DOCUMENT RESUME

ED 253 215 IR 011 492

AUTHOR Bates, A. W.
TITLE New Communications Technology and Distance Education: Implications for Commonwealth Countries of the South. Papers on Information Technology No. 239.
INSTITUTION Open Univ., Walton, Bletchley, Bucks (England). Inst. of Educational Technology.
PUB DATE Dec 84
NOTE 24p.; Paper prepared for Commonwealth Secretariat. Light type may not reproduce well.
PUB TYPE Information Analyses (070) -- Viewpoints (120)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Audio Equipment; *Computers; Cost Effectiveness; Costs; Developing Nations; *Distance Education; Foreign Countries; Mass Media Effects; *Media Selection; *Technology Transfer; *Telecommunications; Videodisc Recordings
IDENTIFIERS United Kingdom

ABSTRACT

This review of the technical possibilities of audio, television, computing, and combination media addresses the main factors influencing decisions about each technology's suitability for distance teaching, including access, costs, symbolic representation, student control, teacher control, existing structures, learning skills to be developed, and feedback. Specific technologies are considered by type as follows: (1) audio: radio, audiocassettes, telephone teaching; (2) television-based: broadcast, cable, and satellite television, videocassettes, and videodiscs; (3) computer-based: hardware developments and some of the functions of microcomputers, computer assisted learning (CAL), computer conferencing, and audiographics systems; and (4) combination systems: computer and videodisc technologies and viewdata, which combines telephone, computer, and television technologies. Questions are raised concerning the potential social and educational effects of introducing these newer technologies to distance education; their cost-effectiveness; their potential impact on the nature of distance education; and whether they should be used in poorer developing countries. Four references are listed. (LMM)

NEW COMMUNICATIONS TECHNOLOGY AND DISTANCE EDUCATION: IMPLICATIONS FOR COMMONWEALTH COUNTRIES OF THE SOUTH

Prepared for Commonwealth Secretariat,
December, 1984.

Dr. A.W. Bates,
Reader in Media Research Methods,
Institute of Educational Technology,
Open University,
Milton Keynes,
England.

THE COMMUNICATIONS REVOLUTION

Expert and politician alike have warned us that we are in the throes of a social and economic revolution at least as significant as the Industrial Revolution; the only difference this time is that it is happening much more quickly. Effective distance education depends on good communications, so it is to be expected that the communications revolution will have as great an impact on distance education as on other areas of our lives.

Until very recently, there were four main media used in distance teaching: print, radio, broadcast television, and local face-to-face tutoring. Main-frame computers have also been used, primarily for administrative functions. But consider the new technologies which have been experimented with in distance education in the last five years:

Audio	audio-cassettes telephone: audio-conferencing
Television	video-cassettes cable TV satellite TV video-discs
Computing	computer-assisted learning computer conferencing audio-graphic systems (e.g. CYCLOPS)
Combinations	inter-active video audio-graphic telephone conferencing satellite video/audio conferencing viewdata and teletext

Selection of media has suddenly become a vital issue for distance teaching institutions wishing to exploit new technologies. Unfortunately, the advantages and disadvantages of these technologies are not always readily apparent. There is plenty of experience of earlier technology-led projects, particularly in broadcast television, failing dramatically to assist the social and educational development of newly emerging nations. Resources are too scarce in any country to be needlessly squandered, so it is prudent to examine carefully just what the new technologies can and cannot do, at what price, and in what circumstances.

What I want to do in this paper then is to review the technical possibilities of the newer media, look at the critical aspects of costs and necessary infrastructures, and lastly to raise some questions about the social and educational implications of introducing such technology. In discussing each technology, I will deal with what I consider to be the main factors which influence decisions about their suitability. These factors are:

- access, i.e. ease of delivery to home-based students or local centres

- costs: delivery, production (all costs are in U.S. $, at £1 = $1.20).

- symbolic representation: text, still or moving pictures, full visual representation, etc.

- student control: permanent or temporary; real time or recorded

- teacher control: preparation time; independence or dependence on professionals

- existing structures: communications infrastructures; institutional organisation

- learning skills to be developed: awareness; comprehension; application of knowledge; motor skills

- feedback: none; restricted; unlimited

It will be seen that technologies differ from each other across each of these factors. Choice of appropriate media depends to a large extent in balancing these factors, according to the particular circumstances and needs of each unique institution. I want to begin though by looking at what we know about some of the "older" technologies, because this will provide a useful base for comparison.

AUDIO-BASED TECHNOLOGIES

There is a tendency to undervalue audio-based technologies. They lack the sparkle provided by colour moving pictures, and hence are sometimes considered less motivating; however, they have much to offer to distance learners.

Radio

The main strength of radio is its accessibility and relatively low cost. Radio is the most accessible of all media for distance education. In even the poorest countries, most people can be reached through radio. Paying reasonable marginal transmission costs (i.e. the actual additional costs incurred by the BBC in transmitting Open University programmes), British OU programmes can reach the whole of the United Kingdom population on the BBC national network for around US $300 per hour. Production costs are also relatively low.

However, radio is a weak instructional medium. It has limited symbolic representation (words, music, sounds), and distance education institutions usually have to go through a separate broadcasting organisation to get access to production and transmission facilities. Even the access factor can be limited by unsuitable transmission times, and by the need for students to be at a set place at a set time to catch the transmission. Students have no control over the medium, having to listen in real time and not having the opportunity for reviewing or stopping to think. No feedback can be provided for activities stimulated by the radio programme itself (although feedback via radio on activities stimulated by other media, such as text or group discussion, can be valuable).

Some of these weaknesses of radio can be overcome in a number of ways, usually involving the use of other media. Radio combined with print, where the radio programme talks students through diagrams, tables or mathematical formulae - indeed, in any situation where it is useful to look and listen simultaneously - can be very effective. Local recording by students or group leaders can provide more tutor or student control over the medium. Radio on its own can be very useful for raising awareness of issues, which can then be followed up at local levels, or for recruiting students to distance education activities. Simple concepts can be taught through imaginative use of repetition or jingles, and more complex comprehension can be achieved through the imaginative use of drama or documentaries. However, radio is a weak medium for mastering skills or subject matter to any depth, unless heavily supported by other media, and getting access to radio for educational purposes is getting more difficult, as radio becomes used more and more for popular music and entertainment purposes in many countries.

Audio-Cassettes

Audio-cassettes can overcome many of the instructional weaknesses of radio, although they too have the same limitations of symbolic representation. The ability to stop, carry out activities, and return to the cassette allows for the development of mastery learning of concepts and intellectual processes, particularly when combined with other media, such as print. Some limited feedback is possible, the tape "hiding" the feedback until it is needed. Cassettes can be used to analyse verbal situations (language development, inter-personal communications, decision-making processes), enabling students to apply more abstract knowledge acquired from print to real-life situations.

In general, radio scores over audio-cassettes in terms of access and costs for large numbers of students. However, access varies considerably from one country to another regarding audio-cassette ownership. In Britain, nearly all households have an audio-cassette recorder, and the costs of distribution are not great. At the Open University, we can copy and deliver a C60 cassette, which will usually involve about three hours of study, for under US $1.00. The cost advantage of radio over cassettes will vary from institution to institution, but radio only becomes cheaper than audio-cassette distribution at the British Open University when student numbers on a single course exceed 1,000. Consequently, at the Open University, radio transmission has declined from nearly 30 hours a week in 1979 to under 12 hours a week in 1984, while in 1984 over 500,000 C60 audio-cassettes were mailed to students.

Both radio and audio-cassettes of course have advantages for teaching illiterate or semi-illiterate students.

Telephone Teaching

Telephone teaching has become increasingly popular in recent years in distance education, particularly in North America. There are two main reasons for this. Firstly, most homes, even in the poorer areas, have a telephone. Secondly, the costs even for long-distance calls compare well with the high cost of internal air-fares and hotel accommodation, given the large distances involved. Thirdly, a lot of North American telephone teaching is in the form of audio-conferencing, i.e. linking up several callers simultaneously. This is often done not between individual students in their homes, but between local centres and a centralised campus (e.g. the University of Wisconsin Extension Service). In this way, costs fall on the institution, not the student, and several students can participate at each location through the use of loudspeaking telephones. Often private lines are used for this kind of teaching.

Even in North America, telephone teaching is not without its problems. The lack of visuals is a major drawback, particularly in teaching mathematics, science, technology and geography. Various measures have been taken to overcome this problem, some of which will be discussed later, but it is fair to say that no adequate solution to the lack of visuals has yet been found in North America. In other countries, there are also major technical problems with even the sound. Poor quality local lines, high tariffs, and loss of conference lines make telephone teaching an often exhausting or frustrating experience for both tutors and students. Tutors need training to run conference tutorials, and more preparation time than for a face-to-face tutorial. At the British Open University, telephone conferences operating within a region perhaps 100 square miles in size, cost about $30 an hour for six or seven students, plus the tutor's fee. Switching from face-to-face to telephone tutorials may save students travel, money and time, but it also increases costs to the institution, often to a level which is unacceptable.

The main teaching advantage of telephone tutoring is the high level of personalised interaction between student and tutor that it permits. However, this is lost if large numbers of students are linked in to one central lecturer. Thus telephone teaching seems better suited to providing back-up to materials delivered in other ways; it is less suited to be the main delivery medium, unless it is being used primarily to extend students who are already well qualified in the subject (e.g. professional up-dating). However, if used solely as a back-up, telephone teaching becomes expensive.

The most valuable use then of telephone teaching in countries where access to homes is limited is to bring three to five students to a local centre and link them with four or five other centres and a teacher, to discuss materials delivered in other ways, which students have already had a chance to study.

While these three audio-based technologies are neither new nor what one might term as "high technology", I make no apology for discussing them at some length and early on in this paper. Despite their limitations and being rather unfashionable, radio and audio-cassettes in particular can provide good returns on low investment, compared with some of the newer technologies that will be considered later in the paper. They therefore provide, with broadcast television, a good base against which to compare the newer technologies.

TELEVISION-BASED TECHNOLOGIES

A great deal of attention has been given to computer-based technology in the mass media, but equally important changes have been taking place in the field of television. Indeed, one of the interesting features of the communications revolution is how the two fields of television and computers have been converging. In this section though I will concentrate on several developments in television alone; in a later section I will discuss the combination of television with other technologies.

Broadcast Television

The great advantage of broadcast television in many countries is that not only does it add the richness of full symbolic representation, but it also has the same kind of penetration into students' homes as does radio in many countries. Less than 10 countries in the world now have no national broadcast television service. In most countries where broadcast television and radio exist side by side, television viewing is higher than radio listening. Indeed, television tends to be heavily used by lower income groups and the less educated - often key target groups for distance education. There is no better medium in most countries for reaching the less educated or for recruiting initially uninterested people to distance education activities.

It comes then as rather a shock to find that broadcast television is not extensively used in distance education. Only two of 14 distance teaching "open universities" made extensive use of broadcast television in 1982, the British Open University and the Chinese Central Television University. Even at the British Open University, production has dropped from around 300 programmes a year in the early days to less than 100 in the 1985 undergraduate production year. A survey carried out in 12 distance education institutions around the world (Bates, 1980) identified a number of reasons for this, some of which are relevant to consideration of the newer technologies.

Firstly, most distance teaching institutions had to go through a separate broadcasting organisation for production as well as transmission. This had several consequences. Although print in most cases carried the main burden of the teaching, television production costs seemed much higher. This was partly because print costs were often hidden (e.g. did not include academic salaries) or were included in the overheads of the distance teaching institution; broadcast television costs, on the other hand, being charged directly by another institution, were "up-front" and public, and usually included a charge for overheads.

Nevertheless, even allowing for this, broadcast television costs tender to be much higher than print costs per hour of study time, and between seven and ten times higher than radio production costs. In Western Europe, marginal production costs, i.e. the cost of each extra programme made, for broadcast television tend to be in the order of $10,000 to $20,000 per hour of finished programme; if overheads are included, these costs can rise to $50,000 to $150,000 per hour.

Distance teaching organisations also often felt that they lost control over teaching style or even content once the programmes went "outside" to the broadcasting organisation. In particular, it was felt that broadcasters tended to make programmes which appealed to a more general audience rather than make the more didactic programmes judged to be needed by committed, enrolled students.

One could have some sympathy for broadcasters on this point. Very few of the institutions surveyed had many courses with more than 500 students enrolled in any one year - the number at which the programme would be targetted. Consequently, national broadcasting organisations were reluctant to devote peak viewing times to such minority audiences. Thus programmes understandably are made to appeal to the much larger number of general viewers, or get pushed into unsociable hours. Broadcast television on a national network does require large numbers of viewers to justify the high production costs.

There were also serious doubts expressed in the survey about the instructional effectiveness of broadcast television. Like radio, it is ephemeral, students cannot use it flexibly in relation to their other studies, and it provides no feedback and weak student interaction. Because of the high degree of professional skills required to produce broadcast television, and the use of a separate organisation, the television production process tends to be separate from the print production process, so lack of integration and irrelevant programming can easily arise. Few distance teaching institutions have been able to develop an equivalent to the course team and partnership arrangement between the BBC and the British Open University, and even this unique partnership cannot always avoid some of the problems outlined above.

While most distance education systems have recognised the value of the high public profile and possibilities of recruitment through broadcast television, in general it makes a small overall contribution, enough for publicity, but leaving the "real" teaching to other media, primarily print.

It can be seen that the "older" technologies each have limitations regarding distance education. To what extent then do the newer technologies overcome these problems?

Cable Television

Cable television is not really a new technology; it has been around since before the Second World War. Until recently, though, the co-axial technology on which it was based allowed only a limited number of television channels to be carried to individual homes, and communication back from the home or college to any other point was not really practical on any scale, thus restricting the potential for interaction between different sites. The introduction though of fibre-optic cable allows many more channels to be carried in a single wire, and also technically offers the possibility of two-way televisual communication between any two sites connected to the system.

In theory, the possibility of many more channels means an end to the restriction of limited transmission times for educational programming. With 40 channels or more, it should be possible to have at least one whole channel devoted solely to educational programmes. Furthermore, students should be able to interact with their televised lecturers in real-time. And, since cable television is local, existing, campus-based institutions should be able to offer off-campus teaching, or perhaps even better, a flexible mixture of on-campus and off-campus teaching.

However, there are major problems with cable. First of all, the educational use of cable television, other than as a pure broadcast relay system (i.e. merely picking up broadcast television programmes and distributing them locally), is much less than one might expect, even in areas which are already extensively cabled. Fibre-optic technology has not yet reached homes in any country, other than in strictly limited local experiments. Its introduction requires a massive capital investment.

The availability of cable television using existing co-axial technology, already varies enormously from country to country, even in Europe. Holland and Belgium have the highest access to cable television in homes in Europe, at around 80% of homes cabled up. There are though special circumstances. Holland has a large number of television companies, and Belgium has two broadcasting organisations, one for each of the two national languages. Both countries are small and densely populated, and can receive programmes from neighbouring countries such as France, Germany, Luxembourg, Denmark and Britain. With such a large number of channels to choose from, and a densely crowded population, cable makes economic sense. About 40% of homes in the U.S.A. are currently wired up. Again, there are compelling local reasons for this. In a large country with scattered communities, the only way to get good reception of nationally networked programmes was to use a large, expensive reception aerial (often located on the top of a nearby mountain), with relay by cable to homes. Similarly, in large cities where skyscrapers interfere with transmission signals, and where there are many apartment blocks, a single aerial with wired relay to individual homes improves reception.

However, it requires a major capital investment to lay down cabling in city areas where there has been no gradual, piecemeal growth. The economics of cabling require many connections per mile of cable laid. Cable, therefore, is uneconomic for isolated farms or villages. In Britain, where 20% of homes are currently wired up with co-axial cable, it is estimated that it will take until at least the end of the century for 50% of homes to be cabled up, and for many homes, it will never be economic. Furthermore, there are major reservations about whether enough of the public will be willing to pay extra for the privilege of being cabled up, particularly in countries where broadcasting has always been received free of charge, subsidised by advertising or other forms of government controlled subvention (taxes or licence fees). More than any other of the new media, the spread of cable television depends on local geography, government policies, private investment and public attitudes to television.

What then are the implications for distance education? Firstly, cable television will be less effective than broadcasting in accessing students. Not only will fewer homes be reached, but because of the pricing structure, with often a premium for minority channels such as education, there is likely to be fewer people on low incomes reached in this way. Where cable television is extensively provided, and many channels exist side by side, it will be weaker than broadcasting in terms of attracting people by chance to distance education. The odds of accidentally stumbling across an educational programme which interests you are far less when there are 20 channels to choose from than when there are only four, particularly if the cable provision of education is limited to the same channel all the time. Cable television, on its own, suffers from most of the instructional weaknesses already identified with broadcast television: it is ephemeral, requires watching at fixed times, and is not easily interrupted or slowed down if students have difficulties.

Nevertheless, cable does have some advantages for distance education. Production costs can be much lower than for broadcasts. Cable stations often do not produce their own programmes, but buy in programmes from other producers. Local colleges therefore with their own television production facilities can use cable to distribute programmes made as part of "local" distance education courses. Secondly, some form of interaction is possible via cable. Students can telephone in and be answered "live" on air by the lecturer presenting the programme, as happens in Knowledge Network in British Columbia, Canada. One or two "dedicated" fibre-optic cable systems linking several sites in the same system with full two-way video have become fully operational in the last year or so. For instance, Charing Cross and Westminster Hospitals' Teaching Schools, forced to merge to make economies, have linked together six sites across London with fibre-optic cable, to allow lecturers in one site to be seen by students on any of the other sites, and to allow students to ask questions, wherever they are located. However, the capital cost alone for this system is not far short of $1 million.

It can be seen then that there are fundamental limitations for the use of cable for distance education for many countries. It requires very high capital investment, accessibility is not as good as broadcasting, and it suffers from many of the weaknesses of broadcasting. Where a cable system already exists, and where there is the chance of low-cost production and distribution, cable may prove useful for a distance education system, but it is not a technology in which large-scale investment could be justified for purely educational reasons.

Satellite Television

There are two main kinds of communications satellite: low-powered and high-powered. Both can relay television signals, but low-powered satellite signals require large reception aerials, costing from $25,000 upwards. Low-powered satellites are used for telecommunications, and for relaying television services which can be "collected" by cable stations and relayed locally via the cable system (or indeed by local transmitters). High-powered satellite signals though can be received by much smaller aerials, thereby making them suitable for direct broadcasting to individual homes (provided the building or garden has a direct line of site to the satellite). High-powered satellites are not limited to direct broadcast services (DBS) but can also be used for other purposes, such as telecommunications. Both types of satellite can also relay large numbers of radio channels. Indeed, many satellites combine a range of functions.

DBS signals can be received on existing domestic television receivers, providing a suitable converter and aerial are used. There are widely varying estimates of the cost of domestic satellite reception equipment. With mass production, some estimates are as low as $300. However, systems currently in use require expenditure of anything between $1,000 and $10,000 for reception equipment.

A significant feature of DBS signals is the large area of land that can be covered by the "footprint". Several medium-sized countries can be covered by one satellite transmission. A DBS satellite can handle from two to five simultaneous television channels (depending on size).

The most important educational experiment to date has been the Indian Satellite Instructional Television Experiment in 1975 and 1976, which reached 2,400 villages in rural parts of India. There have also been experimental projects in several other countries, particularly the U.S.A. and Canada. However, there are very few existing DBS projects at all, let alone for educational purposes, although there will be a rapid increase in the next few years, as can be seen from Table 1 (over).

Table 1: Existing and Planned Géostationary Satellites

Area	- 1984 LP	- 1984 DBS	1985-1987 LP	1985-1987 DBS	Total LP	Total DBS
USA/Canada/Mexico	38	3	33	11	71	14
Asia/Arab States/Australia	9	4	6	5	15	9
W. Europe	7	0	6	8	13	8
U.S.S.R.	8	1	3	0	11	1
Intelsat (international consortium)	14	0	0	0	14	0
Africa/South America	0	0	0	0	0	0
TOTAL	76	8	48	24	124	32

LP = low-powered
DBS = DBS capability

Source: Screen Digest, March, 1984.

There are several points to be noted from this table. First of all there are very few DBS services currently fully operational. Of the eight satellites capable of DBS services at the present time, four were launched in 1984, or were purely experimental. Although a satellite may be capable of providing a DBS service, it may not be doing so, because of lack of programming and/or enough domestic receivers in place to make a service economically viable. The most extensive use of DBS capacity for education on an operational rather than an experimental basis is in Canada. Both Knowledge Network in British Columbia in the West of Canada, and TV Ontario in the centre, use satellite for distribution purposes. Knowledge Network is relaying programmes directly related to distance education courses for direct reception by individual students in their homes in the more remote areas, as well as for onward relay by local cable stations in more urban areas. The Indian educational satellite service has recently become operational, and Japan is also planning an educational service via satellite.

Secondly, within the next three years, the number of DBS satellites will treble, but mainly in North America and Europe, although Australia and China are likely to add DBS satellites to those already provided by Japan, India and the Arab States. However, according to "Screen Digest", there are <u>no</u> plans for any satellites, low-powered or DBS, for Africa or South America, although this may be because the information has not been made available. If "Screen Digest" is correct though it is a pity, since these continents with their large countries and often scattered populations would seem to benefit most from the large footprint provided by satellite transmission.

With such little hard experience to go on, it is very difficult to give realistic costings for the use of DBS for educational services. Knowledge Network pays around $1 million per annum for 98 hours a week of satellite transmission, although I suspect that this is not the full commercial rate. Figures quoted for a five-channel DBS system in Western Europe average out at around $2 to $3 million a channel per annum, given a satellite life of 10 years, which suggests that the capital investment for a DBS satellite is around $200 million (including interest payments). If these figures are correct, and an educational service could make use of a channel on a satellite using the other channels for entertainment purposes, or if five countries could share a channel each for educational purposes, the costs per hour for 100 hours of programming a week work out at around $400 to $500 an hour, which compares favourably with the marginal cost of conventional terrestrial transmission (for instance, Open University pays the BBC around $700 per hour for television transmission).

However, there are several points to note. First of all, unless there is heavy demand from other users, a good deal of programming will have to be provided to keep the cost per hour to a reasonable rate. Thus as well as the high investment in transmission, there needs to be an equally high, if not higher, investment in programming. One major lesson from the Indian SITE experience was the need to carefully plan and invest in the programming side. Knowledge Network does not produce its own programmes. It either buys in programmes from other production agencies, such as TV Ontario and British and American companies, or uses programming produced and paid for by the other educational institutions in British Columbia, such as the universities.

Secondly, DBS services depend on the availability of appropriate reception equipment in homes or institutions. It may be wiser in many countries to transmit to institutions, rather than homes. In this case, though, it may be cheaper to use low-powered satellites and acquire larger receivers. Each country or institution then considering using satellite transmission will need to commission a very careful systems configuration study.

Whatever system is used, there will still remain the general problems already identified with broadcast television: its ephemerality, the lack of review and interaction, and problems of feedback. It is of course possible to build in two-way communication via satellite - at a price. This would require the addition of an "uplink" transmitter at each centre from which two-way communication was required. Again, the advantage of this compared with using existing facilities, such as the telephone or radio for audio only "backwards" communication, would have to be explored.

In essence, satellite television is just another way of distributing broadcast television. In certain circumstances, it may work out more cheaply, but it will not necessarily avoid the inherent instructional weaknesses of broadcast television, and may even restrict access to distance learning, compared with a more popular terrestrial-based distribution system.

Video Cassettes

Compared with broadcast, cable or satellite television, videocassettes have considerable instructional advantages. The teaching material is permanent, and therefore available when the student needs it (if there is a playback machine at home). The programme can be stopped or reviewed as and when the student wants. Activities can be built into the cassette, so students are engaged in active learning.

Furthermore, video-cassettes can be much more economical in terms of production costs than broadcasts. A broadcast is usually of a set length in time and has to be fully comprehensible in itself. With a video-cassette though only those elements which require full audio-visual symbolic representation need to be made available on cassette, which can be made to the actual length required. More arguably, it could be claimed that video-cassettes can also be produced as effectively as broadcast television at a lower cost per playing time. The high levels of staffing and high technical standards required for broadcast television are not necessary for video-cassette production. The quality of low-cost cameras and editing equipment has improved rapidly in recent years. In the U.K., it is now feasible to produce high quality educational video-cassettes for as little as $6,000 per programme hour, including overheads, although a more average figure would be around $20,000 an hour.

Experience at the British Open University and elsewhere suggests that to obtain the full instructional benefits of video-cassettes, they need quite a different production style from broadcast television. Thus cassette programmes are emerging which are made in short, self-contained segments with clear activities indicated at the end of each segment. Each segment is visually indexed, for speedy access, and cassettes can be tightly linked to other media, so students move between print, video and possibly computers as necessary. Video-cassettes have proved particularly useful for promoting discussion in group work when illustrating situations which are open to interpretation or alternative solutions.

The major limitation of video-cassettes in distance education is the lack of student access. The availability of video-cassette machines in homes in various countries is set out in Table 2:

Country	% of homes with TV having also a VCR in 1984
Kuwait	73
United Kingdom	40
Malaysia	54
Canada	15
Australia	33
Nigeria	20

Source: Screen Digest, November, 1984.

This table though does not take account of trends over time. It is expected that in the United Kingdom, half of all homes will have a video-recorder by late 1985/early 1986. Video-cassette ownership in Britain is following roughly the same trends as did UHF and colour television ownership, suggesting that by 1990 most homes will have a video-cassette recorder. Ownership is evenly spread across all income groups in the United Kingdom, except the unemployed. The spread of equipment in Britain is helped by the existence of an extensive rental system, both for machines and programmes on cassettes. As the table indicates, the spread of machines in other countries is extremely variable.

Another disadvantage of video-cassettes is the cost of physical distribution. This is not a problem if programmes are to be watched at a limited number of local centres (although post or transport will be a problem in some countries). Even for home distribution, though, the cost is not excessive for courses with less than 500 students, compared with off-air transmission costs, if the cassettes are returned by the students at the end of the course and re-issued the following year. The British Open University can distribute three hours of video material (equivalent to about six to nine hours of study time) for a distribution cost of $12 per student (or $4 per programme hour) including cassette, copying and administrative costs, using this method of distribution.

It is clear that in a number of countries, video-cassette distribution is becoming a viable proposition, and video-cassette use can eliminate many of the instructional weaknesses of broadcast television. For many other countries, though, video-cassette distribution only makes sense for distribution to institutions or centres, not for home use.

Video-Discs

Video-discs (without computer control) share many of the instructional characteristics of video-cassettes. In addition, they have the advantage of even finer and more convenient forms of control, and the possibility of combining moving images with a huge store of high quality still pictures, and an extensive amount of textual communication, through the video-disc's capacity to store 57,000 single frames, each of which can be identified and accessed almost instantaneously.

However, there are major problems in using video-discs in distance education. Firstly, outside the United States, hardly any homes have a video-disc player. Even in the United States, hardly any homes have the higher quality players which can provide the rapid access and still frame quality required by education. Secondly, broadcast production quality is required for discs, requiring 1" broadcast-standard editing facilities. Thus production costs even for straight transfer on to video-discs are as high as for broadcasts, for new programming.

The video-disc machines themselves are not expensive, retailing at around the price of a video-cassette recorder. However, at the moment, it is not possible to record or transfer video on a domestic video-disc player. The cost of discs depends on the length of run. For large runs of over 10,000, the cost to an institution of copying, distribution and packaging could be as low as $10 per disc (maximum full video running time of 35 minutes) or roughly $20 per programme hour. Furthermore, study time is much higher. The Open University

Materials Science computer-driven video-disc takes at least two to three hours to work through, and even a "stand-alone" video-disc of 35 minutes programme time could take well over an hour to work through if student activities are built in.

The value of video-discs in distance education will depend very much on what happens in the domestic market. At the moment, it does not seem likely to develop to anywhere near the level already achieved by the video-cassette market. On the other hand, it does seem likely to expand in the institutional market. Where students can get to local centres, or where companies can provide machines for industrial training at a distance, then video-discs may have a future for distance education. However, in such cases, they are much more likely to be linked to computers, and this potential will be discussed in a later section.

To summarise then with regard to video-based technologies: broadcast television has severe limitations instructionally, but does have the power to access most of the public, to raise awareness of issues, and to publicise the existence of distance education opportunities; satellite television may in some circumstances be a more economical form of distribution than broadcast television, but its value to distance education will depend very much on its spread into homes for entertainment purposes, and its economic viability is by no means certain; similar comments can be made for cable television, and like satellite television, it still suffers from the instructional weaknesses of broadcast television, although some weak forms of interaction are possible, and production costs are likely to be much lower, but with possibly a parallel drop in programme quality; video-discs have tremendous educational potential, eliminating many of the instructional weaknesses of broadcast television, but are likely to be of limited value in distance education, other than for use in local centres, and will more likely be used in combination with computers; for a good number of countries, video-cassettes are the most promising development, with increasingly high penetration into homes, and allowing for much increased educational effectiveness over broadcast television; for countries though where home access is low and penetration slow, it would be just as economical and more beneficial to locate video-discs in local centres, rather than video-cassettes. With the possible exception of video-cassettes, though, none of the new video technologies comes anywhere near broadcast television in terms of access to and recruitment of the general population.

COMPUTER BASED TECHNOLOGIES

A number of distance education institutions already have considerable experience in using main-frame computers for administration, student records, assignment marking, and even for computer-assisted learning, using terminals at local centres connected by telephone to a main-frame system. However, there have been major developments recently both in the range of functions that can be carried out by computer-based technologies, and in the development of relatively low-cost but powerful micro-computers. I will start with the hardware developments, and then briefly discuss some of the functions.

Micro-computers

It is now possible to pay today about $500 for computing power which several years ago would have cost nearer $50,000. What are the possibilities then of home-based computing facilities for distance education? Let us look at costs first of all. For approximately $750, a home work station can be bought which would allow for some local processing capacity, including the learning of a computer language, word-processing and numerical calculations sufficient for most university-level undergraduate studies, and would also allow for connection through the public telephone service to the institution's main-frame computer; in other words, the home microcomputer can also become a home terminal connected to a powerful computer. For another $150, a local printer could also be provided. Allowing then for variations in price and taxes from country to country, a fairly sophisticated study station could be acquired for around $1,000. What could such a station be used for? This will depend very much on the central facilities that could be provided by the central distance teaching institution, particularly the type of main-frame system and support staff available, although it is fair to say that the size and cost of the support system would to some extent be equated to the number of students and range of functions to be accommodated.

Computer-assisted learning

This is probably the function that many people will associate with computer-based systems. Computer-based learning allows students to be asked questions, and correct answers determined, with re-routing of students to new material or revision material as appropriate. Students can also be given the opportunity to simulate problem-solving or experimental design, with the computer calculating the consequences of their decisions. Thus computer-based learning provides strong interaction and feedback. With the help of computer animation and graphics, it can also provide an intermediary level of symbolic representation, but not inter-personal relationships or natural movement, nor good quality full colour still pictures.

Despite some strong instructional characteristics, I do not see computer-assisted learning being the main use of computing in distance education. At the moment, the range of teaching functions for which CAL is appropriate is limited, and while this will increase with the development of courseware based on principles derived from artificial intelligence, there are some inherent problems which are likely to limit its applications. The main problem is the need to work through some form of authoring language which can convert what the teacher wants to do into terms suitable for the computer. However sophisticated the programme, there will inevitably be restrictions on what the teacher and student can do. Furthermore, the cost of CAL courseware development remains high - about 100 hours of development time for every hour of student use. While these costs should come down with more sophisticated authoring languages making it easier for teachers to write materials for CAL, this technology seems to lack the flexibility of some of the other systems. The power and flexibility of the (natural) human voice and the richness of video's presentational form both highlight some of the inherent limitations of CAL.

Computer Conferencing

Using the local study station linked to the main-frame via the telephone service, a student can type up essays or leave messages or queries for the tutor. The information can be batched and sent down the telephone line in a burst (to save line costs) to be dumped on the main-frame computer. The tutor can call up all the essays one by one from the main-frame on his own micro, mark them and add comments or further work, and using a secure code-word, enter the grades against the students' files. If the tutor wishes, all students can access each other's essays and comments. Students can comment back to the tutor, or with each other, either before or after preparing their assignment. "Conversations" via the key-board can be had in real time via the computer, or messages or queries left by students or tutors to be "collected" when convenient. This system enables a central tutor, not necessarily based in the central distance teaching institution, to handle on a personal basis a relatively small number of students over a wide distance. The tutor's role here is more than remedial or support. Instead the tutor has responsibility for curriculum design, helps students organise their work, provides some direct tuition, and guides further reading. It results in a much more personal relationship between teacher and student than the conventional distance teaching package provides, and there are obvious savings in staff time and print compared to the traditional distance teaching package. Because of the limited numbers that can be handled by an individual tutor, the system is probably better suited to more advanced levels of distance study. It should be noted that neither teacher nor student require specialised computing skills. The software used provides a system of codes and menus which allows students and tutors to collect and assign messages. The software which provides this facility can be bought "off-the-shelf" for $10,000, and can handle up to 200 simultaneous connections, dependent on the main-frame capabilities. Such a system is already operating on a private basis in the U.S.A. (the Electronic University), but has yet to be adopted, as far as I know, by any established distance education institution, although the Open Learning Institute in Canada is considering introducing a course on creative writing using this method of teaching. It is impossible for me at this stage to give an indication of costs of such a system, but it is clear that computer conferencing changes the nature of distance education from a heavily centralised, mass production system, to a system of close individual contacts, mediated by a centralised main-frame computing system, with high equipment costs at the student and tutor ends, but very low production costs.

Audio-graphics systems

It has already been pointed out that a weakness of computer-assisted learning is the lack of natural voice. A great deal of money is going into the development of synthesised voice generated by the computer, but there are simpler solutions to this problem. Another limitation of computer assisted learning has been the difficulty of producing quick and cheap graphics, without the need for a good deal of skill in programming. Again, there are other solutions to this problem. It is now possible **using pre-prepared computer software not only to incorporate** natural voice through the use of standard audio recording with computer programmes, but also to create graphics using a light pen and keyboard without having to learn computer programming. The consequence of this is that any teacher can create audio-visual materials, with sound and graphics, using a micro-computer. These materials can either be stored and distributed via an audio-cassette, or sent down telephone lines.

For instance, the Open University in Britain developed a system called CYCLOPS which digitally converts simple colour video-graphics - handwriting, text, diagrams and simple animation - into sound codes. These graphics can be easily generated using a combination of a standard computer keyboard and an electronic light pen, which "draws" on a standard television screen, or a digitised electronic pad. Because the video pictures generated are converted by the computer into sound codes, they can be stored on audio-cassettes, or transmitted down standard telephone lines as data, then decoded back into a video signal. Using standard audio-cassettes which have two tracks, one of which can be used for the sound and the other for the picture data, or two telephone lines, again one for voice and the other for picture, full sound can be synchronised with the visuals. For instance, each picture created can be stored in the computer, and the computer can be used to call up the pictures or edit them as required, and then the sound track can be added later. The CYCLOPS system was bought by a British company, Aregon International Limited, and converted into a more sophisticated piece of equipment, called EXCOM-100. This system has been used in Indonesia to send audio-graphics to several University sites, using satellite transmission. The system can operate either as an individual work-station, with a student working through a cassette of sound and pictures, or as a distance tutorial, with sound and picture carried by standard telephone lines, using standard conferencing facilities, so that all students and tutors at different sites can see the graphics and hear the sound, and add their own graphics and comments as necessary. Although EXCOM-100 is a dedicated system, it is possible to provide an audio-graphics system as a small chip that fits into a standard micro-computer.

The crucial point about this system is that anyone can use it without the need for specialist computing knowledge. CYCLOPS telephone tutorials ran for over three years with over 600 students on 22 different courses in the East Midlands region of the Open University. The extra costs over and above that of a standard micro-computer are around $150 for the chip and light-pen, or about $4,000 for the dedicated EXCOM-100 system (which provides superior graphics and editing facilities). A standard C60 audio-cassette costs around 50 cents, and in the telephone tutorial mode, the line costs are double that for a normal audio-conference (since two lines have to be used). Thus the system is more expensive than an audio-conference, but far less expensive than the production of a television programme.

All three of these computer-based systems require the availability of a micro-computer and a telephone system capable of transmitting data. And that is the problem for many countries. In Britain, only a third of Open University students have a micro-computer in their homes. Furthermore, there is a great variety of micro-computers owned by these students, and each different brand of micro-computer requires a different version of computer software. Also in Britain, micro-computer ownership is strongly income-related. Low income families rarely have micro-computers. In order to transmit data through the telephone system, a special jack needs to be installed in most homes in Britain, adding further costs. To provide the kind of work station required for distance education means an investment of at least $1,000 per student. In addition, the institution needs a main-frame computer and staff to run it, order appropriate software, and develop appropriate systems. Teaching staff need to learn new skills.

Distance education systems in North America and Western Europe are still likely to make increasing use of computer-based technology. As well as handling some of the teaching functions, computer systems can take on an increasing administrative role, enabling savings on staffing costs. For instance, once a student has a work-station linked to the main-frame, it can be used for choosing courses, registration, fee payment and changes of address - all entered by the students themselves. However, such systems are capital intensive. They need a lot of investment to get them going. They also need an abundant supply of skilled people to introduce and maintain the systems, and good telecommunications facilities, all features lacking in many countries today.

Lastly, a word must be said about the educational effectiveness of computer-based distance education. The range of teaching functions that can be comfortably handled by computer-assisted learning is recognised to be limited. Computer conferencing is as yet unevaluated. Audio-graphics systems are useful, but, like computer-assisted learning, require substantial investment of time in developing materials and require capital investment. In other words, the cost-effectiveness or return on capital of computer-based systems has yet to be proved. The technology certainly has promise, but it is a high risk activity, and its introduction on any large scale in poorer countries would probably be premature.

COMBINATIONS

A feature of the new technologies is that in many cases they can be linked together. The most obvious case of this is the computer and video-disc player. Each of the 57,000 individual frames on a video-disc can be identified electronically. This means that a micro-computer can control the operation of a video-disc player. This does more than just allow pictures to be added to computer-assisted learning packages, or computer activities to be added to video programmes. The video-disc can be seen as an enormous audio-visual data base, which through the help of the micro-computer can be accessed or ordered in various ways. This opens up a whole new range of potential teaching and learning approaches.

Similarly, viewdata systems are basically a combination of telephone, computer and television technologies, again allowing large data bases to be accessed relatively easily by the general public. Satellite distribution systems can be linked into local cable systems, allowing independent cable systems to be networked together.

However, while combinations of media may increase the teaching power of technology, they do not necessarily eliminate the difficulties and limitations of each separate technology. For instance, creating an interactive video-disc from scratch can be horrifyingly expensive - the cost of computer-assisted learning added to the cost of broadcast-standard television can easily exceed the sum of the parts, because of the increased complexity of the process.

SO WHAT DO WE DO?

Unfortunately, there are no easy solutions to the problem of media selection and use in distance education, and if anything the problem is being made more rather than less difficult by the proliferation of new technologies. In such circumstances, it is natural and perhaps sensible to make use of what is readily available in any particular context, but such an approach does leave institutions vulnerable to the pet enthusiasms of powerful politicians or academic leaders or the marketing strategies of hardware companies, and could lead to costly mistakes. So how does a distance teaching institution deal with such a rapidly developing situation? I will try to break this general question down into four smaller questions:

- what will be the likely social and educational effects of introducing these newer technologies to distance education?
- are they more cost-effective than existing media?
- will they change the nature of distance education?
- should they be used in poorer developing countries?

Social and Educational Effects

The more distance education courses rely on students having hardware of certain kinds in their own homes, the greater will be the danger of providing distance education for the wealthy and the privileged. Furthermore, the greater is the likelihood that teachers and administrators will be diverted away from basic educational issues into mastering and managing the technology, and perhaps even more important, the balance of resources between system management and direct teaching may shift away from direct teaching activities. It is already becoming clear that even when hardware and support systems are provided, there is often still a shortage of resources for creating teaching materials - the programmes themselves. Governments are much more willing to provide money for equipment, and far less willing to provide money for people - yet someone has to create the material which will be run on the equipment.

It becomes even more essential then when making decisions about choice of technologies that distance teaching institutions are very clear about their primary aims and objectives. Is the aim to reach all people in a country, including or particularly those who are poor or poorly educated - or is the aim to promote or broaden the base of a technological elite? In the former case, there would necessarily have to be less use of high technology; in the latter case, it would make sense to develop teaching systems around technologies that will themselves be the subject of much of the teaching.

Cost-effectiveness

The introduction of some of the newer technologies is on balance likely to increase the instructional effectiveness of the teaching, but almost certainly at a higher cost per student. Furthermore, it is clear that there is no one super medium. While some of the newer media such as computer-based technologies are strong in areas where other media have been weak - such as broadcast television - these newer media bring their own problems and limitations. This merely reinforces the need for a multi-media approach. Nor is there a direct relationship between the cost of a technology and its effectiveness. Video-cassettes seem to be more effective instructionally than broadcast television at lower cost - if the distribution problem can be overcome; audio-cassettes combine the advantages of low cost and easy access with highly effective teaching when designed properly. Audio plus print cannot do all the things that video can do - but the extra gain is relatively small compared with the extra cost. Micro-computers may be instructionally superior to radio, but this does not help if students cannot get micros or if the cost of developing teaching material suitable for use on micros is too great.

The crucial point is that well-designed teaching is more important than the medium on which it is run. There is though a tendency in my own country for the Government to reduce staffing and hope that the technology will compensate for this. Unfortunately though good design takes time and needs good people.

The Changing Nature of Distance Education

The clearest impact of the new technologies will be on the teaching institutions themselves. There are two important issues here. The first is on the balance between home-based and institution-based distance teaching. To what extent is it important for students to learn at home or to go to a local centre for instruction? Again, the greater use that is made of technology, the more it is likely to force students into attending local centres, where the technologies will be available to all enrolled students. The second issue is the impact some of the newer technologies are likely to have on the larger, autonomous distance teaching institutions. I foresee two trends.

First of all, local schools and colleges do not provide the right kind of architectural environment for students wishing to study independently through technology. The classroom is not the best place for this kind of activity but the library. There are also problems of security and safety when technology such as television or micros are being used. In the first year that the British Open University put video-cassette recorders into study centres, 57 were stolen! This was because they were placed in open class-rooms where access could not be controlled. I suspect then that for several reasons, including the high cost of providing equipment, learning centres will move out of colleges into local companies' premises, with distance teaching more and more geared to company training needs.

Secondly, some of the newer technologies - particularly computer-conferencing, audio-conferencing, and audio-graphics based teaching - do not need the large team approach and industrialised production systems associated with print-based distance education systems. All that is needed is access to an appropriate main-frame via the public telephone system. This means that it will become easier for conventional institutions to provide off-campus teaching (cable television is another development which will encourage this trend) or more importantly, will enable students more easily to combine on-campus and off-campus teaching over a continuous period of time, a development which is important given the need for continuing education and training throughout life.

New technology and poorer developing countries

Being a pessimist, I suspect that the new technologies will inevitably widen the differences between the rich North and the poor South, with regard to distance education. The last thing that Western Europe needs is 13 direct broadcast satellites sending out another 50 channels of television, none of which will be used for educational purposes, whereas a satellite over Africa could provide widespread access to educational materials, if only one could be provided.

My own solution when in doubt is to choose the easiest system to operate at the lowest cost, which would lead me to stick to print and audio-cassettes, with a little radio and broadcast television, for home use, and perhaps video-cassettes for use in groups at local centres with a tutor. If I had the nerve, I would try and stick to this policy, and watch the rich, Northern institutions drain themselves in the race to keep technologically ahead in distance education. But I do not underestimate the technological imperative - indeed, how else can I explain my own fascination with these newly emerging technologies?

References

This paper draws mainly from the following publications:

BATES, A.W. (1980) The Planning and Management of Audio-Visual Media in Distance Learning Institutions. Paris: International Institute for Educational Planning

BATES, A.W. (1984) Broadcasting in Education: An Evaluation London: Constables

BATES, A.W. (ed.) (1984) The Role of Technology in Distance Education London: Croom Helm

BATES, A.W. (1985) Selecting and Using Media in Distance Education London: Croom Helm (in preparation)