INFORMATION AND COMMUNICATIONS TECHNOLOGY, SOCIETY AND EDUCATION IN THE 21ST CENTURY

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ABSTRACT *Technology is perhaps the most significant of the factors which will drive the future. Mechanisation and automation will change the nature of work. Information and communications technology (ICT) will revolutionise the ways in which we gather, manipulate and communicate information in our work, leisure and education. This paper is divided into two sections. The first will summarise some of the main trends in ICT that are taking place and which seem likely to be maintained in the future. The second will outline the likely impact of these trends on societies, in particular their implications for the nature of work and leisure, human relationships and education.*

TRENDS IN TECHNOLOGY

The Information Age

It is almost a truism to say that we are living in a period of transition between an industrial society and an information society (Tiffin & Rajasingham, 1995). Toffler (1970, 1981, 1990), in his widely-read publications, has popularised the perception of history falling into three ages - the agrarian age, the industrial age and, now, the "third wave" of the information age. Negroponte (1995) goes even further, claiming that already we are passing into a post-information age. He notes that the industrial age gave us the concept of mass production, with the economies that come from manufacturing with uniform and repetitious methods in any one given space and time. The information age, the age of computers, showed us the same economies of scale, but with less regard for space and time. In the post-information age, information is extremely personalised; it is made to order and it includes less and less dependence on being in a specific place at a specific time.

Increasingly, ICT is placing a premium on particular work skills and rendering others obsolete. The information age demands a range of skills: being able to control complex systems by monitoring information about the condition of their parts; being able to flexibly operate in a range of social contexts - sometimes in face-to-face teams, sometimes in communication with others in diverse locations - often on a global scale, and sometimes in isolation from others; being self-managing and self-motivating (and, increasingly, self-employed); being able to adapt to change, with its corollary of willingness to engage in lifelong learning to upgrade skills and knowledge; being able to work in small organisational units, with flat hierarchies and a focus on quality assurance and customer care; being

able to deal with widely distributed, very large information storage systems; and being able to independently identify, analyse and solve problems (Graff, 1996; Jones, 1996; McClintock, 1995; OECD, 1989; UNESCO, 1996). Underpinning this new age is the need for a growing number of workers able "to absorb, manipulate, and market information" (Swerdlow, 1995, p.14).

Advances in Information and Communications Technology

Advances in ICT will occur in two broad areas: gathering, storing and transmitting information, and processing and manipulating information.

Gathering, storing and transmitting information. With the substitution of digital for analog coding, and of fibre optics for copper wiring, information is becoming faster, easier and cheaper to gather, store and transmit (McClintock, 1995: sect.74; Negroponte, 1995). Negroponte (1995) invites us to think of fibre as if it has virtually infinite capacity to transmit bits at enormous speed. He points to recent research which indicates that we are close to being able to deliver 1,000 billion bits per second down fibres. Thus, a fibre the size of a human hair can deliver every issue ever made of the *Wall Street Journal* in less than one second. He anticipates that in the future a broadcaster will send out one stream of bits which can be converted by the receiver in many different ways. This will change the nature of the mass media from a process of pushing bits at people to one of allowing people (or their computers) to pull at them. Negroponte also goes on to envisage a future in which computer interface agents will be able to read every newswire and catch every tv and radio broadcast on the planet, and then construct a personalised summary. Thus, "On-demand information will dominate digital life. We will ask explicitly and implicitly for what we want, when we want it" (p. 169). Television will increasingly be turned into an interactive appliance (Butler, 1996).

The Internet, with its access to e-mail and the World Wide Web, is the prime current exemplar of how technology facilitates one's capacity to independently reach out and find information. The introduction of e-mail has dramatically changed the character and speed of communication, with participants able to simultaneously exchange information with a large number of people in a way which uniquely combines ease, speed, immediacy and (increasingly) cheapness. Several features of the Web make up its special character, according to Burbules (1995). Firstly, like no other form of information sharing, the Web is fundamentally egalitarian in that it gives all people with access to it a forum for expressing their views and for seeking and sharing information. In a similar vein, The *Report to UNESCO of the International Commission on Education for the 21st Century* (UNESCO, 1996) notes that this technology means that "the most accurate, up-to-date information can be made available to anyone, anywhere in the world, often in real time" (p.43). Interactive media is making it possible not only to send and receive information, but also to engage in dialogue discussion and to transmit information and knowledge unconstrained by distance or operating time. In turn, this facilitates the establishment of 'virtual' communities of common interest. Secondly, because every node in the Web is linkable to any other node; the structure is decentred and non hierarchical; or, as described by Burbules (1995), it is "hypertextual and rhizomatic". Thirdly, the Web has multimedia capability (i.e.,

it is able to integrate multiple sources and forms of information), a feature which has wide-ranging ramifications for how people access and remember information, for how they conduct their everyday lives and for what they expect of entertainment and education. Networked, multimedia systems will provide general, efficient, enduring and multi-modal (as distinct from a hitherto predominantly verbal) access to cultural works of nearly every form conceivable (McClintock 1995: sect. 262).

The Internet is not without problems, as Burbules (1995) indicates. He asks, for example, How does the potential anonymity of this medium affect communication? Does it allow people to fraudulently hide their identity? Does it allow people to irresponsibly make statements that they do not need to be held accountable for? Or does this actually promote greater frankness by permitting socially unpopular views to be said openly? How do we distinguish the credible from the eccentric, the original from the derivative, the significant from the worthless? Should and can society take responsibility for assisting its citizens to become discerning and reflective consumers and producers of information, and/or should society take steps (if they are feasible) to control the medium? These are questions which, of course, have major implications for the content and delivery of education.

Processing and manipulating information. Information technologies such as databases, spreadsheets, drawing packages, graphing, electronic notepads with voice and handwriting recognition, morphing software, music software, and computer assisted design software will increasingly be used to manipulate information (Ministry of Education, 1996; Butler, 1996). This capacity of machines to engage in "the intelligent processing of information" (McClintock, 1995: sect. 89) represents a remarkable augmentation of the human brain. As McClintock points out, until recently the power of communication tools was largely limited to extending the memory, while leaving the intelligent processing of ideas to take place almost exclusively inside the human body and brain. With the computer, however, these intelligent operations are increasingly able to be carried out without human intervention. Even so, as McClintock is at pains to emphasise, the computer neither displaces these powers nor obviates our needs for them: "humans are as responsible for their conduct with their powers augmented as they were without (sect. 98)."

A related, and equally significant, feature of computers arises from their capacity to be networked or connected with one another, thus facilitating informational linkages. This is commonly referred to as 'hypertext', which Burbules and Callister (1996) describe as a means of allowing widely differing material to coexist in a computer system in which access is controlled by creating networks, links, and branches. Essentially, a hypertext comprises a collection of 'nodes,' or pieces of text, that can be connected to other nodes. Whereas traditional text assumes a style of reading that is primarily linear and sequential, hypertexts facilitate reading strategies in which the reader is making connections laterally, beyond the text, as well as linearly, within it. In hypertext, the primary text exists in a complex network of other textual information that can immediately and interactively be explored in a manner determined by the reader's own interests and experience, or by the task at hand. In this multi-dimensional structure of

hypertext, all references and texts are at a common level, no one of which can claim *a priori* centrality, but only a relative centrality. To a large extent, hypertext is congruent with the ways in which we typically learn - "nonsequentially, dynamically, and interactively, through associations and by exploration" (Burbules & Callister, 1996, p. 31). Also, in the best poststructuralist tradition (if such is possible), "hypertext instantiates [a] decentered view of the text and the shift in authority from author to reader in the interpretive process" (Burbules & Callister, 1996, p. 32).

Virtual Reality (VR) must also be discussed in the context of processing and manipulating information, although it is also relevant to the context of gathering and transmitting information. As Negroponte (1995) points out, VR can make the artificial as realistic as, and even more realistic, than the real. For example, flight simulation, the most sophisticated and longest standing application of VR, is more 'realistic' than flying a real plane. "The idea behind VR is to deliver a sense of 'being there' by giving at least the eye what it would have received if it were there, and more important, to have the image change instantly as you change your point of view" (pp. 118-119). This theme is developed in detail by Tiffin and Rajasingham (1995).

IMPACT ON SOCIETY AND EDUCATION

Representation of Culture

Computers are undermining the hegemony of the printed book as a means of representing culture. This case is persuasively argued by McClintock (1995) who asserts that the content of the curriculum, the design of the classroom, the organisation of the school day, the motivational strategies employed, the scope and sequence of textbooks, and the definition of good teaching practice, have remained very stable over the past 400 years. The reason for this, according to McClintock, is rather simple: the character and limitations of printed materials have remained substantially fixed and have determined the educational provisions designed to employ them. Thus, reliance on text books necessitated the division of knowledge into distinct subjects, the organisation of the students into grade levels based on similarities of age or intellectual ability, the structuring of the school year into fixed days for attendance at a particular site, the breaking up of the school day into periods of fixed length, and the requirement that students work in unison and at the same pace from a prescribed text.

This dominance of the technology of printed materials has lead to various distortions, according to McClintock. Firstly, it amplifies the cultural salience of the things included in the texts that all will study, and it puts the many things left out in a kind of cultural deficit. Secondly, it favours the partition of knowledge and militates against the construction of connections and the integration of studies which, in turn, makes it difficult for a student to take full possession of his or her learning. Thirdly, the lockstep nature of progression through learning institutions means that the student cannot easily go back to material taught earlier or reach forward in the material designated for later years. Fourthly, the sequence of annual curricular increments and regular assessments of one's knowledge of such curricula imposes on everyone a single, arbitrary, over-all order, greatly

complicating the individualisation of learning. Fifthly, it puts severe limits on a student's curiosity and concerns. Sixthly, the combination of the foregoing inculcates the view that only external authority can validate one's learning, thus making it difficult for a student to develop the confidence or capacity to acquire further knowledge, skill, and understanding without dependency on others. In aggregate, these factors undermine the very basis of a liberal education.

Of course, not all education systems, schools or teachers have allowed themselves to be constrained by these limitations. But, as McClintock argues, when a dominant technology (in this case print as the means of representing culture) is still hegemonic, it is often difficult to see its implementation constraints. Instead, they can appear to be part of the natural order of things and not for what they really are - artefacts of the technology. He likens the need to break out of the print-dominant technology to the impact of transport on the location of towns. In the days of reliance on horse-drawn transport, towns needed to be close together. Trains, cars and aeroplanes changed those constraints, with the result that cities got bigger and small towns smaller because the implementation constraints of the old transportation system were not carried over into the new. We are now on the threshold of an era when information technology promises to overturn the implementation constraints of print technology - developments which will be equivalent in their impact as the move from horse-drawn vehicles to trains was over a century ago.

Formation of Communities

The new ICTs will have an increasing impact on the formation and maintenance of communities. In recent times, for example, as Swerdlow (1995) points out, television has glued us to our homes, isolating us from other human beings. This trend is likely to be maintained, with communities becoming less intimate and more isolated as increasing use of the Internet "unplugs us from physical contact" (p. 6). As the Internet extends it sway, however, people will be enabled to form and maintain 'virtual communities' which are not based on geographic proximity. These are communities comprising like-minded people who can maintain instant and relatively inexpensive contact with each other. Not only will the new technologies of communication facilitate the formation of such communities, but they will also actively shape their character, "drawing boundaries of inclusion and exclusion, and influencing to a substantial degree the amount and kind of communication that takes place within them" (Burbules, 1995).

The new ICTs will enable challenges to the borders between the global community and the nation-state, between the nation-state and its constituent sub-cultures, between sub-cultures themselves, and between all of these entities and the individual. At the heart of these challenges is the tension between centrifugal, or centralising influences, and centripetal, or decentralising influences. For example, the trend toward the Internet creating a global culture will be resisted as nation-states and the subcultures embedded within them assert the uniqueness of their own identities. As Burbules (1995) notes, an enormous struggle is going on in some countries between centralising and standardising influences on the Internet and decentralising and diversifying influences.

Authority and Control

The Internet is often described as being 'anarchic', in the sense that it is not under the control of any authority, nor is it susceptible to such control. This view is somewhat glib, however, for there are various levels of control that can be and currently are being exercised over the medium. While it is true that anyone can put on or pull down information from the Internet, it is not equally accessible. Most obviously - not everyone has physical access to it, either because they cannot afford it, or their country lacks the infrastructure to support it or they lack the individual skills to enter into it. Further, the Internet has created a new class of what Burbules and Callister (1996) call "knowledge producers and knowledge organisers" (p. 44) - those who act as interpreters and makers of knowledge, deciding on the inclusion and exclusion of materials in hypertexts and the links between them and who create the filters that help users sort through the enormous volume of information available. Burbules and Callister feel that these people will control access to information in ways that are potentially much less democratic and more restrictive than is now possible with simpler information systems. In a similar vein, the International Commission on Education for the Twenty-first Century (UNESCO, 1996) notes with concern the differences that will arise between societies that will be capable of producing the content and those that will merely receive the information without taking a real part in the exchanges. Another issue of authority and control revolves around the rights of children to have untrammelled access to the Internet. Katz (1996) argues vehemently that children's choices ought not to be left completely to the often arbitrary and sometimes ignorant whims and fancies of their elders. He says that children have the right to assemble online, to form groups, to communicate with like-minded communities, and to challenge the use of blocking software that arbitrarily deny them choice, exposure to ideas, and freedom of speech.

In dealing with these issues of authority and control of the Internet, educationists have several responsibilities. Firstly, they should understand and critically analyse what Burbules and Callister (1996, p. 50) refer to as "the social, moral, and epistemological consequences of technology's influences on teaching and learning". Secondly, it is vital that all learners have at least a minimum level of access to the Internet if they are to be given opportunities to learn from one of the most important sources of knowledge since the printing press was developed. Thirdly, as Katz (1996) argues,

> Children need help in becoming civic-minded citizens of the digital age, in figuring and how to use the machinery in the service of some broader social purpose than simple entertainment. They need guidance in managing their new ability to connect instantly with other cultures. They need reminders about how to avoid the dangers of elitism and arrogance. (p. 4)

Information Age Schools

In recent years, several writers have argued that as we begin the Twenty-First Century, schools must undergo a "third wave" of restructuring. Writing from an American perspective, and in a similar vein to Toffler, Goodman (1995) notes that the first wave of school reforms was in response to America's rural, farm-based society, while the second wave was established to meet the requirements of the industrial age. The third wave is now needed for the rapidly changing information/technology age. He points out that "despite the rhetoric of school reform, the ways of educating children have remained remarkably durable over the past hundred years" (p. 2). He goes on to cite authors who argue that a third wave education system will have to make a quantum leap if it is to adequately serve the future needs of learners in the information age.

Hypertext and Education

As noted earlier in this paper, hypertext is much more than ordinary text presented on a computer screen. It poses major challenges and opportunities for educators. Teachers must develop skills to be accomplished producers, and not merely consumers of hypertext. (This point is also emphasised by the International Commission on Education in the Twenty-first Century (UNESCO, 1996), which notes that education systems have a major responsibility to give everyone the means of coming to grips with the proliferation of information, that is, of displaying a critical spirit in sorting and ordering information.) As well, learners must be helped to understand the nature of hypertext, to become selective and critical readers and to become aware of the potential for manipulation and control that is built into it. Authors of hypertexts will need to produce their work with an eye towards how it will fit within a transformed system of reading where traditional concerns for beginnings, endings, order, and sequencing are vastly more complicated than with traditional text. And, finally, teachers must recognise that hypertext encourages students to focus their investigations on questions informed by their own particular interests and experiences. This flexibility has many advantages, not the least of which is a capacity to accommodate different learning styles.

Individualised Project Methods

As ICT continues to advance and students are enabled to access networked multimedia, the project method will become favoured as a pedagogical approach. Increasingly, teaching will become individualised and student-centred. Negroponte (1995) presents the vision that even as soon as ten years from now, students are likely to enjoy a much richer panorama of options because the pursuit of intellectual achievement will not be tilted so much in favour of the 'bookworm'. Instead, there will be options that will cater to a wider range of cognitive styles, learning patterns, and expressive behaviours.

The trend towards the project approach, according to McClintock (1995), will involve teachers in designing sustained, productive assignments, surrounding

students with an extensive range of open-ended resources and the means to access them via the Internet, and teaching higher order thinking skills. The teacher's role will be to oversee, manage, and facilitate inquiry. In a similar vein, Burbules and Callister (1996) argue that teachers and students should focus more on the important learning processes of interpreting and organising information, and less on the trivial acquisition of facts. Teachers should engage learners at the early stages with explicit explanation and guidance, then gradually remove these supports as the learners become more independent and comfortable with exploring on their own. Increasingly, teacher-learner relationships will alter, with teachers changing from omniscient leaders into 'tour guides for the infosphere' learners (Reinhardt, 1995). Teachers will become facilitators, collaborators and brokers of resources. As Butler (1996) comments, "The networks have the information, but the students need a guide" (p. 16). Of critical importance in the project method advocated by McClintock (1995) will be the selection of significant problems which require students to acquire knowledge, skills and understanding to solve them.

It is likely that in the future learners will increasingly be enrolled in more than one learning institution. This trend, when combined with the shift towards the project method, means that there must be a system in place which allows the teacher to keep track of precisely what parts of the curriculum each student has used at what times and for what purposes. This will create problems in defining 'units of learning', monitoring 'attendance' and 'achievement', and determining who should be held accountable for these. To deal with these issues, Dunn (1994) argues that there should be "narrative reports describing students' mastery of bodies of knowledge" (p. 35) - a situation not unlike that which has emerged in New Zealand and elsewhere in recent years. 'Smart cards', with their capacity to provide evidence of identification and to store information on an individual, may be a somewhat Orwellian means of dealing with such challenges.

McClintock (1995) offers a word picture of a thoroughly computer-based curriculum:

> It will reside in a system of networked multimedia. Each student will link to it with a notebook computer. Additionally, small-group workstations will be ubiquitously available, on average one for every four students, and one per teacher. These will be high-powered systems capable of delivering quality multimedia presentations while multi-tasking complex programs in the background. The networking will be very high speed, sufficiently powerful to provide each workstation with its own stream of digitised, interactive, full-screen video and good audio. The library of materials available through the system will be extensive, consisting of a full cross-section of the culture in all its branches and varieties and effective tools to aid its study. These materials will reside primarily on an advanced server system for the school on the premises, with integrated, high-speed links to other servers, near and distant, so that members of study-groups can call for most any material they want and receive it with insignificant delay. In addition to the small-group workstations, all spaces will have

> appropriately scaled projection monitors or large, flat wall-displays for showing material to larger groups. (sect. 191).

The Cumulative Curriculum

The trends outlined above raise the notion of what McClintock (1995: sect. 247) calls the "cumulative curriculum", as distinct from the more traditional "sequential curriculum". Such a curriculum would reflect the continuous and ubiquitous availability of curriculum content, with sequences being determined more by the individual learner than by *a priori* assumptions made by educators as to the appropriate sequencing of knowledge. If the emphasis in curriculum moves in this direction, this raises the question of "Will there be set of essentials, that must be mastered in a mandatory sequence, with the new system, and if so, how will this component of the curriculum relate to less sequential, less mandatory parts?" (McClintock, 1995: sect. 253).

The Diversified Curriculum

What elements of a culture should be selected for presentation to learners? This question lies at the very heart of education, where there has been a long-standing debate between proponents of 'cultural literacy', who seek a fairly narrow, canonical selection, and advocates of 'multicultural' approaches, who call for a broader, more inclusive selection (McClintock, 1995). ICT, with its facilitation of open access to multiple sources of knowledge and the individualisation of learning, adds a new dimension. As noted by McClintock (1995: sect. 245), the terms of the debate will be "reshaped substantially by the development of a new system of education that uses information technologies with full effect". He argues that the 'electronic school', with its promise of networked, intelligent multimedia, will have the capacity to support numerous cultural literacies - or none at all, if individual choice predominates.

But is this what we want? What degree of variety can any society sustain? As Burbules and Callister (1996) point out, there is something liberating and something dangerous about a situation in which everything, *prima facie*, has equal significance. They ask,

> Do we truly want a knowledge environment in which individuals can construct entirely personal and idiosyncratic ways of organising information, with no eye to the fact that communities of culture and tradition have tended to prioritize things in certain ways rather than other ways? Does the levelling of all information nodes and the decentering of all organising principles lead to more freedom or less freedom? (p.47)

Technology introduces a new dimension into the issue of what should comprise the curriculum in any particular society. As I have noted in a companion paper (Mitchell, 1996), many societies are becoming increasingly pluralistic in character. If, to this trend, we add the trends outlined in this paper, namely that access to diverse cultural literacies will increase, then centripetal forces may well hold

increasing sway over centrifugal forces in the future in determining the nature of the curriculum.

Freedom from the Constraints of Time and Place

Advances in ICT seriously call into question the traditional division of education into units of time (so many years of compulsory schooling, divided into so many days, divided into so many hours of class contact time), carried out in designated locations (schools, classrooms), taking place in groups of a particular composition (classes of a certain size and age, with a single teacher). These arrangements can be viewed as a means for synchronising learners engaging in diverse activities in space and time.

The new technologies open up options with respect to all of these arrangements. In particular, they allow for the asynchronous use of space and time, defined by McClintock (1995) as the ability of people, who are not present in the same place at the same time, to communicate easily with each other in a variety of responsive ways by using interactive multimedia. As he states it, "Networked multimedia systems will increasingly allow any person, any place, to enter into face-to-face exchange with anyone else with remarkable flexibility in time" (sect. 215). In the future, it will be possible in some circumstances for the content of the curriculum to be continuously available to all students and all teachers at all times. Further, by complementing synchronised interactions with asynchronised ones a range of pedagogical arrangements become possible.

Distance is rendered irrelevant by modern ICT. Tiffin & Rajasingham (1995) use the term "virtual class" to portray the notion of a group of learners who are separated by distance being able to talk and be heard and see the same electronically communicated words, pictures and diagrams at the same time. They describe the virtual class as being a meeting place for virtual communities of learners with a shared interest in the same subject. They envisage a future in which learners will be able to switch in and out of a virtual class and a 'real' or 'conventional' class. They describe the latter in the following terms:

> The conventional classroom of the future will be a community classroom, a meeting place for people who live in the same locality and have interests in common because they are neighbours. They may well share the same culture because they live in the same area. ... The education that takes place in them will be more a manifestation of community needs than national needs. It will be a place where people learn social and interpersonal communication skills, to express themselves in song and dance, to take part in sports and team activities, to learn arts and crafts, cooking and woodwork, gardening and pottery and skills ... The custodial function of the conventional classroom will still be there. Someone will have to look after the community's children. It may be that the conventional classroom becomes a community classroom centre where young and old gather for learning in a more informal group centred, nurturing environment than today's school-based classrooms. (p. 177)

Learners with Special Needs

In the information age, learners with special needs will face even more complex and challenging societal demands than are present today. In the most technologically advanced societies, there will be a larger proportion of the population who will have major needs for appropriate and increasingly technologically sophisticated educational support if they are to be active participants in society. For some, the demands may exceed their capacity to acquire the requisite skills, with a corresponding requirement for finding alternative ways of achieving quality lifestyles. Skrtic, Sailor and Gee (1996) raise the spectre of a two-class society, with an elite of 'thought workers' on the one hand and low level service workers and unemployed on the other. In a similar vein, Tomlinson (1995) notes the impact on those with disabilities:

> The expansion of special education is closely linked to the question of what sort of a preparation for as future life should be offered to a large social group who are likely to be partially or permanently unemployed and thus from a traditional industrial society perspective, not economically profitable or "useful" to society. (p. 126)

ICT and other technologies have already made a major contribution to empowering learners with special needs. For example, radar sensors are becoming increasingly sensitive and helpful for the blind; hearing aids' sound discrimination is improving; personalised communication devices are becoming increasingly 'smart'; chronic health conditions can be monitored remotely; and people with disabilities will be able to participate in work, democratic processes and social activities more easily (Butler, 1996). In many ways, ICT provides persons with disabilities with opportunities to exploit their own resources. These developments are likely to accelerate in the future, with consequential improvements in the quality of life enjoyed by people with disabilities.

Teacher Education

For the developments outlined in this paper to occur, high priority will have to be given to the pre-service and in-service education of teachers in various ICT approaches (Butler, 1996). Schools of the future will require the services of highly trained, flexible teachers who continue to be up-dated (and possibly re-credentialled) in their rapidly changing field. Teachers may well feel under threat by the new ICT and the opportunities and challenges it poses. There is no denying that ICT, along with other changes that will take place in education in the future, will impact on all sectors of education, not least of which on teachers. However, as the International Commission on Education for the Twenty-first Century (UNESCO, 1996) points out, these developments do not at all diminish the role of teachers - quite the contrary - but they do change it profoundly and they offer the opportunities that must be seized. The Commission argues that it is therefore essential that teachers' initial training, and even more so their in-service training, should give them a real command of these new tools. They also need to be

"sensitised to the profound changes that modern technologies effect in our cognitive processes" (p 174).

Technology and Change

Undoubtedly, the culture of the school and of teaching will have to undergo dramatic change as education systems accommodate to the information age. This will be no easy shift to bring about. It will be particularly difficult in societies where teaching has been routinised and deskilled. Teachers of the future will need to be intelligent, highly educated, flexible, imaginative, technologically sophisticated, confident people who can assist students to manage their own learning.

Implementing new technology in schools is far from a straightforward matter, even when the surface logic is persuasive. Why is this so, and what can be done about it? In a recent analysis of 'technology refusal' in schools, Hodas (1993) points out that what is often overlooked is the fact that schools themselves are a technology, and that they are "systems for preserving and transmitting information and authority, for inculcating certain values and practices while minimising or eliminating others". He argues that first and foremost, schools are organisations, and as such seek nothing so much as their own perpetuation. They experience change as a disruption, an intrusion, as a failure of their defences, particularly if it means that in order to implement it, their culture must alter its values and habits.

Hodas believes that the institutional and organisational values on which the schools are generally founded include: "respect for hierarchy, competitive individualisation, a receptivity to being ranked and judged, and the division of the world of knowledge into discreet units and categories susceptible to mastery" (p. 3). To the extent that these values are shared with other large-scale institutions, such as business and government, they represent core values and are therefore highly resistant to change. This inherent organisational conservatism is compounded, according to Hodas, by the self selection for teaching of individuals who by and large show neither interest nor aptitude for ongoing intellectual development and who enjoy the condition of lifetime employment. He goes on to note that technologies that have been taken up in schools (e.g., the blackboard, the duplicating machine, and the overhead projector) all have the quality of enhancing the teacher's authoritative position as an information source and are fundamentally supportive of the school-as-organisation values. Tellingly, he points out that the school intercom system, ideally suited to the purposes of centralised authority and the one-way flow of information, is as ubiquitous in classrooms as its polar opposite, the direct-dial telephone, is rare.

According to Hodas, there are two ways in which schools might become more accepting of ICT. Firstly, it may be introduced as a kind of Trojan Horse, by accommodating to existing organisational values, while at the same time introducing new underlying values which will eventually bring about fundamental change in school structure and practice. Secondly, more overt steps could be taken to encourage schools to re-evaluate their social purposes and the manner in which they serve them. Eventually - and in the not-too-distant future - the world around schools will have so comprehensively changed that schools will

be forced to re-align themselves, just as other sectors of society have been doing for some time.

Equitable Access to ICT

One of the major implications for education of these developments in ICT is that learners in some countries will have increasing access to computers in both schools and homes. For example, the US government has recently committed itself to reducing the pupil-computer ratio in K-12 schools from the present 10:1 to 3:1 (Brown, 1996). For most students, home use will complement their use of ICT at school and is likely to comprise a substantial proportion of their total study time (Butler, 1996). Schools may provide modems to link home computers to a school server, rather than improving the pupil/PC ratio inside the school. Currently in New Zealand, about 40% of primary school students and 60% of senior secondary students have access to personal computers in their homes (Ministry of Education, 1996).

Schools of the future will have to provide technologically rich environments (Dixon, 1994):

> In a revitalised school system in which self propelled, active learning is the norm, training for computer literacy must include competency testing on every aspect of using the current generation of computers and specific remedial and developmental training for those whose test results indicate need. Every student must have a notebook computer that is compatible with the school's computer, and every student must make routine use of living room cam corders, faxes, copiers, phones, and so on. If we want controlled evolution from the present publicly operated schools to computerised publicly operated schools, every nation must create and fund a comprehensive plan that will phase in these changes. (p. 364)

Clearly, this is an ambitious goal - and one that is unlikely to be universally attainable. We must be aware that the opportunities afforded by ICT will not be equally accessible to all members of a society, let alone to all societies. This means that there could well be growing disparities in knowledge and basic skills "between those who have access to the wonderworld of educational opportunity of computer - generated virtual reality and those who have not, between those who can pay for the service and those who cannot" (Roll, 1995, p. xii). Issues of social justice will have to be addressed in parallel with the expansion of ICT into education, lest existing disadvantages become compounded. As the International Commission on Education for the Twenty-first Century (UNESCO, 1996) urges, it is essential for education systems to teach all pupils how to master and handle ICT techniques, both to ensure better dissemination of knowledge and to increase equality of opportunity. The Commission notes that with the cleavages that are likely to occur within given societies, between those who can use the new tools and those with no possibility of using them, there is a real danger of societies developing fast and slow tracks. The Commission also draws attention to the

marked disparities between industrialised and developing countries in their capacities to afford and their willingness to accord priority to the use of technology for educational purposes. It argues that everything possible should be done to prevent the gap between developing and wealthy countries' access to technologies becoming wider, calling for close collaboration between business and industry, governments and international organisations.

CONCLUSION

An unstoppable revolution in information and communications technology is transforming most societies around the world. It is transforming the nature of work, business, entertainment, leisure, interpersonal interactions, and community. At the very least, this revolution makes it imperative for education systems to prepare their students for the emerging information age and whatever might follow it. Equally importantly, it challenges education systems to transform, re-align, or re-engineer their missions, their structures and their pedagogies. This means that the established technologies of schools may well need to be displaced.

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