual quest for meaning and relevance. Once learning moves beyond the recall of facts, principles, or correct procedures and into the area of creativity, problem solving, analysis, or evaluation (the very skills needed in the workplace in a knowledge-based economy, not to mention in life in general), learners need the opportunity to communicate with one another as well as with their teachers. This of course includes the opportunity to question, challenge, and discuss issues. Learning is as much a social as an individual activity.

This learning requirement should not cause distress or concern to instructors in the higher education system, particularly those in the liberal arts area. However, learners not only need the liberal arts skills but *also* need them integrated with specialized knowledge in areas such as business, information technology, science, or engineering. Furthermore, they need this knowledge delivered in different ways from the traditional campus-based classroom.

These changes in the workforce highlight the gap between the way educational services are currently provided and the needs of employers and working people. Working people are unable or cannot afford to give up jobs or move house to become full-time or even part-time campus-based students again. They are increasingly looking for more flexible and more responsive forms of education and training.

For instance, if someone is working in a small company, the nearest person with similar interests and expertise may be on the other side of the country, particularly when it comes to leading edge technologies. That person may or may not be an instructor at a college or university. Those seeking professional expertise will look to new information technologies to find the expertise that they need.

Learners will increasingly interact through their desktop or portable workstations in a variety of ways, determined by the nature of the learning task and their preferred style of learning in the work situation. These preferred styles will vary considerably. Different people will have different preferred learning styles. Even the same person may have different preferred learning styles for different tasks.

The learning context will need to enable people to work alone, interacting with learning material (which may be available locally or remotely); work collaboratively (and in an equal relationship) with fellow workers at different remote sites; learn as an "apprentice" or "student" working with a more experienced worker, supervisor, or instructor; and work as an instructor, supervisor, or more experienced colleague for other, less experienced colleagues.

The same person may find herself in each of these roles in a single working day. Learners will also need to be able to work from home, from a work site, or while traveling. They will need to be able to access information (searching, downloading) from multiple sources in multiple formats; select, store, and reorder or recreate information; directly communicate with instructors, colleagues, and other learners; incorporate accessed or reworked material into work documents; share and manipulate information, documents, or projects with others; and access, combine, create, and transmit audio, video, text, and data as necessary. If we take this as a design requirement for teaching and learning, there is then a need to build systems that support this, both for formal and for informal learning.

Especially in research universities, many faculty members may question whether providing lifelong learning, especially for those in the workforce, is an appropriate mandate. They may consider this to be something that can best be done by the private training sector.

This is a strategic issue for publicly funded institutions. Publicly funded research helps create new knowledge. The public may feel that they have a right to access the new knowledge being created through public taxes. Indeed, more than any other higher education institution, the publicly funded research university may be seen as having a major obligation to support lifelong learning. It would be a high-risk strategy for a research university to decide that it will ignore the teaching and learning needs of this major and rapidly developing market.

Thus, although new technologies are being used predominantly to serve the more traditional, full-time, on-campus student, a massive market is now emerging for which these new technologies will have even more relevance for teaching and learning. The intelligent use of new technologies provides an opportunity for universities and colleges to address both markets in a more cost-effective way than through traditional methods of teaching and learning.

Different Rationales for Using Technology for Teaching in Higher Education

A number of factors are leading many postsecondary institutions to experiment with new information technologies for teaching. Here are six of the most frequent reasons given for using technology (although there are probably many more):

- To improve the quality of learning
- To provide students with the everyday information technology skills they will need in their work and life
- To widen access to education and training
- To respond to the "technological imperative"
- 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.

Improving the Quality of Teaching

Certainly in large research universities, this has been the major driver behind the increased interest in using new technologies for teaching. Increased student-to-teacher ratios, increased teaching loads, use of inexperienced or predoctoral teaching assistants, and the lack of interaction and reduced contact between tenured faculty and students at an undergraduate level have led to growing dissatisfaction with the current

classroom teaching environment. The use of technology is seen as one way of casing or alleviating some of these problems. We will discuss the perceived benefits in more detail in the following sections.

Providing Technology Skills for Work and Life

Another reason is the need to prepare students for a world where information technology is likely to be central to their work and everyday lives. It will become increasingly difficult to accept people as being fully educated if they do not know how to use the Internet to communicate with other professionals, if they do not know how to find Web sites that will provide relevant and reliable information in their field of study, or if they do not know how to develop their own multimedia reports for communicating their knowledge or research. Integrating these technologies into the teaching environment is an obvious way to help students develop such skills.

Widening Access and Increasing Flexibility

As a distance educator, this is one of my primary reasons for being interested in technology. My job is to help make available the expertise of on-campus faculty members to those who cannot access the campus. Enabling that expertise to be accessed by off-campus students requires the use of many different kinds of technology, from print to multimedia CD-ROMS, depending on the needs and the circumstances of the targeted learners.

However, there are pressures to make learning more flexible even for those students who can access the campus. There has been a rapid increase in the number of campus-based students who are working part-time as a result of escalating costs (fees, living expenses, travel) and fear that they will end their studies with huge personal debt. With the best will in the world, it is often difficult for such students to avoid having lecture timetables clash with job obligations; yet if denied the opportunity for part-time work, many of them would be denied the opportunity of higher education.

Also, the trend toward lifelong learning and the need for reeducation and training for people already in the workforce are leading to a changing student population, with many more older students, working and with families, returning to postsecondary education (or in some cases never leaving it). These students need greater flexibility in the provision of learning, to fit it around their already busy and demanding lives.

The rapid rate of change in the workplace is also requiring all graduates to continue to be lifelong learners. In many professions today it is essential to update knowledge and skills on a continual basis. However, the requirements of this target group are very different from those of full-time or even part-time students coming directly from high schools.

Because lifelong learners are already in the workforce, it is impractical for them to attend a campus on a regular and frequent basis. Furthermore, they often do not need full degree programs but rather short courses, certificates, or diplomas, or even 'Just-in-time" training in small modules. Also, this target group is often able and willing to afford the full cost of such programs, thus bringing a department much-needed revenue. The flexible delivery of courses and programs through new technologies has many advantages for this target group.

Responding to the Technological imperative

One rationale that leads to great opposition to the use of technology for teaching in academic circles is the *technological imperative*, that is, we have to use technology because of a blind belief that it is good for us. If we don't agree to the use of technology, we will be considered out of date and may lose our credibility.
Those who challenge the technological imperative do so from a variety of positions. Some ask what technology is doing to our ways of thinking and understanding (for example, Postman, 1992). The answer usually is that it weakens our ability to think rationally or logically. Others go further and suggest that the pressure to use technology (in all walks of life, but particularly in education) is a conspiracy by multinational companies and big business to sell technology and to hook young people forever as

technology consumers (see Noble, 1997, 1998). Others recognize the pressure to be fashionable and to have the latest toys and lever that attitude to win support for their technology-based teaching initiatives, but they still believe there are educational benefits in using technology for teaching.

Those like myself who believe that technology can play a valuable role in teaching and learning see arguments against the technological imperative as valid but insufficient to deny it. As Feenberg (1999) puts it: "The overselling of foolish ideas about technology should not be allowed to discredit the whole field of on-line education. We as faculty need to get beyond defensive contempt for this significant educational innovation and look at specific designs with legitimate pedagogical objectives in mind."

Reducing Costs

This is a rationale more likely to come from politicians, the business community, government officials, and senior managers than from faculty members or department heads. However, to assume that investment in technology will lead to reduced cost in higher education is to misunderstand the nature of the educational process in higher education and the relationship of technology to that process. Indeed, the introduction of technology is more likely to lead to increased rather than reduced costs, at least in the short term. There are several reasons for this.

First, there is a high cost of investment in technological infrastructure (networks, computers, technical support staff). Furthermore, technology is changing rapidly. The average life of a computer is often less than four years, and word-processing and specialized software for creating materials, such as PowerPoint, WebCT, or Director, are constantly being updated and improved.

There is also a high and continuing cost of staff development. A steep learning curve has to be climbed by faculty members before new technologies start to deliver the benefits they promise. Climbing that learning curve demands a heavy investment of time from all staff, a point that will be addressed in more detail later in this book. Even when faculty members become skilled in using technology, they need constantly to update and improve their skills as the technology changes.

Although technology can replace some aspects of teaching and can enhance or facilitate communication between teachers and students, and especially those who cannot access the campus, good quality teaching in higher education still needs high levels of teacher-student interaction if creative, critical, and analytical thinking and good communications skills are to be achieved. Higher education therefore is likely to remain "people-intensive." In a knowledge-based society, there is no point in merely reducing cost if it also leads to lower-quality graduates.

Improving the Cost-Effectiveness of Higher Education

Last, some 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 that more students can be taught to the same standard for the same level of investment.

In fact, although technology is unlikely to reduce absolute costs, it can improve the cost-effectiveness of operations in higher education in several ways: by enabling institutions to reach out to more and different students; by reducing or eliminating those activities currently carried out by instructors that are better done by technology, thus freeing faculty members for more productive use of their time; and by improving the quality of learning, either by enabling new skills and learning outcomes to be achieved or by enabling students to achieve existing learning goals more easily or more quickly.

This book attempts to look at what is needed to achieve such goals.

Conflicting Rationales

It is worth noting that faculty members supporting one rationale for using technology for teaching may actually violently oppose another rationale. For instance, the same professor who is a startling innovator in the use of the technology for improving his teaching may violently oppose any suggestion that more

students might be served by the institution through the use of his material. Other professors are fired up by the idea that all the world is waiting to access their ideas, their research, their wisdom through the World Wide Web-a passion to widen access to their expertise. This is not always accompanied, though, by a similar passion to improve the quality of their teaching, as can be witnessed by surfing their Web pages, which may be bereft of good educational design features.

It is important that teachers and institutional decision makers be clear about their reasons for using technology, because it will affect their choice and management of technology. For instance, if widening access and increasing enrollments are the main reasons, then more advanced and expensive technologies need to be avoided. If, however, high-quality teaching using expert systems is the goal, then the use of advanced multimedia technology might be justified.

Can the Virtual University Really Teach?

At this point we need to examine more closely the claim that teaching with technology can lead to an improved quality of learning. The basic university or college teaching paradigm for most subjects has not changed a great deal in the past seven hundred years.

If a student from the thirteenth century suddenly found himself in a university lecture today, he would probably know immediately where he was. Even in more modern disciplines such as science and engineering, teaching methods established by Thomas Huxley in Britain and von Humbolt in Germany in the late nineteenth century-based on laboratory demonstrations and experiments are still the standard.

All that is now under challenge. The new technologies of the Internet and multimedia are not merely enhancing the teaching and learning environment-they are fundamentally changing it. These new technologies are having as profound an impact on education as the invention of the printing press. Furthermore, these new technologies are deceptively easy for faculty to use. Consequently, change is being driven not just by government or employers, nor by university management or administration, nor by ancillary units such as the faculty development office or university multimedia centers as in the past-but by faculty members themselves.

What Are the New Technologies?

First, we need to look at the new technologies and their impact on teaching and learning.

E-mail

Perhaps the most pervasive use of technology in higher education is using e-mail to supplement regular classroom teaching. Thus, e-mail is used not only for administrative purposes but increasingly for communication between teachers and students.

Many faculty are replacing office hours, which require a set time and place for students to contact them, with a bulletin board or e-mail service. A bulletin board enables the instructor to make announcements to all students in a class; e-mail allows for individual communication between an instructor and a student or between individual students. Some instructors have gone even further and established list serves, which enable all students and the instructor to have on-line discussions about relevant or contemporary issues associated with the course. And some instructors are allowing students to submit assignments by e-mail.

In all cases, however, these tend to be supplements to classroom teaching, although this use of technology may well replace some other activities, such as office hours or the physical delivery and collection of assignments. Still, most instructors report that this use of e-mail tends to increase rather than reduce the amount of time they spend in contact with students, which may be good for the students but can lead to work overload for instructors.

Last, in a point I will return to later, the use of e-mail requires both instructors and students to have access to e-mail, through computers and an Internet account. Without explicit policies regarding networking of instructors and students, some students may be severely disadvantaged by lack of access, as indeed may some instructors.

Presentational Software

Presentational software, such as Microsoft's PowerPoint, is another computer technology to enhance classroom teaching that is in pervasive use.

PowerPoint is a relatively easy piece of software to learn, although the skill level needed to incorporate graphics, animation, charts, video, and audio clips can escalate rapidly. Furthermore, design skills in the choice of fonts, the layout of the screen, and the use of illustration make a big difference to the quality of the presentation. It takes a little more time to prepare presentational software than a chalk-and-talk lecture, but it may in fact lead to savings in time where complex overheads or slides were previously used.

The most significant requirements are adequate training in the use of the software, a personal laptop computer for the instructor, and the provision in lecture halls of data projectors that can be quickly and easily hooked up to the instructor's laptop. These require substantial capital investment, some training, and a limited amount of technical support. Although the educational benefits of presentational software often appear obvious, they are in fact difficult to quantify.

Videoconferencing

Videoconferencing is used primarily to increase access and to make limited subject expertise available to students in a wider area.

It is particularly popular in multicampus organizations, such as state university systems in the United States. For instance, a small rural campus may have only two or three students wishing to follow a particular course. These students can be linked to a larger class in a major urban center, thus avoiding the need to hire an additional instructor.

The use of videoconferencing for the regular delivery of teaching requires a substantial investment in capital (not so much for the equipment as for room reconstruction and adaptation), investment in networks to carry the videoconferencing signals, and if several campuses are linked, expenditure on leasing or buying switching equipment.

There are several different arrangements for budgeting for videoconferencing. Sometimes departments are charged for use; at other times the service is considered free because infrastructure costs are often paid for on a statewide or institutional basis. Nevertheless, the local equipment, technical support, and preparation time of instructors are all direct costs for an institution, and the money for the infrastructure comes out of the system somewhere.

The main attraction to faculty members is that there is relatively little change in their normal teaching methods, although videoconferences generally result in more preparation time. Videoconferencing also tends to be quite stressful, particularly if the instructor tries to use interactive techniques to include remote as well as local students in discussions and class activities. The number of students per class also increases, so the amount of interactivity with an individual student tends to diminish.

Although videoconferencing may enable additional students to have access to courses in their more immediate neighborhoods, it increases instructors' workloads, adds overall cost to the system, and comes with a high marginal cost for each additional student served (see Bates, 1995).

The World Wide Web

Many instructors are now using the World Wide Web both as a presentational tool in lectures and as a means of making lecture notes conveniently available to students at other times. The World Wide Web

has an additional advantage in that through Internet links instructors can access other sites from around the world and bring materials from these sites into the lecture.

Another use of the Web is to create databases of slides, photographs, and illustrations that can be drawn on for a lecture or made available to students for on-line access. By employing computer-conferencing software such as WebCT or HyperNews, the Web can also be used to create on4ine discussion forums for students and instructors. Increasingly, publishers are linking texts to Web sites or even Web courses.

The disadvantage of using the Web is that it requires a special if simple computer language (HTML) to create Web pages and maintain a Web server (host computer) for the site. Although new Web-development tools and the automatic conversion of word-processed documents into HTML make it easier for subject experts to develop Web pages, other developments, such as Java programming, make it more complex.

Developing Web materials is therefore time consuming and requires either increased technical skill and preparation time from an instructor or significant technical support. Also, as use increases, the Web ideally requires a specially dedicated computer for a department and technical staff support, with both capital and operating cost implications.

Multimedia, CD-ROM

A relatively smaller number of instructors are using multimedia or CD-ROM technology to support classroom teaching. Language laboratories, computer-aided design in architecture, simulated science experiments, and large research databases containing multimedia resources such as graphics, compressed video, and audio are examples of the main uses of multimedia and CD-ROMs to support classroom teaching.

Multimedia and CD-ROMs are usually used in computer laboratories (where desktop personal computers may be networked to a local server) or on stand-alone computers using a CD-ROM. Currently, multimedia materials with video and audio clips generally require too much bandwidth for convenient delivery over public Internet systems.

There is an increasing amount of off-the-shelf software now available that can be integrated into regular classroom teaching or computer lab work. These include geographical information systems, mathematics and statistical packages, and language teaching software.

Some instructors are beginning to use multimedia to develop problem-solving and decision-making tools based on their own expertise. An experienced subject expert will enter various data and criteria necessary for problem solving and decision making into the computer database, which will also contain a large database of facts and information. The subject expert, usually working with a computer programmer, will also enter decision rules or chain decisions to certain outcomes. There may also be numerical calculations predicting, for instance, the probability of different outcomes. Students "explore" the computer environment so created a nd try solutions to problems and make decisions, and the computer program "predicts" the likely outcomes of their decisions based on the underlying expert system provided by the subject expert.

The development of such uses of multimedia generally requires a combination of subject expertise, computer programming, and graphics and computer interface design skills. It also requires investment in sophisticated and expensive multimedia hardware and software both for development and for student use, a high level of teaching skill, and a high 'level of computer expertise. Consequently, good quality multimedia learning materials are extremely expensive and time consuming to produce (on the order of $100,000 to $500,000 per CD-ROM, toward the higher end if subject expert time is included).

To justify this kind of ex expenditure, extensive use of the material is required and large numbers of students or clients able and willing to pay high prices for sophisticated learning materials must be found. To cover the high cost of development and to ensure widespread use of the developed materials, universities may need to form consortia to develop materials for joint use, or it may be necessary to form partnerships with private sector organizations such as publishers to share the risk.

Although the number of commercial CD-ROMs suitable for application in higher education is increasing, it is still often difficult to find the right kind of material to meet a particular instructor's needs. Consequently, the use of multimedia to support classroom teaching is still relatively low in higher education.

There are two different approaches to the use of technology for teaching. The first is to ' use technology as a classroom aid; the second is to use it for distributed learning. They should be seen as two points on a continuum rather than as necessarily discrete approaches.

Classroom Aid

When technology has been introduced in the past, in the form of overhead projectors, slide shows, film, and videotapes, presentational qualities have been enhanced and students see better examples and illustrations, but the basic method of instruction is still unchanged. Rightly, such technologies have been termed audio*visual aids,* an enhancement to but not a replacement for the basic classroom method.

One reason for the rapid take-up of newer technologies such as videoconferencing and the Web is that these have been easily integrated with traditional classroom teaching methods. No major rethinking of traditional teaching methods has been necessary. However, without changes in teaching methods, the use of technology merely adds to both the work of faculty and the study load of students. The highest cost in teaching and learning is instructor or subject expert time. Can some of that time be found by replacing or, more likely, reducing traditional activities such as lectures, laboratories, or seminars? In particular, can the teacher's role as a transmitter of information be reduced? Can the time of a teacher be concentrated on interaction with students, such as questioning, dialogue, and discussion? Can teaching be reorganized to exploit more fully the potential of the technology? For instance, statistical software can enable the instructor and students to use data sets that are more interesting and also to devote less time to calculating complex formulas and more time to interpreting results.

Distributed Learning

Distributed learning can also be seen as a continuum. At one end of the continuum, technology is used to supplement a somewhat reduced face-to-face teaching load, with significant elements of the learning conducted through the technology by learners working on their own (or in small groups around the same computer). At the other end of the continuum, learners study completely off campus (distance learning).

The Institute for Academic Technology, University of North Carolina, has provided a useful definition of distributed learning: "A distributed learning environment is a learner-centered approach to education, which integrates a number of technologies to enable opportunities for activities and interaction in both asynchronous and real-time modes. The model is based on blending a choice of appropriate technologies with aspects of campus-based delivery, open learning systems, and distance education. The approach gives instructors the flexibility to customize learning environments to meet the needs of diverse student populations, while providing both high-quality and cost-effective learning" (DEOS-L listserv, 1995).

One of the key elements of distributed learning is the use of computer communications technology as part of the teaching and learning experience. Students do not so much interact with the technology as *through* the technology with teachers and other learners. This can be particularly useful when the subject matter requires students to apply concepts or principles to their own context. On-line communication is also useful for areas of knowledge where there are ambiguities or where different values and interpretation are considered legitimate, and particularly for the development of collaborative learning, where students often remote from one another can work together on common tasks.

However, the main benefit of distributed learning is its flexibility and the opportunity to widen access, allowing teaching and learning to extend well beyond the campus of the university.

How Technology Is Changing Teaching

Teaching through technology can, under the right circumstances, have the following advantages over traditional classroom teaching:

Learners are able to access high-quality teaching and learning at any time, at any place.

- Information previously available only through a professor or instructor is accessible on demand through computers and the Internet.
- Well-designed multimedia learning materials can be more effective than traditional classroom methods because students can learn more easily and more quickly through illustration, animation, different structuring of materials, and increased control of and interaction with learning materials.
- New technologies can be designed to develop and facilitate higher-order learning skills, such as problem solving, decision making, and critical thinking.
- Interaction with teachers can be structured and managed through on-line communications to provide greater access and flexibility for both students and teachers.
- Computer-mediated communication can facilitate team teaching, use of guest faculty from other institutions, and multicultural and international classes.

Consequently, new technologies are leading to major structural changes in the management and organization of teaching. These developments are increasingly being referred to in the United States and Canada as *distributed learning*, in the United Kingdom as *networked learning,* and in Australia as *flexible learning.* New technologies have the potential not only to enrich existing classrooms but, equally important, to allow institutions to reach out to new target groups, such as lifelong learners, people in the workforce, and the physically disabled.

In practical terms, we are seeing the following developments: an increase in off-campus teaching, not just for 'full" distance learners who cannot access the campus at all but also for many on-campus students who find it more convenient and cheaper to study at least partly from home or the workplace; substitution in part of "real" laboratory work by computer simulations; new kinds of courses, such as certificate and diploma programs for those already graduated but needing professional updating, customized courses for specific clients such as private sector organizations, and multiple use of materials to serve different client groups, such as undergraduate students, lifelong learners, and employers; partnerships and consortia that share courses and materials to achieve economies of scale and the necessary investment to develop high-quality learning materials; and increased competition, not only from other public institutions enlarging their reach beyond state or national boundaries but also from new private sector organizations, such as the University of Phoenix on-line programs, and corporate universities

Four Case Studies of "Transformed" Teaching

The following examples illustrate how technology changes the whole way in which teaching and learning can be organized.

Case One: Collège Boréal

Collège Boréal is a four-year-old, publicly funded college in Northern Ontario, Canada that serves 165,000 French speakers scattered across a very large area (roughly 360,000 square miles). It has seven campuses, plus another fifteen local sites in different communities. It opened in 1995 after many years of lobbying by the French-speaking community and currently has approximately fifteen hundred full-time learners enrolled.

Collège Boréal relies on distance education technologies such as audio-conferencing, audiographics, and mostly videoconferencing for the delivery of the first year of thirty-two programs in six remote

campuses. Remote learners complete half of their first-year courses in this environment, while the other half is face-to-face. For the second and third years of the program, remote learners move to the main campus. Attrition is low.

A Megastream telecommunications network has been installed to link the seven campuses through a wide area network (WAN), which includes computer-, videoconference, and telephone systems. A Virtual Resource Center and CD-ROM towers are linked to the network to facilitate access to learning materials for faculty members and learners. Across the campuses, there are about three thousand four hundred and fifty access points to the computer network and the Internet. Most classrooms have LCD projectors and document cameras installed and are fully networked, as are many public areas (including the cafeteria and the pub). Staff and learners have access to digital audio/video tools, scanners, multimedia stations, and printers. The college is now beginning to experiment with on-line courses.

On all Collège Boréal campuses and in the majority of its programs, faculty and learners use IBM ThinkPad notebook computers (laptops) as the main working tool of the institution. All full-time faculty are provided with their own notebook computers, and part-time faculty have access to notebook computers. By the year 2000, nearly all learners and all faculty will be provided with their own notebook computer. Learners pay a technological fee of $1,200 a year for their notebook computers. In addition to the computer itself, this fee covers insurance, a support and maintenance service, installation of specialized software, and access to the college intranet and to the Internet at college and from home.

The guiding philosophy is based on a learning transformation from learner dependence (where the faculty decides content and pedagogic approach), to interdependence (characterized by interaction between learners and faculty), to independence (where learners can operate on their own). The goal is learner autonomy in the workplace. This philosophy guides the implementation of any technological and academic initiatives. Laptop computers are used by learners and faculty as part of normal classroom teaching and beyond classroom walls. Learners use technology for research, electronic communications, group work, intercampus collaboration, homework, presentations, career guidance, and so forth.

La Cuisine (The Kitchen) is a physical and virtual place for the exchange of academic "recipes" and for "simmering" academic projects of a multimedia or technological nature. It is designed to meet specific needs in planning, course development, professional development, and experimentation. Faculty members come to La Cuisine for coaching, and La Cuisine provides state-of-the-art software and tools that can be used and evaluated by faculty members.

Collège Boréal has a "tech-coach" scheme to support academic staff in their use of technology. The tech-coaches are usually academic staff who have an affinity with technology. Tech-coaches help their colleagues develop their computer literacy. Through weekly workshops (three hours per week for sixteen weeks) faculty members have the opportunity to develop research, electronic communication, intercampus collaboration, presentations, multimedia productions, and also to develop operating system and software utilization skills. In Collége Boréals first year of operation, the tech-coach-faculty ratio was 1:4 on average, The following year, tech-coaches were scaled down to one tech-coach per twenty faculty on average. Presently, there is one tech-coach for the whole college, now that faculty have become more familiar with the technology.

There are no classes between 8:00 A.m. and 1 1:00 A.M. on Thursdays, because this is set aside to provide guaranteed time for professional development, workshops, and meetings. Collège Boréals Center for Information and Communication Technologies provides technical support services to the ThinkPad project, for example, troubleshooting, maintenance, and repairs. Some learners have become tutors. They are provided with basic training in peer helping and can be called upon at any time by other learners for help.

Although the college spends 2 percent of the total academic salary budget on professional development, it is funded on the same per capita basis as other colleges in the province.

Case two: Virginia Tech

Instructors at Virginia Tech were faced with the challenge of teaching first- and second-year mathematics courses to more than seven thousand undergraduates. There was a relatively high failure rate on the

traditional lecture-based courses, with substantial numbers of students having to repeat courses. By the time those students who did successfully complete the first- and second-year courses got to third- and fourth-level courses, they had often forgotten what they had learned and were unable to apply it to their current learning tasks.

Consequently, the mathematics department established the Math Emporium. This is located on one vast floor of a former discount store, and contains over five hundred computer workstations. It is open twenty-four hours a day, seven days a week, and covers the whole of the first two years' math curriculum. About 60 percent of the computer-based teaching programs were purchased off the shelf, and faculty at Virginia Tech specially developed the remaining 40 percent.

Each workstation comes with a disposable coffee cup painted red. When placed on top of a computer it means a student has a question. Patrolling instructors (some of them senior students) are available to assist the student. If the problem is more fundamental, there are cubicles around the wall of the facility where more intensive individualized instruction can be provided. Lectures are still available as an option. Thus in the Math Emporium, learners can study with a tutor, have one-on-one contact with a faculty, hear a live lecture, work in a small group, and study computer-based material.

Performance on exams has increased by 25 to 30 percent since the introduction of the Math Emporium, and third- and fourth-year students can now drop in and refresh their knowledge as and when needed.

Case three.- Universitas 21 and SEARGI

Universitas 21 is a loose consortium of twenty-one research universities, mainly from former British Commonwealth countries, such as Scotland, England, Australia, New Zealand, Canada, Hong Kong, and Singapore. It also includes the University of Michigan. The universities of Melbourne, Queensland, and British Columbia are three Universitas 21 members. The faculties of agricultural sciences in these three universities are each having to revise completely their academic programs to meet changing needs, in terms of student demand, changing markets, and new approaches to land resource management. The three universities are also potential competitors with one another for international students in Southeast Asia.

The three universities, all of similar research and teaching status in their own countries, have decided to collaborate on the joint development of common programs in the area of land resource management. Students in each of the three institutions will have access to courses from the other two universities. In some cases, courses are being jointly developed so that they draw on the unique complementary strengths of each partner, thereby giving students access to a wider range of topics and teaching approaches.

All the courses will be available to registered students at each of the three institutions through the World Wide Web and CD-ROMS. Students are assigned to on-line discussion groups for each course, with students and instructors from each institution. They can take courses from their own institution in the regular face-to-face mode or in a distance learning mode. Approved courses from the other institutions can also be taken at a distance and transferred into their own program. Alternatively, if students can afford it, they can spend time at one or both of the other institutions, taking some courses in the program in a face-to-face mode and courses from their own university at a distance. Each university reserves the right to decide which courses from the other institutions will be accepted as part of its own program.

Two of these universities, UBC and the University of Queensland, are also associate members of the South East Asian University Consortium for Graduate Education in Agriculture and Natural Resources. This is a collection of agricultural faculties and universities committed to collaboration, and it is partially supported by funding and administrative services from the South East Asian Regional Consortium on Agriculture (SEARCA). SEARCA is a regional multigovemment organization that supports agricultural development in the Southeast Asian region. The full members of the university consortium are Universiti Gadjah Mada, Indonesia; Institut Pertainian Bogor, Indonesia; Kaesetsart University, Thailand; Universiti Putra Malaysia, Malaysia; and University of the Philippines Los Banos.

The consortium has agreed to offer a joint master's in sustainable resource management. Each institution has committed to provide at least two courses toward the program, which is focused on the needs of Southeast Asian countries for sustainable resource management. Each institution will then decide which courses it will accept into its own program. All courses will be offered in a distributed

learning format for students in the other universities, and in some cases as on-campus courses for their own students or for students from other institutions who are able to travel. Each institution will award its own degree.

Case Four.- University of British Columbia and Monterrey Institute of Technology

The University of British Columbia (UBC), based in Vancouver, Canada, is offering postgraduate courses over the Internet that are available not only to its on-campus master's students but also to students registered with the Monterrey Institute of Technology in Mexico (ITESM). ITESM has the rights to offer these courses in Latin America and has a side agreement to offer these courses to students at the Simon Rodriguez Experimental University in Venezuela.

The five UBC courses are integrated into ITESM's master's in educational technology (ITESM offers five more courses as part of its master's), and are available as electives within UBC's master's of education. UBC, which has the rights for the rest of the world, also offers the same courses for continuing professional education (noncredit courses) to students on a global basis. Noncredit students who take all five courses and reach a pass level obtain a postgraduate certificate of education from UBC. They can also transfer these five courses into Athabasca University's master's in distance education.

The courses are delivered using a combination of the World Wide Web, printed textbooks and articles, and satellite TV (in Latin America). Instructors from UBC are linked with students via telephone-based videoconferencing from Vancouver to Monterrey, from where the signal is uplinked via satellite to twenty-nine reception sites in Mexico and Venezuela. The same course material, assignments, and marking schemes are used for all participants, although Monterrey Institute of Technology is responsible for marking and accrediting its own students.

Teams of subject experts, instructional designers, a Webmaster, and specialists in videoconferencing, satellite TV, and graphics develop the courses. The main role of the subject experts from UBC is to research and select appropriate content, develop a Web-based course study guide, provide discussion topics, encourage and moderate student participation in on-line discussions, mark assignments, and provide feedback and guidance to learners.

Each course has between two hundred and three hundred enrollments worldwide from between fifteen and twenty countries. This program of five courses fully covers all its costs from student fees and franchises (see Bates and Escamilla, 1997, for more details), and indeed makes a small profit for UBC.

Conclusion

The examples indicate two rather different points. First, technology is being used to address weaknesses in or to provide advantages over the current conventional system of teaching in higher education. Second, the use of technology in all the chosen examples has required a major reorganization or restructuring of the conventional teaching and learning environment.

Thus, the use of technology for teaching is not just a technical issue. It raises fundamental questions about target groups, methods of teaching, priorities for funding, and above all the overall goals and purpose of a university or college. Consequently, decisions about technology need to be embedded in and subordinated to educational goals. At the same time, the educational goals themselves should take into account the new opportunities that these technologies present.

In this book, I do not question the core functions of a university or postsecondary college: teaching, research, and public service. Nor do I assume that universities and colleges should convert themselves into businesses, using technology to become financially independent of government. I passionately believe that public universities still have important social and public goals to serve.

However, the academy's core values need to be served in a rapidly changing world. Technologies now play a central role in everyone's life, and universities and colleges need to find new ways to respond to the growing demand for lifelong learning. Using technology for teaching can help universities and colleges

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 this needs to be recognized.

Indeed, this book is not really aimed at those who want to ask important and justifiable questions about whether technology should or should not be used for teaching. There are others better qualified for that task (see, for instance, Postman, 1992; Noble, 1997; Feenberg, 1999).

However, whatever the philosophical arguments for or against the use of technology for teaching, improved cost-effectiveness in higher education requires more than just investment in new technologies. It will also require radical changes in teaching methods and organization. The use of technology in higher education **is** a Faustian contract. Dr. Faust, in Goethe's story, sold his soul to the devil for eternal life. Similarly, there is a heavy price to be paid to maximize the educational benefits of technology for teaching, a price some may feel strikes at the very soul of the academy. I will return to this in the final chapter, but in the meantime I will concentrate in the next chapters on strategies needed to support the effective use of technology for teaching and learning.