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Realising the potential of interactive videodisc for education

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A person making a casual examination of the literature about interactive videodisc (IVD) could be forgiven for concluding that a revolution in education and training has taken place, but as Bosco (1984, p.13) observed, "many of the articles and reports on interactive video which have been produced in the last few years are written from a stance of advocacy". A great number of claims made about IVD use in education are speculative. A good example of such exuberance is this comment by Jonassen (1984, p.2), "there is little doubt that microcomputer-controlled videodisc systems represent the most potentially powerful communication device in the history of instructional communication", or Young and Schlieve (1984, p.4), "Videodisc technology may well revolutionise education in both public and private institutions by the end of the decade". Such rhetoric is similar to that which accompanied the introduction of microcomputers into schools. Interactive videodisc technology has great potential for education but there are some important issues to be addressed.

A hybrid medium

The term interactive videodisc has different meanings for different people. Rapid development has resulted in a wide range of equipment and techniques complemented by a diversity of applications but there is agreement that "interactive video represents the fusion of video and computer technology" (Parsloe, 1383, p.83). Teh and Perry (1984, p.2) suggested that IVD "represents the synthesis of the instructional capabilities of television and the computer", while De Bloois (1982, p. 33) suggested "... it is an entirely new medium with characteristics quite unlike each of the composites". The key point of this fusion, as Bosco (1984) pointed out, is that the information on a videodisc can be controlled by the microprocessor so that the system reacts to learner behaviours. Moving images, stills, computer graphics and printed information can be combined and structured into an instructional unit which can readily interact with the learner.

Educators familiar with the plethora of terms used to describe 'earning involving a computer will not be surprised to find that IVD has been incorporated in just about all of them; from Computer Assisted Learning (CAL), Computer Managed Learning (CML), Computer Based Instruction (CBI), to Computer Based Learning (CBL), and Computer Assisted Instruction (CAI). Indeed IVD designs and uses have involved elements of all the above. Using Taylor's (1980) tutor, tool, tutee categories, IVD best fits the tutor paradigm. However, even the fairly unsophisticated IVDs made to date have gone beyond this concept.

Video Disc Capabilities

There are two main videodisc formats - optical laser discs (marketed by Philips, Pioneer and Sony), and capacitance discs, termed Video High Density (VHD), available from Thorn/EMI. In late 1985 production of a new format, Laserfilm, began (Sansui/McDonnell). Optical laserdiscs bounce a focused beam of intense light off a reflective surface of the disc through a photosensitive diode which converts variations in the reflected light into conventional electronic signals, suitable for replay on a television receiver. The optical laserdisc system gives either 36 minutes of playing time and/or 54 000 individually addressable frames when a disc is used in an interactive mode (Constant Angular Velocity - CAV) or 60 minutes of playing time when used in the play-only mode (constant linear velocity - CLV). Video high density discs use electrically conductive plastic and a sensor which resembles an LP record system. This provides 60 minutes (or 45 000 frames) of continuous playing time per disc side. VHD discs can wear out fairly quickly and do not have the same frame address accuracy as laserdiscs, but are 3-4 times less costly. Laserfilm uses photographic process and lasers to record images, sound and data. Mastering and duplication is simple and cheap (4% of Laser Vision costs). While Laserfilm has definite cost and convenience advantages over VHD and Laserdiscs it has less capacity (30 000 frames) and early reports suggest the quality is inferior.

Optical Laserdisc is the preferred format for education at present because it provides fast access times, very high quality pictures, stereo sound and can be controlled by an external computer which provides interactivity, and generates text and graphics. Features such as dual audio channel stop motion, frame by frame review. either slow forward or reverse, auto stop, and rapid scan are also useful control features. If the 54 000 frames were given over to text then there would be room to store: 160 million words, 655,000 A4 pages or 1300 books. The whole of Encyclopedia Britannica could be stored on two-thirds of one side of a video disc (Gienke, 1984). An important feature of a videodisc is its ability to store a variety of multimedia materials (slides, film sequences, audio, etc.) on one format.

Videodisc players with reasonably powerful on-board microcomputers are already available but, despite claims to the contrary, their use to date has been primarily for dedicated tasks. The improved use of onboard microcomputers should do away with costly and cumbersome interface devices and allow for a system that is simpler to operate.

Trends towards miniaturisation and high density storage indicate that smaller discs with greater capacity will be available in the near future There is a strong likelihood that transparent Compact Discs suitable for use as audio and video record and replay, which could be read on both sides simultaneously, will be commercially available within five years. Compact discs (in the form of CD-ROM) are already used for data storage for microcomputers and have the potential to provide a versatile universally compatible standard. Problems of incompatibility may seriously hinder educational use of IVD equipment. Pioneer have gone some way towards a solution with the release of the CLD-900 which can automatically play eight or twelve inch NTSC videodiscs or audio Compact Discs. The speed of innovation in videodisc hardware design makes compatibility an important issue to consider. If wide usage of IVD is to become reality in education, a universal standard will be essential. Standardisation of format, when combined with the ability to re-record, will lead to wide consumer acceptability. Sony and Philips have agreed to collaborate to develop common standards for interactive use of video and audio Compact Disc systems. Such cooperation is crucial to ensure information is standardised for translation to discs (Screen Digest, March, 1986, p.57).

Education and Training

While this paper deals mainly with the educational potential of IVD, many of the issues discussed here affect the development of IVD for both education and training. A number of applications of IVD for training have been isolated. IVD is particularly effective for teaching mechanical and procedural skills (Priestman. 1984). US military human resource laboratories have found that IVD can provide sophisticated simulation training that is more cost-effective than hands-on training in many technical applications (Meyer, 1984). In consequence, the US Department of Defence has taken a leading role in the development of IVD in an attempt to find more cost-effective utilisation of learning resources. As a result IVD has been elected by the US military as its future training delivery medium resulting in the installation of 50 000 fully interactive systems over five years (Screen Digest, February, 1986, p. 38). However, the most immediate potential for IVD is in sales and marketing. Major corporations such as Ford, General Motors and Sears and Roebuck are using the system extensively for training and sales.

Despite the assertions of some authors (Kearsley and Frost, 1985) there remains a need for more convincing evidence that such a costly learning system is an effective method of instruction. Much of the rationale for adopting this method of instruction seems to be based on intuition. Earlier research is based on videotape-based systems and although a number of findings can be translated to disc-based systems, many important areas, such as rapid random access, cannot be generalised to IVD. As Hannafin (1985) asserts there is a need for empirical research to clearly demonstrate the efficiency of IVD use in education.

Doulton (1984) reported on the use of IVD in secondary school science lessons in the United States. A comparison of normal classroom experiments with IVD simulated experiments was conducted. Results indicated that when IVD is integrated effectively improved standards of laboratory work are evident, as was a greater range of exploration by more talented students. An added bonus is the time saved in comparison with setting up normal experiments; this has important time over task management implications.

Communications operators can be taught to operate complex pieces of equipment by IVD simulation. Young and Tosti (1984, p.41) found that "A statistical comparison of learners certified using videodisc simulator equipment showed no difference in the actual ability to operate the complicated communications equipment." Ferrier (1982) described the use of IVD for competency-based training; it was judged a cost-effective adjunct in certain applications in training for leadership, management and organisational development.

There has been a positive response to the Teddy Bear Disc which has been produced by the Open University for use at residential summer schools. Videodiscs are seen as a way of augmenting or even replacing summer school laboratory sessions as well as allowing students to participate in experiments otherwise unavailable to them (Williams, 1984).

Teh and Perry (1984) reported the results of an Australian developmental project which designed and evaluated IVD based instructional materials for teaching the concept of weather forecasting. IVD materials were found to be an effective teaching medium in geography, with trial subjects (who were trainee teachers) achieving superior scores for content understanding. This study also sought to use the videodisc to model complex concepts that would not be possible using existing video technologies.

The Alaskan Department of Education has conducted what is probably the most comprehensive study of the feasibility of using videodiscs in public education. Reports produced by the Alaskan Innovative Technology Project advised caution in moving into this technology (Hiscox et. al., 1981). However, positive endorsement was given to the use of this IVD to replace film and slides. Other developments, which are a by-product of cut-backs in funding for education, are affecting the adoption of this technology. The American ABC-NEA Schooldisc project planned to produce a number of magazine-style IVDs on an annual basis. However, when production costs involving curriculum personnel became too high the project was suspended. A National Science Foundation videodisc development suffered a similar fate (Bosco, 1984). Most educators seem to be adopting a "watching brief" because of the well founded fear of over-extending limited budgets.

The limited data available suggests that IVD is an effective teaching and learning medium, especially in the area of training simulation: removing the variability of human teaching is a major advantage of IVD courseware, but there is an urgent need for more comprehensive evaluations especially related to school environments. Learner acceptability of the medium needs to be established. Comparison of IVD and traditional teaching methods must provide a detailed analysis of cost-effectiveness.

Interactivity - the key

Bork (1984) claimed computers are going to be an important factor in all human learning because they make learning truly interactive for large numbers of learners on a cost-efficient basis. Bork (1984, p.3) also observed that "many of the videodisc plus computer modules produced so far by video people are extremely weak with regard to interaction." He contends that students and teachers are content with very weak forms of interaction because these are such an improvement over non-interactive learning media. Bork's observations seem well founded.

How IVD technology can affect learner interaction requires examination. The University of Nebraska Group has defined four levels of interactivity for a videodisc (Hart, 1984; Priestman, 1984). The sophistication of these levels affect the kind of learning possible.

Level One is the most basic level. Information can be fragmented, suspended, repeated and integrated into new wholes, but specific sections cannot be called up quickly or accurately. The features of "freeze frame", and slow motion (in forward or reverse) are normally used via the keypad. At Level Two a small microprocessor built into the videodisc player allows accurate random access for video segments or single frames, allowing replay in any given order at a given pace. Program information is recorded on the disc, and forms an integral, but unchangeable, part of the system.

Level Three involves linking an external microcomputer to control the videodisc player. An additional source of information is supplied from the microprocessor's memory system. Level Three interactivity is sought by most IVD designers, but it is worth bearing in mind that many worthwhile educational activities are possible at lower levels of interactive sophistication which are relatively easy to design.

Level Four involves linking microcomputers to large databases for storing and running programs. Problems with main frame "time sharing delays" and telephone line capacity will restrict large scale implementation of this level for some time although videotex could assist in overcoming this problem. Access charges have to be accounted for, and although competitive, will still prove a problem for many educational institutions, especially schools.

Design considerations

Balance and control over learning strategy and content by the student is important. Videodiscs provide a vast information base which is quite different to that available from a computer. The more information available the greater the flexibility in combining sequences. Evidence suggests, (Hartley, 1981), that student control over learner strategy is the most efficient approach to CAL design. Encouraging individual routes through information will assist students to become more actively involved in the learning process.

An unrealised potential exists for learners to control instructional presentations, without lessening the overall coherence of the courseware. Hedberg and Perry (1985) claimed that IVD has eliminated the requirement for materials to be structured for the learner. They asserted that not only has IVD improved interactivity with visual materials, which can be incorporated into an instructional sequence, but interactivity beyond the designers" original intention is also possible. Hedberg and Perry (1984, p. 6) also claimed that the addition of "dynamic and static visual display enabled students to 'see' events that were not previously possible as part of CAL lessons."

Nievergelt (1982) agrees that programs involving human/machine dialogues should avoid designs which are passive in format. Instead learners should be given as much control as possible over the programs or at least opportunities tor regaining control at some stage of the instructional sequence. While the potential for learner control of well designed IVDs is acknowledged and considered desirable there is insufficient evidence to date to refute these assertions.

Few educators need to be reminded that learning is not a passive process. Understanding and knowledge involve active processing rather than passive reception. A consistent claim made in favour of developing IVD is that "it changes the student from passive observer to active participant" (Anandam and Kelly, 1981, p.3). The ineffectiveness of modern media as a learning device (in comparison with the written text) is due to the lack of opportunity for interrogation. Allied to this observation is the valid criticism that the learner loses control over the pace of instruction (Clark, 1984). New theories of learning which will inform instructional design will have to be formulated to allow for these new ways of interacting with the subject matter. Such theories will need to be incorporated into IVD designs. Hedberg (1985/86) has suggested a set of design heuristics for IVD which encourages student involvement with the process of learning. If the claims made for IVD are correct, then learners will benefit by a medium more amenable to individual learning styles.

Microcomputers can provide a more individualised learning experience. CAL learning has largely been developed on the basis of learner interaction. Perhaps the greatest limitation of computer learning has been its delivery - predominantly in text or in diagrams, without the visual and aural attractiveness of television. Film doesn't always lend itself to informing about higher order concepts and it is often difficult for a learner to conceive of actions presented in text or diagrammatic form. At the same time, educational television has not produced improvements in learning to the extent originally predicted. Perhaps this is largely due to the receptive mode of learning it encourages (Laurillard, 1982). Certainly the ongoing linear nature of educational television does not adjust for the pace and learning style of individual students (Teh and Perry, 1984). Capitalising on the strengths of the two media, while limiting the disadvantages, should result in a more active learner interaction.

Developing the Innovation

How will IVD translate into effective instructional applications? Cost considerations are, understandably, uppermost in most educators' minds.

Schools are just recovering from spending a considerable portion of available funds on microcomputers. Besides an inability to afford the hardware, there is a pressing need to retrain teachers to accept and use new technology. Teacher acceptance will be an important hurdle to overcome. Presumably the widespread adoption of microcomputers in schools will ease the initial reluctance but may not prevent teachers from feeling that their independence is under attack. Educational administrators will be keen not to exacerbate the problem by lack of consideration of design quality. It is widely accepted that the majority of educational computer software is poorly designed; if IVD is left to be developed by free market forces, a repeat of this situation is probable.

Arguments which centre on increasing the quality of education as a justification for investing in this or any other technology will fall on unsympathetic ears. A number of IVD advocates seem convinced that this technology has the potential to not only transform the delivery system of public education, but also to reduce costs (Price and Marsh, 1983). There is potential for reducing the cost of delivering education using IVD for well targeted applications. However, if IVD is going to be adopted it will be at the expense of some other aspect of education because proposals which require an increase in the overall education budget allocation are doomed.

The cost of developing IVD with even a reasonable amount of interactivity is great in terms of man hours and technology. Media production, especially broadcast quality television, requires a large investment in equipment, and high labour costs. Competent planning is vital with this medium if costs are to be contained and a long shelf life of the courseware is to be assured. Already a number of "how to" manuals are available for IVD producers, and the need to formulate IVD teams with a range of skills; computing, media production and instructional design experience, is emphasised in all of them.

Butler (1981) estimates it would cost between $US 500,000 and $US 700,000 to develop enough courseware for a one-year college course. Philips have quoted £1500 for making a master disc and £8 for release pressings and £20 per 100. The actual discs will cost between £10 and £24 in quantity. As Fletcher (1985) notes, instructional videodiscs are produced in small quantities resulting in high unit costs; for example to produce five or less discs costs $US 615 per side. The unit cost falls to $US 17 per side for quantities of more than 500. These costs are falling but there is still the large courseware design cost to consider. The cost of courseware design and production will easily overshadow the cost of hardware as a major impediment to the utilisation of IVD by education.

Cost-effectiveness

Curiously, few IVD producers seem interested in closely examining the educational cost-effectiveness of the medium. This is true for most media production. There is some evidence to suggest that not all design costs are accounted for. A "cheap" videodisc can be made by enthusiastic students, using on-hand equipment, and the budgets of other departments. Although the lack of IVD costing information is no worse than for other media, realistic total cost analyses for developing IVDs would be useful if arguments in its favour are to be advanced.

IVD will not become a reality in Australian schools and tertiary institutions unless economies of scale can be developed. How this is likely to occur is not clear. if the lack of mutual co-operation in the production of curricula and audio-visual resources to date is any indication, there is no cause for optimism. The development of a national curriculum for certain subjects would allow funds to be pooled to produce IVDs, although local curriculum needs must be considered. Perhaps certain attributes of the technology may be exploited to overcome this problem. A compromise solution to the inevitable conflict of local curriculum idiosyncrasies and the need for economy of scale is needed. "Generic discs" (Jonassen, 1984) or a "video databank" (Cohen, 1984), containing material in a variety of forms related to subject areas, could be developed to form a visual database suitable for use in a variety of circumstances. A simply formulated authoring system would be needed to enable flexible access by the microcomputer to videodisc material. Generic discs could provide video programming at reasonable cost for a wide audience, while allowing for local learning requirements.

Flexible authoring systems which are simple to use, such as MUMEDALA (Barker, 1984) and MICROTEXT, (Barker and Singh, 1984) must be applied if teachers are going to have any chance of utilising this idea. Automatic monitoring of student responses and program effectiveness will allow teachers to revise and improve the designs. Unfortunately there is an inverse relationship between the ease of authoring and flexibility of the program. Authoring languages which provide a very high level of support in the way of prompts and instructions, tend to produce less interactive presentations than those requiring programming. Conversely, writing interactive programs in computer languages takes considerably longer, and as a consequence, costs more.

In the past innovators in educational technology have assumed teachers would alter their methods to accommodate technological advances. But the lack of software may not be as much of a problem as overcoming teacher reluctance, and retraining. Simply making 16 mm films widely available has not resulted in significant learning improvements. Bosco

(1984) has suggested that re-organising certain subjects into modules (similar to industrial training modules) may be a more efficient way of utilising technologies like IVD. Teachers will need to adopt a more managerial role, as opposed to an instructor role, if IVD is going to be used extensively. IVD designs could assist teachers in managing student learning environments; test scores and record keeping are readily organised. Designs could be readily developed that are suited to criteria learning.

The great potential of IVD to provide a complete, individualised learning system will only be realised if professional organisations and expertise are rallied to create high quality software. Some countries have already taken positive steps in this direction. Simcoe (1983) found that approximately 40 per cent of American media centres are utilising some form of IVD, with over 25 per cent using some level of IVD for instructional purposes. The French Education Ministry has already begun supplying videodisc players to schools for use in interactive applications with microcomputers. National Interactive Video Centre has been set up in Britain by the Council for Educational Technology. A register of research and development, technical briefing and support for production consortia are given by the centre. A few Australian tertiary institutions, WA Institute of Technology, Darling Downs Institute of Advanced Education, and Adelaide University have produced IVDs. The Australian Caption Centre has produced the first PAL IVD for schools in cooperation with the Education Department of Western Australia. A national IVD development strategy for education could obviate problems of equipment compatibility and encourage disc production.

Conclusion

Combining the visual stimulation of moving and still images with the interactive capabilities of computer technology has resulted in a potentially powerful learning medium - IVD. However, before IVD can become widely accepted by education some important issues must be resolved. A substantial amount of high quality courseware needs to be developed. For the cost of developing courseware to be justified, it needs to be relevant to the needs of a large and diverse student population.

Poorly considered usage of IVD will result in inappropriate adoption of the technology. There is an urgent need for effective evaluation to establish the type learning best suited to the medium, and whether cost justification for large scale adoption can be established. Large scale adoption of IVD will require a substantial commitment of funds, and energy, if software of a high enough quality is to be developed. Teacher resistance and the need for retraining is a factor that should not be overlooked. Educational budgeting is in fiscal demise, which means that for IVD to be developed other areas of endeavour may suffer. Decisions of this degree of importance should be based on solid cost-effectiveness analyses and educational rationale.

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