

Interactive Videodisc and
Student Control of Learning

By

P. Pemberton, J. Taylor, M. Toeman

Darling Downs Institute of Advanced Education

P.O. Darling Heights, Toowoomba, Q. 4350

Abstract

This paper describes an interactive videodisc laying particular emphasis on the techniques used to provide student control of, and interaction with, the subject content. While the topic treated is Mechanical Vibrations the techniques used are applicable to a wide range of disciplines.

Introduction

The majority of educators appear to agree on certain fundamental maxims:

- * the student should play an active role in the teaching-learning process
- * the process should be individually paced
- * individuals learn in different ways
- * the student should exercise control over his/her own learning.

Unfortunately, and for quite sound reasons, these ideals are seldom approached in tertiary education. Even with the most dynamic lecturer the traditional lecture is inevitably a passive experience for the student. Increasing student numbers make it progressively more difficult to attune the tutorial to different paces and modes of learning. Timetabling constraints and diminishing technician assistance are making demonstrations, and even laboratory sessions, increasingly rare events for students. However interactive videodisc, promises to bring these ideals within reach.

Videodisc at the Darling Downs Institute of Advanced Education

The DDIAE has a substantial external student population spread throughout Queensland at distances up to 2000km from the campus. Consequently, it is very interested in student-centered, as opposed to institution based, teaching methods and technologies. For some years it has used Computer Managed Learning (CML) and telephone tutorials to support its external courses.

The advent of the low priced desktop computer allowed it to move much of the CML off campus to Study Centres distributed throughout its catchment area. Now the development of inexpensive but powerful personal computers raises the possibility of providing CML/CAI to the student in his own home. Australia has a relatively high ownership of videocassette recorders (1 family in 4) and this ratio is even higher

in the remote areas where many of the external students reside. Videotape has therefore also been used to support the external courses.

When interactive videodisc technology became available in Australia it was a natural progression for the DDIAE to undertake a project to assess this new medium.

The Topic

Of all of the courses offered externally by this Institute those in Engineering, with their heavy emphasis on laboratory and practical work, have perhaps the greatest need for innovative teaching methods and technology.

Mechanical Vibrations was selected as the topic for our first foray into interactive videodisc because it offered a valid reason for using a very wide range of video and CAI techniques and hence provided an opportunity to evaluate those techniques in the context of this new medium.

The Courseware Structure

Viewed as a linear programme Mechanical Vibrations consists of five sections:

- (i) an introductory section dealing with simple harmonic motion
- (ii) free undamped vibration
- (iii) free damped vibration
- (iv) forced vibration
- (v) transmitted vibration.

Sections (i), (ii) and (iii) are recorded on side 1 of the videodisc while sections (iv) and (v) are on side 2.

Each section starts with visuals of practical examples as an "opening teaser", an advance organiser in diagrammatic form outlines the content of that section, the phenomenon is then presented as a laboratory demonstration, the theoretical model is established, the effect of the different variables is predicted and demonstrated and the section is rounded off by relating the phenomenon to practical situations before being closed with a formal summary.

Figure 1 summarises the structure of the courseware.

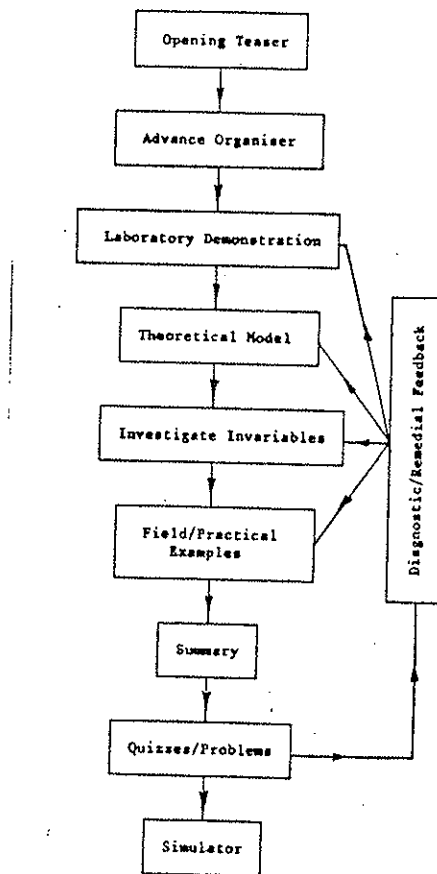


FIGURE 1 STRUCTURE OF COURSEWARE

The student is then presented with a series of quizzes and problems drawn at random from a set and using data which in turn is drawn at random from a set of realistic data. A correct answer allows progression to the next quiz/problem and finally to the next section of the program. An incorrect answer elicits a diagnostic response and directs the student back into a remedial segment of the program followed by further testing.

Finally each section is rounded off with a simulator which allows the student to explore experimentally the effect of the different variables on the phenomenon.

Storage Format

All of the field and laboratory visual sequences, most of the text and graphics used in the primary presentation and all of the audio materials are stored on the videodisc. Sound track No 1 is used exclusively for the primary presentation. Sound track No 2 provides: audio "links" for the different audience presentations, remedial sequences, and supplementary commentary.

Some of the primary presentation text and graphics, all of the text and graphics involved in the quizzes and problems and all of the simulations are stored on floppy disc and generated by computer.

Technical details are given in Appendix I.

Student Control

A certain amount of control over the sequence of presentation is embedded in the structure of the courseware, both videodisc based and computer based. However, four (4) interaction/control techniques are incorporated which, in combination, give the student a very large measure of control over the sequencing and pacing of the presentation.

1. Level of Presentation

Mechanical Vibrations has been structured to suit four (4) different audiences:

- (i) a general interest audience who want only a qualitative overview of vibrations:- for this audience the material is presented in a linear, essentially non-interactive form without any of the formal advance organisers or summaries, and omitting the theoretical models, mathematical treatment, quizzes or problems.
- (ii) a non-technical audience requiring a sound qualitative understanding:- this program, although still essentially linear, provides some interaction, it includes the formal advance organisers and summaries, several qualitative quizzes and a theoretical model of the phenomenon but still without any mathematical treatment.
- (iii) a technician audience requiring a quantitative grasp of vibrations:- here the material is presented in a fully interactive form, a mathematical treatment is included together with an extensive set of quizzes and problems, and each section is concluded with a simulator.
- (iv) a professional engineer audience:- this treatment is essentially program (iii) with additional material to deepen the mathematical treatment.
- (v) in addition to these "vibrations-oriented" audiences provision has been made on side 2 of the videodisc for a very different audience; an audience interested not in vibrations but rather in exploring the

capabilities of interactive videodisc as a teaching medium. This "educational technology" section uses the mechanical vibrations material to demonstrate the features of this medium.

The first interaction between student and medium is for the student to decide which level of presentation best suits his needs.

2. Immediate Controls

Videodisc technology makes it possible to rapidly access any portion of the videodisc and hence to: play any selected segment as a normal video, or in fast motion, or in slow motion or in reverse motion; to freeze any selected picture (frame); or to change audio tracks or delete audio entirely.

Similarly computer floppy disc technology makes it possible to rapidly access any part of the computer based courseware.

These features have been harnessed within a menu structure to give the student "immediate control" over the courseware via the function keys on the computer - see Table 1. Using this facility the student can flip through the courseware in much the same way as he/she could flip through a book.

TABLE 1

IMMEDIATE CONTROLS

Function Key	Control Function
1	Freeze Frame
2	Slow Motion
3	Fast Forward
4	Reverse Play
5	Change Audio Tracks
6	Play in Normal Mode
7	Play video/audio segment prior to interrupt
8	Access LOCAL MENU
9	Access OVERALL MENU
10	Change Target Audience

The MENU functions are particularly powerful controls in that they allow the student to move to any segment of the courseware (both videodisc and computer based) and to change from one level of presentation to another. Figure 2 shows a typical LOCAL MENU.

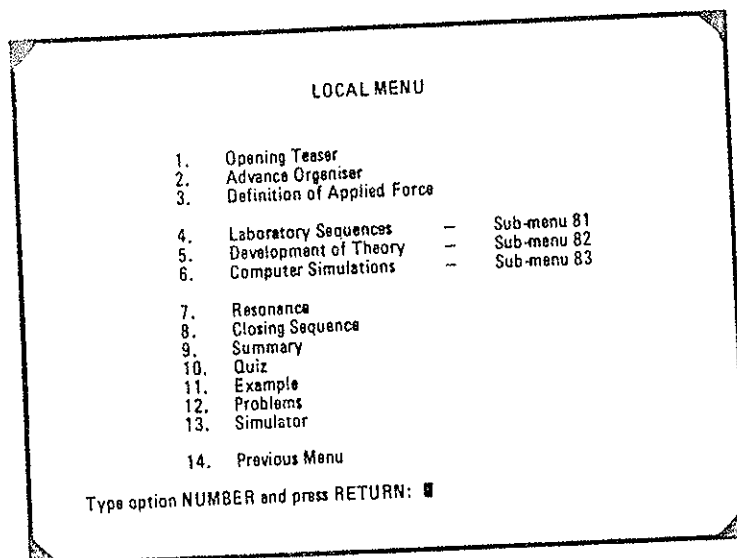


FIGURE 2 LOCAL MENU

3. Problems, Quizzes

At the end of each section the courseware initiates interaction with the student by presenting a suite of quizzes and problems relating to that section.

In both types the question is selected at random from a file of relevant question statements. Data, again selected at random from an array of appropriate data, is inserted into the question and the appropriate diagram is selected from a bank of diagrams. The correct answer and several incorrect answer options are computed and displayed in randomly ordered sequence.

For a problem there are two major directions that the interaction can then follow, see Figure 3.

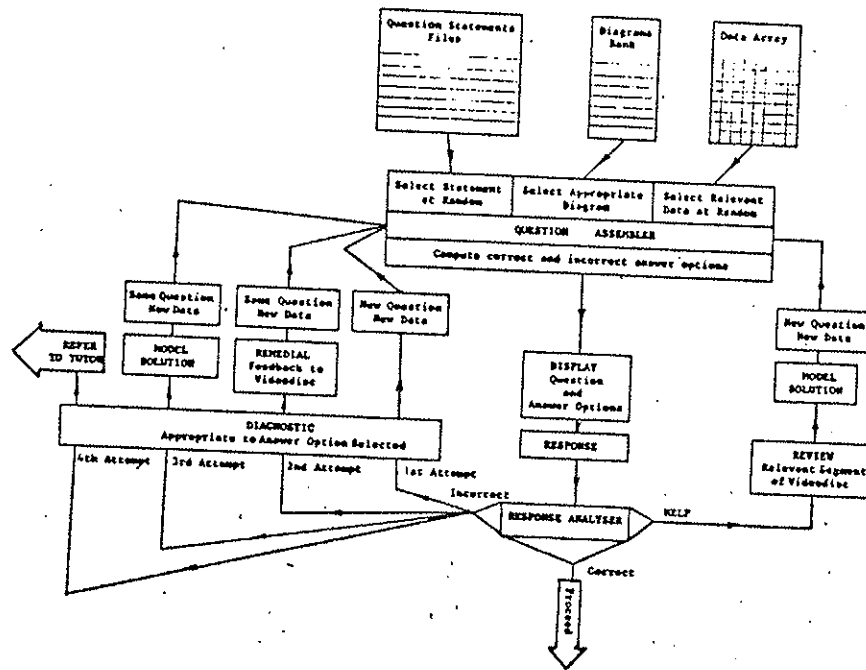


FIGURE 3 STRUCTURE OF PROBLEM

(i) The student can select one of the answer options.

If that option is correct the student progresses to the next phase. However, if the option is incorrect a diagnostic statement appears which explains why that option is incorrect. The student is then offered a new question (testing the same objective though).

If the student's second attempt is also incorrect the diagnostic statement is reinforced by a remedial segment (generally from the videodisc and using sound track No 2). This is followed by exactly the same question but with different data.

A third incorrect attempt elicits a diagnostic statement followed by a model solution generated by the computer and using the data given in the question. The student is then presented with the same question but again with new data.

A fourth incorrect attempt results in the student being referred to a tutor.

(ii) On the other hand the student may select the HELP option. In this case a model solution is presented and then the student is offered a new question (still testing the same objective).

Quizzes follow much the same structure as problems except that only three attempts are allowed and no HELP option is provided.

4. Simulators

I hear and I forget
I see and I remember
I do and I understand

Proverb

If there is any truth in the proverb then simulators are a very powerful teaching/learning tool for they not only give the student the opportunity to do; they allow him to explore the behaviour of systems beyond the limits that would be possible or acceptable in the laboratory or the field; they allow him to encounter in a few hours a range of behaviour that otherwise might take a lifetime to experience.

Evaluation of Videodisc

A monitoring system has been incorporated into the software which will record function key usage and hence the sequence in which a student moves through the courseware. It also records "time on task". This data is recorded on an individual student basis and thus opens the way to investigate relationships between the route taken through the courseware and the time spent on task with such things as student attitude and student performance.

While this monitoring system has not yet been implemented with students we have learned a lot from the general reaction of those audiences that have seen the videodisc and simply from the exercise of producing it.

For the purposes of this paper we will generally confine our comments to our experiences regarding the interactive aspects of the project.

(i) IVD is an active medium - Once the audience recognises its interactive nature and becomes comfortable with the mechanics of that interaction they expect frequent and substantial interaction.

In our experience a linear segment of more than a few minutes duration becomes a distraction in its own

right - the audience is wanting "to do something" and is no longer concentrating on the program.

An "interaction" limited to answering prompts, to doing quizzes and problems is not sufficient; the audience wants to be able to move at any point in the program to any other point, it wants to electronically flip pages, to browse through the program, to try its own thing.

(ii) IVD is a new medium

Interactive videodisc is more than simply the combination of video and CAI - it is a new medium which, as well as inheriting the qualities of its parent media, has special characteristics of its own.

At this stage our perception of its special character is still developing but some aspects are becoming clear:

- * In comparison with conventional video the ability to overlay and step images (including text) could greatly reduce the audio narrative needed to explain theoretical models, to define parameters etc. This on the one hand could make for a faster moving program while on the other allowing for a slower step by step presentation better attuned to the student's grasp of the concept.
- * The inclusion of "real life" images and even sound in the CAI sequences besides enhancing the presentation, opens up a range of activities that were not possible with conventional CAI.
- * The need for frequent interaction will greatly affect the style of presentation - perhaps IVD presentation will be closer to advertising in form and style than to conventional educational film.
- * The need to give the audience some real control over the path followed through the courseware is probably the greatest challenge facing IVD authors. Perhaps IVD programs should be written as a maze, but a maze with a difference, one in which there are no dead ends but instead where every track leads to the goal.

(iii) IVD has Educational Potential

General audience reaction has confirmed our belief in the educational potential of this medium; it is clearly an active learning medium with the ability to go a long way towards matching the teaching presentation to the pace and mode of the individual student learning; towards integrating theory and practice.

Acknowledgements

Scripting and producing an interactive videodisc is very much a team effort. The authors acknowledge the support and contribution of many colleagues to this project in particular:

Rod Ball who was responsible for the video and sound content, and Gloria Robbins who did much of the initial computer programming for both courseware and controlware.

Appendix I

Technical Details

Videodisc

The video was recorded on 1 inch IVC in PAL format and then edited on to 3/4 inch U-matic low band from which a 1 inch broadcast standard mastertape was prepared.

The mastertape was sent to the USA where it was translated to NTSC format and the master disc cut from it. The videodisc is in "constant angular velocity" (CAV) format, this being more suitable for the interactive mode required than the 'constant linear velocity' (CLV) format.

Videodisc Player

Initially the project used a Pioneer Model 3 player. This is a "first generation" player and had some technical limitations, most notably the inability to play an audio track without displaying the video image on the adjoining track and lack of facility to send the frame number from the videodisc player to the computer. As soon as the opportunity presented itself the project was transferred to a more advanced player, the Pioneer Model LD-V6000.

Micro Computer

The Hitachi MBE - 16002 system was selected for the project primarily because of its good colour graphics (640 x 400 pixels) capability. The computer addresses the videodisc player via its RS-232 interface, the control codes being sent in ASCII characters.

Student interaction is via the computer keyboard.

All of the software, both courseware and controlware, is written in Microsoft Basic.