INTERACTIVE VIDEO AS A TEACHING AID.

DAVID REX DAVIES.

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ABSTRACT.

Interactive Video (IV), the combining of video and computers, became a technical reality in the early 1980s. The main aim of this study is to evaluate the potential for the use of Interactive Video techniques in the teaching of Technology based subjects.

The project began in 1983 at the Polytechnic of Wales, Pontypridd. The aim was to produce an Interactive Video package capable of teaching the students in the Civil Engineering Department to use Surveyor's Levels. No previous work on Interactive Video had been carried out at the Polytechnic, thus all the hardware and software systems required for the project needed to be investigated. Eventually a multi-workstation, video tape system was designed, developed and tested at the Polytechnic. Final evaluation took place in the author's own college at Neath, W. Glamorgan.

In late 1984 the author had the opportunity to be involved in a second project. This was for Safety Procedure training at the Central Electricity Generating Board's (CEGB) power station at Aberthaw, S. Glamorgan. It involved a detailed study of Safety Procedures, and the development of an Interactive Video programme to train a wide range of operatives at the power station. The system was videodisc based and produced a training programme of approximately five hours duration.

Results from both projects indicated that Interactive Video material was capable of teaching a wide range of students. The study that follows discusses the theory involved in developing and testing of such an Interactive Video programme.

CONTENTS.

CHAPTER 1. Learning Theory and its application to Interactive Video.

1.0. Interactive Video.

The uses of both video and computer assisted learning (CAL) technologies in education and training have grown over the last two decades. However, educators and trainers have experienced the shortcomings of each medium as well. Video programmes present information in a linear fashion regardless of the learner's comprehension or attention, requiring no active participation and providing no measure of achievement to the instructor (Passive Delivery). CAL, on the other hand, requires activity in responding to questions, and presents information appropriate to those answers through branching, often recording student progress at the same time (Interactive Delivery). However the computer lacks the ability to present the vivid audio and visual information that video can recreate so well. In the early 80's advances in microprocessor technology brought about the integration of these two media, in the form of "Interactive Video" (IV). This new technology promised the best features of both individualised, participatory CAL and realistic, attractive video.

Many people conceive of IV in terms of its hardware (generally described as a microcomputer connected to a video player). However, interactivity is a behavioural concept and an instructional style more appropriately defined by the outcomes of the technology for the learner and instructor (1).

The development of good educational IV software still lags behind the hardware with many of the programs being poorly designed from the educational standpoint. At present, no agreed overall learning strategy exists which copes adequately with the many instructional designs for the varied applications of IV material. Present literature, consisting mainly of case reports of a few individual studies, illustrates the absence of an adequate classification scheme of tasks and instructional design methods.

The following discussion provides a framework for the development and implementation of IV material.

1.1. Theories of Learning and their Influence on IV.

The development of IV has been based on various theories of learning. This section comprises a review of the more widely accepted theories of learning and the influence they have upon IV.

Many attempts have been made to define the term 'learning'. According to Gagne (2), learning is a series of events which determine all human skills, appreciation and reasonings in addition to setting human hopes, aspirations, attitudes and values. Lovell (3) devised a less general definition of learning as a change in behaviour which is more or less permanent in nature and results from activity, training or observation. Mussen (4) provided a general categorisation of learning theory based on research which comprises an area of experimental psychology which derives most of its principles from carefully controlled laboratory studies on sub-human animals such as rats. The use of such laboratory studies has many critics, principally Stones (5), who, whilst recognising that the essential features of human behaviour can be seen in animals, warned of the danger of uncritical extrapolation from animal behaviour to human learning.

The Theories of Learning.

Two main approaches to learning theory have emerged:-

(1) Stimulus Response Associationistic Theory.

(2) Field Cognition Theory.

1.1.1 Stimulus Response Theory.

This theory is closely connected to the type of learning involving reflexive behaviours and primitive emotions, such as fear, which can be described as instances of classical conditioning. Pavlov, experimenting at the beginning of this century, found that when a buzzer sounded at the same time that food was shown to a hungry dog, and the process repeated over a period of time, the dog would come to salivate at the sound of the buzzer. The dog was said to have 'learnt' to do this in a number of trials when the

food and buzzer had occurred together. Watson, working in 1919, expanded Pavlov's study to develop the view that learning was simply a matter of establishing conditioned responses, and came to the conclusion that complex human actions were chains of conditioned responses. Gagne (6), however, strongly contested the concept that most forms of human learning could be accounted for by chains of conditioned responses, using as an example the absurdity of a child learning to ride a bicycle through a series of conditioned and unconditioned stimuli.

B.F. Skinner (7), another S-R associationist stressed the importance of reinforcement in learning, this being a particular arrangement of stimulus and response conditions that bring about the learning of a new association. Thorndike's researches also support the view that a successful response is far more helpful to future learning than a failure or incorrect reply, even if it is corrected.

Early CAL programs developed out of the use of programmed learning techniques. The theory behind these is the theory of conditioning (8). According to this view complex learning behaviours are seen as a network of stimulus-response associations. These bonds are established by providing reinforcement stimuli such as knowledge of results. Skinner proposed that the best method for learning the subject matter was to divide the learning task into several smaller sub-tasks, and concentrated upon each of these in turn. Every time a student shows that he has mastered a particular sub-task his learning is reinforced. However if difficulties are encountered, he is not allowed to progress until he has mastered the point of difficulty. Alternatively it would be possible for some remedial work to be carried out by presenting the task in question in a different way, or by breaking it down further into a number of smaller steps to give the learner the best possible opportunity to progress.

IV programs designed using this form of 'operant behaviourism' must have

complete control over the learner's behaviour, seeking to accomplish specific learning objectives as quickly and efficiently as possible. The program must control the arrangement of content and tasks to encourage the required responses from the learner, and also the type of feedback (i.e. the information given to the learner following a response) and any other reinforcement stimuli, in order to develop more complex learning behaviours by building response chains composed of small steps.

This approach assumes:-

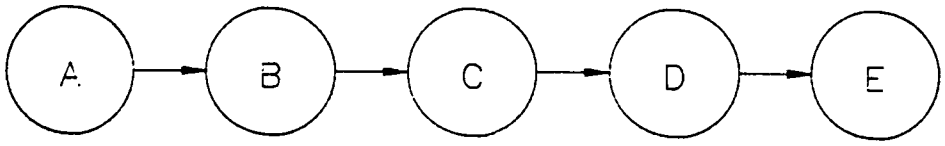
(i) the subject matter can be broken down into small sections that can be structured into coherent learning sequences.

(ii) The learner using the IV program conforms to the behaviourist learning model and responds to the program in the way expected by the theory.

Skinner placed great importance on the need for positive reinforcement and on material being organised to minimise the possibility of the learner responding with the incorrect answer, thus increasing the amount of positive reinforcement received by the learner. The aim was to maintain motivation during a learning sequence.

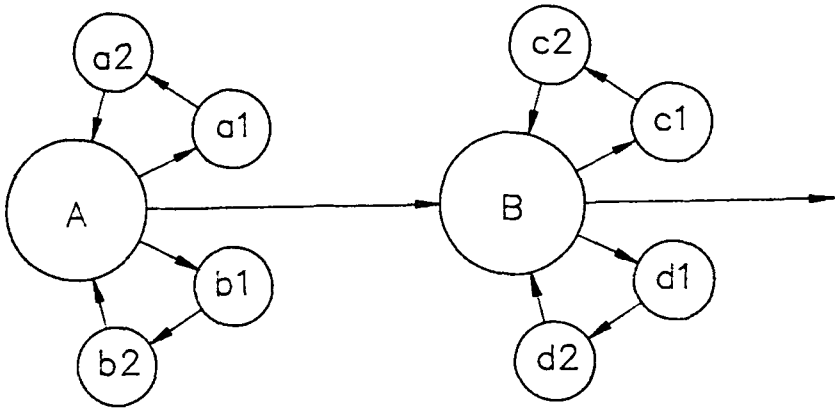
These sequences were however 'linear' and each learner received the same progression of instructional frames as every other learner, with no deviation from the prime path of correct responses being allowed. (See Fig 1.1)

Fig 1.1 Linear Programming.



Crowder's name is associated with developing an alternative to the linear method of programming. 'Branching' or 'intrinsic' programming determines the next step in one of several paths through the material from the learner response to a particular question. (See Fig 1.2)

Fig 1.2 Intrinsic Programming with three Alternative answers, two leading to remedial loops, the third to the next frame.



It was Crowder's belief that a person could learn effectively even from his or her mistakes, provided guidance quickly followed with much emphasis being placed on the student's covert reorganisation of the subject matter. Thus it is important to point out why the learner is correct or incorrect.

The origin of the reinforcement models, as described above, originated from studies of animal learning which need to be qualified when applied to the human learning situation. For example, it is now recognised that feedback should not be regarded solely as reinforcement stimuli, but should also include information which will locate error and inform the learner how to correct it (9).

The provision of immediate feedback is one of the strengths of any computer controlled learning. However, the manner of its action is far from clear with information processing, reinforcing and attention directing theories all vying to account for its effect in various learning situations. Roper (10) demonstrated that information providing feedback was

more potent than feedback which simply indicated whether a learner's response was correct or incorrect. This result also suggested that the error locating and error correcting functions of feedback can be separated, thus making learning more effective. Tait et al (11) provided evidence against merely providing reinforcement. Their results showed that the performance of learners given information feedback was significantly better than that of those learners given reinforcement feedback.

Other studies by Blair (12) found that some students learned more effectively with informational feedback, thus implying that tutorial material should not necessarily be in small steps, but should have tasks large enough to expose the learner's difficulties and provide suitable feedback to enable them to be corrected.

A further study by Anderson (13) revealed the importance of control of the learning sequence by forcing a group of students to look ahead to correct answers before typing their responses (a cheat condition). Their post-test results were significantly worse than all other groups, even one that was given no feedback at all. These results suggest that, whilst learners working from textual programmed learning can, or will, short-circuit instruction by looking ahead to the correct answer, control by the computer can ensure that feedback is not available until after the learner responds.

Another theme of research in behaviourally based style of learning has been in the area of mastery learning, especially in those subject areas which can be arranged in a hierarchical form. Precise decision rules exist, which only allow the learner to progress to further sections when mastery of materials at the lower levels of the hierarchy has been demonstrated.

Gagne et al (14) reported research which showed the value of such decision rules. The investigation was set in mathematics, and one result was that the best indicator of performance on the higher level tasks was

the degree of competence shown by the individual learners at the lower level of the task hierarchy. Hartley (15) suggested that computer based learning incorporating the above ideas should be efficient in aiding learning.

1.1.2 Field Cognition Theory.

In contrast to S-R Associationistic theory, field cognition advocates that all behaviour is purposive or goal directed. Tolman (16) claimed that animals, when discovering themselves in certain situations, would try out several appropriate behavioral patterns until one of them achieved success, e.g a rat would follow several routes through a maze, learning something each time and gradually becoming aware of its surroundings. Lewin (17) emphasised the importance of the individual and his environment, his 'behavioural field'. If an experience can cause a learner to reorganise this field then the experience is said to have resulted in insight.

Motivation plays a major part in this theory and the way in which information is received and fits into the learners' field or environment determines how it is used. Field theorists are associated with the Gestalt psychologists, whose central ideas were that learning develops through an understanding of the whole situation rather than a collection of parts. The best known experiments of the Gestalt psychologists were those involving animal problem solving. Kohler (18) experimented with chimpanzees by suspending bananas in the chimps' cages and leaving poles and boxes nearby where they could easily be seen. Chimps used them to reach the bananas, whilst animals who had never seen the poles and boxes before could not deduce a method of reaching the fruit. Beard (19) suggested that it is possible to devise ways to enable the animal to reorganise its knowledge and thus solve problems.

The research and theory of the Gestalt school does much to confirm the assumption that constructive activity is essential to human thought

processes. This would support the insistance of Thorndike and Skinner that the teacher should try to design the learning situation so that constructional responses are required from the learner. Hebb's theory (20) implies, that as the learner matures, he constructs on the basis of his previous learning experiences. The Gestalt school starts from a premise that as a learner discovers, the structure becomes clearer. His learning of any material is the product of memory and the nature of the problem. Piaget (21) extended the ideas of constructive activity by suggesting that the learner does not discover significant relationships in his learning, but makes them. This intellectual construction is said to have its origins in sensori-motor activity and later co-ordination which becomes imprinted in thought. All Piaget's observations about intellectual growth of the child imply a construction theory of learning, i.e. the child constructs his ideas and concepts of his world, thus confirming the view of making learning as constructive as possible. In sum, Skinner (22) begins with learning and suggests there is no difference between learning and thinking; on the other hand Piaget concentrates upon thinking and judgement and shows that these factors make up constructive learning.

Field cognition theorists place emphasis on the control which the learner has in developing his own knowledge structure, the role of the teacher being to stimulate and monitor the learner's activities, not to function solely as an information provider. These discovery learning methods allow the learner not only to arrive at an answer, but also to learn about the process involved in deducing the answer. Bruner (23) used this principle of learning extending beyond the given information to develop the hypothesis that learning based on discovery provides rewards for the learner in excess of learning itself. A computer controlled package incorporating these ideas would guide a learner through the process of 'learning by discovery', gradually revealing to him both subject matter and theory as he

through the program.

Whereas an IV package based on the S-R theory is used to present the subject matter and to monitor and control a learner's progress through the learning sequence, an IV package based on the ideas discussed above would function as a mediator between the learner and a hidden model of a real life situation. The learner through the computer interacts with this model, and thus develops a feeling for its behaviour under various conditions and also the rules that govern it.

IV simulation programs attempt to realise this aim by allowing the learner to test hypothesis against this model (24). Typically, the learner is allowed to experiment by varying parameters, and the consequences of the variation is shown. Within certain predetermined limits there are few restrictions placed upon the learner who is required to evaluate this output to guide further decision making.

Such packages are best used by those learners who have enough background knowledge to provide them with a framework for exploration.

Some CAL packages achieve this by a simple menu command system. This is designed to allow the learner to select and sequence the material. The learner can therefore guide the direction and type of instruction, thus developing his own experience. The learning objectives of such packages cannot be expressed as behaviours formed through basic stimulus-response associations, but as complex mental procedures and knowledge structures which are constructed and utilised by the learner.

Other studies have concentrated upon how an individual stores, organises and retrieves information and how new knowledge is incorporated into the existing cognitive structures possessed by the learner.

Research has established the importance of the type of representation given to the task and also the type of organisation, structuring, and coding activity used. For example, Ausubel (25) suggested

that the degree of meaningfulness, as opposed to rote learning of new subject material, is related to the interaction with the learner's existing cognitive structures. He suggested that learning is helped if the learner's existing knowledge can be used to provide an 'ideational' framework for the new material and that, prior to the instruction, 'organising' material which has a general bearing on the subject matter is presented to the learner. Slatterly and Telfer (26) introduced 'advanced organisers' to groups of secondary school pupils and found the greatest learning gains were achieved where the organiser was used with specific reference to its organising properties.

There is much evidence of the usefulness for including organisers into CAL and therefore IV. The organiser can be given before the computer controlled instruction, and can function as a teaching framework for interactive programs. Pask (27) has provided evidence that the type of organisation of the subject matter interacts with individual differences in students. Tillema (28) is in agreement, and argues that the process of instruction should involve providing learners with a network of knowledge that can be integrated into their existing cognitive structures.

In the learning situation, one important factor is the type of feedback given to the learner. Research has suggested that learners presented with a 'free' learning situation are not always able to make a good self assessment of their own ability and therefore sometimes fail to make effective decisions. Pask (29) arrived at such conclusions after studies which utilised several different concept learning tasks. He observed that a strategy evolved, in which control programs accepted student decisions, maintained motivations and produced equally good results. Similar results were obtained by Abbatt (30) who studied the teaching and planning of statistical investigation for under-graduate psychology students; his findings strengthened the argument for adaptive decision rules to allow his

students to direct their own learning.

The principles of learning theory that have been outlined in this section have direct relevance to the design and writing of IV programs which are to be used regularly by learners, and if implemented would increase both the efficiency and potential of such material. The major outcome of the theories outlined is that of learning by objectives (The Systems Approach). This allows the Instructional Designer the opportunity to specify learning outcomes, methods of achieving learning, and finally the testing of achievement.

1.2 Classification of IV Tasks.

In the previous section the theoretical principles that influence IV were discussed. Firstly there are a number of behavioural objectives that must be considered and secondly that the learning task must be applied to the nature of the subject matter to be learned.

Bloom's taxonomy classifies these objectives into three domains:

(i) **Affective objectives,** emphasizing qualities expressed in attitudes, interests, values and emotional biases.

(ii) **Cognitive objectives,** emphasizing remembering, reasoning, concept formation and creative thinking.

(iii) **Psychomotor objectives,** emphasizing muscle and motor skills and manipulation.

To this range of behavioural factors there must correspond an equally wide range of learning schemes and tasks.

IV literature reflects a lack of such a classification, the majority of the literature, at the time of writing, consisting of reports of individual studies. The following classification schemes may be useful in order to describe the different styles of IV and to relate them to the general framework of educational psychology.

1.2.2 Classification One.

In their classification scheme Nuthall and Snook (31) proposed the following catagories of teaching procedures:

(1) Behavioural Control Models.

(2) Discovery Learning Models.

(3) Rational Models.

1.2.2.1 Behavioural Control Models.

This type of learning stresses complete control over the learner's behaviour and over the conditions under which learning takes place. The designer's role is that of a manager who seeks to achieve specific learning objectives as efficiently as possible. IV programs can be directive in style, and relate directly to the associationistic view of learning.

1.2.2.2 Discovery Learning Models.

In contrast to the previous model, discovery learning techniques stress the control the learner has in constructing his own knowledge structures. IV programs developed for this teaching model are based upon the cognitive theories of learning.

1.2.2.3 Rational Models.

The Rational Model emphasizes the importance of dialogue and reasoning in learning. Language plays an important part in this process, as it acts as an interface between the instructor and the learner as each in turn presents, explains and defends their case.

Pask (32) studied learning conversations and found that the teacher projects his own argument and interpretation of the subject matter being studied. The understanding of a topic is only reached when the teacher and the learner agree both on a derivation and explanation.

The origin of such an approach owes more to philosophy and linguistics than to a practical method of learning.

An implementation of this model could prove too complex using IV.

1.2.3 **Classification Two.**

The following classification scheme was proposed by Kemmis (33) in order to describe his different CAL systems and relate them to a broader educational framework. Four models were devised:-

(1) Instructional

(2) Revelatory

(3) Conjectural

(4) Emancipatory

1.2.3.1 Instructional Model.

The view presented by this model is that the computer instructs the learner. The psychological basis for this classification is the theory of condition attributed to B.F. Skinner.

(b) Revelatory Model.

This category is based on the field cognition theories of learning and, as the name implies, guides the learner through a process of learning by discovery.

1.2.3.2 Conjectural Model.

In this classification the learner is firmly in control of the instruction and uses the computer to formulate and test hypothesis. Programs of this type adhere to the concept that knowledge can be developed through the learner's experiences, and allows time to explore the subject matter. Programs such as these can offer sophisticated aids for modelling real life situations. Some IV packages in the United

States, particularly in the medical field, have been based on this model.

1.2.3.3 Emancipatory Model.

This model is concerned with the use of the computer to make work easier for the learner. McDonald (34) stated that there are two types of labour a learner must undertake in order to achieve learning objectives.

(1) Authentic Labour.

This is a task which makes a direct valuable contribution to a particular learning objective, and is also part of it.

(2) Inauthentic Labour.

A task of this type is not an integral part of a learner achieving objectives, but is necessary because it makes learning possible. An example is a student carrying out a scientific experiment, who needs to perform some calculations. The main purpose of the experiment is the final result, although it may be useful for the learner to practice numeric calculations. In general this model is sometimes difficult to recognise as it usually appears in conjunction with others.

1.2.4 Each of the classifications discussed outlines the way in which the learning task is influenced by the feature of the computer in the system. The methods described correspond directly to one another. For example, both the behavioural and instructional models relate to the use of the computer as a 'tireless tutor', while the discovery learning and revelatory models describe the use of the computer system to control the simulation of a real event in which the learner can take control.

It is clear that, whatever model is taken, the computer adds a dynamic aspect to the learning which is difficult to achieve with traditional media. This also leads to a more learner centred approach in the preparation and delivery of the material.

1.3 IV Learning Strategies.

The previous sections give rise to three main catagories of strategies for learning. These are:

(i) Passive Learning - as in a lecture, one way communication from teacher to learner.

(ii) Active Learning - as in the laboratory or an audio-tutorial approach. One way communication, but with the learner able to make an active contribution, answering written questions, performing exercises. The learner then checks against a model answer given in the text or AV programme.

(iii) Interactive learning - as in a tutorial, programmed learning, or CAL The learner takes an active role, answering questions and making choices, or arguing with a tutor. The route through the learning sequence, or tutorial is dependent on the learner's responses and performance.

All current research indicates that the effectiveness of learning increases significantly as the amount of Passive Learning decreases and the Active and Interactive Learning increases.

In IV there is a need to reduce the main category into smaller categories to produce suitable strategies for a particular learning situation. The following are methods which can be achieved with the current technology:

1.3.1 Telling.

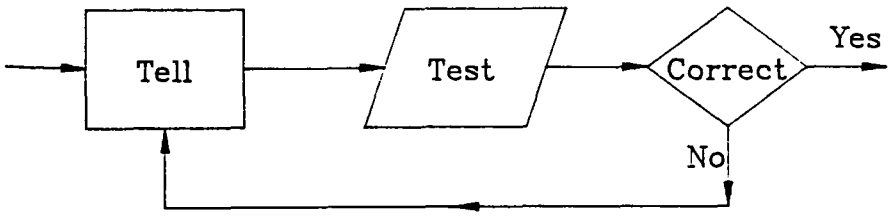
This is the strategy adopted in lectures, textbooks, and most films and video productions for education. The 'teacher' describes and explains to the learner without any feedback designed into the system. Most instruction must have an element of 'telling'. This is imperative to cover the introductory knowledge required to start the new learning. The strategy needs skillful application in deciding when to tell, what to tell, and how to tell. In itself 'telling' is not an effective learning method and needs to be combined with other strategies.

1.3.2 Telling and Testing.

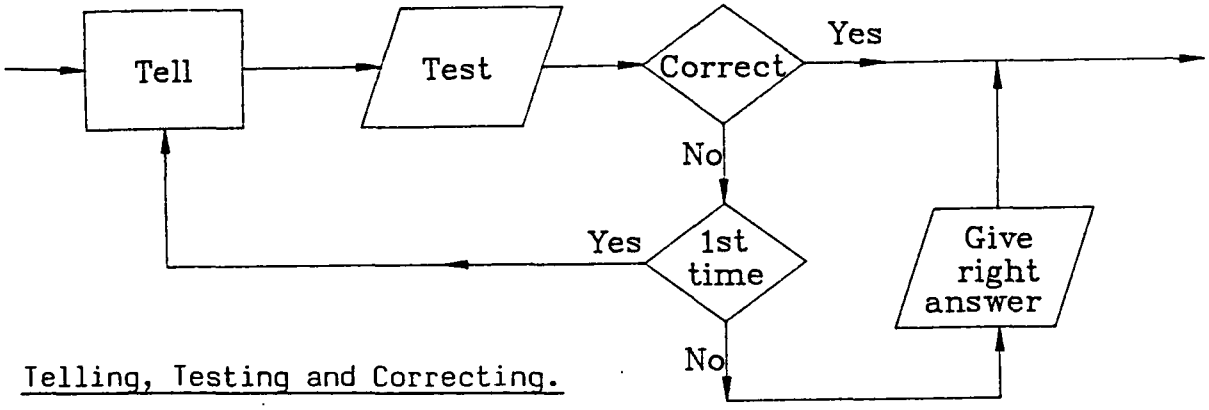
By adding a test of understanding or knowledge immediately after a 'telling' sequence, a more effective strategy is arrived at. In its simplest form the learner is only informed whether the response is correct or incorrect. It is left to the learner to decide the source of the 'wrongness'.

1.3.3 Telling, testing, and repeating.

In this case a wrong answer starts a repeat of the telling-testing process. It forms a loop, and the learner can only escape by presenting the correct answer. It is at this stage in development that a flowchart diagram becomes advantageous in the understanding of the design strategy.

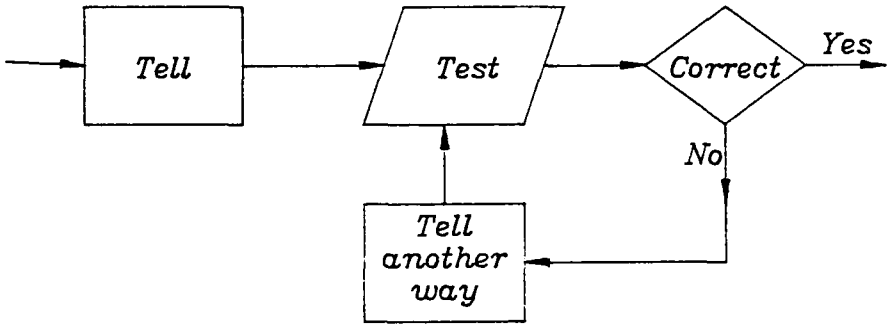


In a practical application of this method, there will have to be a mechanism at the decision point to prevent the learner looping endlessly through the system. It could consist simply of a 'count' which will restrict the number of times the learner proceeds through the loop. This is shown below with a count of one wrong answer being allowed.

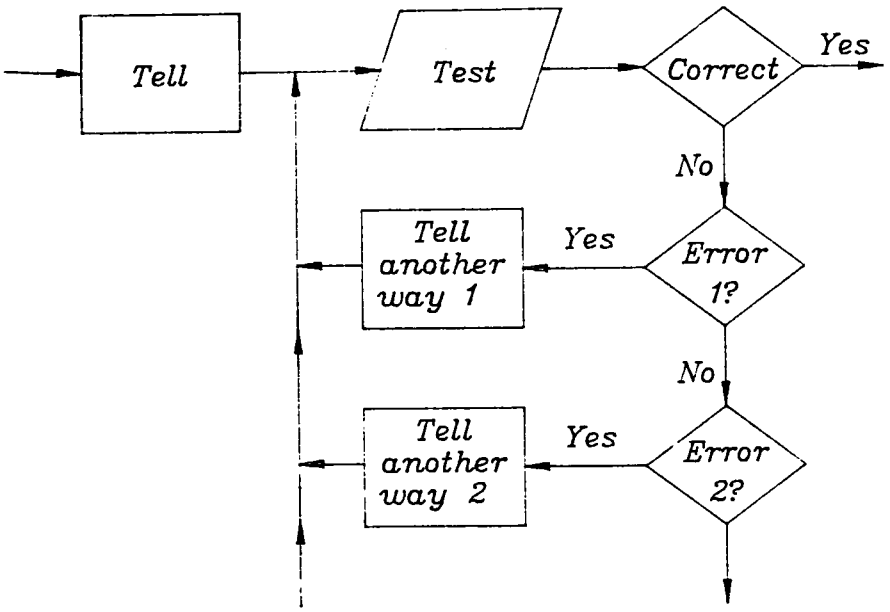


1.3.4 Telling, Testing and Correcting.

An advance on Telling-testing-repeating is to offer a correcting branch in the case of a 'wrong' answer. Under the instance of a wrong answer, instead of just repeating the same 'telling ' segment, the learner is presented with a different 'telling' segment, thus correcting the mistake much more directly.



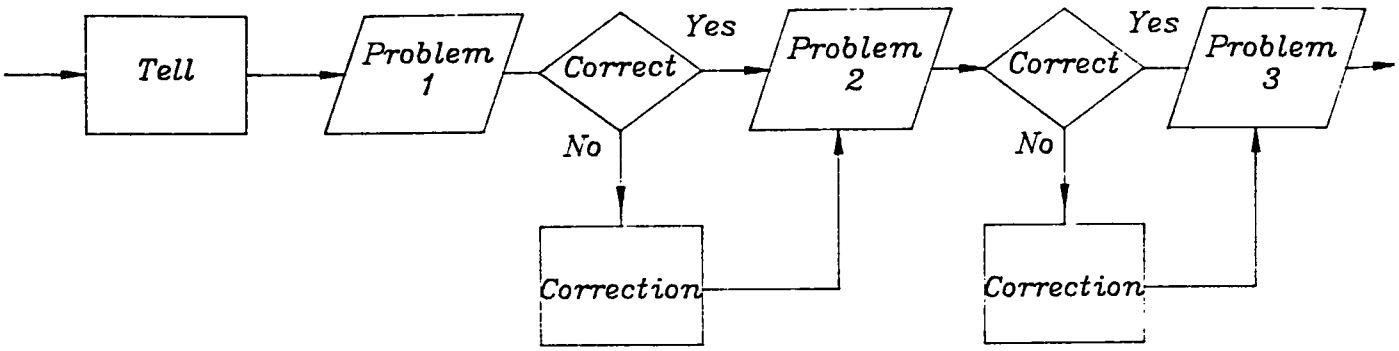
A more complex model of this strategem can include a variety of different 'tell another way' segments. The test system would also have to be more complex in judging a 'best fit' for the correcting sequence particular to the error made by the learner.



As the complexity increases to this level, CAL and IV begin to show their strength compared to other forms of instruction, excluding the face to face tutorial.

1.3.5 Drill and Practice.

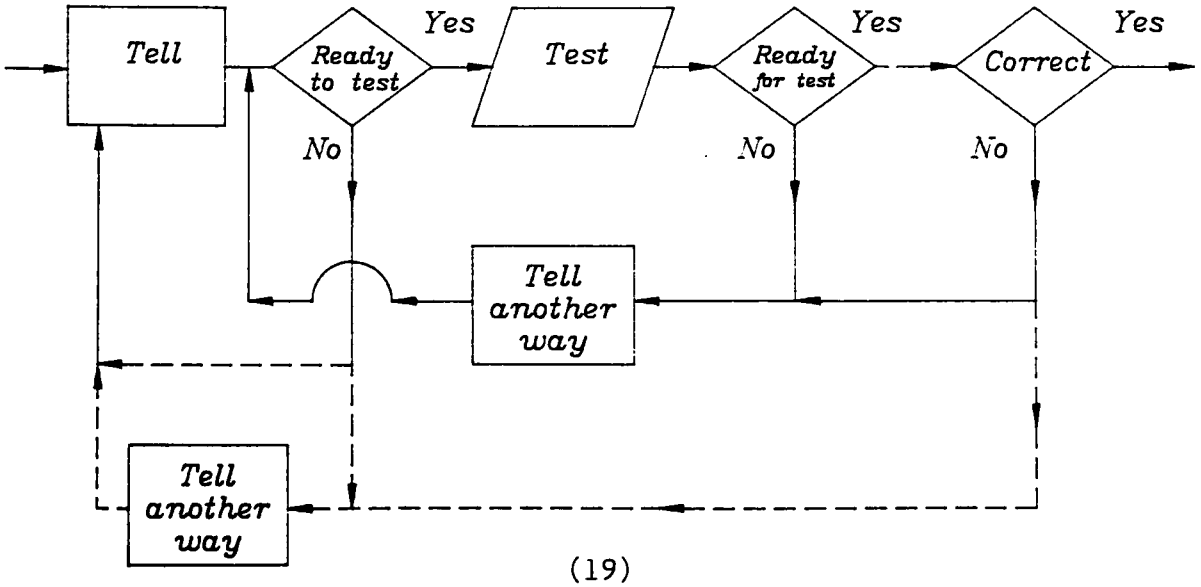
A variation of tell-test-correct-repeat is the drill and practice strategy. After 'telling' about a process, the learner is presented with a series of exercises giving practice in the use of the process. The strategy consists of a series of steps which are assessed and corrected as the learner progresses. It is usual to organise the sequence with steps of increasing difficulty. The system should be designed to allow the learner to come out of the sequence either by choosing to do so, or when some set criterion is reached (e.g. getting eight out of ten answers correct, or by getting all answers correct at the first attempt).



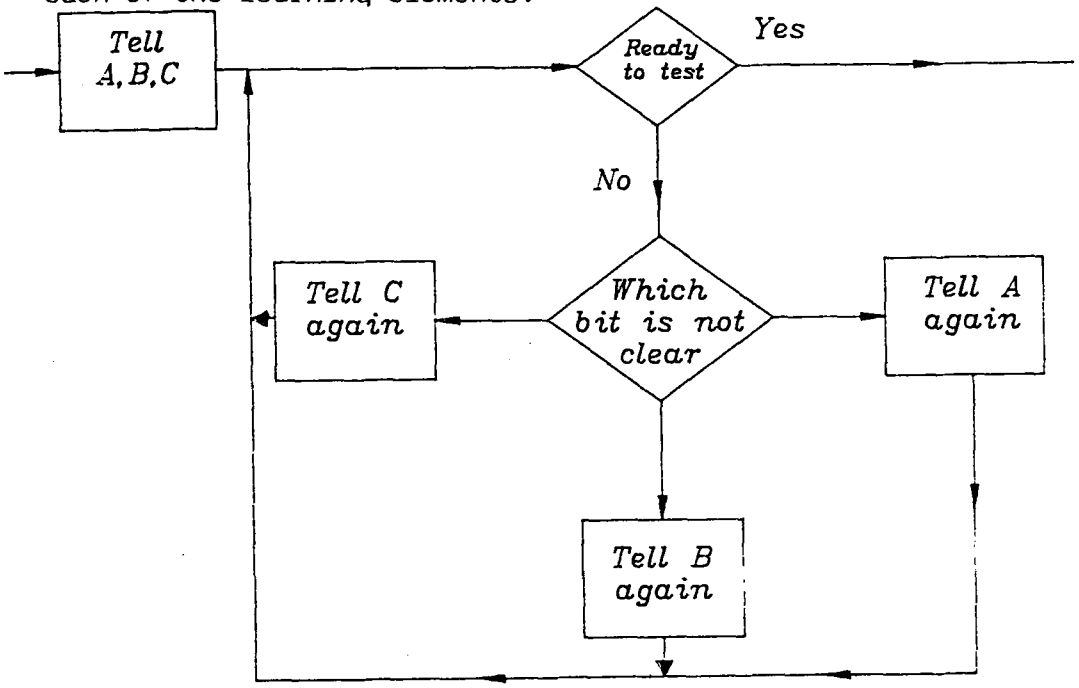
'Drill and practice' may seem an unimaginative use of IV (it may also seem similar to the system that gave programmed learning and CAL a bad name), but it certainly has a place in a learning strategy. Certain essential skills can only be acquired by repeated practice, some examples being simple arithmetic, reading, learning a new language and remembering essential data. When using this strategy the designer will have to consider how to make the routines interesting, attractive and challenging, so that the learner actively wants to follow through the instructional sequence.

1.3.6 Telling, Testing, and Prompting-Helping.

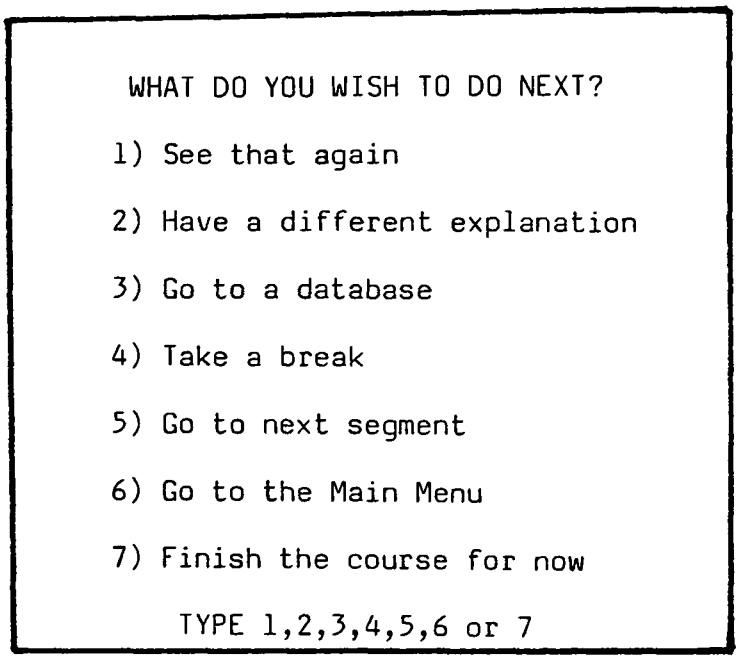
Instead of insisting on a choice of test answer and correcting the forced error, the system can allow the learner to request help, either immediately after the 'telling' step, before presentation of the 'test', or after presentation of the 'test'. The learner makes a decision about his understanding of the 'telling' and thus of his preparedness to be tested upon this content.



Clearly, the loops and branches provided by such a system can be extremely complex, allowing the 'prompting' and 'help' steps, as well as the 'correcting' loops to be partly or wholly diagnostic. An example is, if the topic covered in the 'telling' has the elements A, B, and C, then if the learner interrupts with a 'help' request or indicates unreadiness to take the 'test' when offered, a 'menu' step would be presented. This would provide prompting or additional information on each of the learning elements.



In a well-designed interactive system, it should be possible for the learner to take the initiative in requesting 'help' or additional 'telling' sequences simply by interrupting the program to ask for it. Normally some form of 'ESCAPE' key may be assigned to this function by giving it an 'interrupt' priority. This may be programmed to occur anywhere in the system or activated at important steps within the program. The system should present an option menu whenever 'ESCAPE' is pressed. An example is shown overleaf:



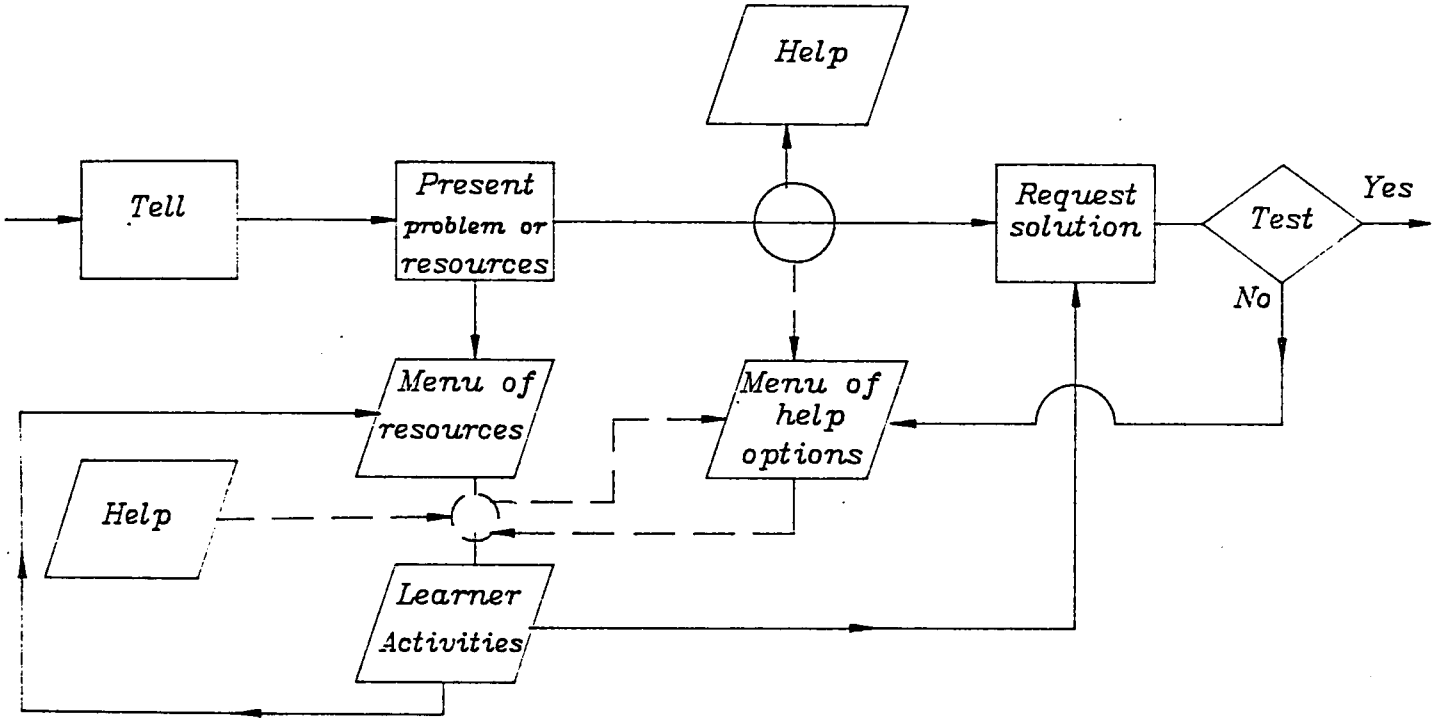
Programming is certainly simpler if all 'Prompt', 'Help' and 'Correction' choice points are of the 'multiple choice' type, requiring just one key press input to select the next step. But this requires the designer to predict all the possible 'help' activities that the learner might need.

Ideally, 'free text entry' at an option point is desirable, allowing the learners to request help in their own terms, rather than from a presented list. In practical terms the same design problem persists in that the computer program must contain a discrimination routine which recognises words or word-roots to be matched to the keyed input. Careful choice of word-root-matches can, however, provide a very 'friendly' way of giving a choice and make it easier for the learner to express difficulties. This form of input is used on computer 'adventure' games and proves successful, the only reservation being that a dictionary of recognised words or phrases should be given to the learner to prevent the frustration of such messages as 'I'm sorry I do not know that word'.

1.3.7 Telling, Discovering, and Testing.

In this approach, an introductory 'telling' sequence sets the scene and presents background information or outlines a problem to be

solved. The learner is then challenged to discover a method of solving the problem, and is provided with a set of resource segments 'on demand' to assist in the process. When the learner expresses readiness the solution presented is compared against a model one. The key elements in this strategy are the availability of a help interrupt at any time, giving access to a set of option menus, a bank of resource materials, both video and computer-based as well as physical materials, which permit learners to discover the solution to the problem on their own.



Clearly, the flowchart for an effective 'discovery' strategy can be immensely complex, and the approach demands a great deal of imagination on the part of the designer, as well as a sound knowledge of the subject matter. There is no doubt, however, that it is in this type of strategy that IV can score heavily over other methods.

1.3.8 Problem, Simulation, Assessment.

Another strategy for a learning sequence is for the IV system to present a practical problem and then place the learner in a simulated environment to produce a solution. This is a variant on the 'discovery' strategy, differing in that the resources are dynamic. The learner may

be required to decide which experimental or testing technique is appropriate to solve the set problem, and then to 'manage' that experiment, choosing equipment, connecting components, selecting rates of activity, timing processes, etc. on the computer/video screen. The simulation can be made very real, allowing the learner to take readings, carry out calculations, determine actions, or deduce explanations. It could put the learner 'inside' a management situation, and present alternative consequences as a result of decisions. The assessment strategy may have to be more 'open' than in other strategies, as there might not be only one 'correct' solution, but a range of solutions of greater or lesser probability of success.

This is probably the most difficult strategy to plan for, but because it allows the greatest flexibility and interest to the learner, it is more likely to be able to satisfy a variety of situations of different attitudes, abilities and personalities. It is also likely to lead to very effective, mature learning - if the package is well designed.

1.2.9 IV as an Open-Ended Resource.

As well as providing prepared learning sequences, IV can also be offered as an audio/visual/tutorial resource, an electronic encyclopedia for free and open access to the learner. The instructional design involved in such a strategy is a mammoth task. Superficially it seems simple, but to catalogue 55,000 individual colour still pictures, and to give written descriptions of each, presents a problem in the searching of such a database. A good example of such a system is provided by the BBC Domesday Discs. This type of visual/textual database is flexible enough in its search routines to be incorporated into an existing learning scheme, simply as an additional 'discovery' resource.

Organizing the Strategies.

The Nebraska video disc Design/Production Group have identified seven different types of video disc 'frames' (not necessarily individual stills; each frame of the program could be a sequence of related stills or moving images). These can be assembled in a variety of ways to achieve various instructional strategies:

(i) Orientation Frames.

One or more frames listing a segment title, contents (a Menu), objectives and related information which the learner must see before the instructional sequence begins.

(ii) Content Frames.

These are where the 'telling' occurs, and consists of a short lesson of factual information, description of concepts, or demonstrations.

(iii) Decision Frames.

These provide the learner with options, and they require input from the learner before the program can continue.

(iv) Strategy or Comment Frames.

These frames offer advice on how to achieve a learning objective. They might be offered at frequent intervals, or be made available on the learner's request.

(v) Summary Frames.

These conclude each content sequence, concisely summarizing the knowledge or skills that should by now have been acquired. They are free of all irrelevancies and could well be in the form of a table or list of attributes of a new concept or an algorithm-like summary of a process.

(vi) Problem Frames.

These are sets of frames presenting questions/problems to test mastery of the set learning objectives. Answers, correction or re-routing frames must also form part of these sequences of frames.

(vii) Help Frames.

One or more frames available on request or, when the learner's responses indicate confusion or lack of mastery. They might offer remedial sequences or sets of resources to assist solution of a problem.

These seven types of frame can be assembled to create any of the learning strategies described previously. Each could be a still photograph, drawing, or diagram, a sequence of moving pictures, computer generated text, or computer generated graphics, selected as appropriate.

1.4 Attributes of Video and Computer Technologies as Learning Media.

The selection of video and computer technology for application in the learning process is based on evaluating the four primary attributes of the technologies. These are visual, audio, calculation and sequence.

Visual

Video is a recording device showing the relevant and irrelevant features of any visually-based event. On the other hand, computers can only provide programed visuals, normally omitting any irrelevant information. These tend to be line diagram representations, and can present difficulties to learners who have received little or no graphical training. Some computers are now capable of storing digitised pictures, but are severely restricted by memory in this function. Video is currently the most cost-effective means for recording and displaying visual information. Film is much too expensive for normal applications, except perhaps for commercial organisations who require large scale

distribution. Video has already become popular in the conventional training and teaching establishments. Video based visuals offer still pictures, motion, colour, and repetition of specific sections both at normal and different speeds. Computer graphics offer still diagrams, and animation. Selection of media for the visual needs of a course should therefore include an analysis of the following:

Video	**Computer**
Linear motion	Animated graphics
Still frames	Dynamic display of visuals
Minimal loss of irrelevant information	Loss of irrelevant information not important.

Audio.

Both video and computer technology offer audio presentation. Video based media give audio mixed with the visuals and allow the inclusion of irrelevant information. Computer audio, similar to its visuals, is limited in irrelevant information. A "voice" is available on the computer, but is very limited in reproduction compared to the video version. In certain applications the computer sound may prove to be far more flexible because of its random access retrieval capability, and its dynamic nature to create infinite sound productions. The retrieval capabilities of the video disc and compact audio disc have now become a serious challenger in this area. The second channel on a video disc offers thirty eight minutes of sound. It could consist of a large vocabulary of single words or phrases, any of which can be accurately accessed and played.

Video based audio should be regarded as a pre-recorded attribute that provides a realistic reproduction of live sound. Computer audio, on the

other hand, should be regarded as providing instantaneous, dynamic sound.

Calculation.

This attribute is the prime purpose and function of computers. Video technology is not capable of calculation. The calculation capability offers a number of possibilities for providing direct individualized instruction. These include such things as immediate assessment for diagnosis and prescription of instruction, updates of learning needs, ready access to learner cumulative instructional records, flexibility in simulation, speed in presenting decision making information, creative forms of learner control and decision making, and other spontaneous instructional and learning conditions only previously available in a one to one learning situation.

Sequence.

Conventional instruction can be described as presenting information in a linear sequence. Video is a good example of this linear sequencing, but it can, unlike a formal lecture, be interrupted for review. Computers, on the other hand, provide maximum flexibility in sequencing. The lowest form of program controlled sequencing is the branching technique used by Crowder(33), but now sophisticated computer based management systems provide for adaptive sequencing responding to performance, learning time, response patterns, period of learning and the structure of the content to be learned, as demonstrated by Tennyson and Park(34).

1.5 Summary of Chapter.

In this chapter I have tried to outline the main Theories of Education relevant to CAL and hopefully therefore to IV. There are many

studies suggesting that the application to CAL have been successful. Strategies and systems for the design and implementation of an IV programme have been put foward. It is intended to show how these have been developed and used to produce two independent IV packages:

1) Use of Surveying instruments at the
   Polytechnic of Wales.
2) Safety Document Procedures at CEGB's
   Aberthaw power station.

The next chapter discusses the detail involved in Interactive presentation, and the development of a hardware and software system.

CHAPTER 2. The Technology to achieve Interactive Video.

2.0 Models of Interactivity.

Many people perceive Interactive Video in terms of the hardware (stereotyped as a micro computer linked to a video disc player). In reality interactivity is a behavioural concept and becomes an instructional style more appropriately defined by the outcomes for the learner and instructor. Gayeski and Williams (37) suggest a model for 'levels of interactivity' which attempts to interrelate hardware, programme design, and the information provided to the learner and the manager of the instructional process. This is presented in fig 2.1.

The first level is 'direct address'. This does not employ specialized technology, but uses the powerful technique of scripting that 'speaks' directly to the learner. The technique can involve asking questions for the learners to answer 'in their heads' or highlighting particular aspects of the scenario. Direct address also requires a thorough understanding of the learner group so that the programme relates its content in a suitable style, an example being a phrase like "What do you think is the explanation for ....?"

The second level is a 'paused structured' program. In this there are predetermined points where learners are instructed to stop the video machine in order to engage in some other activity. This might be answering questions in a workbook, engaging in thought or discussion, examining an object or practising a skill. Information for self-assessment of the activity is presented when the program is resumed.

Specialized hardware is introduced at level three in the form of a 'random access controller'. This device allows the playing of previously defined video segments in a defined order by entering a two digit number. The number appears within the program as the label of a section which can be selected or as part of a multiple choice alternative. In this way, the video 'branches' to different segments depending on the choice, thus providing only the information required by a particular learner in light of his or her

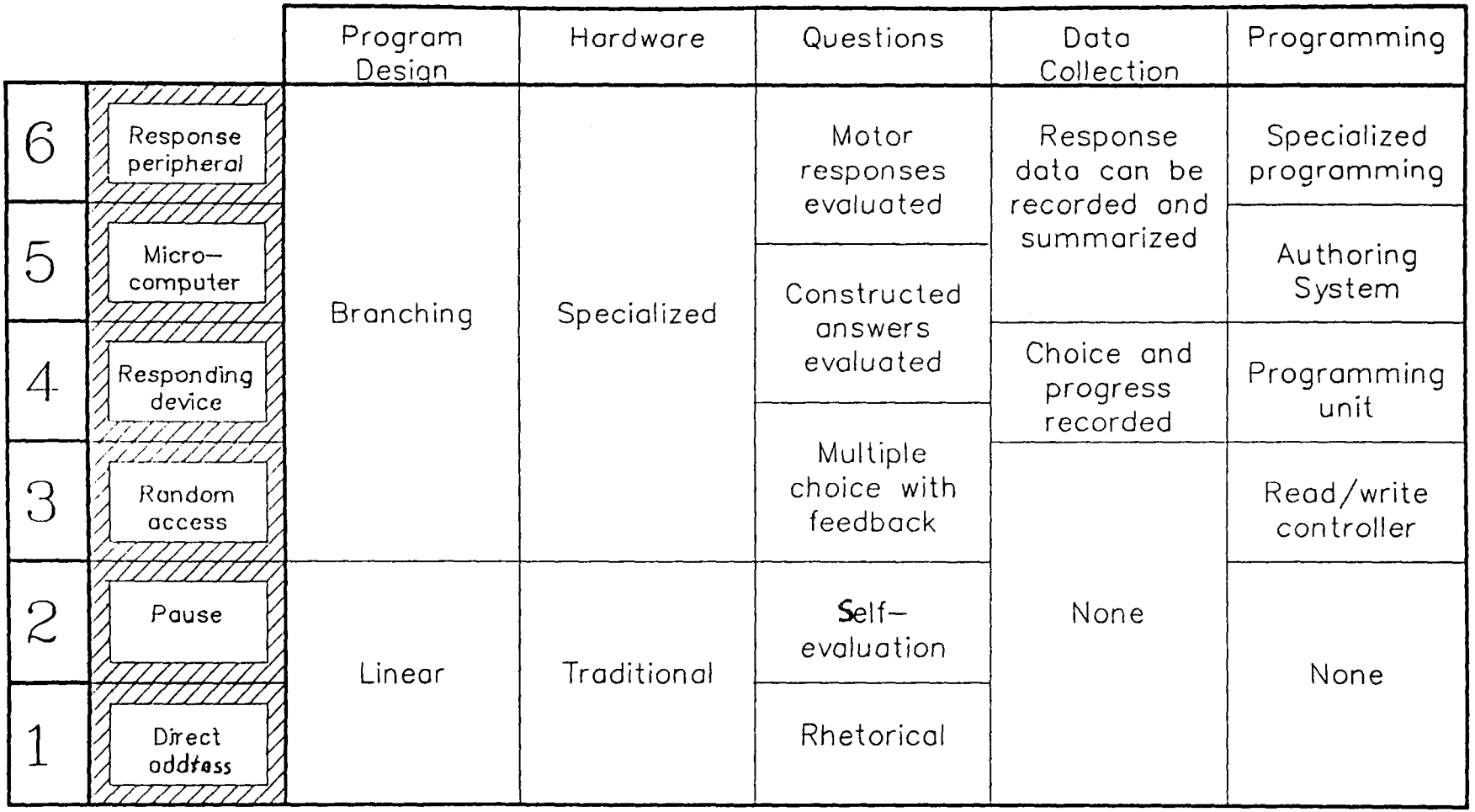


Fig 2.1 Levels of Interactivity

demonstrated understanding, or expressed preference.

Level four interactivity uses a 'responding device'. It usually consists of a special purpose microprocessor, which enables selection of a response to a 'choice type' question by entering a digit through a device panel. At this level, each response and resultant branching are recorded by the system. These are then summarized and may be printed out at the end of a session. Some responding systems are also capable of producing simple text screens to supplement the video segments.

The use of a micro computer together with an 'interface' allows the control of the video player functions and constitutes level five. In this level, typed-in answers can be evaluated by judging models within the system's program, and the full range of computer functions can be utilized in conjunction with video. In addition, branching can occur in relation to an ongoing assessment of the learner's overall progress and/or response style. The system is capable of recording and reporting a learner's complete path and progress through the instructional sequence. It is also able to produce more general reports concerning the average results of a group of learners on the system. At this level a full range of instructional frames is available including video, computer generated text and graphics, a combination of both, audio with video, audio with computer graphics, or audio on its own. The computer system will allow several forms of response including multiple choice, yes/no, text matching, and the more powerful pattern matching and keyword formats. The inclusion of the micro computer also introduces the capability of calculation into the learning material.

At level six, a great variety of responses can be assessed using peripheral devices. In many cases, motor skills can be quantitatively analysed in the same manner as they would be performed. The skill is sensed by a special wired version of the instrument used; the computer is used to analyse the output from the device, and the program responds to this input.

There are a number of hardware/software systems, and new ones are constantly being introduced. Video disc and video tape are both used as the playback media and both need due consideration when choosing a system.

2.1 SYSTEM ELEMENTS.

Figure 2.2 details the four key elements of an advanced IV system. The authoring facility enables the designer to create any text and graphics, to assemble and control the structure of the final presentation. In operation, the interactive presentation automatically presents the learner with video images, text, questions and choices. The learner interacts using some form of input device and branching occurs according to the responses made.

The analysis and management facility usually monitors learner response and program effectiveness. With this information, the designer can again use the authoring facility to revise and improve the effectiveness of the program. The diagram shows that all the elements interlink and are facilitated by the hardware within the system. Although this seems to indicate that the hardware is a main consideration, it should not be an overiding influence. In fact the hardware should be chosen to achieve the presentation required rather than governing the format.

In advanced IV systems, monitoring is done by a computer through an alphanumeric keyboard. Only when the text element is omitted altogether is an alternative 'programmer' used as with the Sony Responder video cassette system. Learner response is either achieved using the same keyboard as is used for authoring, or a special, simplified keyboard or keypad. As the technology improves, additional alternatives can be considered e.g. touch sensitive screen, light pen, mouse, and voice recognition may be used. Even specialist digital and analogue instruments can be used. Finally, the facility to have a permanent record of text for the learner is sometimes provided by a printer unit.

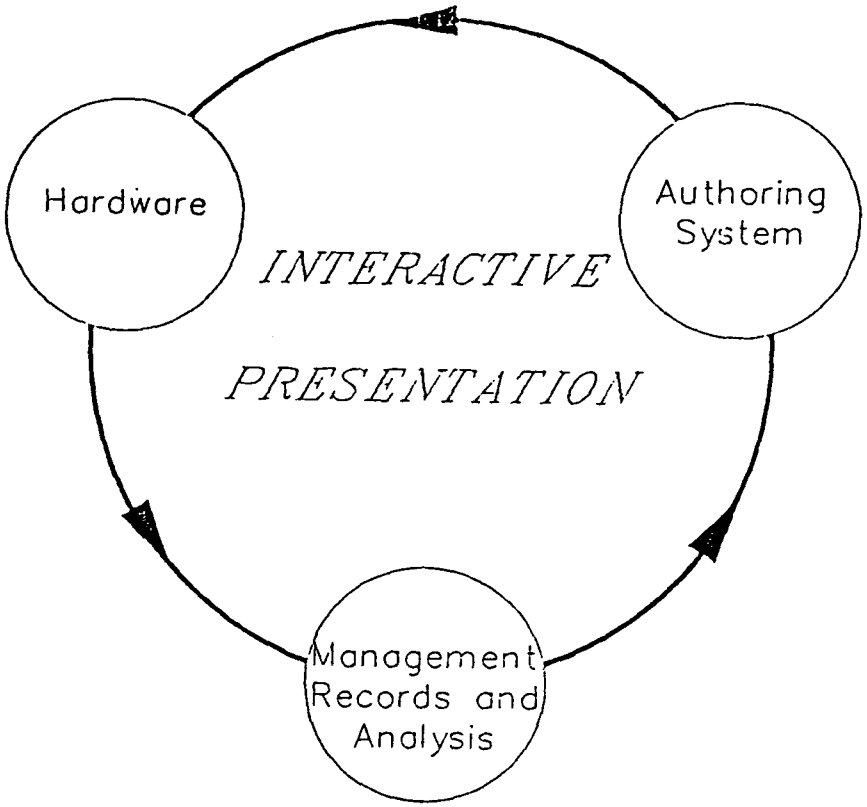


Fig 2.2 Interactive Video System Elements

Authoring facility — (Language or system) enables the creation of text and graphics and provides a course structure comprising text, graphics, video and audio.

Interactive Presentation — utilizing keyboard, keypad, or touch screen input etc. and video monitor with sound. Courseware- software, videodiscs, and tapes.

Management & Analysis — learner records, performance analysis, question analysis, group performance and course evaluation.

Hardware — comprises videocassette or videodisc, micro computer, interface controller, image switcher, or image overlay facility.

2.2 HARDWARE SYSTEMS.

Figure 2.3 shows the requisite parts of the hardware configuration for IV.

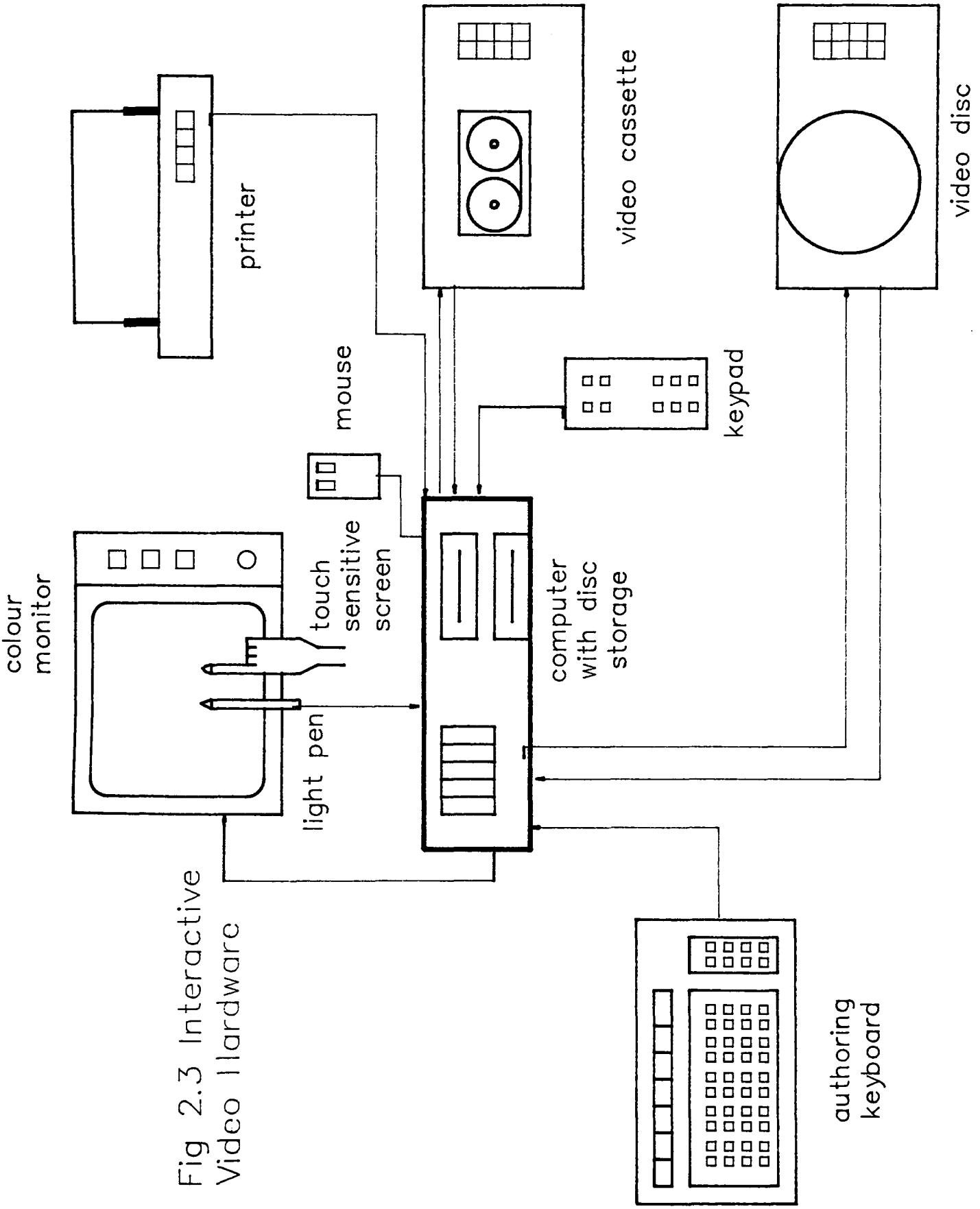


Fig 2.3 Interactive Video Hardware

The current range of systems divide into three main catagories summarised in Fig 2.4, and described in the following paragraphs.

	Video Disc	Video Tape
Programmer Control Units + video machine	Philips VP835	Random Access Controller Sony U-matic National Panasonic
Component stations micro + video machine	Apple/Philips Apple/Sony BBC/Philips BBC/Sony IBM/Philips IBM/Sony	Apple U-matic Apple/VHS IBM/U-matic BBC/VHS IBM/U-matic IBM/VHS
Integrated Systems	IBM/Window FELIX Sony Acorn (Domesday)	CAVIS FELIX

Fig 2.4

2.2.1 Programmer Control Units.

At the lowest end of interactivity is a tape player with a remote controller to access specific tape segments, and is only available on a limited number of machines. The design of the random access controller and the way the program is able to ask questions usually severely limit the use of this approach.

Random access can be used to good advantage by combining it with 'cue' programmers and video caption messages. A tape system employing this technique is the Sony Responder. The low flexibility and limited control of the unit has however made the system extinct.

2.2.2 Component Systems.

Within this category are many combinations of micro computer and video disc or video tape machines.

1. Video disc

In the UK, only three video disc players are currently available which lend themselves to computer control, namely the Philips Professional LaserVision (VP405,410,412,415), Sony (LDP-1500P and 1550P) players, and Pioneer (LD4000,4100, and 6100) player series.

These units are driven externally by a serial RS232 interface which is a method of communication implemented on most computers. One of the Philips machines (VP412) also has the advantage of having a teletext encoder within the unit. This allows text data to be sent from the computer to the player. Here it is encoded within the picture coming from the player. The result is that when this signal is sent to a teletext receiver, the text can be decoded and displayed on the screen; either on its own or overlaid with the picture. The VP412 (like the earlier VP705 and 835) is thus well

matched to interactive video applications having both external control and text generation capabilities. The procedure of sending acknowledgements back and forth is known as 'handshaking' and the advantage of the RS232 protocol is that communication can be achieved in both directons. For interactive programming 'handshaking' is particularly useful.

Various micro computers can be used in conjunction with the video disc players to provide a means of generating text, diagrams and interactive control. The table shows the Apple, BBC, IBM PC and Philips micros' specifically, although in hardware terms at least many more micro computers could be used. Authoring facilities are available for all these computers. (See AUTHORING FACILITIES.)

2. Video tape

The control of video cassette machines is more difficult than disc machines because of the absence of any internal 'control intelligence' within the machines themselves. Whereas, with disc players like the Philips and Sony, it is sufficient to simply send a string of commands to search or find a location (eg. P504R), with video cassette control the tape position and machine status have to be determined by the external computer controlling the device.

Searching back and forth is most difficult in terms of control. Two techniques are currently employed to achieve this, both using interface hardware. One counts the video sync pulses off the tape as the tape itself moves foward or back. This count is compared with the location required and on coincidence the machine is driven into play. The problem with this technique is that positional accuracy is dependent on an accurate count. Tape stretch, loss of head to tape contact, and lacing and unlacing will cause cumulative errors over a period of time. There are also problems with counting these pulses at rewind speeds.

A second technique is to record, on the spare audio channel, an absolute reference of 'time' postions on the tape. This is usually referred to as 'time-code' and ensures accurate search over periods of continuous use. Because of this necessary interface hardware, interactive tape systems tend to be more expensive than disc, especially if they allow for duplication and replication of the courseware materials produced. However, on a small scale the tape courseware may be cheaper to produce.

2.3. HARDWARE CONFIGURATIONS.

The three hardware configurations considered and developed during this project were:

1) BBC micro and Video disc.

2) Apple II micro and VHS tape.

3) IBM PC Compatible and Video disc.

2.3.1 BBC Micro and Video disc.

A BBC micro computer (Model B with floppy disc unit), a Phillips Laservision 705, and a Ferguson 16" teletext television had already been purchased for the project prior to the author's joining it. The video material available at the time was limited to two video discs, one being "The BBC Videobook of Garden Birds", and the second dealing with the game of Golf.

The Birds disc covered many descriptions, moving footage and was viewable with interaction. The disc itself was capable of being viewed by controlling it from the front panel of the player. The manual supplied with the disc player, suggested that it was also capable of being controlled using a computer to transmit electronic signals to the player through a suitable RS232 interface. With the BBC (RS432) the interface proved to be a

5 way cable with suitable plugs at each end.

After several attempts it was discovered that the commands could be communicated to the player by sending ASCII characters through the RS232. These could be arranged as a group of commands using 'string variables' in BASIC. It thus became possible to play sequences of video from the disc. It soon became apparent that, to exercise any degree of control over the disc unit, the disc player would also have to respond back to the computer. This meant that the RS232 interface had to read information from the player as well as transmit to it. The major obstacle here proved to be the timing of the signals to and from the disc player. The player required different times to accept and respond to various commands. Therefore, when sending strings of commands, time delays had to be built into the BASIC program.

Eventually a program was developed around a series of video sequences based on the owls found in the UK. This was programed in BASIC. It included control of video sequences, teletext superimposed on moving and still video, questions, and branching on responses from the user. An example of a BASIC program to control the disc player is shown in Fig 2.5.

During this initial trial with the hardware, two major problems became immediately apparent.

The first was the difficulty in using existing video materials. The standard broadcast television technique of using the audio to introduce a change in video picture (the commentary preceded the change in picture) represented an obstacle, and the solution meant introducing text screens before the commencement of the video, so as to allow the audio to be played at a sensible point. Also, the timing of short scenes were further aggravated by views of the commentator, David Attenborough, ending a sentence with his eyes closed thus preventing the stilling of the video. It was obvious that any video material prepared for IV work would have to be

Fig 2.5

```
1700DEFPROCGET423
1708*FX7,7
1709*FX21,1
1710*FX2,1
1715REPEAT
1720AN=GET
1725UNTILAN=6
1730*FX2,0
1799ENDPROC
2000DEFPROCLITTLE
2010VDU2:PRINT"T/HBN":PROCDELAY
2015PRINT"T/R01/GR/DH@LITTLE OWL@":PROCDELAY
2020PRINT"T/R04/02/GW/NH@YOU WILL NOW BE SHOWN A SHORT VIDEO@":PROCDELAY
2030PROCDELAYLL
2045PRINT"P32264R":PROCGET423
2046PRINT"T/HBL":PROCDELAY:PRINT"T/R01/02/GW/SB/DH@LITTLE OWL@E3/":PROCDELAYL
2050PRINT"E0":PROCDELAY
2060PRINT"K":PROCDELAY:PRINT"N":PROCDELAY
2061PRINT"T/HBN":PROCDELAY:PRINT"T/R01/02/GW/SB/DH@LITTLE OWL@E3/":PROCDELAY
2065PROCDELAYL:PRINT"P33381S":PROCGET423
2067PRINT"T/HBL":PROCDELAY
2068PRINT"E1":PROCDELAY
2070VDU3
2099ENDPROC
2100DEFPROCTAWNY(S1$,S2$)
2110VDU2:PRINT"T/HBL":PROCDELAY
2115PRINT"T/R01/GR/DH@THE TAWNY OWL@":PROCDELAY
2120PRINT"T/R04/02/GW/NH@YOU WILL NOW BE SHOWN A SHORT VIDEO@":PROCDELAY
2130PROCDELAYLL
2145PRINT"P"+S1$+"R":PROCGET423
2146PRINT"T/HBL":PROCDELAY:PRINT"T/R01/02/GW/SB/DH@TAWNY OWL@E3/":PROCDELAY:PROCDEL
2150PRINT"E0":PROCDELAY
2160PRINT"K":PROCDELAY:PRINT"N":PROCDELAYL
2161PRINT"T/HBN":PROCDELAY:PRINT"T/R02/GW/SB/DH@TAWNY OWL@E3/"
2165PROCDELAY:PRINT"P"+S2$+"S":PROCGET423
2167PRINT"T/HBL":PROCDELAYL
2168PRINT"E1":PROCDELAY
2170VDU3
2199ENDPROC
5000DEFPROCTEST
5001DIMCOMP$(25)
5005VDU2:PRINT"T/HBL":PROCDELAY
5006PROCDELAY
5010PRINT"T/R04/10/CY/NB/CR/SB/DH@TEST TIME @E3/":PROCDELAY
5020PRINT"T/R08/C3/NB/CW/SB/NH@THERE WILL NOW BE SOME QUESTIONS@E3/"
5025VDU3
5030PROCCONT
5100VDU2:PRINT"P30837R":PROCGET423
5105PRINT"E0":PROCDELAY
5106QUEST$="T/R20/02/CB/NB/GW/SB/NH@WHAT TYPE OF OWL IS SHOWN@E3/"
5107QUEST1$=""
5110PRINTQUEST$
5115PROCINPUT
5120COMP=3:COMP$(1)="B":COMP$(2)="R":COMP$(3)="N"
5130PROCCOMPARE(COMP)
5135PROCDELAY
5138VDU2
5139PROCDELAY
5140IFY=1THEN PRINT"T/R21/13/CG/SB/NH@CORRECT@E3/" ELSE GOTO5145
5143PROCDELAYLL:VDU3:GOTO5155
5145PROCNO
5150PROCBARNMAIN("30650","31000")
```

carefully timed and natural 'break points' introduced because IV depends on this principle of hundreds of little snippets.

The second problem was that of the complexity of the computer program. BBC BASIC did allow 'procedures' and these were developed for the various control routines required. An example of this was a 'procedure' for searching, finding and playing a sequence of video. The video picture is referenced by a frame number, and this number is sent with a control command to the player. The command routines were constructed so as to only require the frame numbers to be passed to the 'procedure' for processing. Other routines had to developed for learner responses, for example multiple choice, yes/no, and key searches. Although all these were possible in BASIC it also became apparent that the information for procedures and routines would be better kept in files, and programs 'chained' in sequence because of memory size limitations on the computer. Some investigation into the use of the Sideways ROM system implemented on the BBC was carried out. This consisted of re-writing the routines in machine code and 'burning' them onto an EPROM. Although this was obviously a feasible proposition it was felt that it would only detract from the main theme of the project. It was also decided at this stage that some means of simplifying the programming process had to be found, otherwise the only people who would become involved in IV would be proficient programmers and not subject specialists.

These two conclusions resulted in a closer look at another system which would ease the problems of producing the relevant IV learning materials.

2.3.2 APPLE IIe and VHS TAPE.

The second system that was conceived utilised video tape and was designed in February 1983. The main problem with using video tape was the control of the video tape player. Most domestic players were controllable through a remote handset, but no external access was available for computer

control. The video image and computer image were incompatible, and would require some form of image switching. Industrial players on the other hand had some means of programming which allowed continuous showing of video for exhibition purposes. These also had a more complex hand controller with some access to the internal electronics of the player. It was possible to send signals to instruct the player to execute all the main functions available on the machine, e.g. play, fast foward, fast reverse, stop, pause, play slow, etc. There still remained the problem of image switching and accurate search facilities to identified video sequences. An electronic circuit board produced by B.C.D. (38) offered a solution. This board was capable of switching to the VDU either video material from the tape player or from the computer. It was also able to send signals to the video player remote socket in order to control the various play functions. The ability to search and find any section of the video tape was also available through this system. The industrial player was capable of recording TWO simultaneous sound tracks. The system used the second sound track to record an audio generated 'time code'. This consisted of a 1 kHz signal dubbed on to the final recording of the tape. Using this the system was able to search for and find the video material to within a twentyfifth of a second, i.e. to one frame of video.

One other area of concern was the production of graphics screens as a means of illustration and instruction. If programming in BASIC was the only means of producing these, the process would become laborious. The Robo Bitstik system for producing graphics on the Apple system was investigated and finally purchased. This proved to be relatively simple to operate and allowed the production of complex illustrative drawings with little computer expertise. These could not be overlaid on video, but were presented as separate computer images. The system allowed the playing of audio material whilst the graphics were present on the screen, and this proved a very

useful feature, especially where the graphic diagrams were complex.

An authoring station (one used to produce a program) therefore consisted of:

Apple IIe micro computer with dual
floppy disc drives.
Panasonic 8100 VHS recorder/player
14" JVC colour video monitor
Robo Bitstik system
Epson dot matrix printer

A student station (one used to only play a program) consisted of:

Apple IIe micro computer with single
floppy disc drive.
Panasonic 6200 VHS player.
14" JVC colour video monitor.

These are shown in Figs 2.6 and 2.7 respectively.

All the video material was produced, edited, and mastered on Low Band U-matic tape. The 'time code' was also recorded on the U-matic tape. A U-matic machine was also able to be connected to the computer system, and this allowed all the material to be checked on the master tape. The final version was then copied down to VHS. This proved to be successful, but care had to be taken with the audio levels on the 'time code' track in order to maintain the integrity of the control signal on the VHS version. If the code was recorded directly onto each copy of the VHS, then the discrepencies in timimg had to be corrected for each tape. Although this was not too difficult a task, it did mean that each individual tape needed a

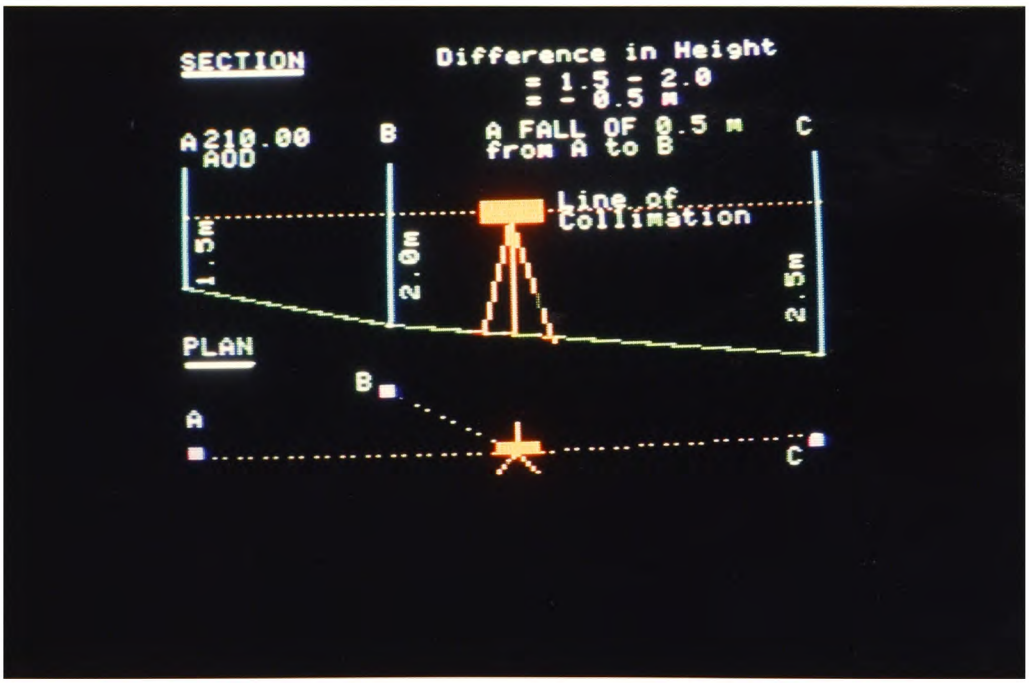
corresponding matching floppy disc. This would require external management of the learning materials, and could lead to confusion and frustration to the user if the discs and tapes became mixed. The solution used was to record the 'time code' on the master U-matic and transfer this to the VHS. Accurate recording levels had to be maintained on the audio tracks.

It was also felt that the learners operating this system would be reasonably 'computer literate' and the keyboard would be suitable as the input device. The 'booting' up of the Apple system was fairly straight foward, and the video system only required the insertion of the requisite tape. A simple instruction manual was prepared (see Appendix 2) which was issued to learners before commencing on the system. This manual also included the necessary workbook for the materials in the package.

Fig 2.6 The Apple IIe authoring station.

Fig 2.7 The Apple IIe student workstation.

Fig 2.8 A graphics screen.



2.3.3 IBM PC Compatible computer and Video disc.

This system was designed in 1986 and was to serve as the delivery unit in an industrial environment. It was the first of the systems considered in this project that not only had to be capable of presenting IV, but also to have a defined specification at the outset. The unit was to be installed at the Central Electricity Generating Board power station at Aberthaw for on-site training, 24 hours per day. The initial client specification was that it had **'to run from a single 13 amp socket without a computer expert to start the thing running'**. It was also anticipated that each station would need to carry the current records of approximately 100 trainees at any given time. The program itself was expected to be large, and several versions would need to be installed on each workstation. The version selected would normally be under the control of a training supervisor, but the operation still had to be kept to a simple non-computer expert level.

With these considerations in mind the (then new) BBC master, and the Apple IIe microcomputers were rejected. The application required a 'hard disc' machine with far more than 64 kbytes of user memory. The separate hard disc systems provided with these two machines tended to be units with no more than 10 Mbytes of storage. The expansion of the user memory past 128 kbytes also presented problems. A 20 Mbytes hard disc was decided as being the minimum practicable. At this time the technology of other machines such as the IBM PC were presenting the user with relatively cheap hard discs. The operating system (MS-DOS) also allowed simple 'boot-up' routines to make the machine almost automatic in its start up procedure. The computer also came with a RS232 port as standard and therefore was capable of controlling a video disc player.

Having resolved the problem with memory and disc storage the next step was to discover whether the computer could be used with video. A new board had just been introduced by Video Logic (MIC-2000) (39) which was

compatible with an IBM PC. It could be used to control the video player and provide both image switching and overlaying of computer graphics/text onto the video image. In addition to the above functions the MIC-2000 board was capable of independently fading sound tracks, video images and computer video. It automatically initialised itself to the computer/disc player configuration used. The software provided with the board also greatly simplified the command structure required for computer control of the video disc player. Examples of these commands are as follows:

PLAY SEGMENT(2240,2540,NORMAL)	would play from frame 2240, to frame 2540 at normal speed.
FINDFRAME(2240);WAIT;STILL	would search for frame 2240, and stop the picture at this frame showing a still image
FADE VIDEO(255,200);AUDIO2 OFF	would fade the video picture from blank to full intensity in 2 seconds, and switch off the second sound track.

This command structure could be used by any computer language and implemented by opening up a channel to the RS232 (COM1) port and then 'printing' the commands using BASIC. Responses from the player unit could also be received using such commands as WAITFRAME(2240) allowing the player to tell the computer it had reached frame 2240. The timing problems encountered with the BBC and Philips 705 player were eliminated by the software on the MIC-2000. In fact, due to the initialisation and configuration routines in the software, the timing factors for each type of video player were automatically accounted for. This was borne out when substituting another manufacturer's disc player at a later stage; the programme ran first time without modification.

The MIC-2000 manufacturers claimed the board would work with IBM PC compatibles. To date it has proved to be compatible and reliable with the following machines:

IBM XT and AT

Tandon PCX and PCA

Commodore PC10 and PCA40

Beltron XT and AT

The board is supplied in both CGA and EGA graphics versions. The enhanced graphics version was chosen to provide better graphics and text presentations.

The next stage in hardware selection concerned the video disc player. Initially the Philips VP835 player was chosen and used in a development system. This proved technically suitable, but was somewhat bulky and only available as a 'top loader' i.e the disc was loaded through a lift-up lid on top, as in a record player. The Sony 'front loader' was then considered and tested. In this the disc was loaded in a motorized drawer in the front panel, as in a CD player. This was physically smaller and could be stacked in the cabinet of the workstation much more conveniently. In addition the Sony player actually proved faster in its search function, thus reducing some of the irritable delays which can occur in a programme. The new Philips 400 and Pioneer (4000) series of players now being offered (1988) are also front loaders and have vastly improved search times over the early Philips 700 and 800 series.

The final hardware problem to be resolved was the learner input device. CEGB training staff at Aberthaw had decided at an early stage that the conventional computer keyboard should not be used. They felt that the task at hand did not include 'keyboard literacy' and the normal keyboard would present learner inhibitions. In January 1986 it was felt that the 'touch screen' had as yet to prove its reliability and suitability in an

industrial environment. A 'mouse' or 'trackerball' were also suspect in the dirty atmosphere of a power station, and perhaps would be difficult to master. This left some form of 'concept keyboard' or digitizer board. The latter was ruled out as too expensive (in excess of £800). It was decided to experiment with an A4 pressure pad board. An overlay could be designed to fit and areas of the pads designated to respond as the equivalent of keys pressed on the keyboard. The pad used was a 'Keyport' which is an American product. On early trials with the computer and using the software supplied it seemed reasonably acceptable, even though the pressure applied seemed to vary over different parts of the layout, and very little feedback was felt by the user's fingers. However, when coupled into the other software being used on the machine, a major problem revealed itself. The pad was causing timing problems with the running of the other software. This not only affected the programs, but also caused the video player signals and timing control to malfunction. After several consultations with the supplier it became apparent that the pad software was designed to run at 4.7 MHz (Standard XT speed) and the IBM AT was running at 8 MHz. Neither the American manufacturer nor the British agent seemed able to offer any help in the way of technical support or willingness to supply additional versions of the driver software. This led to the decision to abandon the keypad. (It was later discovered that Jaguar UK were experiencing the same problems with that keypad on their IV project. The input device now became a major stumbling block to the hardware system. The decision was then made to look at the manufacture of a specially designed keyboard. The control program had been almost completed at this stage, and it became apparent that only a limited number of keys were being used. A standard IBM keyboard was taken apart and from this it was discovered that it would be a relatively simple matter to convert it. The circuitry was transferred to a different box, and only the required keys were wired up. These were wired to push switches

which had legend covers. This arrangement allowed a key legend to be produced which could match the illustrations produced by the graphics on the screen. An example is the 'GO' key which in keyboard terms was the ENTER or RETURN key.

The IV workstation as used by the trainee is shown in Fig 2.8, and that used by the trainer in Fig 2.9

Fig 2.8 The trainee workstation at Aberthaw.

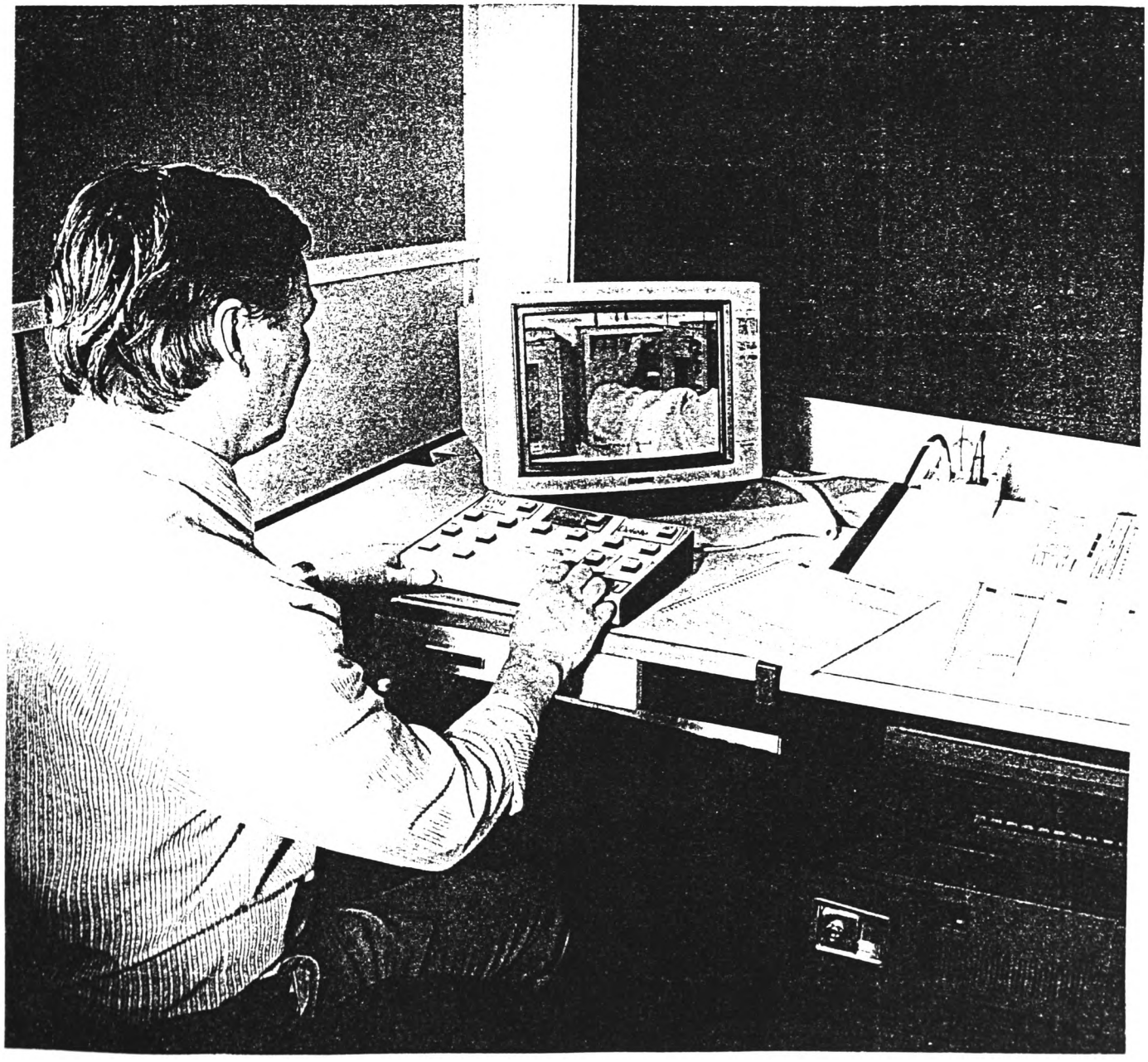
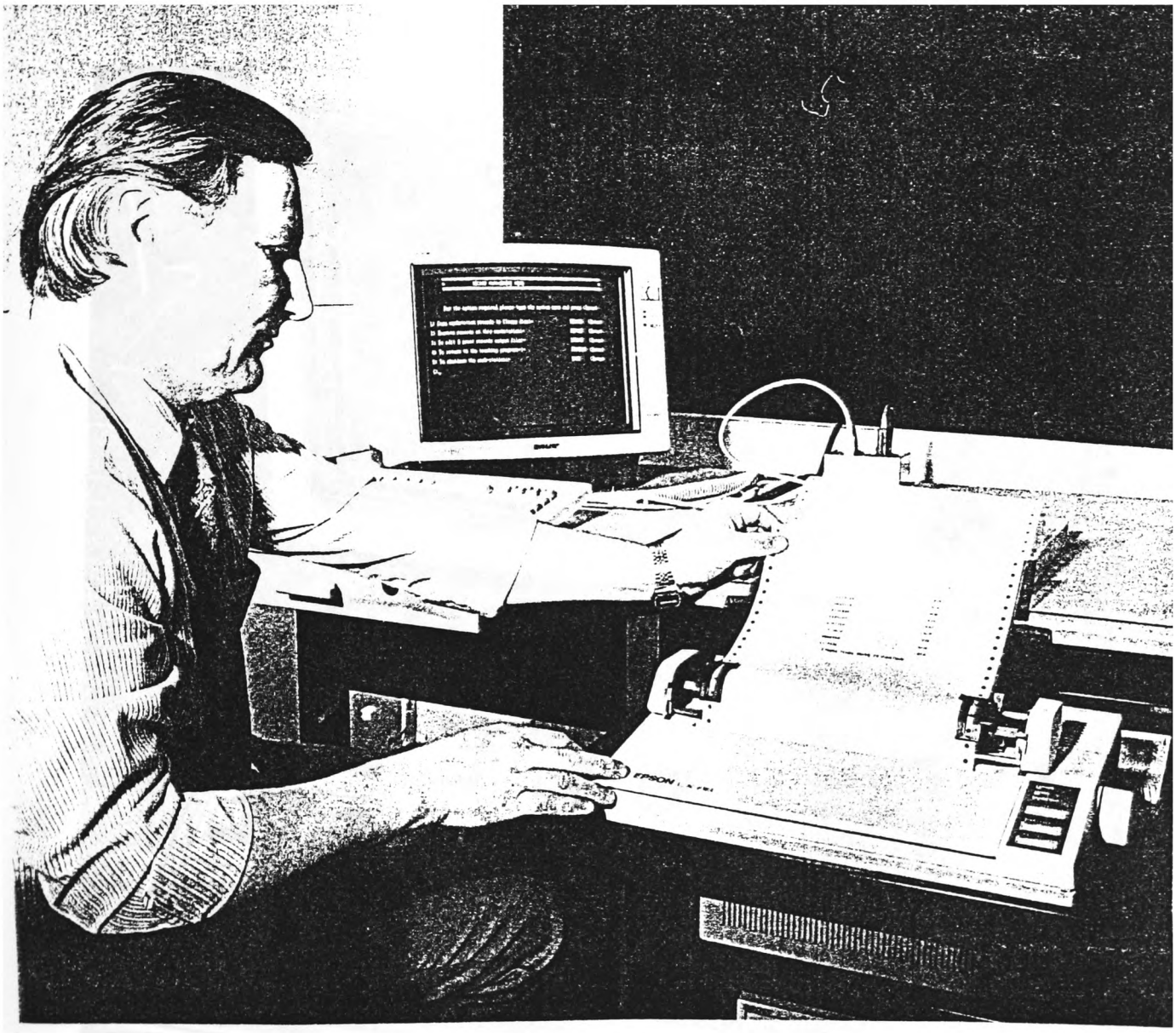


Fig 2.9 The trainer access to the work station.



The final version of the customized keyboard, complete with legend, is shown in Fig 2.10 below:

Fig 2.10 The final customized keyboard.

2.4 AUTHORING LANGUAGES AND SYSTEMS.

In order to put the interactivity into an IV programme, the producer/designer in some way has to provide a set of instructions that the micro computer in the system can interpret and carry out. In normal computer terms instructions can be written in several forms.

Right down at the lowest level there is 'machine code'. The Programmer writes the instructions to the machine using binary code, consisting of only '0's and '1's. The flexibility and speed of computer operations are very high. Machine code programs are written for a diverse range of applications. The video disc player is capable of accepting these instructions on the RS232 port, and some attempt was made to write a program on the BBC/Philips system. One of the main advantages with machine code is that the program can be quite small, and in fact it could be written to an EPROM chip. This could be inserted into the BBC computer 'Sideways' ROM thus allowing the major control routines to remain in memory. The timing difficulties mentioned earlier with this system were dealt with quite easily by using the requisite number of NOP (No operations) within a loop in the code. The timing of a NOP would vary from manufacturer to manufacturer, but can be adjusted in the code for each. One other problem that did begin to cause concern was the problem of transposing the machine code instructions from one type of computer to another. It was at this stage that the penalty of tedium and complexity became too large for the speed and flexibility gained by this method.

At an intermediate level there are general purpose programming languages such as BASIC, PASCAL, C, FORTH, PILOT etc. These provide a reasonable amount of flexibility, but are **languages** and being so the user has to be become familiar with them before embarking upon writing a program.

The final alternative is very high level software which makes the actual operation of the software totally transparent to the 'programmer'.

The 'programmer' is able to communicate with the computer using very English-like words and commands. For instance, programs like Lotus 1-2-3 and Wordstar make it possible for most people to communicate immediately. These high level systems are normally referred to as Authoring Languages or Systems. There tends to be an inverse relationship between the ease of authoring and the flexibility of the interactive presentation that is produced. Normally a very sophisticated IV programme demands a highly flexible authoring facility, and this tends to be difficult to use. Alternatively, an easy to use authoring facility provides less flexibility and tends to restrict the availabiliy of interactive options. Some facilities provide a compromise between these two extremes.

2.4.1 AUTHORING SYSTEMS.

An **authoring system** is usually characterised by the level of support it offers the author. This support is normally in the from of prompts, menus, and help information. It should point out and explain errors that the programmer enters and not simply reply with the age old message 'Syntax Error' . An example of this support in the IVL authoring system is when the author has forgotten to insert a video tape. The system responds with the message 'Please insert a tape!'.

An authoring system should allow the author to work to pre-planned flowcharts laid out on a pro-forma sheet. These are especially necessary when complex answer matching and branch sequences are included.

Menu options are the most common method for the entry of information. These are acceptable providing the system responds quickly, but can be tedious when entering large amounts of information, possibly leading to silly mistakes. When the system is well designed and responds quickly this method can be very efficient. In the more advanced systems, video and computer images can be viewed simultaneously. This facility is essential where overlaying of text and graphics is envisaged.

For any serious training use, the authoring system must provide learner record management. This must be simple to operate, otherwise the information gathered could prove to be inaccurate or even useless.

The two authoring systems used during this project were IVL and SAM.

2.4.1.1 **IVL-Interactive Video Learning.**

This package was produced by Dalroth Computer Products Ltd. It was devised to run on an Apple IIe computer with a B.C.D. interface and either a Panasonic VHS or Sony U-matic industrial tape unit.

The package was menu driven and so proved quick and responsive. Unfortunately the help facilities were restricted to a manual. There were pro-formas provided with the package, and these were used extensively during the Polytechnic project.

IVL provides the means for producing the necessary 'time code' on the video tape. This was achieved simply by dubbing a signal produced by the computer on to the master tape. The video scenes were then identified by playing the tape and pressing the **'S'** key for the required start point and **'E'** for the end point of each individual scene. It was also possible to produce repeat scenes and to sub-divide scenes using this method. The scene details regarding time and frames could then be printed out. The following is a printout of a programme at the Polytechnic:

INTERACTIVE VIDEO LEARNING
********** ***** ********

VIDEO LOGGER SCENE DETAILS

Date 15/03 Time 11.15

	Start		End		Length	
Scene	Frame	Time	Frame	Time	Frames	Time
1	783	0:0:31:8	1784	0:1:11:9	1001	0:0:40:1
2	2010	0:1:20:10	3071	0:2:2:21	1061	0:0:42:11
3	3231	0:2:9:6	3987	0:2:39:12	756	0:0:30:6
4	4105	0:2:44:5	5110	0:3:24:0	995	0:0:39:20

The major criticism here is that there was no space allocated, within the printout, for a comment to identify the contents of the scene. This meant having to refer back to the relevant pro-forma sheet to interpret the record.

The package was a simple and reasonably flexible system for producing the learning material, this being split into single topic sections called 'blocks'. The blocks were then sub-divided into segments, and branching was allowed from segments inside and outside the current block. The segment types offered were fairly basic and were selected of a choice from the following menu:

Presentation Mode	Testing Mode
Video Scene	Multiple Choice
Computer Text	True/False
Graphics	Missing Word
Printouts	Free Answer
Audio	Tutorial Routine

A typical pro-forma for the information required to create a test segment is shown in Fig 2.11, and a graphics segment with audio sound track is shown in Fig 2.12. The graphics were created using the Robo Bitstik, saved and then recalled using IVL.

A printout was also available on demand of all the Blocks and segments that had been created, complete with the relevant branching information. An example of this is shown in Fig 2.13. A complete set of pro-formas for all the types of segments is included in Appendix 2.

Fig 2.11

Free Answer Test Block:2 Segment:9

Test Type: Ordinary. Block test relates to:

Satisfactory % Score : 80
Branch if satisfactory : 15
Branch if unsatisfactory(1): 10
Branch if unsatisfactory(2): 92

NOTES:

Max number of questions 1 - 5 Key words OR Range of answers
Segment range 1 - 101 Block range 1 - 20
Block range 1 - 20 Max wide or large 18
Key words variable 1 - 3 Range of answers variable 1 - 5
Test types : Ordinary, Pre-post, Pre-only, Post-only

Free Answer Test Question 1 of 5

Question

A surface which is everywhere at right angles to the direction of gravity is known as:

==========

KEYWORDS

1 L E V E L

2 . . . . . .

3 . . . . . .

==========

RANGE OF ANSWERS

1 . . . . . .

2 . . . . . .

3 . . . . . .

4 . . . . . .

5 . . . . . .

==========

BEST ANSWER

A L E V E L S U R F A C E .

Fig 2.12

Computer Graphic Block:2 Segment:6

Graphic Title: B L O C K 1 / 4

Scene Number if with audio: 2

Next Segment: 7

CONTENT:Diagram to differentiate between level and horizontal lines.

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

Levelling has been defined as the operation of determining the differences in height of points on the surface of the earth. In order to understand how the principle of levelling is applied, it will be necessary to define some of the terms used.

A LEVEL LINE (as shown by the blue line) is one of constant height relative to sea level and is therefore a curved line concentric with the mean surface of the earth. At any point this line will be at right angles to the direction of gravity.

A HORIZONTAL LINE (as shown by the red line) is a straight lin which is tangential to a point on a level surface, and is at right angles to gravity at this point only.

TIME: 50 seconds

INTERACTIVE VIDEO LEARNING
********** ***** ********

Fig 2.13

Course name: USE OF THE LEVEL.

Date 00/0 Time 00.00

Certificate: No
Graphics on disk 2: No
Time Kit: No
Free Choice option: No
Opening Segment Number:1

Block	Block Name	First Seg	Next Logical Block
1	Introduction.	1	2
2	Definitions.	4	3
3	Instruments.	15	4
4	Reading the Staff.	31	5
5	Rise & Fall Bookings	53	6
6	Glossary.	63	21

No	SegType	TestType	TestOf	Block	Sc	Branching 1--	2---	3--	4--	5------	Title
1	Text			1		2					Introduction.
2	Video			1	1	3					
3	Text			1		4					Structure of Cours
4	Stud.Choice			2		9	10	11	12	62	
5	Text			1		6					Objectives.
6	Graphic			2	2	7					BLOCK1/4
7	Graphic			2	3	8					BLOCK1/2
8	Video			2	4	9					
9	Free Answer	Ordinary		2		15	10	86			
10	Stud.Choice			2		24	25	26	27	31	
11	Graphic			2	2	10					BLOCK1/4
12	Graphic			2	3	10					BLOCK1/2
13	Video			2	4	10					
14	Mult.Choice	Ordinary		2		15	10	87			
15	Graphic			3	5	16					PLEVEL1
16	Video			3	6	17					
17	Text			3		18					SETTING UP A LEVEL
18	Video			3	7	19					
19	Text			3		20					SETTING UP A LEVEL
20	Video			3	8	21					
21	Text			3		22					SETTING UP A LEVEL
22	Video			3	9	23					
23	Text			3		24					Summary of Feature
24	Text			3		25					SUMMARY.
25	Stud.Choice			3		64	78	100	1		
26	Free Answer	Ordinary		3		31	25	87			
27	Video			3	6	23					
28	Video			3	7	24					
29	Video			3	8	24					

The IVL package proved simple to use, and several members of staff were trained in its use. Unfortunately it did prove restrictive in the way material was structured and presented. Repeat and alternative segments had to be constructed using separate blocks. These segments were carbon copies of earlier ones, and this rapidly used up the 100 segments allowed in one programme. The Free Answer segment was in fact a matching routine, and allowed up to three strings to be matched. The main disadvantage with IVL is its lack of calculation facilities. This severely restricted the application, in as much as the subject area contained many simple calculations. Exercises could have been built around problem solving, both in the workbooks, and at the keyboard. The management facilities proved comprehensive. Each student's individual responses and his/her passage through the structure were recorded. The reporting included scores and averages not only for the individual, but also for a group, thus making it easy to identify problem areas in the structure and content of the programme.

2.4.1.2 **LEARNCOM'S SAM.**

This package was produced by Learncom of the USA. It was devised to run on an IBM XT/AT or compatible, and used in conjunction with the MIC-2000 interface. The combination would allow the production of IV using a Philips/Sony video disc player, or National Panasonic/Sony tape players.

The system was menu driven which proved quick and responsive during production. There was a full 'on-line' help facility, and two hefty manuals. Unfortunately some features were not apparent from either, and a great deal of time was spent in sorting out some problems. A typical instance was the computer based limit of allowing only 255 questions to be recorded per trainee. This only showed itself once 255 had been exceeded, and the system gave no indication that this was erroneous, just producing what seemed to be

intermittent errors in recording information.

The menu system provided many options. There was a full-text editor which produced the text on screen as it would appear in the final programme. Linked to this was a good graphics package, and diagrams and illustrations were easily produced. It would have benefited from the use of a 'mouse' for this purpose. For more complex drawings, it was possible to import and use files produced in other graphics packages into the main programme. Another feature used together with text and graphics was the ability to overlay one screen on top of another and this proved invaluable when reinforcing responses to questions. This was also the technique adopted to produce overlays of text on to video images. The 'branching' and special features options were more than adequate, and were as follows:

BRANCHING MENU: Press ? for help Page:100

Special Features	Page Types	Other
Video Commands	Press Enter	Test Number
Word Animation	Time Delay Page	Question Number
Graphics Animation	Yes/No or True/ False	Hint Page
Checklist	Multiple Choice	Menu Page
Find Input Field	Use Special Keys	
Lesson Variables	Areas of screen	
External Program	Video segment	
Assign Special Keys	Single Fill-in	
Remove Special Features	Multiple Fill-in	
	Forms Fill-in	
	List of answers	
	Branch on Test Results	
	Go To Page and Return	
	Random Pages	

The package was designed originally for producing CAL programmes, and is the result of a great deal of development. It is quite complex and takes some effort to learn the features. After two years of use, 'new' functions and methods are still being developed by the author. Because of the complexity of the package it is intended only to outline some of the more important features applicable to the CEGB project.

Instead of the 'segment' as a unit, as in IVL, the 'page' is the unit in SAM, and there is no block structure. The 'page' is actually an operation or function, for example producing screen text, playing a video segment, analysing a trainee response, branching, or calculating a result. The package fully supported the MIC-2000 command structure. The system was capable of playing the video, complete with frame number, whilst in the authoring mode. A background colour for the screen could be chosen and the computer made this 'transparent' so that the video scene could be viewed. Any text or graphics needing to be overlaid would be given a colour other than that of the background. This produced the effect shown in Fig 2.14. In this instance there had been a change in the procedure for filling in the form after production of the disc, and the word 'YES' was computer generated.

Fig 2.14

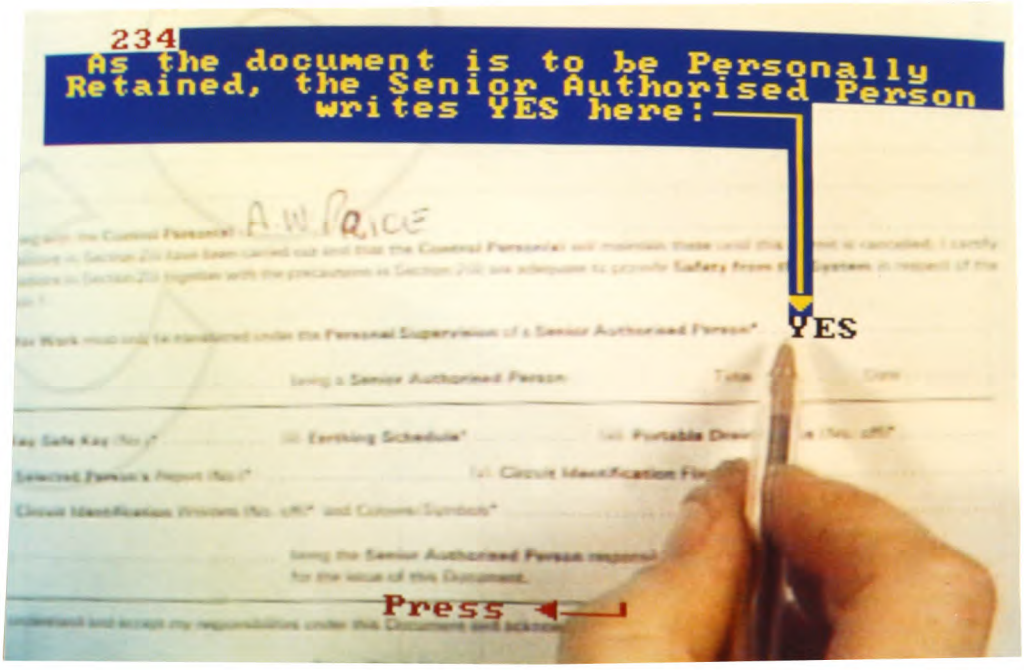


Fig 2.15 shows another example of text overlaid on a video image.

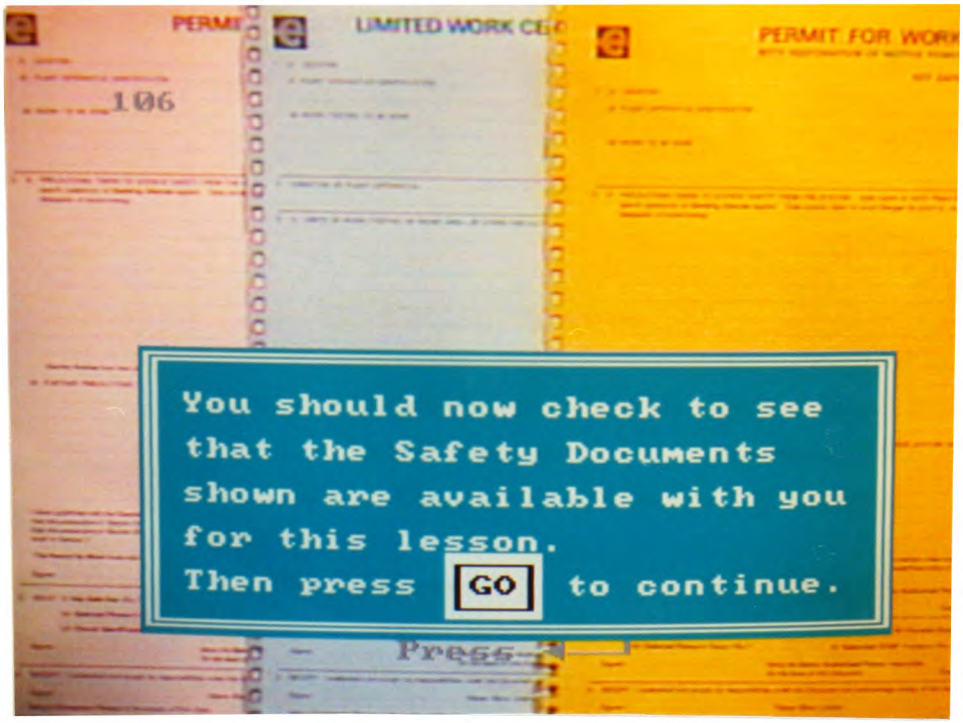
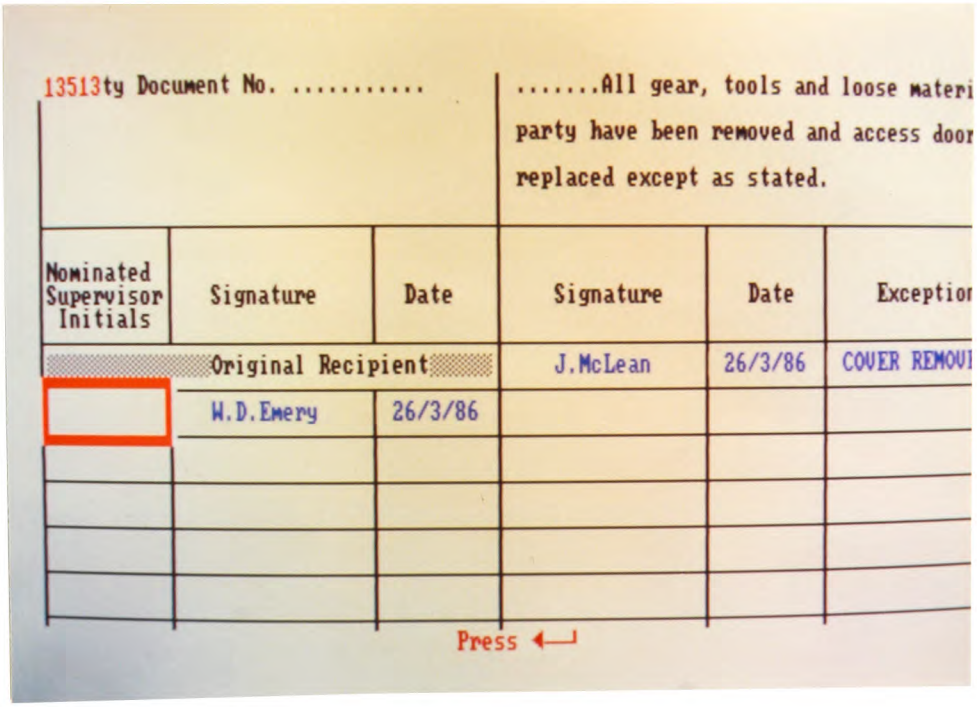
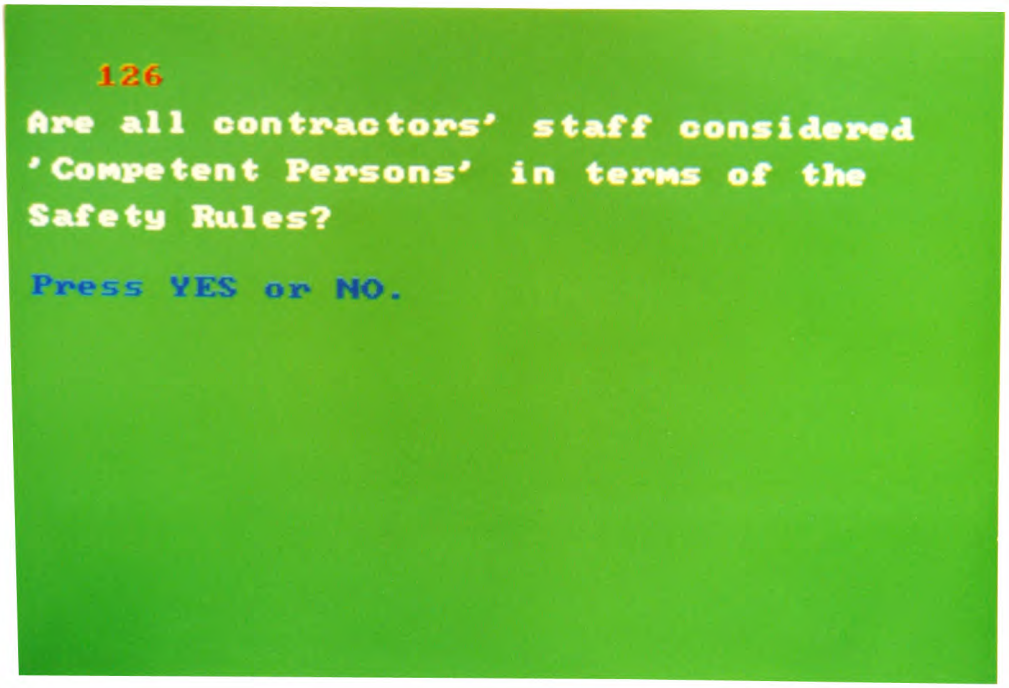
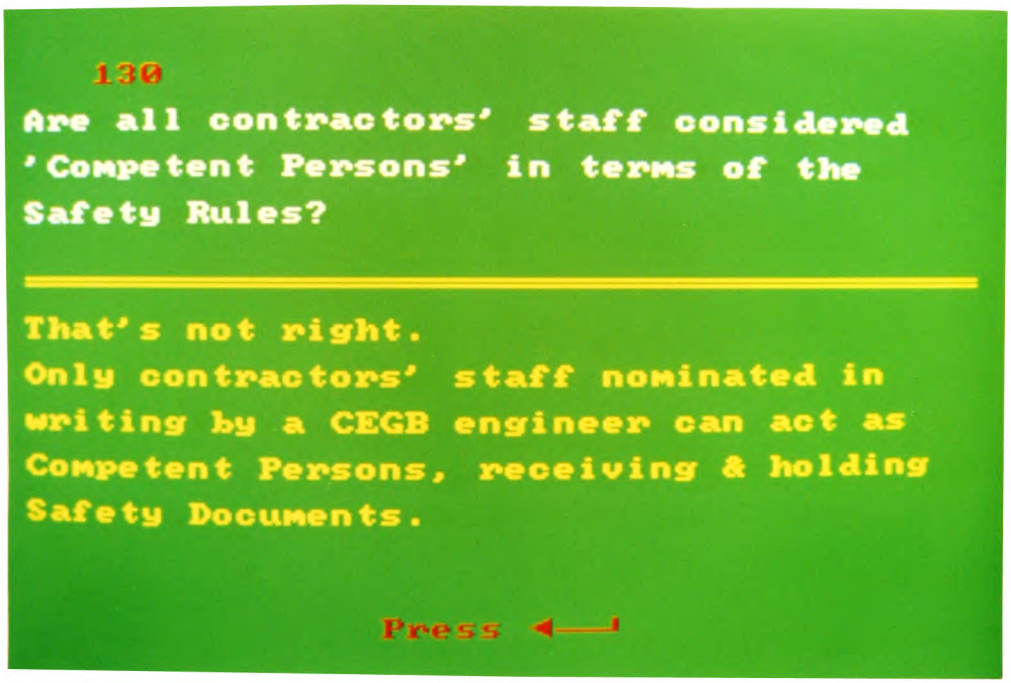


Fig 2.16 shows a computer generated graphics screen. This was a new version of the document which was originally on video



Figs 2.17, and 2.18 show the overlay of one text screen on to another giving reinforcement to a response.





Another important feature of SAM was that it allowed calculations within the programme. Thus a trainee can input numbers and the package calculates and compares answers. The normal numeric and trigonometric functions were available. Linked to the provision of 19 independent variables was the availability to 'SHELL' to other MS-DOS programs and to transfer the values of these variables. This allowed the designer the opportunity to transfer information to and from such packages as spreadsheets and databases. The Lesson Variable function was much used for setting 'flags' within the programme to keep track of where a trainee was. Firstly, it was possible to re-enter the programme at a later date, without having to repeat too much of the previously completed material. Secondly, the variables were used to guarantee some form of structure, and thus prevent confusion to the trainee when choices were given and acted upon.

The Random Pages option made it possible to select lesson pages at random for a series of alternative pages. The function was used to produce randomness in the sequence of questions of some of the tests.

The authoring system required that a number be allocated to each question and test so that the package was able to record trainee responses. The records could be interrogated at a later date. Typically the information given was:

Trainee Identification

Time on system

Response to allocated questions

Whether response was correct/incorrect

Percentage correct.

SAM proved to be a powerful package which satisfied the needs of the CEGB project. Used in conjunction with the MIC-2000 software it was capable of accepting other input devices e.g. a Microsoft mouse, lightpen

etc, providing the correct MS-DOS drivers were made available by the supplier. The final program file occupied about 500 kbytes on the disc, thus confirming the need for a hard disc system. The floppy disc version was slow due to the computer continually accessing the disc for information. With the size and complexity of the final programme, the author feels that programming in BASIC or PASCAL would have been impossible in the time available.

The package had reasonable error detecting procedures, but the screen messages were sometimes confusing. One of the main drawbacks, as with IVL, was the need to leave the editor and load the package into a 'run-time' mode to view the programme sections as they are completed by the author.

2.5 Chapter Summary

In this chapter the author has outlined the technology of the hardware and software available for providing an interactive video presentation. During the project, the technology has changed vastly from the simple approach of the BBC computer with Teletext, through the Apple and video tape, to what now seems to be setting, if it is at all possible, something of an industry standard (in so far as this is possible in a highly competitive market) i.e. the IBM/MIC-2000/video disc.

This chapter is probably the hardest to finalise. Every week the IV press publishes details of new hardware, and predicts the obsolescence of existing equipment. It is hoped that what is not lost sight of is the content of the first paragraphs of this chapter, i.e. the concept of 'Interactivity', and not become sidetracked by the technology which is capable of producing it.

CHAPTER 3. Instructional Design for Interactive Video.

3.0 Instructional Design for Interactive Video.

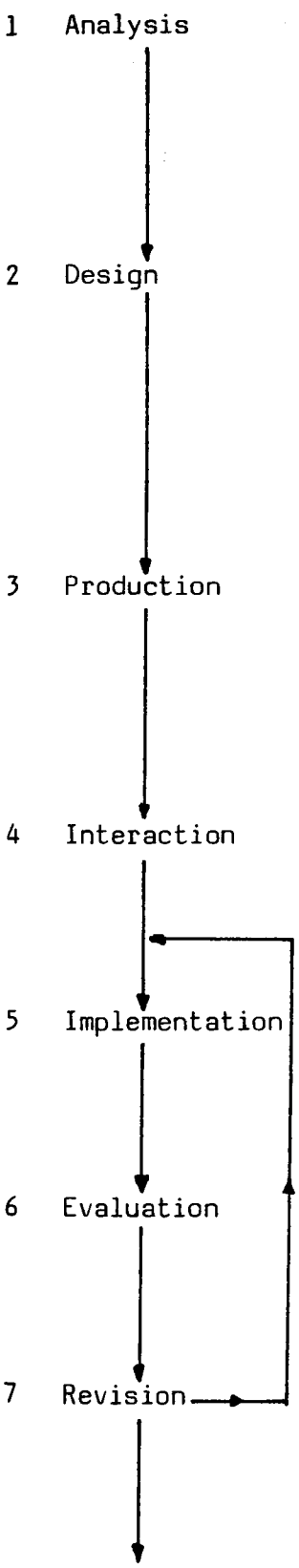
In the first chapter the theories of education were discussed. In this chapter it is hoped that it can be shown how these are applied to the production of an IV learning package.

The design and development of any learning package is essentially a systematic one which involves a number of discrete but interdependent stages. These can be presented as a simple linear progression, but in reality the decisions taken at any stage may have to be reconsidered as a result of decisions made at a later stage. When designing by such a systematic approach it is essential to leave the detailed design until a broad outline has been settled upon.

It would be over optimistic to assume that any initial plan would remain unchanged after an evaluation of a project was completed. Due allowance should be made for this, and provision made for pilot testing with a 'live audience'. These results must be assessed and any necessary amendments made. Careful planning is needed at the outset when an expensive video production is envisaged.

The main stages in the design of a learning package are shown in Fig 3.1. These in fact could be representative of most open or distance learning material.

Fig 3.1 Stages in the development of an IV learning programme.



1 Analysis - to define the objectives of the programme, and to provide a means of classification and structure. From this analysis, identify content areas.

2 Design - to produce an overall programme plan, the form of interaction, develop detailed structure and routeways, produce script details for audio, video, computer text, and graphics.

3 Production - to shoot, edit, and produce video and audio in final format. Create the relevant computer text and graphics.

4 Interaction - to program the question/answer, and learner choice structure.

5 Implementation - to pilot test the programme with a representative group of the intended audience.

6 Evaluation - to investigate the results of the pilot scheme. Identify problem areas in the materials.

7 Revision - incorporate the necessary amendments identified in the evaluation.

8 Validation - to establish the level of success the programme achieves with the anticipated audience group.

The early stages of development of an IV programme consist of Analysis and Design.

3.1 ANALYSIS

Analysis can be divided into three basic stages:

1) Develop and classify the objectives and identify any prerequisites.
2) Analyse the objectives to reveal the main programme content areas.
3) Analyse the target audience to determine the level of content required.

3.1.1 Develop and classify objectives and identify prerequisites.

At this stage it is assumed that an educational or training need has been identified. It is now necessary to analyse that problem in detail in terms of the particular skills or attitudes the programme is intended to convey. After completion of this analysis any prerequisite knowledge, skill or attitude areas should be identifiable.

The programme on the Use of the Level was designed as one of several on different aspects of Surveying intended for students with little knowledge of the subject. As a starting point for planning, the overall purpose of the programme was elaborated in the form of an AIM.

AIM to enable students of surveying to use the Surveyor's Levels.

The aim is broad but does give the direction of the programme and indicates the outcome of someone using it.

The statement does not explain how to recognise someone who can fulfil this aim. It is now necessary to identify what a successful learner is able to do

after using the programme, that is to analyse the aim and identify the elements that the learner has to master to achieve this aim. This process will lead to the identification of **general objectives** or **major purposes.** They differ from an aim, in that they use more precise verbs, and describe what the learner has to be able to do. Some of the major purposes of the Surveying programme were:

The student will be able to:

i) define various terms used in Levelling

ii) identify types of Instruments used

iii) read, record and reduce the measurements taken for level survey purposes.

These statements give a much clearer indication than the aim of the skills which the learners are to achieve. There is however one more stage which needs to be considered.

This stage is deciding on the level at which the learner has to perform the objective. The subject expert will know the level of competance required in each skill. The Instructional Designer has the problem of committing this to paper in such a form that it would be easy for an observer after watching the learner, to decide whether the tasks have been carried out satisfactorily. This is especially important when using the computer as the 'observer'.

The general objectives are now supplemented by specific objectives of learning.

(i) The learner should be able to define various terms used in Levelling

a) Differentiate between 'level lines' and 'horizontal lines'.

b) State the 'reduced level' of a point.

c) Identify Ordnance Survey Bench Marks.

d) Determine the value of OS Bench Marks from maps and tables.

These are four objectives of many that could be derived from a major objective (i). The objectives are not in an arbitrary order, but are placed as in the order in which they will be dealt with in the programme. It is not suggested that this is the only way of organising the objectives. It is possible for the Instructional Designer to classify them to the types of skill they describe, and this can be important if one is concerned to ensure that a full range of skills will be learnt.

In the Levelling programme, the objectives have been ordered because they represent a sequence of instruction with the achievement of earlier objectives being a prerequisite to the achievement of subsequent ones.

In many programmes it would be appropriate to specify prerequisites which must be fulfilled before the user starts the programme. It is possible to test for these at the beginning (Pre-Test) and to allow the user to progress through the programme, or not, depending on the results. In a Post-Test the learner may be allowed to complete the whole set of questions before making a decision as to the next learning sequence. It has been found with Pre-Tests that as soon as the learners have answered a critical question incorrectly then they should be routed immediately to the beginning of the learning sequence, without being forced to go through the remainder of the Pre-test. This process has been found to reduce frustration in the learner.

3.1.2 Analyse objectives to reveal programme content areas.

Once the objectives are established, the next stage concerns the derivation of the content relating to these objectives. In the programme envisaged for the Polytechnic one of the objectives was that the learner would be able to distinguish between various types of Surveyor's Levels. This not only involves the recognition of the different type, but also the differences in adjustments required for use. Also there would be common components between types, and the method of reading of each would not differ. The content could then be related to each of the objectives, and forms the basis of the script for the programme.

3.1.3 Analyse audience needs to determine the level of content required.

This analysis of the audience is a particularly important stage if different levels of learners are envisaged for the programme. One of the more useful attributes of IV is that the information may structured in many ways for different audiences, and can all be contained in the same programme. The level of material accessed, is determined by the computer as the learner responds and progresses through the programme.

It may be found necessary to provide a routeway through the programme which gives less details about the operations involved. Using this method it is possible to present material to a more knowledgable learner without appearing to 'speak down'.

The routeway a learners take through the programme can be determined by their responses to questions which check whether the skills have been mastered allowing them to bypass elements of instruction. It is a simple task within the programme to route a person with the prerequisite skills to a segment containing more advanced material.

The Polytechnic programme was aimed at a group of students with much the same academic level. The CEGB project, on the other hand, had a

much wider range of levels. Initially the material content presented to the various groups was to differ.

3.2 Design.

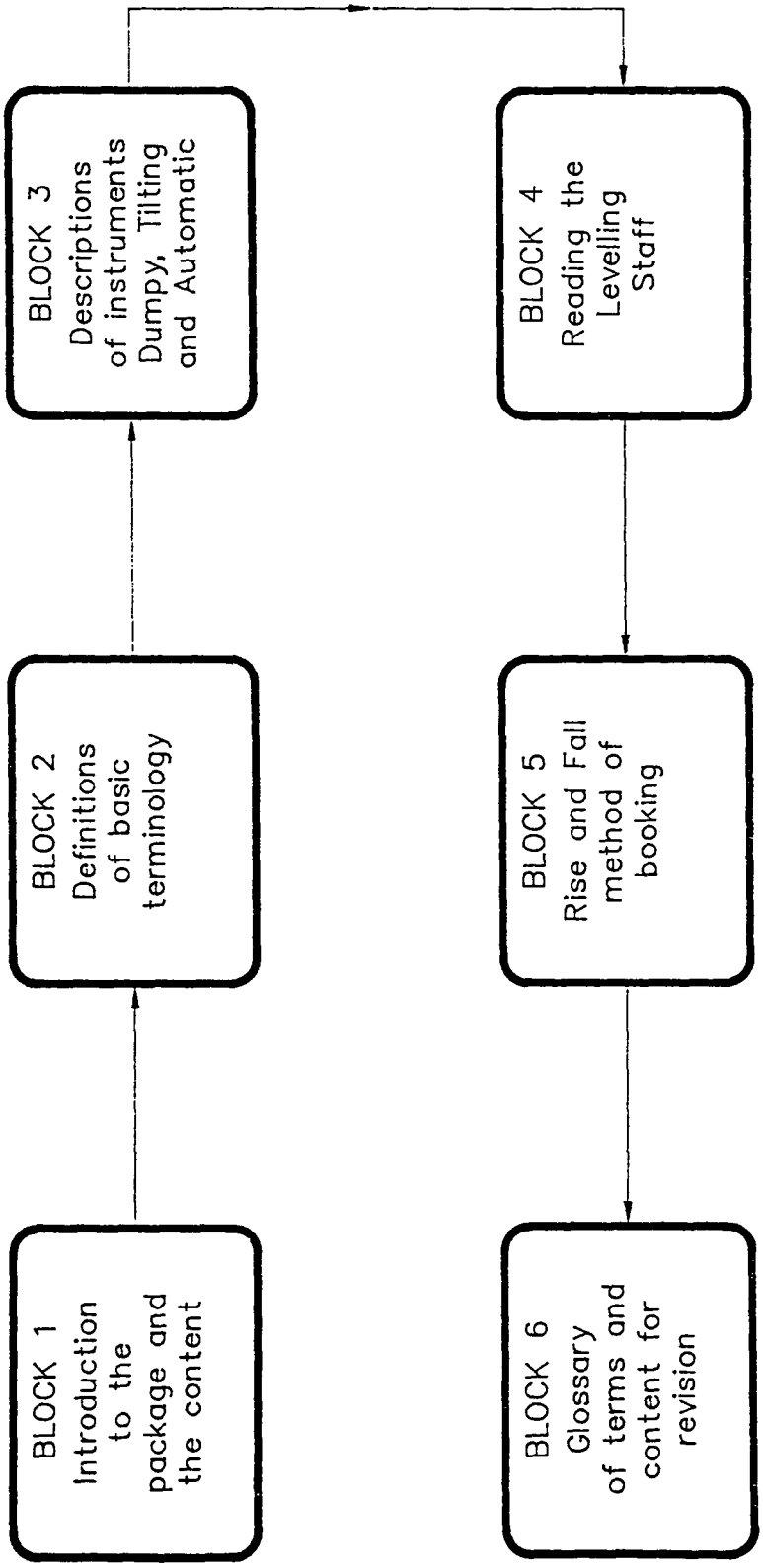
The design of a programme can be divided into five main constituent parts:

1) to produce an overall plan of the programme, and to indicate the main blocks of information.
2) to fill in the remedial and other support blocks required.
3) to develop the inquisitional style of the programme to facilitate the interactivity.
4) to produce a flowchart from the information identified in the previous steps.
5) to produce a full script of the programme.

3.2.1 Produce an overall plan of the programme indicating the main blocks of information.

The purpose of this stage is to allow the Instructional Designer to perceive an overview for the programme, and to develop an outline structure. The most common method for this operation is the use of some form of outline flowchart. It consists mainly of blocks of information which can be joined by lines to show the progression through the learning material. The block chart for the Levelling programme showed a linear progression and consisted of six main blocks which are shown in Fig 3.2.

Fig 3.2



Flowchart for Surveying Programmes at the Polytechnic of Wales

The block chart for the CEGB programme was far more complex. This was developed in conjunction with the training staff at Aberthaw. It served an important purpose in the design, as it allowed the CEGB (the subject specialists) to establish clearly the process involved in the Safety Documents Procedure, and the Instructional Designer to produce an overview of the process. The block chart for the analysis provided a particularly useful facility in the team planning situation where different ways of structuring the information could be tested. It was at this stage that a decision was taken as to the audience range and level of the instructional material. The block chart showed that the material required by most trainees was the same, and it was important that, although trainees may not be involved in later stages of Document Procedures, they should still realise the consequences of their deeds. This became such an effective method that it was decided to produce a large scale block chart. This was done on an A2 piece of card. The main blocks of information which the programme was to contain were then written separately and 'pasted' to the card. The blocks were joined by lines, and arrows added to show the routes through the programme structure. This final block chart proved an invaluable asset to a team approach on the project. It produced a document which was easily read, and was capable of showing the effect of amendments to both the Instructional Designers and the subject specialist. This system chart also provided the means of initially testing the flow logic through the programme. (It must be pointed out that the title 'Task Analysis' described the various tasks involved in the Safety Documents Procedure, and not the tasks involved in developing the programme.

The final block chart for the CEGB project is shown in Fig 3.3. This was arrived at after several versions as the Design and Subject specialists both developed expertise in its use. The information in each box now represented a functional block of the Document Procedure.

Fig 3.3.

Please Note:

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in the
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This block was self contained, and could be directly related to adjacent blocks. As important, at this stage, was the fact that the block also appeared complete as regards forming a test on the information contained. It thus formed the natural 'unit' of the instructional programme design.

3.2.2 Fill in any remedial or other support blocks of the programme.

With the overall plan of the main programme completed, it now became necessary to give more attention to the branching. These are the parts of the programme to which the user would be taken for remedial help or additional information. It soon became obvious that these blocks or segments could be accessed in different ways depending on the structure of the programme. The user could select the branches by referring to an index or menu. Alternatively the user may only reach the segments as a result of a single response, or even a group of responses.

In both the projects, each video scene never lasted more than about three minutes. If several important points were included in a scene, then the scene must be capable of being broken down into smaller components. This method allowed the quicker learner to view the whole scene and answer questions. The slower learner was able to repeat the scene, either as a whole or by selecting the smaller components as required.

The Surveying programme also had a revision section which was organised as a Glossary. This was in the form of a series of menus, and the learner could browse through the material. It was presented in the form of video segments together with short computer text summaries.

The CEGB programme's revision section was mainly short reviews of the material. These were chosen by the trainee from a menu, and the number of viewings was not restricted.

3.2.3 Develop the style of inquisition to facilitate interactivity.

There are various of ways in which interaction can be facilitated. Some of these will be dependent on the choice of the hardware, and others on the

facilities available through the authoring system. It may be necessary to check the learner's comprehension after certain of the programme blocks and to route accordingly. Another alternative is to present the learner with several options, and then allow an option to be chosen. The learner will then be allowed to choose when to be tested on the content.

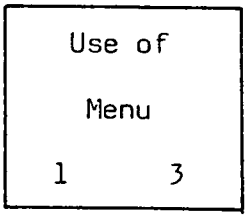
In the Surveying programme the learner was guided through the first block which contained the basic definitions. After this the other sections allowed the learner to take the test at the end of a block. If the learner did not reach a prescribed level, a menu was offered allowing revision of the material in small blocks. This maintained, for a learner, the control on how much and how often the material was seen. The initial testing was carried out using 'Free-answer' matching questions, while on repeat testing multiple choice tests were used. Later in the programme, the learner was required to take readings from instrument views on the screen. These were entered in a 'Work Book', and checked by the computer at a later segment. The learner was also requested to carry out calculations, and to check these against answers given in the programme.

The CEGB programme was limited in the responses that a trainee could make, by the simplified keyboard. The style of the programme originally only allowed a choice of route between the two main types of Document Procedures. Upon progression through the programme the trainee was branched to more complex situations, but the same style of testing was used. The final section of the course did allow choice of the order of the blocks, but the trainee had to complete these in total before being judged as having finished the course. Later it was decided to alter the routing, and allow the trainee to control some of the material. This involved menus at the end of each block. These permitted the learner the opportunity of repeating the material in small sections, as many times as was required.

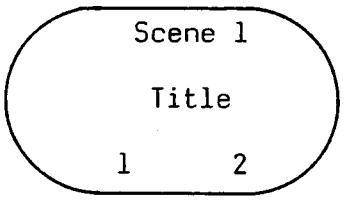
3.2.4 To produce flowcharts of the information identified in the other phases of the design process.

It was decided that the most useful way of representing all the information identified from the previous design stages was in the form of a flowchart. The type of flowcharting technique adopted was similar to that used by computer programmers. The symbols used were derived from standard computer symbols, which were available in the form of templates.

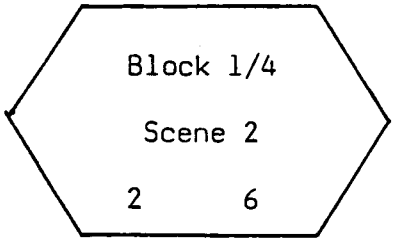
The system developed for the Polytechnic programme used the following symbols:



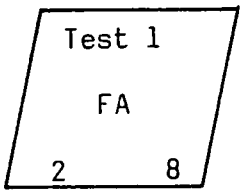
Represents a screen of computer text. The numbers at the bottom of the symbol are: left corner Block number, and right corner Page number.



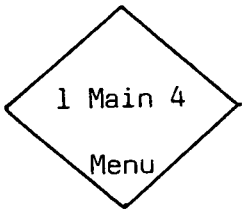
Represents a video sequence. The scene number is the one identified in the authoring system. These were used in preference to the video frame references.



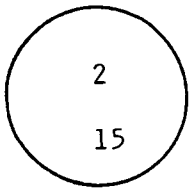
Represents a computer graphics screen. The computer disc file name of the graphics is Block 1/4, and a sound commentary available on video tape as Scene 2.



Represents a test question. The question number is identified, as is its type in this case a 'Free-answer' format.



Represents a learner branch or choice. In this instance allowing the learner a choice of options.



Represents a connector to another part of the programme. This allows simplification when long connecting flow lines are required.

The amount of written detail entered on the flowchart was kept to a minimum, it merely provided a cross reference to the pro-forma sheets of the authoring system. These sheets then contained the full screen text, commentaries, questions, answers, and all the relevant branching numbers.

Fig 3.4 shows the flowchart for the complete Surveying Programme. The complete pro-forma sheets for Block 2 are contained in Appendix 3. These show the development from the flowchart to the detail required for the production stage.

Fig 3.4

Please Note:

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The design of the CEGB programme proved far more complex. This led to several stages of flowcharting, each showing more detail. The first charts were direct descendants from the block chart. The text content was removed and the main routes were established. These showed the relationship between the blocks and the combination of blocks to give a level of knowledge. They consisted of simple symbols representing a block of information, its 'in' and 'out' points, learner choice, and programme structure, and importantly they began to identify the different personnel involved with the Document Procedures.

Fig 3.5 shows the procedure involved in one of the two documents covered. Level 1 of the programme describes when a document is issued for a task to be completed in one stage. Level 2 involves the change of personnel at the end of a working shift when the task is incomplete. These charts were not only used to develop more detailed charts, but provided the information for continuity (matching personnel to situations and time) necessary in writing the detailed shooting schedules.

Each block was then broken down into learning sequences. As the detailed flowcharts were being prepared the script writing was also being progressed in parallel. Both these operations derived their information from the block charts. Fig 3.6 shows the detail of Block C, which covered the issue of a Safety Document. The video sequences in the flowchart correspond to the scene numbers on the script sheet. This, approach of using the flowcharts as a source of information, allowed close liason between members of the Design team, and tasks to be split between them without confusion. The final script written for Block C is included in Appendix 3. As the programme progressed, the structure of each block altered. It soon became apparent that a general structure was needed and this is represented in Fig 3.7. It includes the routing, flagging of variables for learner progress, and specific numbering of pages for general tasks within each block.

Fig 3.5

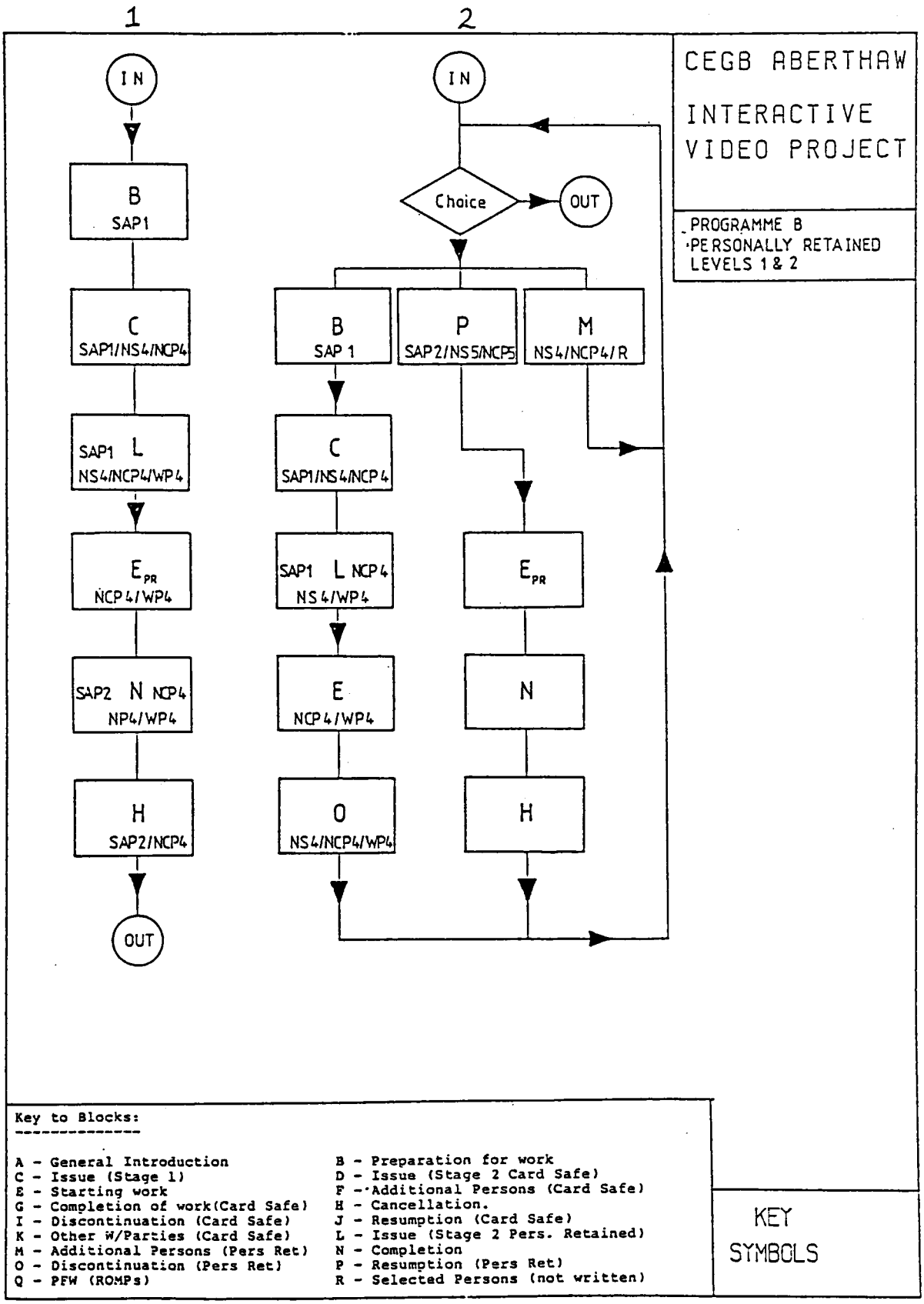

1
2
IN
B
SAP1
C
SAP1/NS4/NCP4
SAP1 L
NS4/NCP4/WP4
E PR
NCP4/WP4
SAP2 N NCP4
NP4/WP4
H
SAP2/NCP4
OUT
IN
Choice
OUT
B
SAP 1
P
SAP2/NS5/NCP5
M
NS4/NCP4/R
C
SAP1/NS4/NCP4
SAP1 L NCP4
NS4/WP4
E
NCP4/WP4
O
NS4/NCP4/WP4
E PR
N
H
CEGB ABERTHAW
INTERACTIVE
VIDEO PROJECT
PROGRAMME B
PERSONALLY RETAINED
LEVELS 1 & 2
Key to Blocks:
A - General Introduction
B - Preparation for work
C - Issue (Stage 1)
D - Issue (Stage 2 Card Safe)
E - Starting work
F - Additional Persons (Card Safe)
G - Completion of work(Card Safe)
H - Cancellation.
I - Discontinuation (Card Safe)
J - Resumption (Card Safe)
K - Other W/Parties (Card Safe)
L - Issue (Stage 2 Pers. Retained)
M - Additional Persons (Pers Ret)
N - Completion
O - Discontinuation (Pers Ret)
P - Resumption (Pers Ret)
Q - PFW (ROMPs)
R - Selected Persons (not written)
KEY
SYMBOLS

Fig 3.6

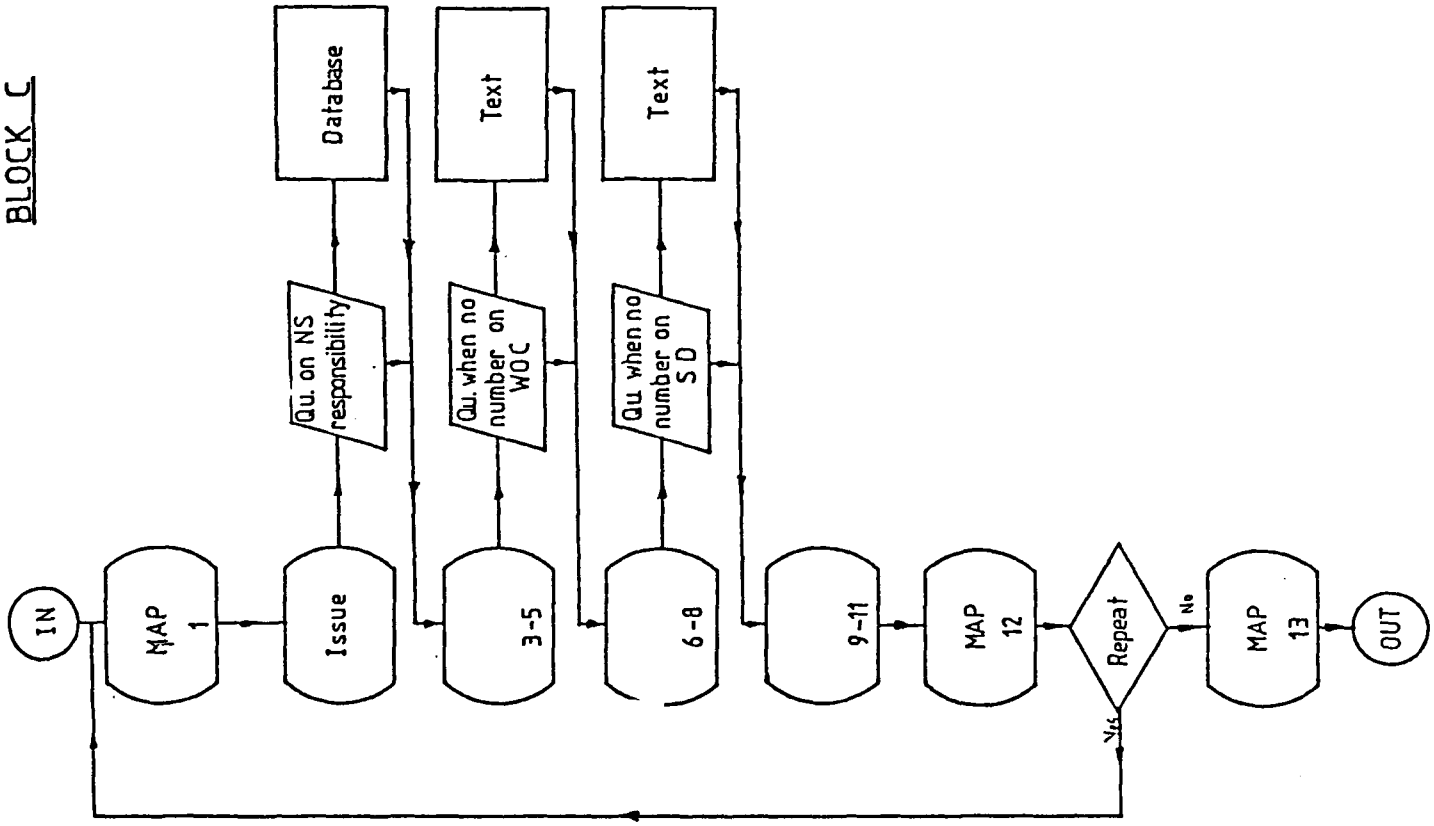
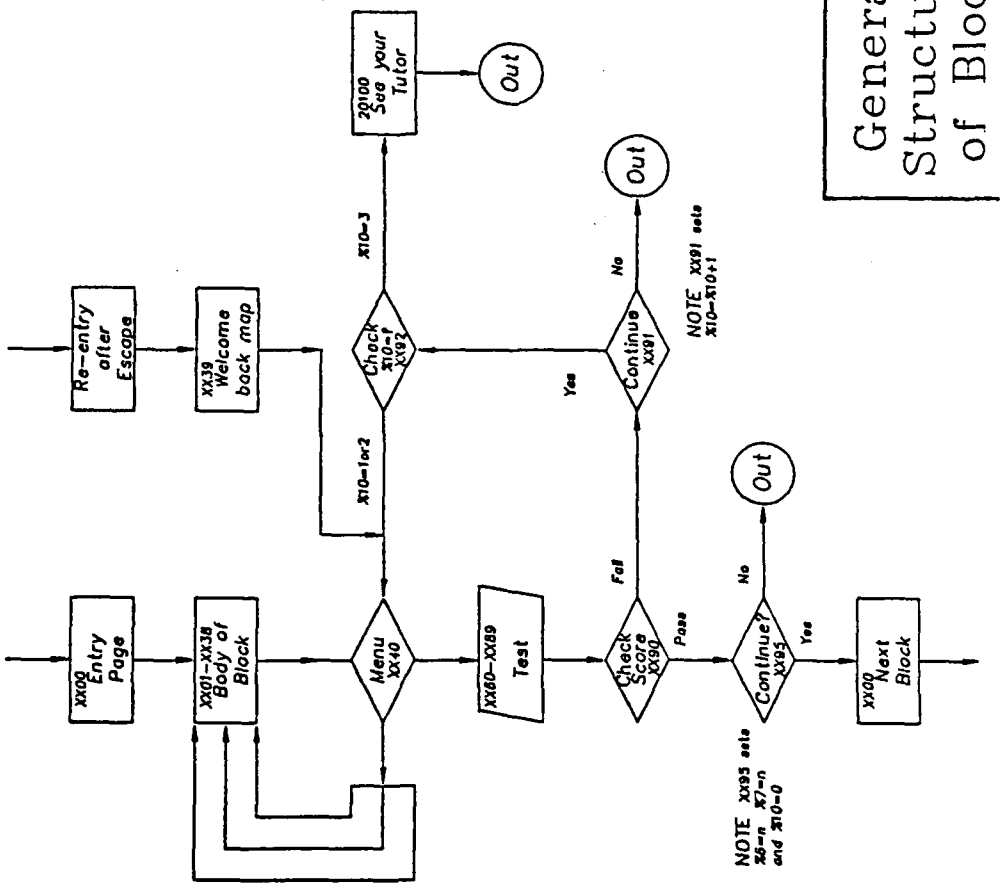

BLOCK C
IN
MAP 1
Issue
Qu. on NS responsibility
Database
3-5
Qu. when no number on WOC
Text
6-8
Qu. when no number on SD
Text
9-11
MAP 12
Repeat
No
Yes
MAP 13
OUT

Fig 3.7


General Structure of Block
XX00 Entry Page
XX01-XX38 Body of Block
XX39 Welcome back map
Re-entry after Escape
Menu XX40
XX60-XX89 Test
Check Score XX90
Fail
Pass
Continue? XX95
No
Yes
XX00 Next Block
Out
Continue XX91
No
Yes
Check X10=1 XX92
X10=3
X10=1or2
Out
29100 See your Tutor
Out
NOTE XX91 sets X10=X10+1
NOTE XX95 sets X5=n X7=n and X10=0

Eventually all the information was presented in an overall flowchart shown in Fig 3.8

Each Block is again represented by a rectangle, tests by parallelograms, choices and routing points by diamonds. Where a route was determined by the computer program, the flag used and its value were indicated in or near the symbol. These values of flags proved to be very useful when testing and de-bugging the programme at an advanced stage. It was possible to gain entry to any point in the programme by setting the required values of the flags %5, %6, %7, thus alleviating the work and tedium of having to repeat large sections of the material. Learncom does not provide any way of easily checking sections of the complete programme. The points at which the flags were changed also became the exit and entry points for the trainees, thus allowing for a trainee to leave a programme at a series of convenient points. When re-starting, the trainee was routed back to the beginning of the block previously exited from, and presented with a 'map' showing where he/she had re-entered. The map was followed by the block menu giving the choice of revision before commencing with the Block test questions.

Fig 3.8

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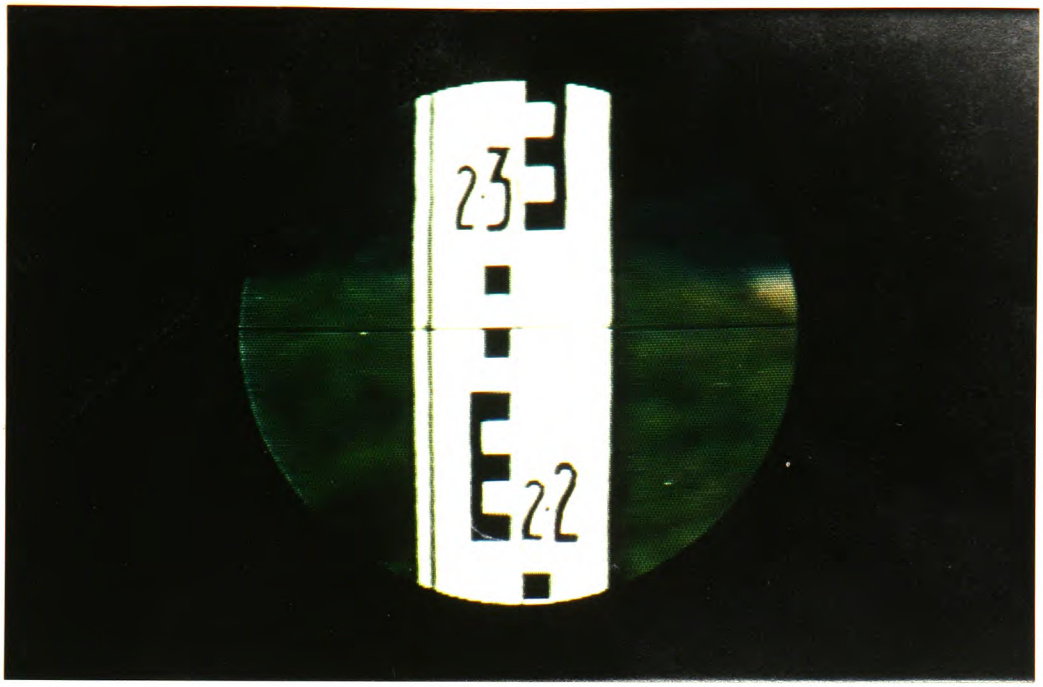
3.2.5 Prepare a full shooting script.

This was the final step in the design stage, and involved the preparation of a full script. It included the narrative, the computer generated text and graphics, and the video components. In the case of the Polytechnic project, the vast majority of the video material was to be shot under studio conditions. This allowed for more control in the preparation, and adjustments could be easily made. The detailed scripts were prepared on the authoring system pro-formas. Some additional external footage was required of items such as Ordnance Survey Bench Marks, use of the staff, and these were intended to create an 'atmosphere' of reality to the subject area. Also at this stage the graphics screens were designed and the narrative written to accompany them. The text screens were laid out, colour combinations of text and background tried, size of text, whether lower case or upper case, and the content were all decided upon. The shots through the telescope of a surveyor's level were also considered at this stage. After several abortive attempts at trying to shoot directly through the telescope, it became necessary to simulate this using photographs. Colour photographs of the levelling staff were taken. The cross hairs of the instrument were then created by a thin cotton thread stretched over a card former, and a circle superimposed by a special effects generator. The result produced a realistic video shot, and both inverted and upright images could easily be created. The method also had the advantage of being able to produce unlimited 'readings' for very little time and effort. A typical video shot is shown in Fig 3.9.

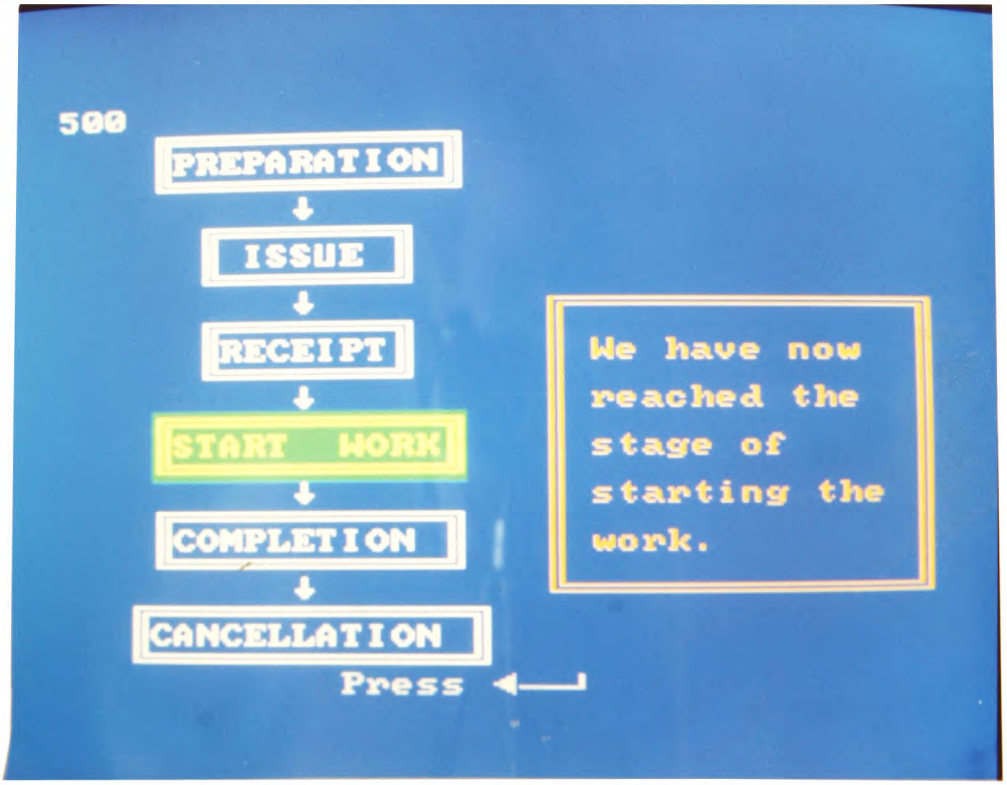
The project was fortunate at this stage to procure a volunteer from the Polytechnic staff to perform as the actor for the video. He was fully familiar with surveying instruments and, as importantly, had experience of television work with the BBC. He also helped with scripting and made suggestions for camera positions, shots, and presentation.

Fig 3.9



As stated earlier, in the CEGB project the flowcharting and scripting stages actually overlapped. This meant that the scripts were almost in their final format as the charts were completed. The major problem was of ensuring continuity between the blocks, and this was achieved using narrative with computer generated graphics. The method also allowed the introduction of a course 'map', which indicated to the trainee his/her progression in the Document Procedure. A typical 'map' screen is shown in Fig 3.10

Fig 3.10



The questions used for routing and for the tests at the end of each block were also developed at this time. A variety of questions on each individual block were written by the design team, using multiple-choice and yes/no formats. These were also required for the repeat blocks at Level 2. They were card indexed, and vetted by the subject specialist for correctness of wording and response. Eventually a set for testing each block at each level was selected and approved. In total the programme contains 225 unique questions in 33 learning blocks.

The final format of a script is shown in 3.11; the leftmost column indicates the scene number corresponding to the flowchart. The next column indicates the view on screen, and could either represent video footage or computer text/graphics. The third column is the narrative, or sound effects, and the next column the audio track number upon which it is produced. (The video disk allowed two simultaneous tracks). The final column is an approximate time (in seconds) for the scene, estimated by reading the narrative at approximately three words per second. The complete script, and corresponding flowchart for Block C, "The Issue Procedure", are presented in Appendix 3.

Fig 3.11

1 'Map'	Graphics	The first stage of the Safety Document issue procedure is the same whether the document is to be Card-Safe-Retained or Personally-Retained.	2	8
2 Planning Office NS picks up WOC(s)	Video	We move foward in time to when a line foreman acting as a Nominated Supervisor in the context of the Safety Rules, picks up the Work Order Cards for the shift.	1	11
3 Question	Graphics	Question on responsibilities of NS		
4 NS looks at WOC checking details finds NCP	Video	At the beginning of the shift, the Nominated Supervisor checks the Work Order Card, and issues it to a Nominated Competant Person.	1	7

From the scripts and flowcharts the shooting schedules were prepared. These were necessary because the story line required changes of location, and of personnel involved in the various scenes. They were produced for all the major locations, and included all the filming details for a location. An example is shown in Fig 3.12. The first column represents the shot number, and the second describes the activity to be filmed. The next includes the estimated commentary timings from the script, the fourth column identifies the scene with both the script and flowcharts. The fifth column lists the personnel required for that shot, and the last describes the 'props' necessary for the scene.

Samples of the complete shooting schedules for three major locations are given in Appendix 3

Fig 3.12

SHOOTING SCHEDULE:

LOCATION - REF. A PLACE: EXTRACTION PUMP 'A' STATION BASEMENT

	ACTIVITY	TIME	BLOCK/FRAMES	PERSONS	MATERIALS
1.	NCP + working party at work - NS arrives to do spot check	1 min 15	A 8	NS1 NCP1 WP1	Tools SD's WOC's
2.	SAP Locking off valve on pump	45 secs	B 5,6 (CS)	SAP1	Chain, lock. CN's, keys
3.	NCP arrives at pump - identifies details on WOC against plant - starts work by undoing bolts	56 secs	E 1-6 (CSR)	NCP1 WP1	WOC Tools
4.	Several nuts undone - one marked "SEIZED" - Welder with torch required to burn nut off	1 min 12	F 1 - 4	NCP2 WP2 W	Tools, WOC, Welding gear Scrap metal

3.3 Production.

This final phase of development can be divided into two components:

1) The pre-production stage, where a choice of mastering format is made.

2) The production stage, where all the material is generated.

3.3.1 Pre-production - the choice of mastering format.

Video disc - The choice of mastering format is a crucial one, particularly where the video disc is concerned. In this instance the premaster must either be a completely edited 16mm or 35mm film, or an edited and frame synchronised video tape produced on near broadcast-quality equipment. Anything less will usually give visually disappointing results, particularly at edit points. For the CEGB project it was decided that the video would be produced in Beta-Cam format using a production company. All the 'rushes' would be checked using portable playback machines at the end of each location's filming. The rushes would be transferred to U-matic for the offline edit, and the edited draft would be viewed and checked on VHS. The final version would be edited on-line to give a 1" master tape for processing by Philips.

Video cassette - For tape based systems the choice of mastering format is slightly less crucial, but nevertheless important. The main consideration is likely to be the number of 'generations' through which the material has to pass before it reaches the final delivery format. Generally, the lower the number of generations the better the quality of the final version. 'Low band' U-matic developed through three machine generations is acceptable for most educational and training applications. In terms of facilities costs, it is half that of 'High band', and this factor alone influences the final

decision. The question of quality must also be considered when the final version is to be VHS, and the final transfer should be carried out using a time base corrector. It was decided that the programme at the Polytechnic would be mastered on low band U-matic, and after editing would be second generation. The final version would be copied down to VHS.

3.3.2 The Production Phase.

This phase involves the shooting and recording of the video elements, recording of sound, generation of the graphics and the integration of the visual and audio material. The latter was achieved using the authoring systems as outlined in Chapter 2.

As the techniques of shooting video and recording sound do not differ from those used for generating traditional video programmes, it is intended to concentrate on those aspects peculiar to IV.

Sequencing the Video.

In IV the video elements can be presented in any desired order (as selected by the computer), irrespective of their position on the tape or disc. To assemble the video material on the disc in a random sequence therefore seems feasible. To do so would certainly result in a useable programme, but it would be unlikely to be satisfactory to the user. The reason for this is what is known as 'access time'. This is the amount of time it takes to search from one given point on the tape or disc to another given point. In this respect, disc technology scores significantly over tape. For example the Sony disc player has an average search time of 2.5 seconds, and that includes from one end of the disc to the other. For a thirty minute VHS tape played on the National Panasonic NV6200 industrial player, the worst case is about 30 seconds. The pre-roll time of approximately 4 seconds would then have to be added to this, irrespective of the actual search time.

For determining the most efficient sequence of elements, the flowchart is particularly useful. By referring to optimum pathways through the material, the geography of the tape or disc can be organised. This is less critical in the case of a disc, and it sometimes proves convenient to group still frames at the beginning or end of the disc. However, if a series of pictures or diagrams are to be stepped through without an appreciable access time (Surrogate Walks on BBC Domesday videodisc) they must be placed at exactly the points needed. Sometimes long access times can be disguised by text screens for the learner to read whilst the player is searching. In any event, if slow access times do occur, the text screen should indicate to the learner that he/she has not been forgotten. The IVL authoring system produces the message 'Busy searching' automatically when looking for a new video segment. The CEGB disc access times were minimised by arranging the material in suitable pathways, and the 'map' of the contents of the disc is shown in Appendix 3. The second audio track material was also organised to be adjacent to or parallel to the other material relevant to that block. This ensured that the additional audio for Block C was placed in the same position on the disc as all the other material for Block C.

For disc preparation the editing of the master tape is far more complex than for a videotape. This is largely due to the fact that with IV the facility of using 'still frame' may be desirable. In order to get still frames which are steady on the screen, it is necessary to eliminate the problem of 'inter field flicker', i.e. a field of one frame being viewed simultaneously with a field from another. The method adopted to ensure that correct field relationships are established is to use a sophisticated piece of equipment called a 'field correlator'. These units are available from the disc mastering agencies. The problem with their use is that the submitted master has to be played back through the field correlator and re-recorded on 1" C format. Inevitably, a small amount of picture degradation will occur because of this.

Mastering of the video disc.

The process for mastering a Laser disc varies slightly from one manufacturer to another, but the basic elements are similar. During editing, the master video tape is time-coded, and the frame numbers are inserted in the vertical blanking interval between frames. The material is carefully checked for quality and placed in a secure environment. A layer of photoresist to a specific depth is used to cover a high quality polished ground glass plate. Once cured this layer is exposed to a laser beam modulated by the (analogue) video signal from the master tape, which produces the 'pitted' (digital) pattern characteristic of the optical disc. A nickel stamper is then produced from the glass original. The stamper is used to produce the disc replicas by a process of thermoplastic injection moulding. The resulting plastic disc is covered with a layer of reflective aluminium followed by a protective clear plastic coating. Two sides may be bonded together to give a double sided disc. Some manufacturers are now offering various check masters. The shelf life of the glass original and stamper is normally quoted as 12 - 18 months. After this to produce more discs the whole process has to be repeated. After two years of use the prototype disc used by the Design team is showing signs of physical breakdown. This seems to be occurring from the outside edge, and seems due to the ingress of moisture and/or oxygen between the sandwiched layers. The aluminium has discoloured, and certain parts of the disc are now unplayable, with other parts showing picture degradation. (This is probably a rare occurrence).

3.4 Implementation.

This phase commenced after the initial IV programmes had been produced. The process was that of a pilot scheme to check on the content and routing of the programme. It was hoped the process would highlight problem areas before subjecting the material to larger scale use.

Both pilot schemes were implemented with a small random sample of

users. Some with previous subject knowledge and some without any were used. The results were recorded by the authoring systems and used in an initial evaluation for revision to the material.

A description of the results and the revisions and alterations are described in the next chapter.

3.5 Summary.

In this chapter the author has attempted to describe a process of Instructional Design applicable to IV. The process has been derived from a 'systems approach' to learning, and has tried to incorporate the models of learning established in Chapter 1. No attempt has been made to present an all encompassing methodology. Rather it has been intended to show the development of an approach begun on the tape programme and finalised on the disc project.

Both approaches satisfied the need for design, and were appropriate to their own requirements. The eventual system used on the CEGB project proved invaluable at all stages, and became essential where a team of designers and subject specialists were concerned. It would be interesting to apply this approach to the design of a more inquisitional, resource based programme, where the routing and branching would be far more complex, and more learner controlled.

CHAPTER 4. Evaluation and Testing.

4.0 Evaluation of Initial or Pilot Testing.

The evaluation of educational or instructional providing technology is not a simple task. Interactive Video now presents a complex system where it becomes even more difficult to separate the learning process from the technology used to implement it. Evaluation can be an inexact science which deals in subjectivity, people's reactions and value judgements. One of the most demanding aspects of evaluation is to determine the variables capable of measurement, and those which could influence the outcome, but may not be accurately measured.

It is intended to outline the testing and evaluation of the pilot schemes on both the Polytechnic and CEGB projects. This has led to modifications of the programmes, and a method of implementing a total IV scheme.

4.01 Evaluation of the Polytechnic Pilot.

The primary objective of the pilot scheme was to investigate the reliability of the hardware and software for the 'Levelling' programme. The learners were chosen at random and consisted of teaching staff, students studying Surveying, and non-subject specialists, totalling 20 in number. They were asked to complete the package on their own, and at their own pace. During this time the author was available for consultation. This also disguised the observation of the learner by the author. After completing the package a short interview was carried out. This was to identify the difficulties experienced by the learner, and also to gain a first-hand impression of the system.

Of the 20 who completed the package 19 expressed satisfaction with the method, the one who was the exception being a non-specialist who seemed to have great difficulties with the first block of definitions and test questions. Several students enquired if there was more IV material for their

studies. A note was made of the few discrepancies in the video material. These mainly consisted of technical terms used on the audio track. When questioned on IV being the only method of learning the material, all 12 surveying students requested backup text to take away for reference purposes. The five non-subject specialist students also expressed a need for text material for reference at a later date.

Upon analysis of the management records there did seem to be some problem areas with the test questions. These were concentrated around the post-test on the first block covering definitions. The subject specialist lecturer was consulted, and it was agreed to re-consider this block. Generally less than 40% of the learners actually succeeded on their first attempt at this test.

The hardware was reliable throughout the pilot. Initially some problems were experienced with corruption of the floppy discs for the programme. This was eventually identified as magnetic interference between the computer and floppy disc drive, as the drive had been mounted directly on the case of the computer. When the drive was removed to the desk at the side of the computer the problem no longer occurred.

It also became evident that, if the workstations were to be used without supervision, an instruction booklet covering the 'logging-on' to the system would be required.

During the early stages of the project it was suggested that the validation process should include the formation of experimental groups, who could be subjected to the IV package, and a comparison made with control groups of students following the normal method of study. This would involve the testing of both groups for personality, and some measure of academic level. The tests chosen were the Eysenck Personality Inventory (EPI) and the AH5 High Grade Intelligence tests. These were given to a group of approximately 40 Civil Engineering students on their first year of a degree

course. These students were also chosen to test the package on the evaluation exercise that was to follow the pilot testing. The first of the two tests required about 35 minutes to complete, and the second approximately 75 minutes.

Outcomes of the Initial Evaluation.

It was evident from the early stages of the pilot study that the learning materials were being successful, and the students enjoyed the IV method of study. One of the major problems was that of noise in the area where the equipment was situated. This consisted not just of the sound tracks from the video tape, but also noises generated by the computer system and intended to draw attention to the learner's successful or unsuccessful response to the test questions. It was decided to provide each workstation with headphones when in use with individual students. When two students occupied a workstation and headphones could not be used then the volume had to be reduced to a minimum in order not to interfere with other students in the room. The problem of the computer generated sounds was solved by a hardware adaptation: the internal speakers were simply unplugged.

The next problem to be considered was that of the first block containing the definitions. On further investigation of the management records produced by IVL, it became obvious that the major obstruction to the learner's progress was the strict pattern matching that the author had imposed on the system, which only accepted completely accurate spelling. A typical example of a 'correct' answer being rejected was the mis-spelling of the word HORIZONTAL as HORISONTAL. It was decided that the important thing was to test basic understanding, not the correctness of spelling. The programme was altered to allow for a certain amount of latitude in this area. The 'key' match for the above example was changed to 'HORI' and 'HORI***TAL', where * would accept any letter. The problem of exact matching also appeared in the question of whether full words or recognised abbreviations would be acceptable as a response. It was decided to accept

both and the test questions were adjusted to suit. An example being 'TEMPORARY BENCH MARK', here the pattern matching became 'TEMP***** BENCH MARK', 'TBM', or 'T.B.M'. IVL did not recognise 'numbers' as input and read them as 'string variables'. This proved to be a severe drawback in a technical area such as the Surveying Programme. When numerical input was to be assessed the pattern matching method had to be adopted. When a reading from the staff or result of a calculation was to be entered into the computer, the matching patterns had to be carefully considered. An example of this would be if a reading was 0.83. The matches would consist of:

.83

0.83

0.830

If IVL had a numerical input and processing facility, it would have simplified the programme design, and allowed more complex exercises for the learners.

It was at this time that the alterations to the audio sequences were made. Fortunately these were minor and were simply re-recorded and 'insert' edited onto the master tape.

The 'logging-on' instructions and the workbooks for the projects (see appendix 3) were also prepared. The graphics for the support material were produced directly from the Bitstik sofware, and the text based on the definitions and summaries included in the main programme.

The final aspect of the evaluation concerned the comparison of IV with conventional teaching methods for the subject area. The two alternatives that seemed to be applicable to the situation were:

1) The formation of groups. Then using a control group taught by a conventional classroom lecture, and comparing that group with a group using IV as the means of learning. This would involve selecting both groups, and testing them so as to eliminate

errors due to academic levels and personality factors. The tests used in the pilot scheme indicated that a great deal of time would be necessary to carry out the tests in comparison to the actual learning time using IV. A further factor to be considered was that the section of the syllabus covered by the IV programme was small, leaving little time to observe the students actually working. Each student would take approximately 45 minutes on the IV programme, but 120 minutes on the tests.

2) The second alternative was not to select particular groups by testing, but to take a random group. Obviously these students would all be covering the Levelling course as part of their studies. The students would then be observed in detail, and questioned as to their attitudes to the system. Their actual performance on the programme would be automatically registered by the computer system. This also allowed the author the opportunity to study groups of students at his own college, where the groups were generally quite small (up to 12 compared to up to 60 at the Polytechnic). This also had the advantage that they could be studied over a two year period as they progressed through their course. It was felt that this 'illuminative approach' would be more applicable to the project as it evolved.

It was at this stage that it was decided to put as many students through the programme as was physically possible and finally test the system. This is covered in 4.1.1

4.02 Evaluation of the CEGB Pilot.

Again the primary objective for the pilot scheme was to investigate the reliability of both the hardware and the software for the programme. The

training staff at Aberthaw were responsible for the selection of the trainees and testing of the programme. Again, approximately 20 trainees were involved in assessing the system. They were instructed by the trainer on the operation of the equipment, and allowed to work through the package; sometimes on their own, and sometimes observed by the trainer. The process took about 3 months, and during this time minor errors in programming were identified and corrected as they occurred. These included rectifying incorrect spelling on text screens, altering the start and endpoints of video scenes, lowering the video levels at the end of the scenes to highlight instructional text, adjusting audio levels between tracks, and minor routing errors due to mis-typed numbers. At the end of the pilot scheme several points were identified as having to be resolved before the IV programme could be implemented on a larger scale. These were:

1) The hardware had proved reliable during the test. The system had met the requirement of being initialised and ready to run simply by switching on the unit at the mains. The problem was now to make the workstation mobile and tamperproof for use at the workplace, that is in the workshops. It was at this time that the Sony front loading videodisc player was substituted for the Philips top loader. This simplified the design of the workstation case, as everything was now accessible from the front of the unit. The casing was built in two units, one being the desk for the monitor and keyboard, the second a cupboard containing the computer, videodisc player and printer. The monitor was modified so that only the volume control was available for adjustment by the trainee, all other controls being blanked off. It was also at this time that the decision to replace the computer keyboard with the keypad was made (see Chapter 2). Although no problems with interference on the

electricity mains was experienced at the training centre, for plant use a simple mains filter unit was added to the workstation. Eventually, the CEGB decided to purchase 5 workstations in order to complete the training programme, which involved approximately 600 of their own staff and 200 of their sub-contractors staff.

2) There were several problems in the routing of a trainee through the programme, and some improvements were necessary.

The first problem was easily dealt with. Initially the learners were able to enter and leave the programme at will, although there was some structure to the routing which was transparent to the user. This meant they could in fact be studying both 'card safe' and 'personally retained' document procedures and did not need to complete one procedure before finishing the route on the other. This led to confusion and was dealt with by 'flagging' the learner, and not allowing the progression onto the other document procedure until the first was completed. The learner still had a choice of the order in which the procedures were to be learnt.

The second problem concerned the routing of the learner when the responses were incorrect. The programme in its original format forced the learner back to the beginning of a block if any of the block test questions were incorrectly answered. The staff involved in the pilot scheme found this most frustrating, and felt it to be de-motivating. The question of repeating the whole block was resolved by the introduction of a 'menu' system at the end of each block prior to taking the test. This allowed the trainee to decide whether he/she was ready for the test, or needed to look at some of the material again. This fitted a

model presented in Chapter 1. If the test question responses were subsequently incorrect the trainee was then re-routed back to the menu, allowing any desired section(s) of the material to be viewed repeatedly until the trainee felt ready to repeat the test again. It was felt that this degree of decision making by the trainee allowed learning to take place more effectively than if the computer made the decisions. Continued incorrect responses also caused a problem as the trainee would become trapped in a loop with no method of escaping. This was normally resolved (but, illegally) by the trainee simply switching off the unit at the mains! This caused havoc with the record-keeping, as it left files 'open' within the computer, and destroyed what records were available. It also prevented the user from being 'recognised' when trying to log-on to the system at a later date. The problem was overcome by introducing a loop in the test/menu route. This contained a 'counter', (the variable %10 in the SAM, authoring system), which was set to escape from the programme after the trainee had incorrectly answered a particular set of test questions for the third time and instructed them to see a tutor to sort out the problem. The trainee also had the option to 'escape' from the programme at the end of a test whether sucessful or not, these being judged as suitable exit points. SAM allowed the trainees to 'escape' at any time and re-routed them back to the exact point of exit. This was found to be confusing to the trainee, as no recap was possible. The programme was now altered to make the re-entry point the menu at the end of the block, thus allowing the trainees the opportunity of revision. It also made sure they were re-tested on the last block before continuing on to new

material.

Finally, before implementation of the scheme, a process for validation of the learning method was decided upon. The system would give detailed results of the trainee's progress through the programme. These results would show the effectiveness of the IV material, but would show nothing of how the medium was being accepted by the trainees. To accomplish this a questionnaire was devised, which would be completed by a selection of the personnel using the system. The questionnaire is shown in Appendix 4. In addition, the training staff responsible for implementing the scheme were interviewed on a regular basis during the main training period. This is described in 4.1.2.

4.1 Validation of IV as a method of Learning.

The validation of any method of learning is a complex task. It can be attempted by trying to compare and measure the efficiency of a new method with that of of a traditional one. Statistics can be used to illustrate the results and find correlations with factors of 'intelligence' and personality factors.

4.1.1 The Polytechnic Project.

During the Polytechnic project an attempt was made to test students for academic levels (AH5) and for personality (Eysenck EPI); see Appendix 4 for examples. It was found that these introduced extra identified variables into the equation of learning, and perhaps others which were not so readily identified.

AH5 Tests.

These tests were tried on a wide band of students who studied Levelling as part of their syllabus. The test was split into two distinct parts (see Appendix 4). The first was a test using questions based on literacy and numeracy. The group of students likely to be found on the Polytechnic courses were of mixed cultural and ethnic backgrounds. Although most groups fared reasonably well on the numeracy questions, overseas students did not perform well on the literacy questions. This cast doubts on its validity for the project. The second part of the test was in the form of graphical questions. The recommendations here suggested that if the testee had any formal training in graphical communications then the test scores would need adjustment. Again the wide diversity of the backgrounds of the students caused concern regarding the validity of the testing process. It was observed that with the small sets of data available the main difference between the performance of students with high and low scores was reflected in the time taken to finish the package. This showed itself not only in the number of repeat sequences, but also in the time taken to complete some of

the calculation exercises required by the package. These results matched those discovered in projects involving Computer Assisted Learning packages (40). The system also seemed to favour the medium to slow learner with its everlasting patience in repeating sequences. A more detailed study of the students' attitudes to the system regarding this would be worthy of further investigation.

EPI Tests.

The personality factors considered for the purpose of this study were extraversion and neuroticism, these being assessed using the standard Eysenck Personality Inventory. Consistent evidence exists that for young children up to the age of about eleven years there is a positive correlation between extraversion score and academic attainment (41,42,43). However, for the university student this relationship is negative (44,45). It seems reasonable to explain this in terms of the different learning situations involved. In the young child, the learning environment is likely to be a social situation which would appear to favour the extravert, while private study forms the most important learning activity for the university student. It also appears from Eysenckian norms that extraversion normally peaks at about thirteen to fourteen years of age. It would have been expected to have found negative correlation between extraversion and performance on the IV study. Unfortunately the group tested was so small that no figures could be accurately interpreted. The use of IV in the learning process can certainly be influenced by personality. The learner can identify much more directly with the presenter who appears on the video material than with written text or graphics on CAL. The added complexities and lack of finite measuring techniques made any judgements invalid, and the use of personality tests was abandoned at this stage. It is obvious that a further more intensive study would be required to investigate the interaction between personality and IV methods. This should take into account the way in which an introvert may

feel less threatened by video than by a real situation. It is also felt that the extravert may feel that the video material in the style of IV does present the attention demanded by this personality type.

Validation of the Final IV Programme.

Eventually it seemed the only way to validate the IV programme on Using the Surveyor's Level was to subject a group to the material and observe their progress through the learning process. To maintain control over, and observe completely users of the system, it was felt the work should be done back at the author's own college.

An early experiment with a group of students had been successful. This had consisted of dividing a group of students into pairs, the pairing being decided by the student group themselves. Each pair was taken and the IV system explained to them. Once they had been instructed on how to load up the machine they were left on their own until they had completed the package. The pair was then presented with a Level instrument similar to one shown in the video material. The students were instructed to 'set up' the instrument and to determine the difference in height between two points. Each of the six groups completed the exercise successfully without any further instruction than that given by the IV package. The only difference in performance had been the time taken to go through the package, and it seemed those who were slowest on the IV material tended to be the slowest carrying out the practical exercise.

It was decided to extend this process over a longer period of time. The students on the courses only studied the subject area for about six weeks each year. They were also called upon to use the surveying equipment in their second year of study. Thus approximately six months would divide the initial learning and a second exercise with the instruments. The whole cycle was repeated twice, thus allowing two student groups to be subjected to the observation process.

The experiment described above was carried out with a first group of students (14 in number) and proved as sucessful as the trial group. The time taken to work through the package varyied from 50 to 75 minutes. It also became apparent from the observations that an interesting model was being demonstrated regarding a pair of students working with the IV package. The purpose of the IV was to be a focus of the two-way flow of information between the learner and the learning environment. It was able to provide information, guidance, and feedback between the learner and his/her learning environment. In the experiment the students worked in pairs, and by being able to discuss their progress and learn from one another as well as the package, it was observed that such interaction increased the efficiency of the IV involvement. The results reinforced those of Grubb (46) who suggested the two models of learning shown in Figs 4.1 and 4.2.

Fig 4.1

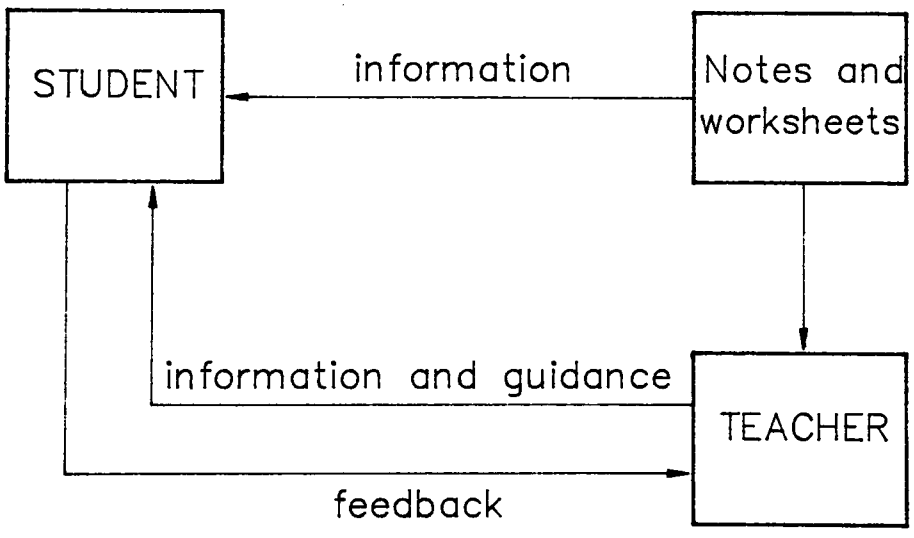
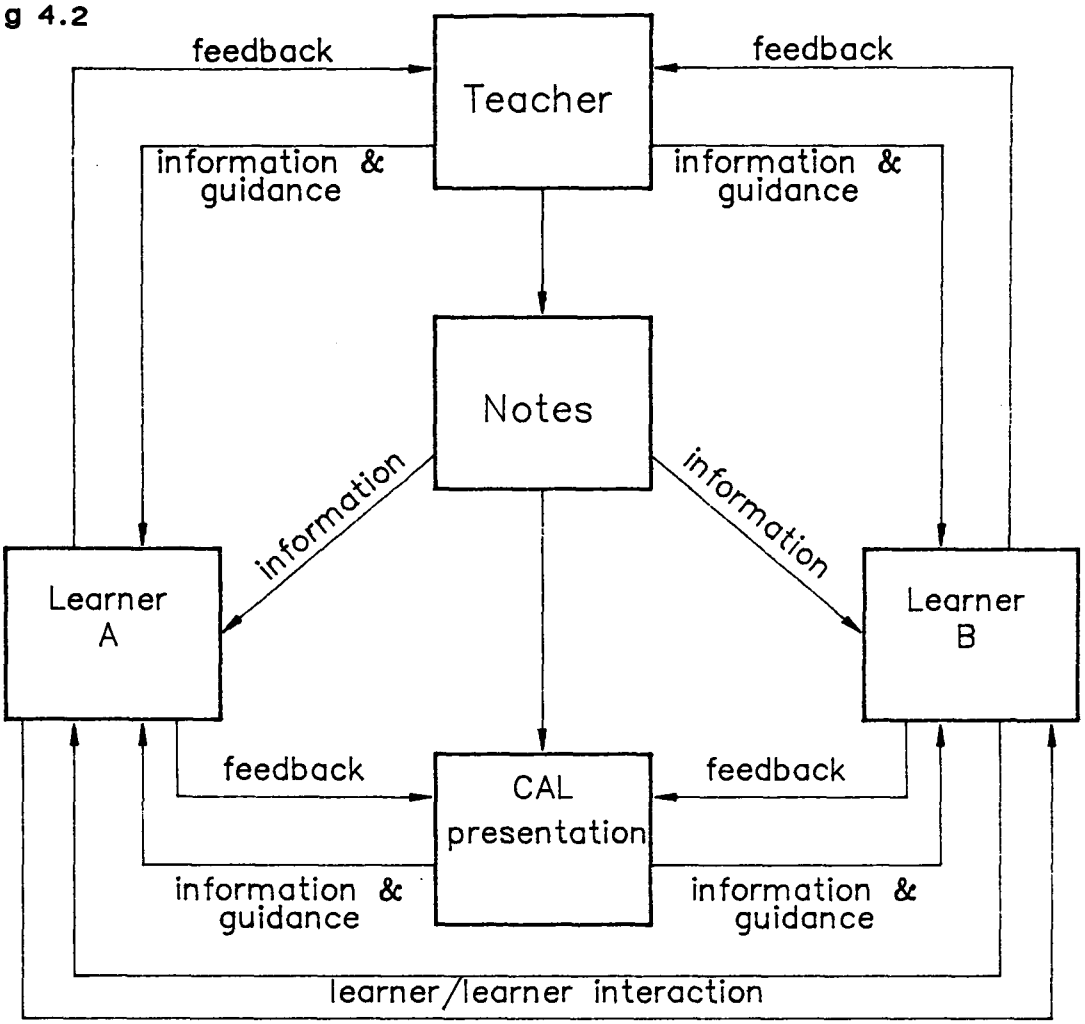


Fig 4.2



During the following year a second group of students (12 in number) used the package with similar results (see Appendix 4). By this time the first group had reached the stage where they again had to use the surveying instruments. This first group successfully carried out the setting up proceedures of the various types of levels without any revision or prompting, but required some assistance with the calculations and booking of the results. The group's reaction to a formal class session for revision was that of requesting to use the IV package. This was possible by using the entry menu and skipping to the fifth block on the calculations section. Noticeably they avoided the glossary and were content with being guided through the entire block. At all times the group's attitude to the IV package was positive, and as at the Polytechnic, several requests were made for similar IV material in other subject areas.

When the second group came through to their final year, another group was combined with it. This other group had in fact studied the Levelling topic by conventional means with another lecturer. Although monitoring of the two groups had not been previously carried out, it was decided to try and compare the performance of the two groups under similar conditions in their second year Levelling exercise. During observation of the setting up procedures, the IV group completed the exercise before the conventionally taught one, but both groups still needed revision work with the calculations and bookings. The IV group behaved in the same way as the previous one in that they went to the fifth block and proceeded to study all the material in that block. The conventionally taught group, though, were far more insistent on starting the package at the beginning and studying all the way through. This presented no additional resource needs in the way of staffing and only a small amount of student time, these being primary advantages of any CAL package. The two groups were interrogated regarding the IV package and responded by commenting that it was easier to remember the setting up procedures after seeing a video of the process. They also commented on the lack of practice given on the calculations. This was limited by the hardware/software combination and the lack of a still frame facility on video tape. If the package was to be transcribed to videodisc, the use of still frames and the random function in SAM authoring system would extend the usefulness of the package considerably. Also with SAM the exercises could be further extended by the arithmetic functions available within the programme.

The hardware proved reliable through the testing period, only requiring routine maintenance, that is cleaning of heads on the video and floppy disc units. Towards the second year, however, the VHS tapes were discarded and new copies made from the master U-matic videotape, because by then the system seemed to be having difficulty in finding some segments of

video. The reason could have been tape stretch, as the tape is continuously being rewound and stopped in its operation. The other reason could have been the degradation of the audio track containing the code for finding the video sequences. It was not determined which caused the problem, and it was deemed unimportant since the package was only used on a small scale, where copying costs were small. This would have to be investigated in more detail if large scale production was to be considered. Further investigation showed that the expected life of a pre-recorded video tape should be about five years, but in most practical instances this was reduced to three years.

During the course of the project the system was subjected to open criticism by subject specialists. This was achieved by presenting a lecture and demonstration at the National Conference of Surveying Teachers at Bircham Newton in December 1984. The system was generally received with enthusiasm, but doubts were expressed about the cost benefits. A few did not grasp the concept of interactivity, and commented that the same results could be achieved by switching the video off at the relevant point and asking students questions. When enquiries were made of the size of student groups, the answers were usually in excess of 40. When considering these circumstances, their doubts regarding cost benefits were difficult to comprehend, as the time taken to question in excess of 40 individual students on every item would give excessive times in normal lectures.

The second exposure to subject groups came with the presentation of a paper (see appendix 4) to the South Wales Branch of the Royal Institution of Chartered Surveyors during February 1985. This again took the form of a lecture followed by demonstrations. As this took place at the Polytechnic all the workstations were available for demonstration. Most members in fact insisted on working through all the package themselves rather than having it demonstrated to them.

4.1.2 The CEGB Project at Aberthaw Power Station.

The validation of the scheme at Aberthaw was largely dependent on CEGB requirements. The Safety Document Procedures comprised an important daily routine for most of the employees at the power station. The employees had previously been trained by a conventional method. The supervisory staff received formal training by attending a course run at a national centre, and this was passed down by the 'cascade method'. During safety audits this was found to be unsatisfactory, and accidents were still occurring through misunderstanding of the set procedures. Many of the operatives needed to be trained and declared 'competent' in order to handle the Safety Documents. Besides the dangerous risks to others, their wage earning potential would be affected if they were judged not to be competent. The CEGB carried out a survey to establish some of the problem areas with their existing training and concluded the following regarding the Safety Document Procedures:

1) the Procedures were alien to the normal craft operative abilities, and consisted mainly of manual skills
2) the Procedures were regarded as boring
3) the complexity and mundaneness of the Procedures proved demotivating.

From these findings the CEGB decided that any training method would have to satisfy the following criteria if it was to be judged successful:

1) it must be interesting to all levels of staff
2) it must be participative
3) it must be able to directly assist in assessing competence
4) it should be capable of volume and individual applications
5) it must be consistent in presentation and assessment
6) it must be able to provide management information upon which quality decisions could be made.

Any validation of the programme would have to consider these requirements in judging its effectiveness. Some of the criteria could be assessed from the results produced by the package, whilst others required information provided outside the package. It was hoped that the questionnaire designed at the evaluation stage would provide some indication of the staff attitudes to both the package and to IV as a training method.

The questionnaire was presented to approximately 40 of the first 100 trainees put through the course. It was possible to identify the trainee with both the questionnaire and the test results from the package, although for industrial relations reasons the trainee was unaware of the connection. The full results of the questionnaires are contained in Appendix 4.

The first question regarding the number of sessions for completion showed that many of the trainees had in fact sat at the workstation for approximately 3.5 to 4 hours. This was reflected in their answers to the length of the training period as being too long. Although this time may seem excessive, it must be stated that the trainee was at liberty to leave the workstation at intervals to take refreshment, etc. One must also take into account that the conventional training sessions would last a working day of eight hours. Generally the responses regarding interest and quality of the content were favourable. The answers to the questions regarding testing also showed no adverse comment, which suggests that the trainees participated in the course and regarded the testing as a composite part of the learning process. The question regarding the use of video in training sessions caused some puzzlement (Question 14), as the CEGB use many videos and films in their conventional schemes. On further investigation of the trainees, there had been some misunderstanding and the question had been read as 'Have you used Interactive Video before?'. As far as content was concerned, the results showed that the staff both accepted the programme as accurate, and the method as interesting. They were enthusiastic about IV as a method of

training, and suggested other areas which they would like treated in this way. The question on the increase in knowledge (Question 11) must be considered together with that on how familiar they were with the Procedures before using the IV package (Question 4). The response that they had learned anything should be regarded as positive.

Many responded with comments on the repetitive nature of the course. Upon further investigation this proved to be confined to two specific areas:

1) If they failed one question in a test, the whole test had to be repeated. This could be dealt with in several ways. The first would be to send the trainee back to the block menu as soon as one question was incorrectly answered. The second would be to set a minimum pass score (less than 100%) which would allow progress onto the next block, but as Safety was involved full competence must be checked and this solution was disregarded. The third solution would be to disregard correct questions on re-testing. Although it was felt the final solution would present an improved presentation, the CEGB decided not to implement any of them.

2) The other case of repetition involved the repeating of the material in the same blocks which were presented at different levels. The same block could appear several times in different routes. This would be boring if just repeated verbatim. This fact was considered in the design of the Contractor's version of the programme. In this instance the video material was not repeated every time, but the audio track was played with accompanying computer text and in some circumstances graphics to present a summary version.

The results from the computer record system are presented in

Appendix 4. Twenty Engineering staff and ten Supervisory staff were selected at random. The printout from the system provided information on the payroll number, the date of training, total time taken, and the response to every test question with its correctness. These results could be intepreted to show how many times a block had been repeated, and the questions which caused the repeat identified. The results presented in Appendix 4 were abstracted from the original computer printouts. These originals were always kept at Aberthaw because of their confidential nature. The identifying numbers of the test, the number of repeats, and the incorrect question number were listed. This allowed problem questions or misunderstandings of content to be analysed. For example question 114, in test 16, gave problems to several trainees, and was shown to be misleading in its wording. However, test 13 showed question 89 as causing problems for Supervisory, but not for Engineering staff. The question was identified as being more inclined to the line management structure, which had led to incorrect interpretation. This illustrated a misunderstanding which needed to be corrected in other training courses on line management. The times recorded were representative of the whole group of 100 trainees, and were regarded as being satisfactory by the CEGB. A further 500 CEGB staff have since completed the programme, and in addition over 200 contractors' staff have been trained on their version. The average time for craft operatives has been about 5.5 hours, but some have taken as long as 12 hours (though not in one continuous session!).

As far as motivation is concerned there was a demand by the staff to be included in the training scheme. When one department had completed the package others proclaimed their disappointment when discovering it was not their turn next. The system proved its capability for mass training by completing the training of over 800 personnel over an 18 month period. The time taken was a reflection on the availability of staff rather than on any restrictions of the equipment.

When interviewing the training staff several important points were brought foward:

1) Training on the package was more effectively carried out at the training centre. This was due to the quieter environment, plus the training centre was regarded by the operatives as the 'place to train'. Secondly if anyone had any misgivings about the method or equipment there was normally a member of the training staff available to act in a supportive role.

2) It was felt that eventually a 'cheat list' of answers to questions might be produced by the less scrupulous trainees. This contingency was dealt with by randomising the order of questions presented in some of the tests. Another 'cheat method' was to repeat the test four times in order to answer a multiple choice question correctly. There was some evidence of this happening. The number of times a test was attempted was indicated in the printouts from the package. Some trainees had not reported to their supervisors as requested by the programme after repeating the test three times. They simply logged back on and repeated the test a fourth time. The only solution to this was vigilance in scrutinising the printouts for each trainee.

3) Some unexpected outcomes of the package were the identification of an unusual form of colour blindness (yellow/brown - the combination of text and background colours initially chosen for test question pages). The inability to write and in one case the inability to read were also identified. It must be stressed that these occurred with contractor's staff who were not screened by CEGB entry tests, as were all permanent staff.

4) The IV system cast a wider net over the staff at Aberthaw. It

was felt that a conventional course of training would be regarded as successful if it covered 80% of the staff. The IV package, with its detailed results from the computer, highlighted the personnel who had not been through the system. By May 1988 only 4% had not been trained, and these had been identified and each allocated a date and time for the completion of their training.

5) Industrial relations did not present problems with the implementation of the package. Early consultation with the trade unions had gained their approval. They considered the question of assessment by the package and the final judgement of competency by management to be fair. There were no objections to the form of assessment, with its lack of a fixed time period, and the allowance of repeats. In fact the Unions made the statement that they would 'welcome more assessment' by this method.

6) Although the training staff structure and personnel had changed at Aberthaw during the project, the new staff had (and retain) a positive and enthusiastic approach to the IV package.

7) Senior staff at Aberthaw felt the system had achieved the objectives set, and are actively encouraging its adoption by other power stations within the CEGB.

The package did not set out to directly improve safety standards at Aberthaw, but to improve the operatives, proficiency in the handling of the documents associated with safety procedures. The final validation of the system will not be complete until another Safety Audit is undertaken by CEGB and the results after IV training are compared to the previous audit. The audit consists of checking random samples of completed sets of documents for their correctness. It is not just carried out after an individual accident.

During the early part of 1989 the staff will begin a revision scheme. This will include the material in the original package, and in addition the randomised test questions. Again this should provide a large sample of results and would provide an interesting area of research in retention of the original material.

4.3 Conclusion.

In this project the author has attempted to detail the processes to be considered when producing an effective Interactive Video learning/training package. No attempt was made to quantify the comparison between traditional method of learning and IV, only to show that if the IV material is well designed then it has a far better likelihood of being successful as a system of learning. It has been shown that IV does fit into existing theories of learning and can achieve a wide range of learning experiences. During the process of preparing the packages systems of design were produced. These have been shown to be appropriate for both systems of presenting IV with video tape and video disc. The design and production of an IV programme demands the integration of a number of skills, and the most successful efforts are likely to be team enterprises. Authoring can be expected to develop best where there is considerable computer programming support. With the introduction of more powerful authoring systems it is possible, however, to consider the development of basic interactive 'resource' compilations, which will allow local teachers/trainers to create specific teaching programmes.

Over the lifespan of this project there have been tremendous changes in hardware - not only in the technology; the costs have also reduced considerably. In 1983 the prices quoted for a tape-based authoring system were in excess of £12000.00. In 1988 a disc-based authoring system can be purchased for less than £4000.00. As knowledge increases on the production process, the making of the videodisc becomes less formidable. One

has to accept that a disc may well contain some visual errors, even with the most careful planning, and soon one should be able to overlay substitute computer generated, photographic quality, pictures over the video errors. The hardware and authoring system, however, should be flexible enough to minimise the effect of these in the final programme. The current development of totally integrated IV workstations has demonstrated the hardware industry's commitment to IV. They are also developing specialist functions which will greatly enhance the presentation, such as frame storage, and the digital compression of the audio tracks. It only remains to be seen whether this will lead to a more general standard for production of the courseware, or in fact less compatibility between systems.

Many new courseware packages are becoming available. There is a fair proportion being imported from the USA, but as yet these seem to be only available on NTSC format. This again raises the problem of incompatibility, and at a recent exhibition it was suggested that a workstation could not be considered complete unless it contained both PAL and NTSC players!. The National Interactive Video Centre (NIVC) at London has issued figures which indicate a positive picture of the growth of IV in the UK. Sales of hardware have doubled between 1985 and 1986, with a total installed base at the end of 1986 of between 6000 and 7000 units. They predicted an increase to 13000 during 1987, and estimate the total by 1990 to be in the region of 60000 units. Courseware production figures have also shown increases. There was a 250% increase in 1986 over 1985, and currently there are approximately 500 programmes listed in NIVC publications. Educational applications are developing slowly. NIVC claim 11% of the IV market is education, and this takes into account the major initiatives taken by the Department of Trade and Industry. These include the IV in Schools project (IVIS) and the Domesday Project, and currently the Further Education sector has commenced a project to produce 'generic' software. In the

author's own Local Authority there are currently four Domesday and three IVIS systems. September 1988 will see the introduction of IVIS into several schools, and an evaluation exercise commenced. There are also preliminary plans for a local Domesday project based on life in the 1880/90 period to be part of the Local Authority's Centenary celebrations. These developments suggest that it has now been accepted that IV is an effective learning system. The main problem facing education, as opposed to training, is that of whether there are sufficient financial resources to fund the high initial costs of installing the hardware. The other major obstacle will be the cost of the rapidly changing technology. These are problems which have been faced previously with the introduction of computers into schools, and anyone trying to make predictions 5 to 10 years ago would probably have been in the same position.

As an additional part of the CEGB project a study was made (47) as to the introduction of IV as a method of training on a national scale. The main conclusion of the report was that IV would be a suitable medium for aspects of their training programme, but to be effective it would have to be incorporated in an open learning environment. This is the same conclusion reached by other large organisations such as Ford and Austin Rover regarding their IV training programmes. The final judgement of the effectiveness of the CEGB project will be shown when a new Safety Audit is carried out, and a comparison of the operators' performances on Safety Document handling, made before and after the training programme. It would be interesting to follow up the retention rates of trainees when the revision programme is started in 1989. This would give an even more reliable indication of the effectiveness of the system, and would show whether it maintains the motivation indicated in the first stage. When this is completed there will be a wealth of quantitative data for analysis.

It is felt that the results from this project support the early

guidance given in a CET report by Duke (48) which made the following observations:

1) Interactive Video offers unique opportunities to exploit electronic technology to support a range of educational and instructional tasks. As industry becomes more aware of 'knowlege based' systems, the commercial prospects of IV are worthy of due consideration.
2) Broadcast television alone cannot offer individual control over when, where and how the medium is used. Programmes are transmitted at fixed schedules, and aim at the average viewer as perceived by the producer. These characteristics are largely common to other system such as cable networks.
3) Computer-based learning systems can offer a range of individual educational experiences, but even now tend to provide relatively clumsy visual displays and poor audio, which inhibit full acceptance of the technology.

Finally, the unique character of Interactive Video is that it can offer all the attributes required of an educational communication system. It can encompass a variety of different teaching and learning strategies. It can monitor learner performance and adapt to individual needs, and it can provide the essential motivation needed for effective learning.

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APPENDIX 2. Hardware and Authoring Systems.

Student instruction booklet for 'logging on to Apple/VHS system.

THE POLYTECHNIC OF WALES.

Interactive Video Project.

WORKBOOK 1

SURVEYING-Using the Level.

INTERACTIVE VIDEO.

This learning package consists of a computer program on a floppy disc, and video material on a standard VHS tape. Make sure you have a floppy disc which matches the video tape. In certain instances there will be additional material in the form of notes and this will be made available to you on completion of the course.

Make a note below of the number of the floppy disc you are using:

Disc Number .....

If you have not used the Apple computer previously, a keyboard familiarity program is available on a separate disc.

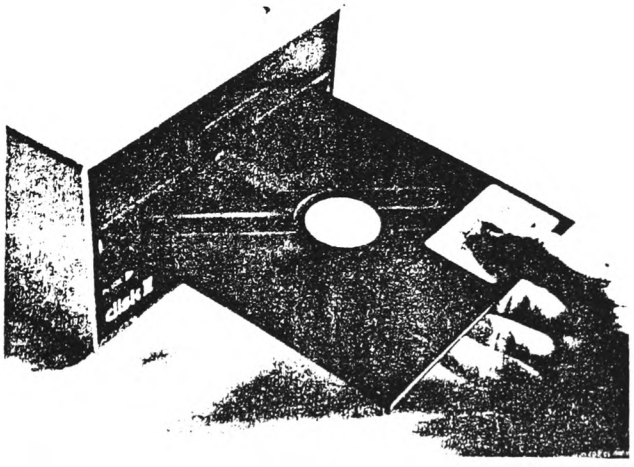
RUNNING THE SYSTEM.

DO NOT INSERT DISC OR TAPE YET.

Switch on the system. Check:

1) Computer is on. (Green light on keyboard)
2) TV monitor is on. (Green light on panel)
   Controls at top set to AUTO and INPUT B.
3) Video Tape Unit is on. (Red light on front)

Press and hold the CTRL key on the computer (middle left) and simultaeneously press the RESET key (top right). Release the RESET key and then the CTRL key. The red light on the disc unit should now go off.

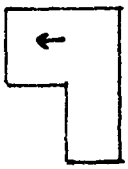


Make sure the flap on the disc unit is raised and insert the disc as shown in the diagram. Push fully home and close the flap.

Press and hold the CTRL and (bottom left) keys, whilst holding these press the RESET key (top right) once. Release all keys. The red light on the disc unit will now show, and after a few moments the screen of the TV will inform you of what is happening.

IDENTIFYING KEYS

RETURN



SHIFT LOCK

CURSOR LEFT

Check that the SHIFT LOCK key is locked in the down position, this allows all your entries to be in upper case. If you make mistakes in your entries, these can be corrected by moving the cursor back over the mistake using the CURSOR LEFT key. Simply retype your correct answer.

Enter your name when requested. You will also be requested to enter the date in a particular format.

DAY MONTH YEAR

This format requires the entries to be in a TWO digit form.

i.e. 1 = 01 6 = 06 11 = 11

Therefore the 1st of January 1984 becomes:

010184

During the video sequences of the course, the video may be halted by pressing the '2' key. This stops the video and displays the following:

1 Resume 2 Skip to end 3 Restart

These options apply to the current video sequence only. Selecting 2 or 3 will skip to end or restart this video sequence only. You can decide at what stage you have seen enough of the video especially when viewing the sequence for the second time.

There are exercises for you to complete on the following pages.

Samples of pro-forma sheets for Segment details on IVL.

Student Choice Block:1 Segment:4

NOTES:
Segment range 1 - 101
Block range 1 - 20
Options range from 2 - 5

OPTIONS.	BRANCH TO
1 Start Course.	5
2 Instruments.	15
3 Reading the Staff.	31
4 Booking the Results.	52
5 Glossary.	69

Computer Graphic Block:2 Segment:7

Graphic Title: B L O C K 1 / 2

Scene Number if with audio: 3

Next Segment: 8

CONTENT:Datums and Ordnance Datum

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

A DATUM SURFACE is a level surface to which the heights of points are refered. In Great Britain the normal datum is Ordnance Datum. This is the mean sea level at Newlyn in Cornwall.

The REDUCED LEVEL of any point is the elevation of that point above (or below) the datum to which the point is referred. The point shown in the diagram is 10 metres higher than Ordnance Datum, and the reduced level is 10 metres above Ordnance Datum.

TIME:30 seconds

Video Scene Block:2 Segment:8

Scene Title: B E N C H M A R K S

Scene Number: 4

Next Segment: 9

CONTENT: Maps with BM and shots of OS bench marks.

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

Bench marks are fixed points of pre-determined height. The Ordnance Survey have set up bench marks throughout Great Britain. Their locations and values may be determined from Ordnance Survey Maps.

The most common type being the Cut and Arrow (or Crow's Foot) as shown here.

This type of Bench Mark is also found marked on vertical faces of permanent features. The reduced level is the centre of the horizontal line.

TIME: 50 seconds

Multi Choice Test Block:2 Segment:14

Test Type: Ordinary Block test relates to: 2
Satisfactory % Score : 80
Branch if satisfactory : 15
Branch if unsatisfactory(1): 10
Branch if unsatisfactory(2): 92

NOTES:
Max number of questions 1 - 5 Range of responses 1 - 5
Segment range 1 - 101 Block range 1 - 20
Block range 1 - 20 Hint optional
Correct answer on second attempt scores half marks.
Test types : Ordinary, Pre-post, Pre-only, Post-only
Answer range 1 - 54321

MULTI CHOICE TEST QUESTION 1 OF 3

QUESTION

The determination of differences in height between points is known as:

. . . . . .

ALTERNATIVE RESPONSES

1

Traversing.

. . . . . .

2

Heighting.

. . . . . .

3

Levelling.

. . . . . .

4

Datum measuring.

. . . . . .

5

Reducing.

. . . . . .

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 3

OTHER ACCEPTABLE ANSWER (1): 2

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST QUESTION 2 OF 5

QUESTION

A surface everywhere at right angles to the direction of gravity is known as :

ALTERNATIVE RESPONSES

1

A Datum surface .

2

A Horizontal surface.

3

A Level surface.

4

A Reduced surface.

5

. . . . . .

. . . . . .

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 3

OTHER ACCEPTABLE ANSWER (1): 0

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST QUESTION 3 OF 5

QUESTION

A level surface to which the heights of points are referred to, is known as:

ALTERNATIVE RESPONSES

1

A Datum surface.

2

A Horizontal surface.

3

A Reduced surface.

4

A Bench mark.

5

A Reduced level.

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 1

OTHER ACCEPTABLE ANSWER (1): 2

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST QUESTION 4 OF 5

QUESTION

A straight line which is tangential to a point on a level surface would be a:

ALTERNATIVE RESPONSES

1

Datum line.

2

Horizontal line.

3

Reduced line.

4

Level line.

5

Bench mark line.

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 2

OTHER ACCEPTABLE ANSWER (1): 0

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST QUESTION 5 OF 5

QUESTION

The elevation of a point above a datum surface is known as it's:

ALTERNATIVE RESPONSES

1

Bench mark.

2

Horizontal height.

3

Reduced level.

4

Datum level.

5

. . . . . .

. . . . . .

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 3

OTHER ACCEPTABLE ANSWER (1): 4

OTHER ACCEPTABLE ANSWER (2): 0

Computer Text Block:3 Segment:23

Heading : S U M M A R Y O F F E A T U R E S .

Display Speed : 255
Centering(Y/N): N
Backround Colour: Black
Next Segment : 24

Scene No if with Audio : . . .
Boxing (Y/N) : Y
Text Colour : White

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

Speed range 1 - 255
Max Regular or Tall Characters 37
Max wide or large chartracters 18

---

1 :COMMON FEATURES OF LEVELS.

2 : . . : . . : . . : . . : . . : . . :

3 : . . : . . : . . : . . : . . : . . :

4 :1) TELESCOPE

5 : Used to sight staff, has

6 : crosshairs to mark line of

7 : sight of instrument.

8 : . . : . . : . . : . . : . . : . . :

9 :2) LEVEL INDICATOR

10 : Normally a spirit bubble which

11 : is centred to show instrument

12 : level.

13 : . . : . . : . . : . . : . . : . . :

14 :3) LEVEL ADJUSTMENT

15 : Main base with three footscrews

16 : known as TRIBRACH, or ball and

17 : socket attachment.

18 : . . : . . : . . : . . : . . : . . :

19 : . . : . . : . . : . . : . . : . . :

20 : . . : . . : . . : . . : . . : . . :

Samples of pro-forma sheets for Page details on Learncom's SAM.

Pro-forma sheet for use with Learncom.

Page ___

Mode _____ Overlaid ____ Background _____

Video ____ Transcolour _____ Previous Page _____

Next Page _____

Special _____ Branching _____

Text/graphics

Video Commands

Comments

Sample of BASIC program to drive Philips 735 from a BBC microcomputer.

```
I ..
     5PROCSTART
    10MODE7
    15VDU2
    20PRINT"T/P200":PROCDELAY
    22PRINT "T/HBL":PROCDELAY
    23PROCTITLE
    24PRINT "T/R02/12/GR/DH@BRITISH OWLS@":PROCDELAY:PROCDELAY
    25PRINT"T/HBN":PROCDELAY
    26PRINT"T/R05/01/GW/NH@THERE ARE @GG@THREE@GW@ MAIN BRITISH OWLS@":PROCDELAY
    27PRINT"T/HBN":PROCDELAY
    30PRINT"T/R10/10/GB/NH@ THE BARN OWL@":PROCDELAY:PRINT"T/HBN":PROCDELAY
    35PRINT"T/R12/10/GB/NH@ THE LITTLE OWL@":PROCDELAY:PRINT"T/HBN":PROCDELAY
    40PRINT"T/R14/10/GB/NH@ THE TAWNY OWL@":PROCDELAYL
    58VDU3
    60PROCCONT
    65PROCBARNMAIN("30117","32263")
    70PROCLITTLE
    80PROCTAWNY("33382","35099")
   100PROCTEST
   110PROCEND
   999END
  1000DEFPROCNAMES
  1010PRINT TAB(10,10)"1. BARN OWL."
  1020PRINT TAB(10,12)"2. LITTLE OWL."
  1030PRINT TAB(10,14)"3. TAWNY OWL."
  1099ENDPROC
  1100DEFPROCCONT
  1101PROCDELAYL
  1105VDU2:PRINT"T/HBN":PROCDELAY
  1106PRINT"T/R23/06/GY/FL/SB/NH@PRESS C TO CONTINUE@EB/"
  1110AN$=GET$:IFAN$<>"C"THEN1110
  1150VDU2:PRINT"T/HBL":VDU3:PROCDELAY
  1199ENDPROC
  1200DEFPROCBARNMAIN(S1$,S2$)
  1205VDU2
  1210PRINT"T/HBL":PROCDELAY
  1220PRINT"T/R01/GR/DH@THE BARN OWL@":PROCDELAY:PRINT"T/HBN":PROCDELAY
  1230PRINT"T/R05/GW/NH@YOU WILL NOW BE SHOWN A SHORT VIDEO@":PROCDELAY
  1265PRINT"P"+S1$+"R":PROCGET423
  1266PRINT"T/HBL":PROCDELAY:PRINT"T/R01/GW/SB/DH@BARN OWL@EB/":PROCDELAY
  1270PRINT"E0":PROCDELAY
  1275PRINT"K":PROCDELAY:PRINT"N":PROCDELAYL
  1281PROCDELAY:PRINT"P"+S2$+"S":PROCGET423
  1282PRINT"T/HBL":PROCDELAY
  1283PRINT"E1":PROCDELAY
  1285VDU3
  1299ENDPROC
  1400DEFPROCDELAYLL
  1410FORI=1TO2500:NEXT:ENDPROC
  1500DEFPROCSTART
  1510*FX5,2
  1520*FX8,7
  1525VDU2
  1530PRINT"P200R":PROCGET423:PRINT"E1"
  1536VDU3
  1537PROCDELAY
  1599ENDPROC
  1600DEFPROCDELAY
  1620Z=INKEY(10)
  1630ENDPROC
  1650DEFPROCDELAYL
  1655Z=INKEY(25)
```

```
1699ENDPROC
1700DEFPROCGET423
1708*FX7,7
1709*FX21,1
1710*FX2,1
1715REPEAT
1720AN=GET
1725UNTILAN=6
1730*FX2,0
1799ENDPROC
2000DEFPROCLITTLE
2010VDU2:PRINT"T/HBN":PROCDELAY
2015PRINT"T/R01/GR/DH@LITTLE OWL@":PROCDELAY
2020PRINT"T/R04/02/GW/NH@YOU WILL NOW BE SHOWN A SHORT VIDEO@":PROCDELAY
2030PROCDELAYLL
2045PRINT"P32264R":PROCGET423
2046PRINT"T/HBL":PROCDELAY:PRINT"T/R01/02/GW/SB/DH@LITTLE OWL@EB/":PROCDELAYL
2050PRINT"E0":PROCDELAY
2060PRINT"K":PROCDELAY:PRINT"N":PROCDELAY
2061PRINT"T/HBN":PROCDELAY:PRINT"T/R01/02/GW/SB/DH@LITTLE OWL@EB/":PROCDELAY
2065PROCDELAYL:PRINT"P33381S":PROCGET423
2067PRINT"T/HBL":PROCDELAY
2068PRINT"E1":PROCDELAY
2070VDU3
2099ENDPROC
2100DEFPROCTAWNY(S1$,S2$)
2110VDU2:PRINT"T/HBL":PROCDELAY
2115PRINT"T/R01/GR/DH@THE TAWNY OWL@":PROCDELAY
2120PRINT"T/R04/02/GW/NH@YOU WILL NOW BE SHOWN A SHORT VIDEO@":PROCDELAY
2130PROCDELAYLL
2145PRINT"P"+S1$+"R":PROCGET423
2146PRINT"T/HBL":PROCDELAY:PRINT"T/R01/02/GW/SB/DH@TAWNY OWL@EB/":PROCDELAY:PROCDELAY
2150PRINT"E0":PROCDELAY
2160PRINT"K":PROCDELAY:PRINT"N":PROCDELAYL
2161PRINT"T/HBN":PROCDELAY:PRINT"T/R02/GW/SB/DH@TAWNY OWL@EB/"
2165PROCDELAY:PRINT"P"+S2$+"S":PROCGET423
2167PRINT"T/HBL":PROCDELAYL
2168PRINT"E1":PROCDELAY
2170VDU3
2199ENDPROC
5000DEFPROCTEST
5001DIMCOMP$(25)
5005VDU2:PRINT"T/HBL":PROCDELAY
5006PROCDELAY
5010PRINT"T/R04/10/CY/NB/CR/SB/DH@TEST TIME @EB/":PROCDELAY
5020PRINT"T/R08/CB/NB/CW/SB/NH@THERE WILL NOW BE SOME QUESTIONS@EB/"
5025VDU3
5030PROCCONT
5100VDU2:PRINT"P30837R":PROCGET423
5105PRINT"E0":PROCDELAY
5106QUEST$="T/R20/02/CB/NB/GW/SB/NH@WHAT TYPE OF OWL IS SHOWN@EB/"
5107QUEST1$=""
5110PRINTQUEST$
5115PROCINPUT
5120COMP=3:COMP$(1)="B":COMP$(2)="R":COMP$(3)="N"
5130PROCCOMPARE(COMP)
5135PROCDELAY
5138VDU2
5139PROCDELAY
5140IFY=1THEN PRINT"T/R21/13/CG/SB/NH@CORRECT@EB/" ELSE GOTO5145
5143PROCDELAYLL:VDU3:GOTO5155
5145PROCNO
5150PROCBARNMAIN("30650","31000")
```

```
5152VDU3:PROCDELAY:GOTO5100
5155VDU2:PRINT"T/HBL":PROCDELAYL:PRINT"P34588R":PROCGET423:PRINT"A0":PROCDELAY
5156PRINT"K":PROCDELAY:PRINT"N":PROCDELAY
5158PRINT"P34634S":PROCGET423
5159VDU3
5160PROCINPUT
5165COMP=3:COMP$(1)="T":COMP$(2)="W":COMP$(3)="Y"
5170PROCCOMPARE(COMP)
5171VDU2
5175IFY=1THEN PRINT"T/R21/13/CG/SB/NH@CORRECT@EB/" ELSE GOTO5177
5176PROCDELAYLL:VDU3:GOTO5200
5177PROCNO
5180PROCTAWNY("33456","33654")
5185GOTO5155
5200VDU2:PRINT"T/HBL":PROCDELAY
5205PRINT"P31300R":PROCGET423
5210QUEST1$="T/R19/05/CB/NB/CW/SB/NH@WHAT PROPERTY DO THESE@EB/"
5220QUEST$="T/R20/01/CB/NB/CW/SB/NH@FEATHERS GIVE TO THE OWL'S FLIGHT@EB/"
5230PROCINPUT
5240COMP=5:COMP$(1)="S":COMP$(2)="I":COMP$(3)="L":COMP$(4)="N"
5250PROCCOMPARE(COMP)
5255VDU2:PRINT"T/HBN":PROCDELAY
5260IFY=1THEN PRINT"T/R21/13/CG/SB/NH@CORRECT@EB/" ELSE GOTO5290
5270PROCDELAYLL:VDU3:GOTO5999
5290PROCNO
5291VDU2:PRINT"E0":PROCDELAY:PRINT"T/HBL":PROCDELAY
5292PRINT"P31185R":PROCGET423:PRINT"K":PROCDELAY:PRINT"N":PROCDELAY:PRINT"P31322S"
5296GOTO5200
5330PROCINPUT
5999ENDPROC
6000DEFPROCCOMPARE (COMP)
6010Y=1
6020FORI=1TOCOMP
6030X=INSTR(AN$,COMP$(I),1)
6040IFI=1 AND X <>1 THENY=0
6050IFX=0THENY=0
6060NEXT
6070ENDPROC
6100DEFPROCINPUT
6105*FX21,0
6130AN$=""
6151VDU2
6152PRINT"T/HBN":PROCDELAY
6153PRINT QUEST$:PROCDELAY:PRINTQUEST1$:PROCDELAY
6158REPEAT
6160A$=GET$
6165IFA$=""THEN6160
6168IFA$=CHR$(13)THEN 6190
6170AN$=AN$+A$
6180SC$="T/R21/10/CB/NB/GW/SB/NH@"+AN$+"@EB/":PRINTSC$:PROCDELAY
6190UNTILA$=CHR$(13)
6195VDU3
6199ENDPROC
6200DEFPROCTITLE
6210PRINT"T/HBL":PROCDELAY
6215FORI=1TO20:TP$=TP$+"p":NEXT
6220TP$="T/R03/GG/08@"+TP$+"@"
6222PRINTTP$:PROCDELAY
6225FORI=4TO15:WLN$=RIGHT$("00"+STR$(I),2)
6230WD$="T/R"+WLN$+"/GG/08@5@18@j@"
```

```
6235PRINTWD$:PROCDELAY
6240NEXT
6250PRINT"T/R16/GG/08@upppppppppppppppppz@":PROCDELAY
6256NE$=CHR$(181)+"       THE       "+CHR$(234)
6260PRINT"T/R05/08/GG@5@CR/07@THE@GG/06@j@":PROCDELAYL
6270PRINT"T/R07/08/GG@5@CR/03@POLYTECHNIC@GG/02@j@":PROCDELAYL
6275PRINT"T/R09/08/GG@5@CR/04@OF  WALES@GG/03@j@":PROCDELAY
6280PRINT"T/R12/08/GG@5@CY/03@INTERACTIVE@GG/02@j@":PROCDELAYL
6285PRINT"T/R13/08/GG@5@CB/FL/05@VIDEO@ST/GG/04@j@":PROCDELAYL
6288PRINT"T/R14/08/GG@5@CM/05@PROJECT@GG/04@j@":PROCDELAYL
6298FORI=1TO5000:NEXT
6299PRINT"T/HBL":PROCDELAY
6300PRINT"P230R":PROCGET423
6310PRINT"E0":PROCDELAY
6315PRINT"A1":PROCDELAY
6320PRINT"K":PROCDELAY:PRINT"N":PROCDELAYL
6325PRINT"P780I":PROCGET423
6326PRINT"T/R20/10/SB@PROGRAM BY D.R. DAVIES@EB/":PROCDELAY
6327PRINT"P950I":PROCGET423
6328PRINT"T/HBL":PROCDELAY
6330PRINT"P1178S":PROCGET423
6331PRINT"E1":PROCDELAY
6335PRINT"T/HBL":PROCDELAY
6399ENDPROC
7000DEFPROCNO
7001NO$=""
7005VDU2:PRINT"A0":VDU3
7006PROCDELAY
7010VDU2
7015PRINT"T/HBL":PROCDELAY
7020FORX=1TO3
7025NO$=NO$+"NO! "
7030PRINT"P34373R":PROCGET423:PRINT"K":PROCDELAY:PRINT"N":PROCDELAY:PRINT"P34390S"
7040PROCGET423:PRINT"K":PROCDELAY:PRINT"O":PROCDELAY:PRINT"P34373S":PROCGET423
7045PRINT"T/HBN":PROCDELAYL
7050SCREEN$="T/R20/08/CB/NB/CR/SB/DH@"+NO$+"@EB/"
7055PRINTSCREEN$:PROCDELAY
7094NEXT
7095PRINT"E1":PROCDELAY
7096PRINT"A1":VDU3
7098ENDPROC
8000DEFPROCEND
8010VDU2:PRINT"E1":PROCDELAY
8020PRINT"T/HBL":PROCDELAY
8030PRINT"T/R10/06/CY/NB/CR/FL/SB/DH@END OF PROGRAM @EB/":PROCDELAY
8099ENDPROC
```

APPENDIX 3. Instructional Design.

Workbook for use with Surveying Programme.

THE POLYTECHNIC OF WALES.

INTERACTIVE VIDEO PROJECT.

SURVEYING - Use of the Level.

Programme

Interactive Video.

EXERCISE 1

Use this page for entering readings from the Levelling Staff exercises. Remember when reading the staff the following procedure is recomended:

1) Read staff.

2) Book reading.

3) Recheck staff reading with booked reading.

1)	.....	Staff reading.
2)	.....	1st reading through telescope.
3)	.....	2nd reading through telescope.
4)	.....	1st inverted image reading
5)	.....	2nd inverted image reading.

Interactive Video.

EXERCISE 2

Back Sight	Int Sight	Fore Sight	Rise	Fall	Reduced Level	Remarks
1.500					210.000	Bench Mark
	2.000					Point B
3.000		2.500				Point C
						Point D
						Point E
						Point F
						Point G

Additional Learning Materials for Surveying Programme.

THE POLYTECHNIC OF WALES.

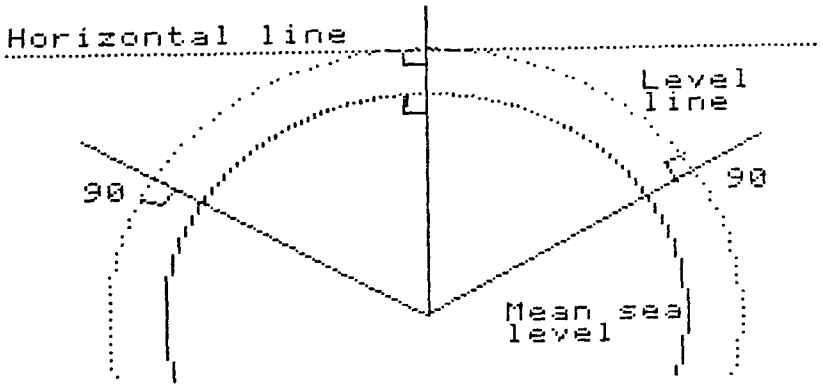
Interactive Video Project.

ADDITIONAL MATERIAL

SURVEYING-Using the Level.

DEFINITIONS.
==========

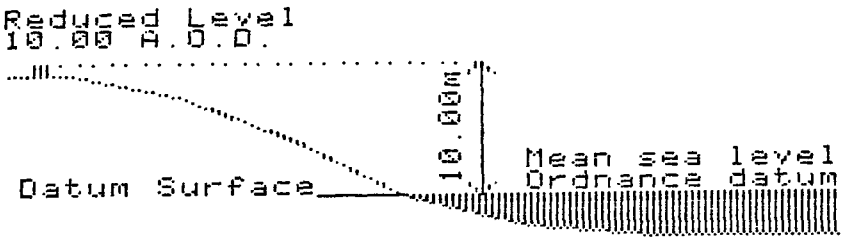
Levelling has been defined as the operation of determining the differences in height of points on the surface of the earth.



LEVEL LINE is a line of constant height relative to sea level, and is therefore a curved line concentric to with the mean surface of the earth. At any point this line will be at right angles to the direction of gravity.

HORIZONTAL LINE is a straight line which is tangential to a point on a level surface and is at right angles to gravity at this point only.

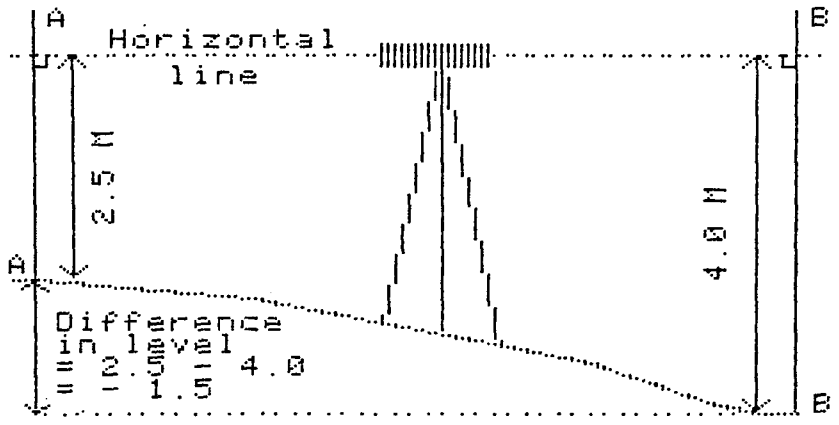
DATUMS AND REDUCED LEVELS



DATUM SURFACE is a level surface to which the heights of points are referred.

REDUCED LEVEL of any point is the elevation of that point above (or below) the datum to which the point is referred.

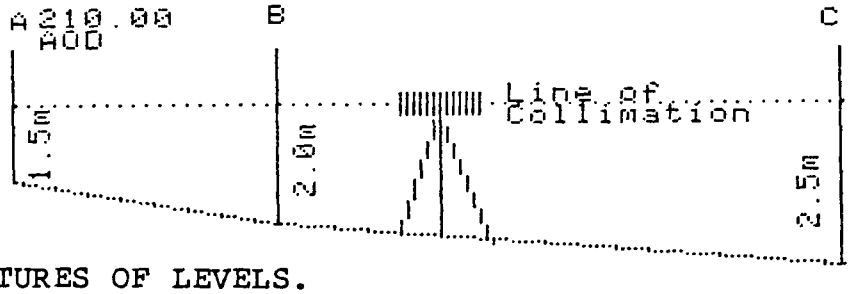
PRINCIPLE OF LEVELLING.



A horizontal line is established with an instrument, this intersects staves at A and B. The difference in height between the two points is the difference bewtween the two readings.

NOTE- a negative difference is a FALL
a postive difference is a RISE

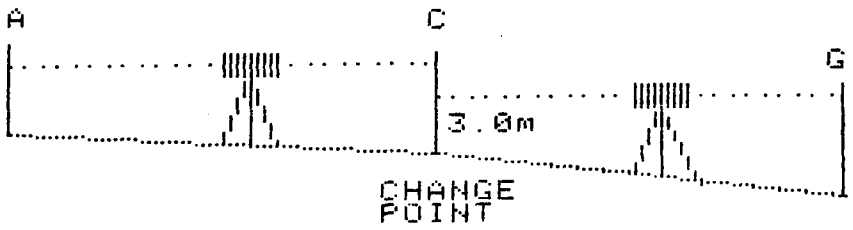
SECTION Difference in Height



COMMON FEATURES OF LEVELS.

1)TELESCOPE - Used to sight staff, has CROSS HAIRS to mark centre of line of sight.
2)LEVEL INDICATOR - Normally a spirit bubble, which is centred to indicate the instrument is 'level'.
3)ADJUSTMENT FOR 'LEVEL' - Main base with THREE footscrews, known as TRIBRACH, or in the Quickset type a BALL and SOCKET head.

EXTENDING THE SURVEY
CHANGE POINTS.



EXERCISE 2

Back Sight	Int Sight	Fore Sight	Rise	Fall	Reduced Level	Remarks
1.500					210.000	Bench Mark
	2.000			0.500	209.500	Point B
3.000		2.500		0.500	209.000	Point C
	4.000			1.000	208.000	Point D
	1.500		2.500		210.500	Point E
	1.000		0.500		211.000	Point F
		3.500		2.500	208.500	Point G
4.500		6.000	3.000	4.500		

ARITHMETIC CHECK.

Sum of the Back sights - Sum of Fore sights = Sum of Rises - Sum of Falls

= Last RL - First RL

4.500 - 6.000 = -1.500

3.000 - 4.500 = -1.500

208.500 - 210.000 = -1.500

BLOCK 2 of the Surveying Programme.

Computer Graphic Block:2 Segment:6

Graphic Title: B L O C K 1 / 4

Scene Number if with audio: 2

Next Segment: 7

CONTENT:Diagram to differentiate between level and horizontal lines.

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

Levelling has been defined as the operation of determining the differences in height of points on the surface of the earth. In order to understand how the principle of levelling is applied, it will be necessary to define some of the terms used.

A LEVEL LINE (as shown by the blue line) is one of constant height relative to sea level and is therefore a curved line concentric with the mean surface of the earth. At any point this line will be at right angles to the direction of gravity.

A HORIZONTAL LINE (as shown by the red line) is a straight line which is tangential to a point on a level surface, and is at right angles to gravity at this point only.

TIME: 50 seconds

Computer Graphic Block:2 Segment:7

Graphic Title: B L O C K 1 / 2

Scene Number if with audio: 3

Next Segment: 8

CONTENT:Datums and Ordnance Datum

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

A DATUM SURFACE is a level surface to which the heights of points are refered. In Great Britain the normal datum is Ordnance Datum. This is the mean sea level at Newlyn in Cornwall.

The REDUCED LEVEL of any point is the elevation of that point above (or below) the datum to which the point is referred. The point shown in the diagram is 10 metres higher than Ordnance Datum, and the reduced level is 10 metres above Ordnance Datum.

TIME:30 seconds

Video Scene Block:2 Segment:8

Scene Title: B E N C H M A R K S

Scene Number: 4

Next Segment: 9

CONTENT: Maps with BM and shots of OS bench marks.

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

Bench marks are fixed points of pre-determined height. The Ordnance Survey have set up bench marks throughout Great Britain. Their locations and values may be determined from Ordnance Survey Maps.

The most common type being the Cut and Arrow (or Crow's Foot) as shown here.

This type of Bench Mark is also found marked on vertical faces of permanent features. The reduced level is the centre of the horizontal line.

TIME: 50 seconds

Free Answer Test Block:2 Segment:9

Test Type: Ordinary. Block test relates to:
Satisfactory % Score : 80
Branch if satisfactory : 15
Branch if unsatisfactory(1): 10
Branch if unsatisfactory(2): 92

NOTES:
Max number of questions 1 - 5 Key words OR Range of answers
Segment range 1 - 101 Block range 1 - 20
Block range 1 - 20 Max wide or large chartracters 18
Key words variable 1 - 3 Range of answers variable 1 - 5
Test types : Ordinary, Pre-post, Pre-only, Post-only

Free Answer Test Question 1 of 5

Question

A surface which is everywhere at right angles to the direction of gravity is known as:

==========

KEYWORDS

1 L E V E L

2 . . . . . .

3 . . . . . .

==========

RANGE OF ANSWERS

1 . . . . . .

2 . . . . . .

3 . . . . . .

4 . . . . . .

5 . . . . . .

==========

BEST ANSWER

A L E V E L S U R F A C E .

Free Answer Test Question 2 of 5

Question

A level surface to which the heights of points are referred to, would be:

. . . . . .

KEYWORDS

1 DATUM

2 . . . . . .

3 . . . . . .

RANGE OF ANSWERS

1 . . . . . .

2 . . . . . .

3 . . . . . .

4 . . . . . .

5 . . . . . .

BEST ANSWER

A DATUM SURFACE.

Free Answer Test. Question 3 of 5

Question

A straight line which is tangential to a point on a level surface would be :

==========

KEYWORDS

1 H O R I

2 . . . . . .

3 . . . . . .

==========

RANGE OF ANSWERS

1 . . . . . .

2 . . . . . .

3 . . . . . .

4 . . . . . .

5 . . . . . .

==========

BEST ANSWER

A HORIZONTAL LINE.

Free Answer Test Question 4 of 5

Question

T h e e l e v a t i o n o f a p o i n t a b o v e a d a t u m s u r f a c e i s k n o w n a s t h a t p o i n t ' s :

==========

KEYWORDS

1 R E D U C E

2 . . . . . .

3 . . . . . .

==========

RANGE OF ANSWERS

1 . . . . . .

2 . . . . . .

3 . . . . . .

4 . . . . . .

5 . . . . . .

==========

BEST ANSWER

R E D U C E D L E V E L.

Free Answer Test · Question 5 of 5

Question

A point of predetermined heights to a datum surface is known as:

. . . . . .

==========

KEYWORDS

1 B E N C H

2 M A R K

3 . . . . . .

==========

RANGE OF ANSWERS

1 . . . . . .

2 . . . . . .

3 . . . . . .

4 . . . . . .

5 . . . . . .

==========

BEST ANSWER

A B E N C H M A R K .

Student Choice Block:2 Segment:10

NOTES:
Segment range 1 - 101
Block range 1 - 20
Options range from 2 - 5

OPTIONS.	BRANCH
1 Horz & Level Lines.	11
2 Datums.	12
3 Bench Marks.	13
4 Continue Course.	14
5 Finish Course.	92

Computer Graphic Block:2 Segment:11

Graphic Title: B L O C K 1 / 4

Scene Number if with audio: 2

Next Segment: 10

CONTENT:Diagram to differentiate between level and horizontal lines.

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

Levelling has been defined as the operation of determining the differences in height of points on the surface of the earth. In order to understand how the principle of levelling is applied, it will be necessary to define some of the terms used.

A LEVEL LINE (as shown by the blue line) is one of constant height relative to sea level and is therefore a curved line concentric with the mean surface of the earth. At any point this line will be at right angles to the direction of gravity.

A HORIZONTAL LINE (as shown by the red line) is a straight line which is tangential to a point on a level surface, and is at right angles to gravity at this point only.

TIME: 50 seconds

Computer Graphic Block:2 Segment:12

Graphic Title: B L O C K 1 / 2

Scene Number if with audio: 3

Next Segment: 10

CONTENT:Datums and Ordnance Datum

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

A DATUM SURFACE is a level surface to which the heights of points are reffered. In Great Britain the normal datum is Ordnance Datum. This is the mean sea level at Newlyn in Cornwall.

The REDUCED LEVEL of any point is the elevation of that point above (or below) the datum to which the point is referred. The point shown in the diagram is 10 metres higher than Ordnance Datum, and the reduced level is 10 metres above Ordnance Datum.

TIME:30 seconds

Video Scene Block:2 Segment:13

Scene Title: B E N C H M A R K S

Scene Number: 4

Next Segment: 10

CONTENT: Maps with BM and shots of OS bench marks.

NOTES:
Scene number range 1 - 50
Segment range 1 - 101
Block range 1 - 20

SCRIPT.

Bench marks are fixed points of pre-determined height. The Ordnance Survey have set up bench marks throughout Great Britain. Their locations and values may be determined from Ordnance Survey Maps.

The most common type being the Cut and Arrow (or Crow's Foot) as shown here.

This type of Bench Mark is also found marked on vertical faces of permanent features. The reduced level is the centre of the horizontal line.

TIME: 50 seconds

```
Multi Choice Test                                        Block:2 Segment:14
-------------------------------------------------------------------------

Test Type: Ordinary                        Block test relates to: 2
Satisfactory % Score        : 80
Branch if satisfactory      : 15
Branch if unsatisfactory(1): 10
Branch if unsatisfactory(2): 92
-------------------------------------------------------------------------
NOTES:
Max number of questions 1 - 5        Range of responses 1 - 5
Segment range 1 - 101                Block range 1 - 20
Block range 1 - 20                   Hint optional
Correct answer on second attempt scores half marks.
Test types : Ordinary, Pre-post, Pre-only, Post-only
Answer range 1 - 54321

-------------------------------------------------------------------------
```

MULTI CHOICE TEST QUESTION 1 OF 5

QUESTION

The determination of differences in height between points is known as:

. . . . . .

ALTERNATIVE RESPONSES

1

Traversing.

. . . . . .

2

Heighting.

. . . . . .

3

Levelling.

. . . . . .

4

Datum measuring.

. . . . . .

5

Reducing.

. . . . . .

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 3

OTHER ACCEPTABLE ANSWER (1): 2

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST . QUESTION 2 OF 5

QUESTION

A surface everywhere at right angles to the direction of gravity is known as :

ALTERNATIVE RESPONSES

1

A Datum surface .

2

A Horizontal surface.

3

A Level surface.

4

A Reduced surface.

5

. . . . . .

. . . . . .

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 3

OTHER ACCEPTABLE ANSWER (1): 0

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST· QUESTION 3 OF 5

QUESTION

A level surface to which the heights of points are referred to, is known as:

ALTERNATIVE RESPONSES

1

A Datum surface.

2

A Horizontal surface.

3

A Reduced surface.

4

A Bench mark.

5

A Reduced level.

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 1

OTHER ACCEPTABLE ANSWER (1): 2

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST, QUESTION 4 OF 5

QUESTION

A straight line which is tangential to a point on a level surface would be a:

ALTERNATIVE RESPONSES

1

Datum line.

2

Horizontal line.

3

Reduced line.

4

Level line.

5

Bench mark line.

HINT

. . . . . .

. . . . . .

. . . . . .

BEST ANSWER : 2

OTHER ACCEPTABLE ANSWER (1): 0

OTHER ACCEPTABLE ANSWER (2): 0

MULTI CHOICE TEST QUESTION 5 OF 5

QUESTION

T h e e l e v a t i o n o f a p o i n t a b o v e a d a t u m s u r f a c e i s k n o w n a s i t ' s:

ALTERNATIVE RESPONSES

1

B e n c h m a r k .

2

H o r i z o n t a l h e i g h t .

3

R e d u c e d l e v e l .

4

D a t u m l e v e l .

5

. . . . . .

. . . . . .

HINT

. . . . . .

. . . . . .

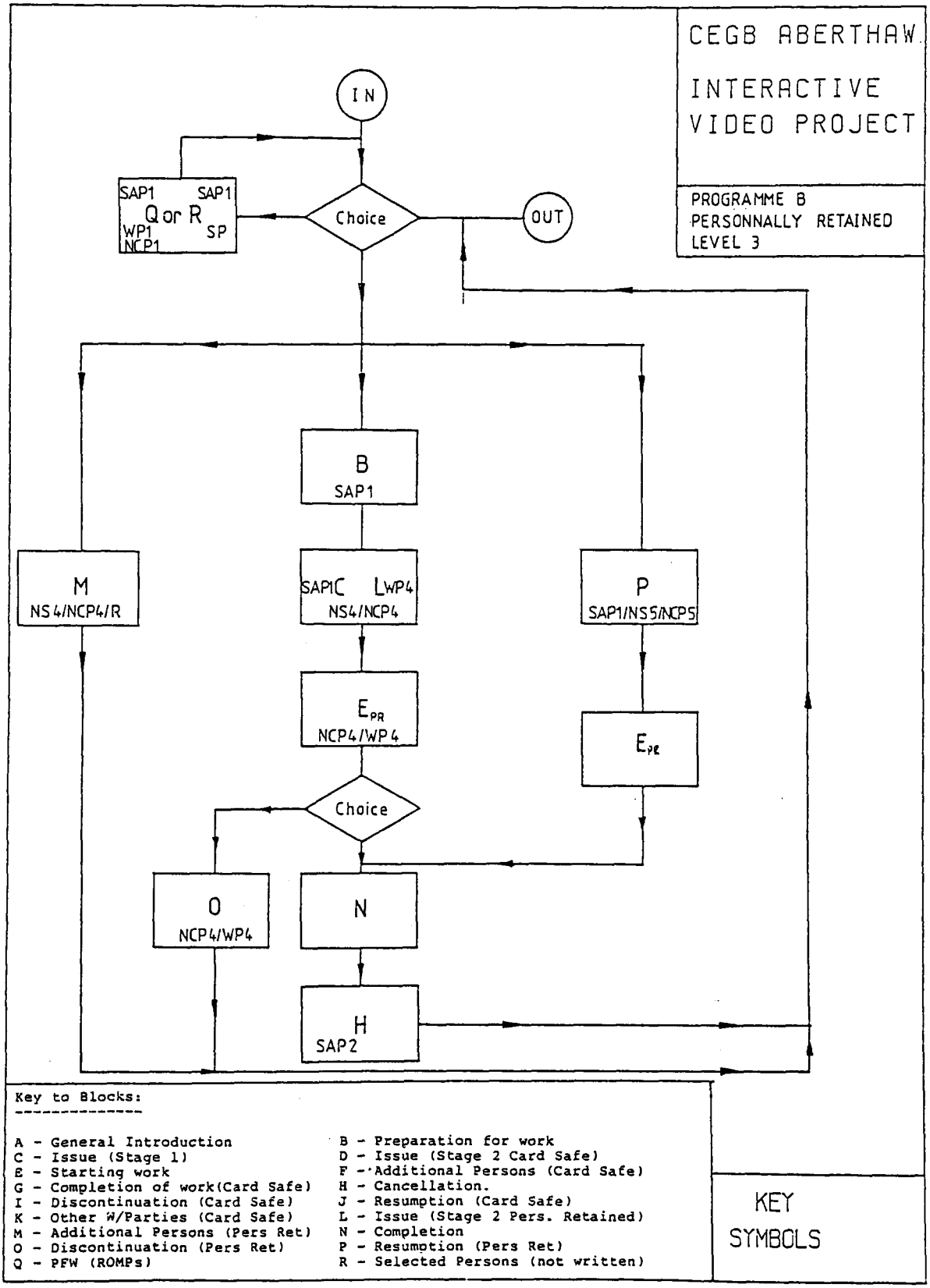
. . . . . .

BEST ANSWER : 3

OTHER ACCEPTABLE ANSWER (1): 4

OTHER ACCEPTABLE ANSWER (2): 0

BLOCK C of the CEGB Programme.


CEGB ABERTHAW
INTERACTIVE VIDEO PROJECT
PROGRAMME B
PERSONNALLY RETAINED
LEVEL 3
IN
SAP1 SAP1
Q or R
WP1 SP
NCP1
Choice
OUT
B
SAP1
M
NS4/NCP4/R
SAP1C LWP4
NS4/NCP4
P
SAP1/NS5/NCP5
EPR
NCP4/WP4
EPL
Choice
O
NCP4/WP4
N
H
SAP2
Key to Blocks:
A - General Introduction
B - Preparation for work
C - Issue (Stage 1)
D - Issue (Stage 2 Card Safe)
E - Starting work
F - Additional Persons (Card Safe)
G - Completion of work(Card Safe)
H - Cancellation.
I - Discontinuation (Card Safe)
J - Resumption (Card Safe)
K - Other W/Parties (Card Safe)
L - Issue (Stage 2 Pers. Retained)
M - Additional Persons (Pers Ret)
N - Completion
O - Discontinuation (Pers Ret)
P - Resumption (Pers Ret)
Q - PFW (ROMPs)
R - Selected Persons (not written)
KEY SYMBOLS

TASK ANALYSIS

BLOCK B : PREPARATION

Planning Office prepares Work Order Card (WOC)

↓

WOC, with Safety Document Request (SDR) containing same details, sent to Senior Authorised Person (SAP)

↓

SAP determines isolation requirements and type of Safety Document (SD) required, checks/enters those details on WOC, signing and dating the entries. The WOC is normally returned to the Planning Office at this stage, SAP retaining SDR for reference while preparing the SD.

↓

SAP carries out (or instructs operations staff to carry out) the isolation etc. needed to make the area and/or plant or apparatus safe against system-derived hazards.

↓

SAP puts isolation keys, fuses etc. in a Key Safe and locks the safe with a SAP's common key.

↓

SAP allocates a SD number and prepares a SD by filling in the 'Preparation' section : work to be done, precautions taken to achieve safety from the system, precautions to be taken during work. He also decides whether the SD is to be Card-Safe-Retained or Personally-Retained. If it is to be Card-Safe-Retained he writes 'N/A' after the statement referring to conditions of Transfer.

↓

SAP signs that precautions to achieve safety from the system have been taken, counterlocks the Key Safe with one of the unique keys and attaches that key to the card copy of the SD.

↓

If the WOC has been retained by the SAP, he writes the number of the SD in relevant box on WOC, signing and dating that entry.

BLOCK R : Selected Person's Report

After completion of the safety precautions taken to achieve safety from the system, the SAP may consider it necessary to obtain a report from a Selected Person on any additional precautions to remove or prevent danger.

SP may be (i) the Station Chemist or NJB staff under his direct control, or an employee of an outside agency nominated by the Station Chemist (if plant/apparatus may contain or give off toxic, asphyxiating or flammable substances, or if work is in a confined space, or for general atmosphere checks) or (ii) a SAP (for general atmosphere checks in tanks, fan and boiler ducting etc.) or (iii) electrical maintenance engineer and his 1st and 2nd assistant engineers.

SP completes SPR, ensuring that the SAP fully understands its contents and implications. SP is responsible for the accuracy of the SPR

The SPR is then retained in appropriate file in Permit Office and a copy may (at SAPs decision) be attached to and issued with the Safety Document.

BLOCK C : ISSUE (1)

Completed WOC is picked up from Planning Office by a line foreman, called in context of Safety Rules terminology the Nominated Supervisor (NS)

↓

At beginning of shift, NS checks WOC and issues it to a Nominated Competent Person (NCP), explaining the nature of the job and the Safety Rules and SD requirements. If (as is likely) the SD number has not yet been entered on the WOC, NS draws this to the attention of the NCP and instructs him to get the SAP to add it at a later stage.

↓

NS sends NCP, with WOC, to SAP in Permit Office for face-to-face meeting to collect SD.

↓

SAP and NCP go through details of Safety Rules aspects of job, SAP reading from his prepared SD, NCP reading WOC. All significant details must tally (though possibly not word-for-word), including the number of the SD; if the SD number has not yet been written on WOC, SAP must do so now, signing and dating the entry. All uncertainties must be resolved before proceeding further; any disagreement which cannot be resolved at this stage must be referred to the NCP's Section Head.

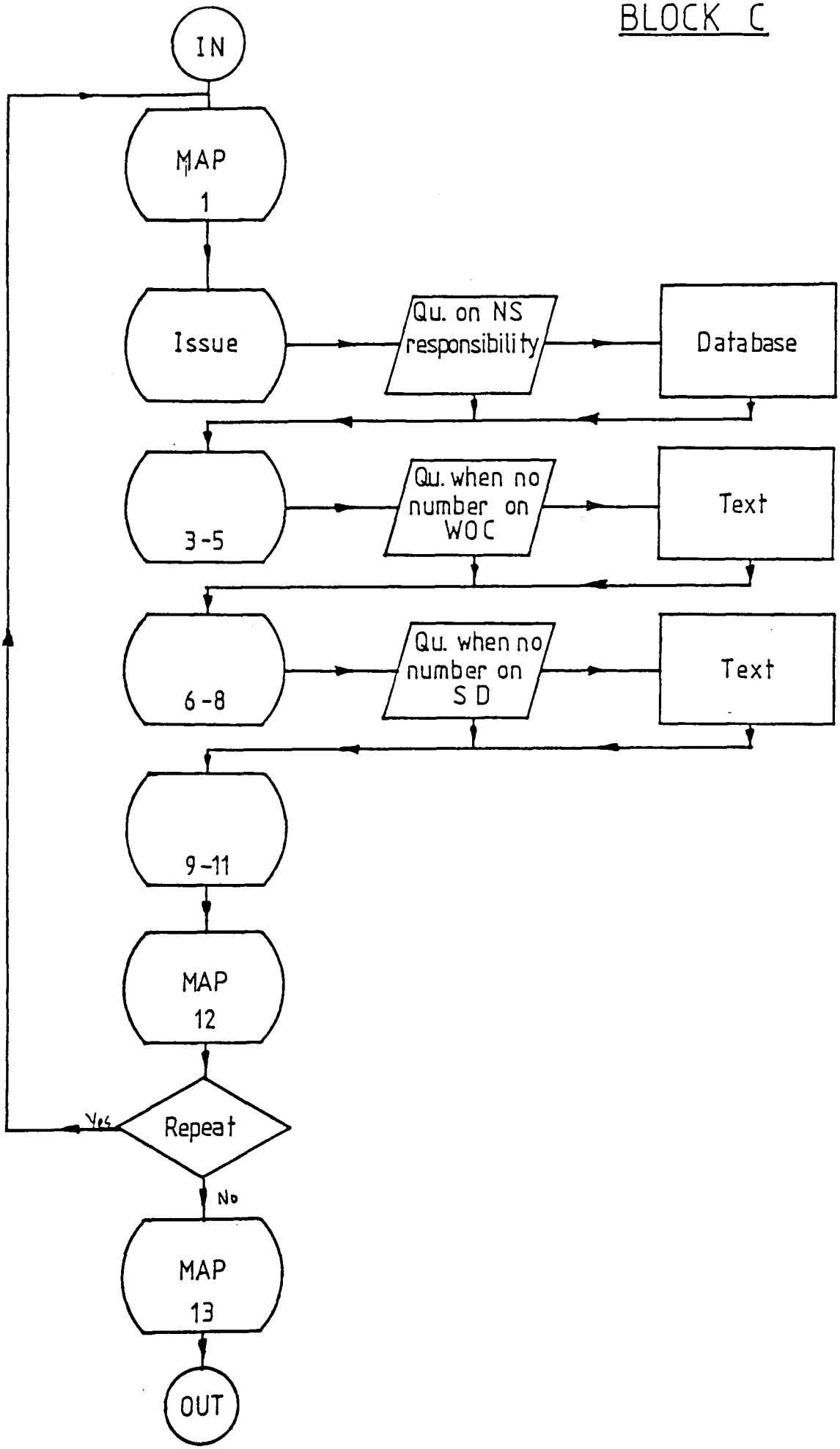
↓

SAP tells NCP whether SD is to be Card-Safe-Retained or Personally-retained.

↓

SAP completes and signs the 'Issue' section of SD, including Key Safe number, other documents issued, etc., writing 'N/A' where not applicable.

BLOCK C


IN
MAP 1
Issue
Qu. on NS responsibility
Database
3-5
Qu. when no number on WOC
Text
6-8
Qu. when no number on S D
Text
9-11
MAP 12
Repeat
Yes
No
MAP 13
OUT

			Track.	Time.
1 'Map' Highlight Issue (1) line	Graphics	The first stage of the Safety Document issue procedure is the same whether the document is to be Card-Safe-retained or Personally-retained.	2	8
2 Planning Office JS picks up WOC(s)	Video	We move forward in time to when a line foreman, acting as a Nominated Supervisor in the context of the Safety Rules, picks up the Work Order Cards (for the shift)	1	10
3	Graphics	(Computer test on responsibilities of NS)	—	—
NS looks at WOC, checking details finds NCP	Video	At the beginning of the shift, the Nominated Supervisor checks the Work Order Card, and issues it to a Nominated Competent Person.	1	7
4 NS goes through WOC, explaining details	Video	The NS explains the nature of the job and the Safety Rules and Safety Document requirements relating to the job.	1	7
5 NS points out that Safety Document number is missing	Video	If the Safety Document number is not written on the Work Order Card, the NS points this out and tells the NCP that he must get the SAP to insert that detail when he goes to see him.	1	13
	Graphics	(Computer test on circumstances of missing number).	—	

6 MCP being sent to Permit Office, to SAP	Video	The foreman now sends the MCP, with his WOC, to the Senior Authorised Person in the permit office, for a face-to-face meeting, to collect the Safety Document and to go over the Safety Rules aspects of the job.	1	14
7 MCP and SAP sitting at desk SAP reads from PFW, MCP checking WOC	Video	The two of them go carefully over the Safety Rules points, the SAP reading from the prepared Safety Document, and the MCP checking on his WOC.	1	9
8 Checking details BCU of Safety Document number on PFW	Video	The significant details must tally (though possibly the wording might differ slightly). In particular, the Safety Document number must be identical!	1	8
9 MCP handing WOC to SAP SAP writing in number, signing and dating WOC	// Video	~~(Computer test on lack of SD number)~~. If this number has not yet been written on the WOC, the MCP must point this out and the SAP must then insert it, signing and dating the entry.	— 1	— 10
10 BCU of Safety Doc. number on WOC MCP and SAP discussing a detail	Video	All uncertainties must be resolved before going any further with the procedure. If any disagreement ~~over procedures~~ cannot be resolved, ~~they~~ it must be referred to the MCP's section head - there is an 'approved procedure' to follow.	1	12

6 NCP being sent to Permit Office, to SAP	Video	The foreman now sends the NCP, with his WOC, to the Senior Authorised Person in the permit office, for a face-to-face meeting, to collect the Safety Document and to go over the Safety Rules aspects of the job.	1	14
7 NCP and SAP sitting at desk SAP reads from PFW, NCP checking WOC	Video	The two of them go carefully over the Safety Rules points, the SAP reading from the prepared Safety Document, and the NCP checking on his WOC.	1	9
8 Checking details BCU of Safety Document number on PFW	Video	The significant details must tally (though possibly the wording might differ slightly). In particular, the Safety Document number must be identical!	1	8
9 NCP handing WOC to SAP SAP writing in number, signing and dating WOC	// Video	~~(Computer test on lack of SD number)~~ If this number has not yet been written on the WOC, the NCP must point this out and the SAP must then insert it, signing and dating the entry.	– 1	– 10
10 BCU of Safety Doc. number on WOC NCP and SAP discussing a detail	Video	All uncertainties must be resolved before going any further with the procedure. If any disagreement ~~over procedures~~ cannot be resolved, ~~they~~ it must be referred to the NCP's section head - there is an 'approved procedure' to follow.	1	12

11 BCU of 'Issue' section of PFW, partly complete SAP writing "N/A" [SAP signing and dating]	Video Graphics	At this stage the SAP now completes the 'issue' section of the Safety Document, inserting the Key Safe Key number, and "N/A" in the other sections as there are no extra documents or equipment being issued. (He then signs the Section, and enters the time and date. (Computer aside on 'extra documents' - e.g. "Selected Persons Report", which is covered by separate training programme.	1 2	22 4
12 'Map' Highlight 'Issue (1)' line (Repeat? Y/N)	Graphic	And that completes the first part of the 'Issue' procedure - ensuring that the correct Safety Document is issued for the work to be done (would you like to go over it again?)	2	11
13 'Map' Highlight 'Issue (2)' line	Graphic	We can now go on to look at the second ~~part~~ stage of the "Issue" procedure...	2.	5

* NOTE: This close-up shot must avoid showing the line in Section 2 refering to transfer (ie card safe/pers ret) - otherwise two visuals will be required, one for each programme.

(13 A) That's not right etc . . . . . training programme.)

Sample Location Schedule for CEGB.

SHOOTING SCHEDULE:

LOCATION - REF. A PLACE: EXTRACTION PUMP 'A' STATION BASEMENT

	ACTIVITY	TIME	BLOCK/FRAMES	PERSONS	MATERIALS
1.	NCP + working party at work - NS arrives to do spot check		A 8	NS1 NCP1 WP1	Tools SD's WOC's
2.	SAP Locking off valve on pump		B 5,6 (CS)	SAP1	Chain, loc CN's, keys
3.	NCP arrives at pump - identifies details on WOC against plant - starts work by undoing bolts		E 1-6 (CSR)	NCP1 WP1	WOC Tools
4.	Several nuts undone - one marked "SEIZED" - Welder with torch required to burn nut off		F 1 - 4	NCP2 WP2 W	Tools, WOC Welding ge Scrap meta
5.	NCP completes work by tightening bolts - clears away men + tools - departs job		G 2, 3	NCP1 WP1	Tools etc
6.	SAP unlocking valve on pump		H 4 (CS)	SAP2	Keys
7.	NCP at work on dismantled pump - finishing shift but not job		I 3	NCP1 WP1	Tools etc.
8.	NCP arriving to resume work after shift change over (prior to (4))		J 7	NCP2 WP2	WOC Tools
9.	NCP arrives (as additional working party) to split coupling on pump		K 12	NCP3 (NCP1 & WP1 in back- ground)	WOC Tools

SHOOTING SCHEDULE:

LOCATION - REF.' B PLACE: EXTRACTION PUMP MOTOR - 'A' STATION BASEMENT

	ACTIVITY	TIME	BLOCK/ FRAMES	PERSONS	MATERIALS
1.	NPC arrives at motor - identifies details on WOC against motor - starts work		E 1 - 4 (PR)	NPC4 WP4	Tools, wallet of docs.
2.	NPC going to work location with plastic wallet of documents		L 6	NCP4 WP4	Tools Wallet of docs.
3.	NPC putting plastic wallet into tool bag		L 7	NCP4 WP4	Tool bag Wallet
4.	Rigger reports to NCP to assist with lifting operation on motor		M 3 - 5	NCP4 WP4 R	Tools Wallet (in bag)
5.	NCP clearing away men + tools work completed - departs job		N 2 - 7	NCP4 WP4	Tools Wallet
6.	NCP clearing away men & tools, leaving cover off (or otherwise providing an 'exception') - end of shift but not of job		O 3	NCP4 WP4	Tools Wallet
7.	NCP4 going to work, collecting mate on way (as shot 1)		E 1 (con) (PR)		
8.	NCP4 examining pump motor and Safety Document		E 2 (con) (PR)		

SHOOTING SCHEDULE

LOCATION - REF. C PLACE: WORKS OFFICE - 'A' STATION

	ACTIVITY	TIME	BLOCK/ FRAMES	PERSONS	MATERIALS
1.	General view of office		B 1	Scheduler + others	
2.	WOC being printed - torn off by scheduling engineer		B 1	Scheduler	WOC, printer.
3.	SDR being made out		B 1	Scheduler	
4.	NS collecting WOC's for his shift		C 2 (CS)	NS1 Scheduler (?)	Folder of WOCs.
5.	As (4)		C 2 (PR)	NS4 Scheduler (?)	Folder of WOCs.
6.	As (4)		K 3, 4	NS2 Scheduler (?)	Folder of WOCs.
7.	Scheduling engineer specifying job for contractor.		B 1 (Con)		
8.	Safety Document Request being made out (as shot 3)		B 3 (Con)		

Sample Completed Pro-formas for CEGB.

Pro-forma sheet for use with Learncom.

Page 401

Mode T 40 **Overlaid** No **Background** Green

Video Off **Transcolour** Opaque **Previous Page** 10207

Next Page 402/403

Special None **Branching** Multiple Ch

Text/graphics

What is locked away in the Key Safe?

1) Safety Documents

2) Work Order Cards

3) Fuses, Safety Keys

4) Declaration Forms

Press 1,2,3 or 4

Video Commands

None

Comments

Correct = 3 -- 402]

-- 404

Wrong = 124 -- 403]

Pro-forma sheet for use with Learncom.

Page 276

Mode . Overlaid No Background Green

Video On Transcolour Green Previous Page 275

Next Page 10114

Special Video Branching Goto/return

Text/graphics

Video Commands

Fade audio(152,1);audio 2 off;play segment(8610,8814,normal);

waitframe(8730)

Comments

Goes to 10114

From 10114

Pro-forma sheet for use with Learncom.

Page 700

Mode Text 40 Overlaid Yes Background Green

Video Off Transcolour Opaque Previous Page 610

Next Page 10600

Special Video Branching Goto/return

Text/graphics

Map [CANCELLATION] highlight

Video Commands

Audio off;Findframe(27630);delay(5)

Comments

Sets up H/1-4

Goes to 10000 returns from 10603

'Map' of the CEGB disc showing times and geographical positions.

CEGB Safety Rules Interactive Video.

Running times for Draft #3

Block	Time
A	2 - 16
B(Con 1 - 4)	44
B(Main)	3 - 39
B(PR & Con 9 - 11)	29
B(PR & Con 17)	8
C(PR)	2 - 02
C(CS)	2 - 02
C(Con 1 - 4)	47
D	2 - 01
E(CS)	46
E(PR)	47
F	53
G	2 - 15
H(CS)	1 - 16
H(PR)	16
I	1 - 06
J	1 - 00
K	1 - 34
L	1 - 25
M	54
N	1 - 30
O	56
P(Main)	1 - 12
P(Con)	26
Q	4 - 19
R	1 - 20
	36 - 20

APPENDIX 4. Evaluation and Validation.

Eysenek Personality Inventory.

E ○ N ○ L ○ [| | | | | | | | | |]

FORM A

		YES	NO
1.	Do you often long for excitement?	○	○
2.	Do you often need understanding friends to cheer you up?	○	○
3.	Are you usually carefree?	○	○
4.	Do you find it very hard to take no for an answer?	○	○
5.	Do you stop and think things over before doing anything?	○	○
6.	If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?	○	○
7.	Does your mood often go up and down?	○	○
8.	Do you generally do and say things quickly without stopping to think?	○	○
9.	Do you ever feel "just miserable" for no good reason?	○	○
10.	Would you do almost anything for a dare?	○	○
11.	Do you suddenly feel shy when you want to talk to an attractive stranger?	○	○
12.	Once in a while do you lose your temper and get angry?	○	○
13.	Do you often do things on the spur of the moment?	○	○
14.	Do you often worry about things you should not have done or said?	○	○
15.	Generally, do you prefer reading to meeting people?	○	○
16.	Are your feelings rather easily hurt?	○	○
17.	Do you like going out a lot?	○	○
18.	Do you occasionally have thoughts and ideas that you would not like other people to know about?	○	○
19.	Are you sometimes bubbling over with energy and sometimes very sluggish?	○	○
20.	Do you prefer to have few but special friends?	○	○
21.	Do you daydream a lot?	○	○
22.	When people shout at you, do you shout back?	○	○
23.	Are you often troubled about feelings of guilt?	○	○
24.	Are *all* your habits good and desirable ones?	○	○
25.	Can you usually let yourself go and enjoy yourself a lot at a gay party?	○	○
26.	Would you call yourself tense or "highly-strung"?	○	○
28.	After you have done something important, do you often come away feeling you could have done better?	○	○
29.	Are you mostly quiet when you are with other people?	○	○
30.	Do you sometimes gossip?	○	○
31.	Do ideas run through your head so that you cannot sleep?	○	○
32.	If there is something you want to know about, would you rather look it up in a book than talk to someone about it?	○	○
33.	Do you get palpitations or thumping in your heart?	○	○
34.	Do you like the kind of work that you need to pay close attention to?	○	○
35.	Do you get attacks of shaking or trembling?	○	○
36.	Would you always declare *everything* at the customs, even if you knew that you could never be found out?	○	○
37.	Do you hate being with a crowd who play jokes on one another?	○	○
38.	Are you an irritable person?	○	○
39.	Do you like doing things in which you have to act quickly?	○	○
40.	Do you worry about awful things that might happen?	○	○
41.	Are you slow and unhurried in the way you move?	○	○
42.	Have you ever been late for an appointment or work?	○	○
43.	Do you have many nightmares?	○	○
44.	Do you like talking to people so much that you never miss a chance of talking to a stranger?	○	○
45.	Are you troubled by aches and pains?	○	○
46.	Would you be very unhappy if you could not see lots of people most of the time?	○	○
47.	Would you call yourself a nervous person?	○	○
48.	Of all the people you know, are there some whom you definitely do not like?	○	○
49.	Would you say that you were fairly self-confident?	○	○
50.	Are you easily hurt when people find fault with you or your work?	○	○
51.	Do you find it hard to really enjoy yourself at a lively party?	○	○
52.	Are you troubled with feelings of inferiority?	○	○
53.	Can you easily get some life into a rather dull party?	○	○
54.	Do you sometimes talk about things you know nothing about?	○	○
55.	Do you worry about your health?	○	○
56.	Do you like playing pranks on others?	○	○

AH5 Test Sheets.

TEST AH 5

INSTRUCTIONS

Below are some examples of the Test. Do them now.

Write your answers on the Answer Sheet. Write the number, not the word.

Some of the examples are already done for you.

Take the questions in any order you like.

DO NOT WRITE ANYTHING ON THIS PAPER

EXAMPLES

Q 1	Which one of the five words on the right bears a similar relation to each of the two words on the left? Just. Blonde. — (1) Light. (2) Only. (3) Unjust. (4) Fair. (5) Brunette.	Q 1
Q 2	Which one of the five words on the right bears a similar relation to each of the two words on the left? Loud. Hard. — (1) Noisy. (2) Brittle. (3) Soft. (4) Difficult. (5) Inaudible.	Q 2
Q 3	Write down the number of the word which would come in the middle, if the following words were arranged in order according to their meaning. (1) Paragraph. (2) Letter. (3) Book. (4) Sentence. (5) Page. (6) Chapter. (7) Word.	Q 3
Q 4	Multiply the second whole number by the third decimal: 1, ·9, 2, 4, ·8, ·7, ·6, 8, ·5	Q 4
Q 5	*Hear* is to *see* as *listen* is to.... (1) touch, (2) audit, (3) see, (4) feel, (5) look.	Q 5
Q 6	*Backwards* is to *reversed* as *upside-down* is to.. (1) forwards, (2) inside-out, (3) right-side-up, (4) converse, (5) inverted.	Q 6
Q 7	Give the next but one member of the series: $\frac{1}{2}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{7}{8}$, $\frac{9}{10}$, $\frac{11}{12}$, ...	Q 7
Q 8	The third member of this series is missing. What is it? 6, 12, ... 48, 96.	Q 8

If there is anything you do not understand, please ask the tester *now*.

DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO

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Q 1	Which one of the five words on the right bears a similar relation to each of the two words on the left? Order. Immediate. 1 Plan. 2 Instruct. 3 Tidiness. 4 Direct. 5 Command.	Q 1
Q 2	Write down the number of the word which would come in the middle, if the following words were arranged in order of magnitude: 1 Street. 2 Continent. 3 Room. 4 Country. 5 Universe. 6 Town. 7 County. 8 Planet. 9 House.	Q 2
Q 3	*Overeating* is to *stomach-ache* as *negligence* is to .. 1 drunkenness, 2 accident, 3 caution, 4 Christmas, 5 laxative.	Q 3
Q 4	How many members are omitted in the following series? 3, 6, 6, 12, 12, 12, ... 48, 48, 96, 96, 96, 96, 96, 96,	Q 4
Q 5	Which one of the five words on the right bears a similar relation to each of the two words on the left? General. Easygoing. 1 Particular. 2 Brigadier. 3 Specific. 4 Universal. 5 Pedantic.	Q 5
Q 6	Add the smallest to the largest: 0·771473, 0·482976, 0·662943, 0·218527, 0·229415, 0·219134, 0·768254.	Q 6
Q 7	*Mountain* is to *molehill* as *valley* is to . 1 hollow, 2 chasm. 3 hill, 4 plain, 5 mound.	Q 7
Q 8	The third member of this series is omitted. What is it? 0·1, 0·7, ... 34·3, 240·1.	Q 8
Q 9	Which one of the five words on the right bears a similar relation to each of the two words on the left? Class. Shape. 1 Rank. 2 Grade. 3 Analyse. 4 Size. 5 Form.	Q 9
Q10	Here are five classes. Write down the number of the class which contains two, and two only, of the other four classes: 1 Terriers. 2 Mammals. 3 "Scotties." 4 Dogs. 5 Canines.	Q10
Q11	*Sniff* is to *handkerchief* as *shiver* is to ... 1 blow, 2 fire, 3 catarrh, 4 burn, 5 sneeze.	Q11
Q12	How many members of the following series are missing? 1, 2, 5, 6, 7, 11, 12, ... 20, 21, 22, 23.	Q12
Q13	Which one of the five words on the right bears a similar relation to each of the two words on the left? Stream. Tolerate. 1 Brook. 2 Contribute. 3 Bear. 4 Support. 5 Pour.	Q13
Q14	Working from the left, divide the fourth whole number by the fifth fraction: 8, 6, $\frac{1}{2}$, 3, 9, $\frac{5}{6}$, $\frac{3}{8}$, 1, $\frac{17}{12}$, $\frac{4}{5}$.	Q14
Q15	*Wood-cutter* is to *timber merchant* as *farmer* is to .... 1 lumberer, 2 goat-herd, 3 forester, 4 greengrocer, 5 labourer.	Q15
Q16	Give the next but one member of the series: 2·7, 4·79, 6·88, 8·97, ...	Q16
Q17	Which one of the five words on the right bears a similar relation to each of the two words on the left? Accept. Rise. 1 Refuse. 2 Assent. 3 Fall. 4 Ascent. 5 Decline.	Q17
Q18	Write down the number of the word that would come sixth if the following words were arranged in order, with the longest period on the extreme left: 1 Week. 2 Year. 3 Hour. 4 Decade. 5 Minute. 6 Day. 7 Century. 8 Second. 9 Month.	Q18
Q19	*Face* is to *countenance* as *try* is to .... 1 succeed, 2 persevere, 3 aspect, 4 endeavour, 5 attain.	Q19

GO ON TO NEXT PAGE

DO NOT WRITE ANYTHING ON THIS PAPER

Q20	Give the next but two member of the series: 70, 56, 42, 28, ...	Q20
Q21	Which one of the five words on the right bears a similar relation to each of the two words on the left? Stingy. Signify. 1 Insignificant. 2 Matter. 3 Generous. 4 Indicate. 5 Mean.	Q21
Q22	Write down the largest but one of these fractions: $\frac{4}{7}$, $\frac{8}{9}$, $\frac{11}{21}$, $\frac{7}{13}$, $\frac{9}{14}$, $\frac{5}{8}$, $\frac{7}{10}$.	Q22
Q23	*Irrelevant* is to *useless* as *red herring* is to..... 1 blue stocking, 2 green fingers, 3 white elephant, 4 red tape, 5 purple patch.	Q23
Q24	Give the next but one member of the series: 1, $\frac{2}{3}$, $\frac{4}{9}$, $\frac{8}{27}$, $\frac{16}{81}$, ...	Q24
Q25	Which one of the five words on the right bears a similar relation to each of the two words on the left? Keep. Go. 1 Send. 2 Return. 3 Come. 4 Dismiss. 5 Stay.	Q25
Q26	In the following list, two series are jumbled together. Write down the number of the word, or phrase, which would come in the middle of the longer series, if it were arranged in order. 1 Unlikely. 2 Never. 3 Frequently. 4 Very probable. 5 Seldom. 6 Certain. 7 Very rarely. 8 Impossible. 9 Very often. 10 Even chances. 11 Likely. 12 Always. 13 Very improbable.	Q26
Q27	*Where* is to *upstairs* as *when* is to..... 1 how, 2 underneath, 3 soon, 4 place, 5 time.	Q27
Q28	In the following series, the fifth member is omitted. What is it? 56, 35, 20, 10, ... 1.	Q28
Q29	Which one of the five words on the right bears a similar relation to each of the two words on the left? Slight. Lenient. 1 Pronounced. 2 Tender. 3 Severe. 4 Touchy. 5 Slender.	Q29
Q30	Write down the fourth smallest of the following fractions: $\frac{3}{8}$, $\frac{7}{12}$, $\frac{28}{48}$, $\frac{13}{24}$, $\frac{5}{6}$, $\frac{1}{2}$, $\frac{9}{18}$.	Q30
Q31	*Repeat* is to *continue* as *again* is to..... 1 often, 2 encore, 3 still. 4 more, 5 reiterate.	Q31
Q32	The fourth member of this series is missing. What is it? 0, 3, 15, ... 255.	Q32
Q33	Which one of the five words on the right bears a similar relation to each of the two words on the left? Portion. Separate. 1 Part. 2 Together. 3 Lot. 4 Division. 5 Share.	Q33
Q34	Mrs. Brown, part time foundry worker, has factory number B209/M. Miss Green, full time worker in the tool room, has factory number A512/S. Mrs. White, full time foundry worker, has factory number B938/M. Which one of the following factory numbers is most likely to belong to Miss Grey, a part time worker in the tool room? 1 A531/M, 2 B519/S, 3 A965/S, 4 B473/S, 5 A530/S, 6 A527/S, 7 B611/M, 8 B528/S.	Q34
Q35	*Smile* is to *statement* as *manner* is to..... 1 doubt, 2 matter, 3 frown, 4 morals, 5 word.	Q35
Q36	In the following series, the fifth member is missing. What is it? 8, 16, 26, 40, ... 100.	Q36

END OF PART I

A.H.5. PART II.

EXAMPLES.

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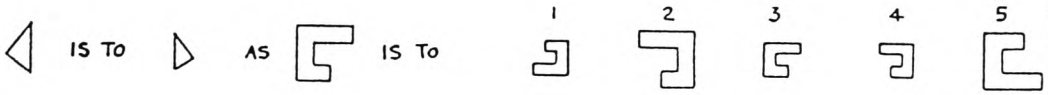
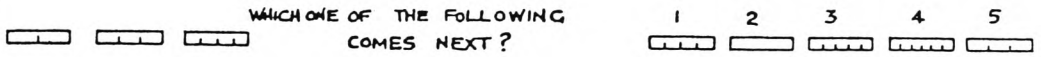
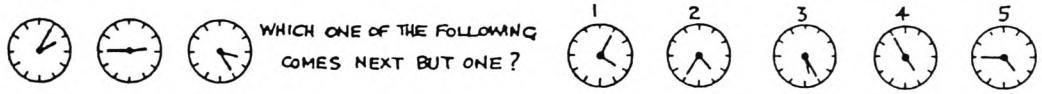
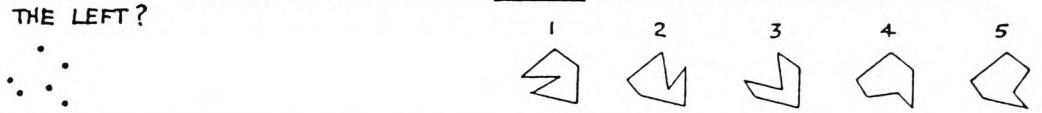
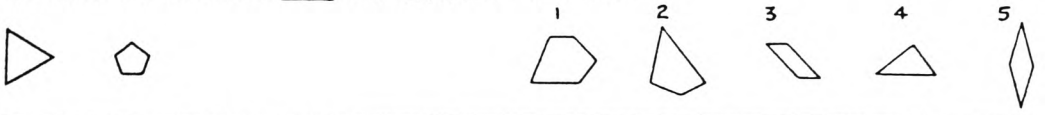
2		2
3		3
4		4
5	WHICH ONE OF THE FIGURES ON THE RIGHT CAN BE MADE BY JOINING THE DOTS ON THE LEFT? 	5
6	WHICH ONE OF THE FIGURES ON THE RIGHT CANNOT BE MADE BY JOINING THE DOTS ON THE LEFT? 	6
7	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT HAS THIS FEATURE. WHICH IS IT? 	7
8	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT LACKS THIS FEATURE. WHICH IS IT? 	8

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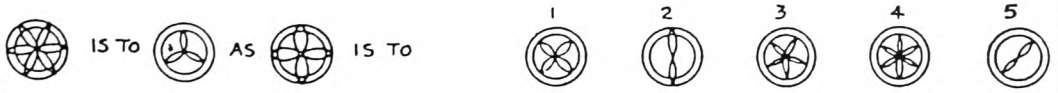
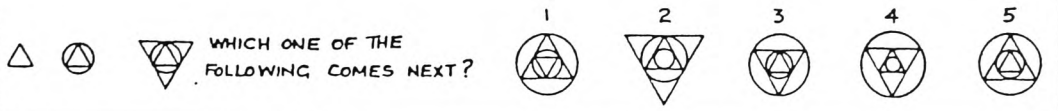
1		1
2		2
3	WHICH ONE OF THE FIGURES ON THE RIGHT CANNOT BE MADE BY JOINING THE DOTS ON THE LEFT? 	3
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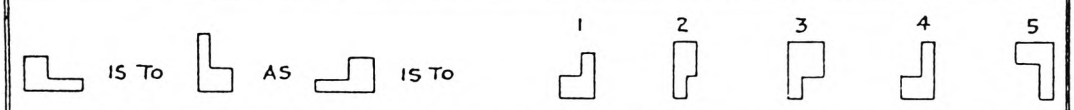
5		5
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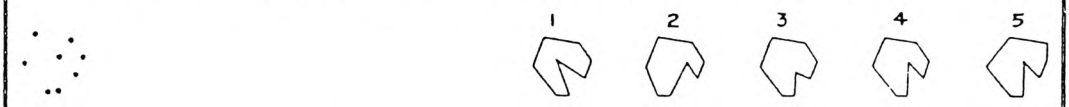
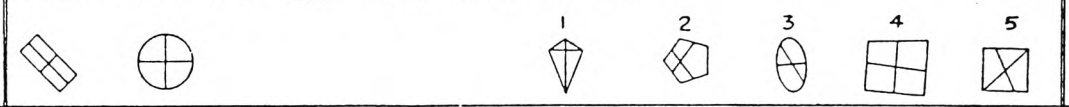
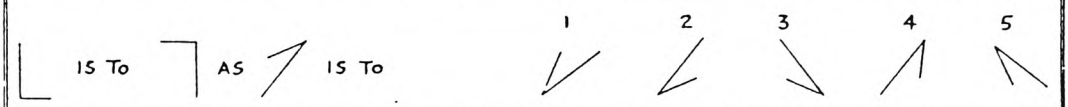
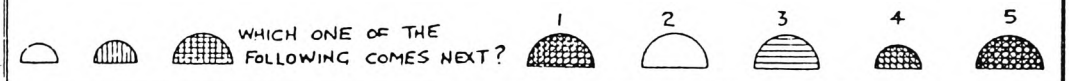
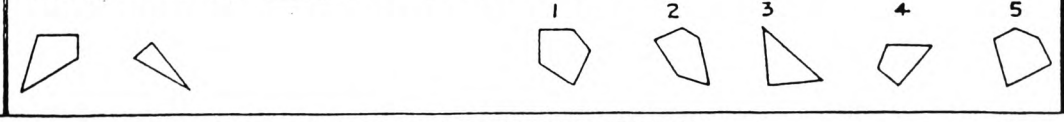
7	WHICH ONE OF THE FIGURES ON THE RIGHT CAN BE MADE BY JOINING THE DOTS ON THE LEFT? 	7
8	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT HAS THIS FEATURE. WHICH IS IT? 	8
9		9
10		10
11	ASSUMING THE CLOCK ON THE LEFT TO BE REFLECTED IN THE MIRROR A B, WHICH ONE OF THE CLOCKS ON THE RIGHT SHOWS THE CORRECT TIME? 	11
12	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT LACKS THIS FEATURE. WHICH IS IT? 	12

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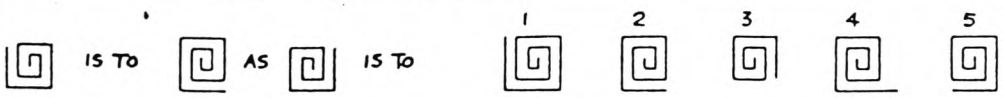
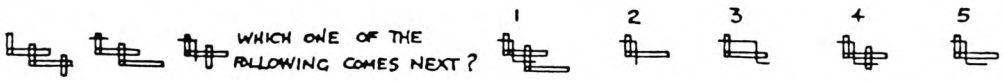
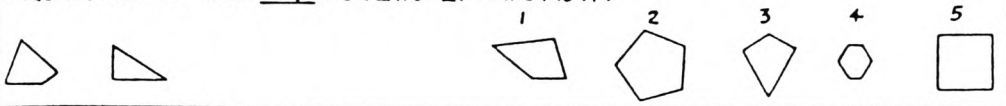
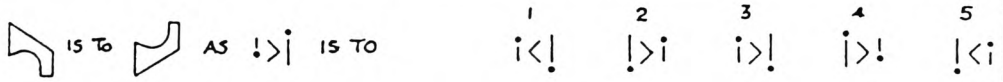
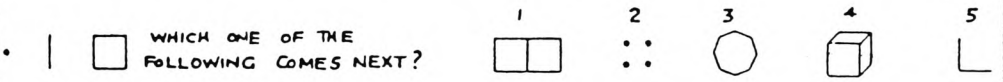
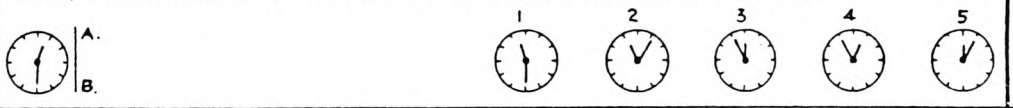
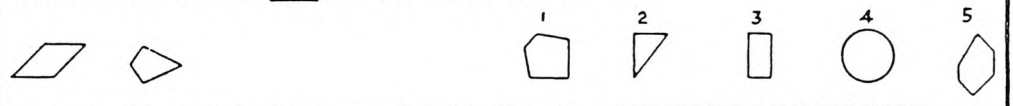
13		13
14		14
15	WHICH ONE OF THE FIGURES ON THE RIGHT CANNOT BE MADE BY JOINING THE DOTS ON THE LEFT? 	15
16	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT HAS THIS FEATURE. WHICH IS IT? 	16
17		17
18		18
19	THE FIGURE ON THE LEFT IS THE REFLECTION IN THE MIRROR A.B., OF A CLOCK WHICH IS 25 MINUTES SLOW. WHICH ONE OF THE CLOCKS ON THE RIGHT SHOWS THE REAL TIME? 	19
20	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT HAS THIS FEATURE. WHICH IS IT? 	20
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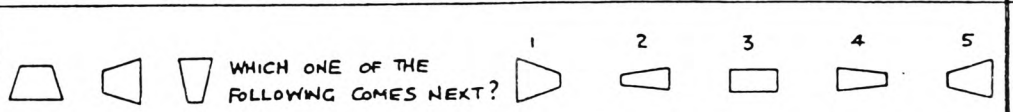
22		22
23	WHICH ONE OF THE FIGURES ON THE RIGHT CAN BE MADE BY JOINING THE DOTS ON THE LEFT? 	23
24	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT LACKS THIS FEATURE. WHICH IS IT? 	24

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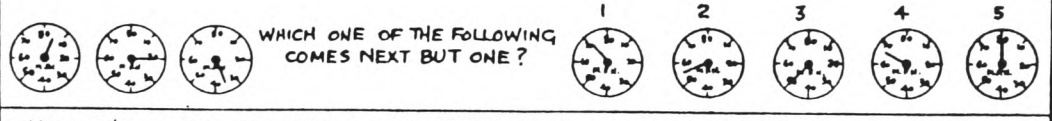
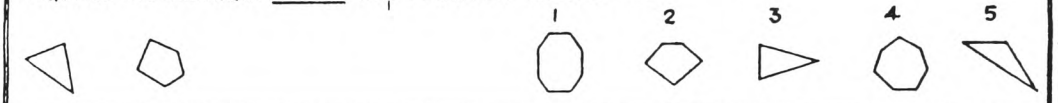
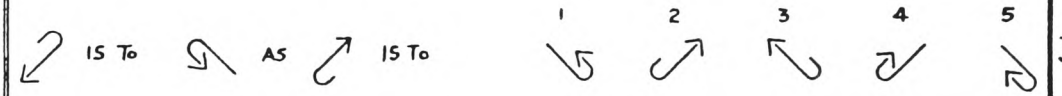
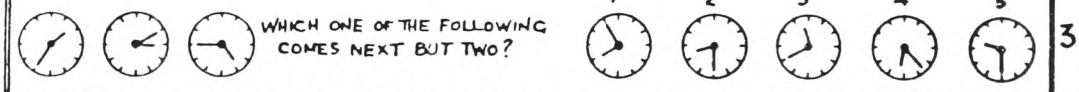
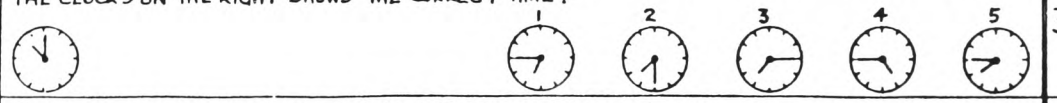
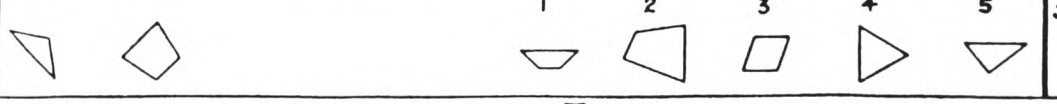
26		26
27	WHICH ONE OF THE FIGURES ON THE RIGHT CANNOT BE MADE BY JOINING THE DOTS ON THE LEFT? 	27
28	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT HAS THIS FEATURE. WHICH IS IT? 	28
29		29
30		30
31	HOW MANY OF THE LETTERS ON RIGHT CAN BE CONSTRUCTED USING ANY OR ALL OF THE THREE FIGURES ON THE LEFT, IN ANY POSITION? 	31
32	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT LACKS THIS FEATURE. WHICH IS IT? 	32
33		33
34		34
35	THE CLOCK ON THE LEFT IS A MIRROR IMAGE OF A CLOCK WHICH IS HUNG UPSIDE-DOWN. IT GAINS FIVE MINUTES A DAY. ASSUMING THAT IT WAS PUT RIGHT EXACTLY THREE DAYS AGO, WHICH OF THE CLOCKS ON THE RIGHT SHOWS THE CORRECT TIME? 	35
36	THE TWO FIGURES ON THE LEFT HAVE A FEATURE IN COMMON. ONE, AND ONE ONLY, OF THE FIGURES ON THE RIGHT HAS THIS FEATURE. WHICH IS IT? 	36

END OF PART II.

Paper presented to RICS, and National Conference of Surveying Teachers.

COMMUNICATIONS

TEACHING SURVEYING WITH THE AID OF INTERACTIVE VIDEO

Brian Collins MSc PhD CEng FIMinE FRICS,
Principal lecturer in Civil Engineering, Polytechnic of Wales, and
Rex Davies CertEd (University of Wales),
Lecturer in Construction, Neath College

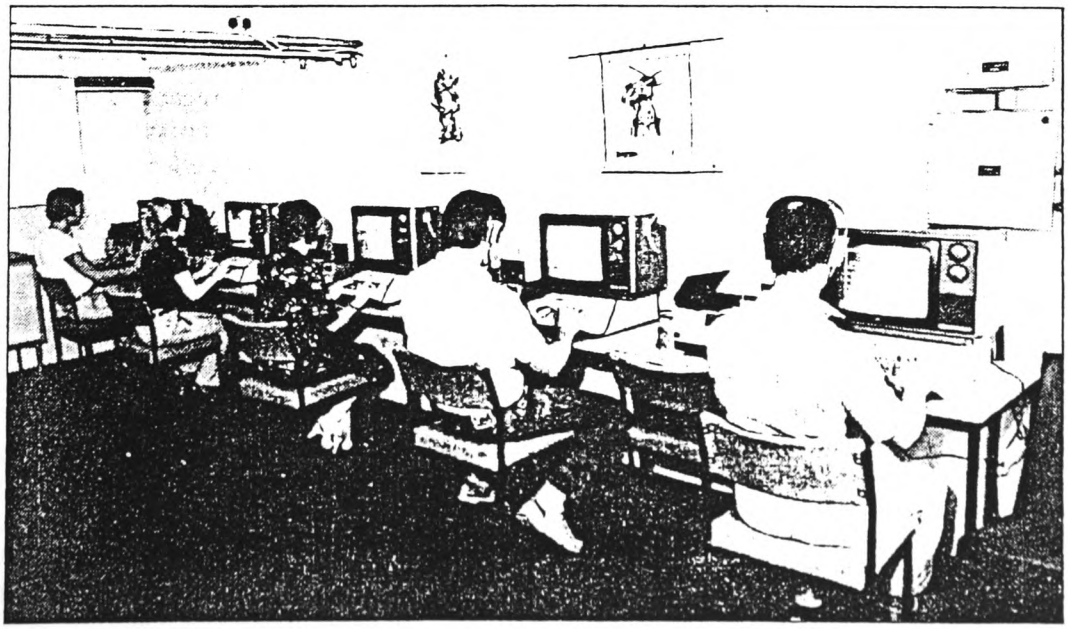
The application of interactive video to teaching problems within the Polytechnic of Wales was first considered in 1983 when a capital commitment was made towards suitable learning projects. Owing to particular staff interests at the time, the first topic area to be considered was surveying, although it is intended that at least some of the many proposals in other subject areas will come to fruition. At the time of writing, one software package entitled "The use of the surveyor's level" has been completed, and work is proceeding on others, including "The use of the theodolite".

Interactive video (IAV) describes a system which comprises a microcomputer linked to a videodisc *or* video cassette player, these being capable of "handshaking", giving control of the video player to the computer, which is itself being preprogrammed within the overall software package. With this facility, the traditional computer-aided learning program, made up of screen text and/or graphics displays, can be very effectively supplemented with movie material where and when desired. Thereafter, to use such a program, further hardware items would include a quality monitor and a disc drive to facilitate the microcomputer control. In order that IAV software may be produced, the set-up would include a video recorder as opposed to a video player, a printer and a dual disc drive, together with any other computer peripherals which may be specifically required in relation to the particular microcomputer being used.

Selection of hardware

Returning to the Polytechnic project, it was first necessary to investigate the

Figure 1. *Bank of five student work-stations*



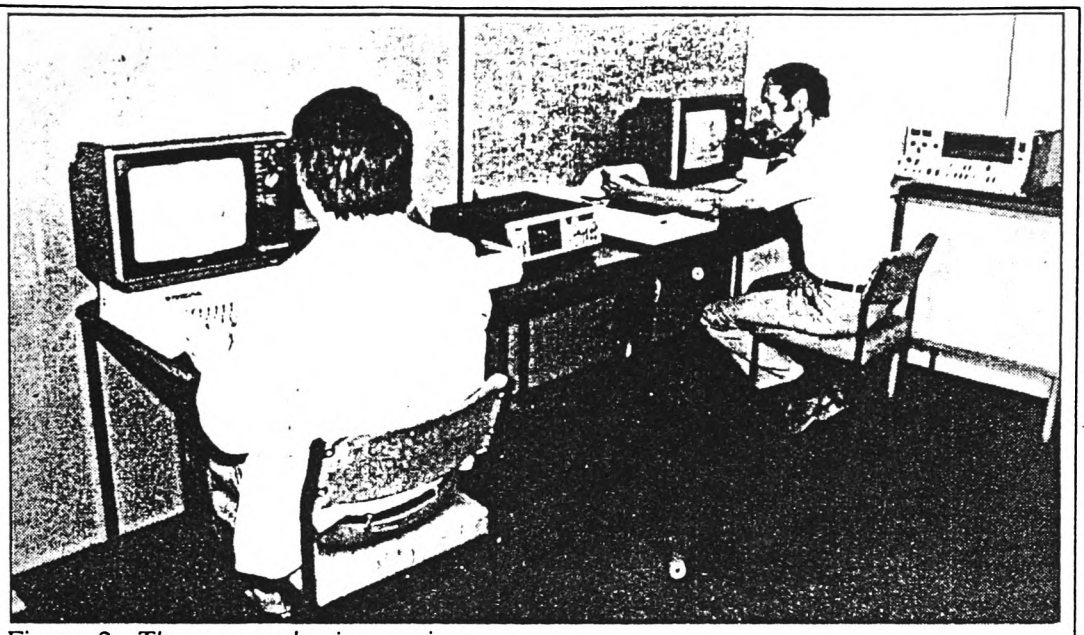


Figure 2. *The two authoring stations*

available hardware combinations in a rapidly advancing technology. The speed of advancement was emphasised by the fact that new models or versions of certain items were announced while quotations had been requested or orders were being placed for those which were being replaced. Patience at this early stage was rewarded through leaving the bulk of the ordering until the last moment possible. The initial choice was seen to be between video disc and video cassette systems.

Choice between video disc and video cassette systems

Many advantages accrue from the use of the video disc, including picture quality and stability, wearing characteristics, speed of forward and rewind movements, precisely selected still frame, slow motion, forward and reverse playing, and so on.

However, its chief disadvantage lies in the fact that professional quality video material is required in its production, and that it cannot be produced "in-house". Only a limited number of specialist companies are able to produce video discs, with consequent delays and high production cost.

The video cassette, on the other hand, is much slower and less precise in use, has poorer wearing characteristics, cannot be played in reverse mode, has limited still frame capability and so on. However, its major advantage is seen in the facility to produce immediate tape sequences which are available for authoring into IAV software packages.

Following careful consideration of these and other factors, it was decided to adopt the video cassette system, and it became possible to purchase five student stations and two authoring stations as illustrated in figures 1 and 2.

Student stations

Each student work station comprises an Apple IIE Microcomputer with video display unit and disc drive, linked to a Panasonic industrial video cassette player as seen in figure 3.

Authoring stations

Each authoring station is equipped with an Apple IIE Microcomputer with

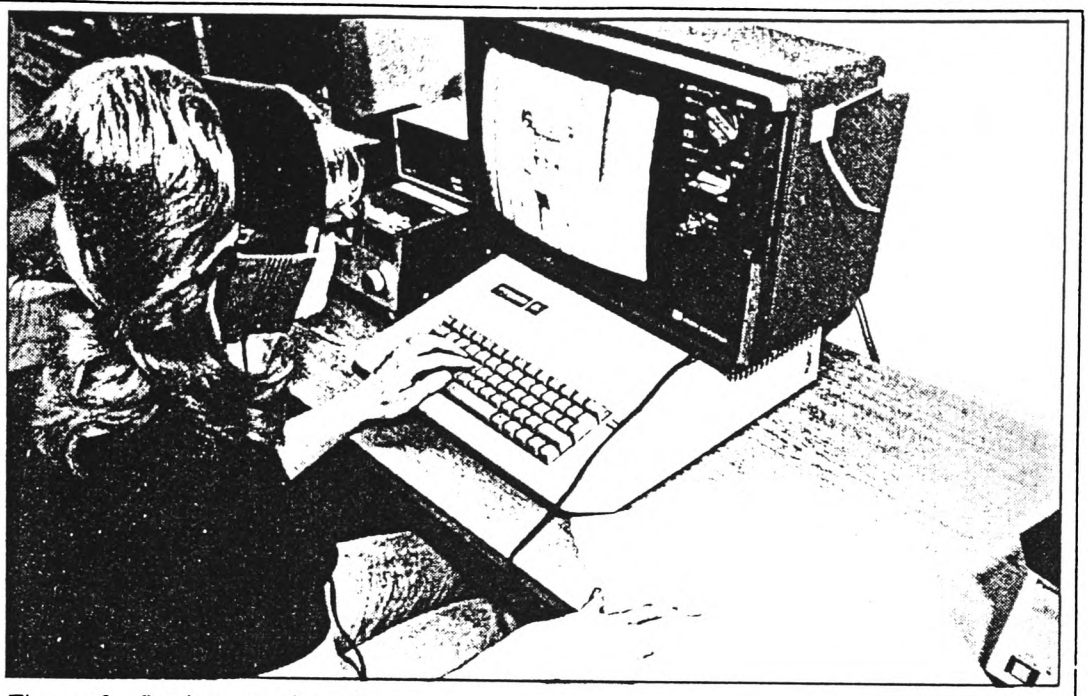


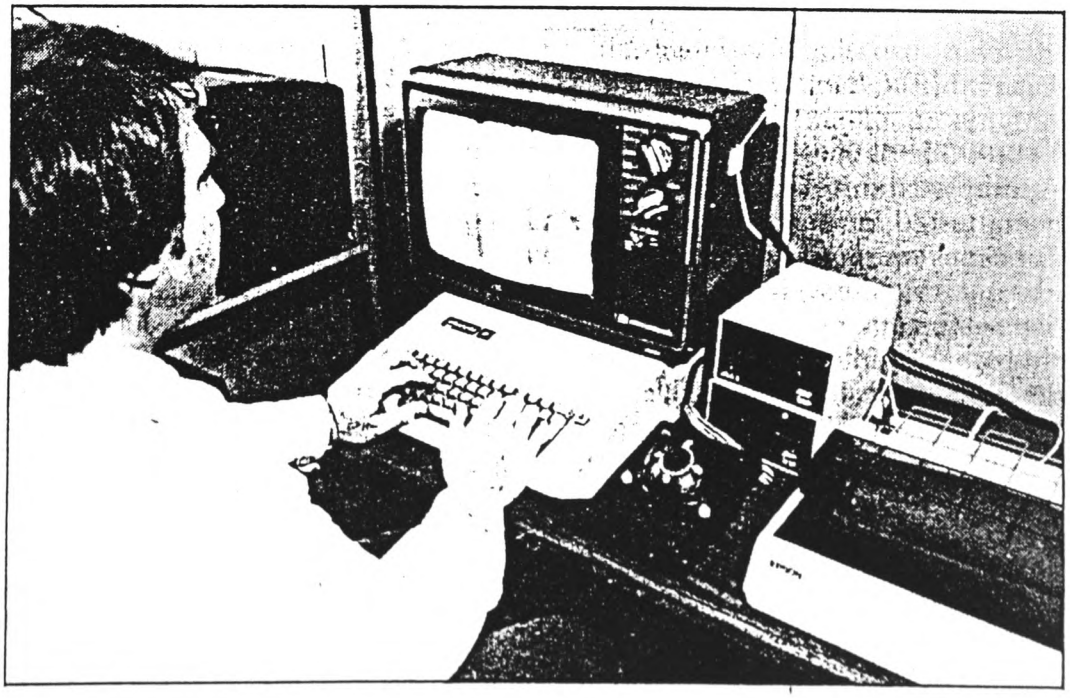
Figure 3. *Student work-station*

VDU and dual disc drive, linked in this instance to a Panasonic video cassette recorder, with the additional facility of a printer and a Robo Bit Stik for the preparation of computer graphics. The layout is shown in figure 4.

Authoring system

An authoring system comprises the above hardware and software requirements to enable an IAV course to be constructed. The software would normally take the form of an authoring language. The authoring language is simply a computer program which allows the course author to construct the IAV course

Figure 4. *Authoring station*



without having an extensive knowledge of computers or computer programming. The IAV course structure and presentation will be dictated by the facilities' provided by the authoring language.

The structure imposed by the authoring language IVL, produced by Dalroth Computers Ltd, is that of "blocks" and "segments". The segment is the basic learning unit and can be one of the following:

(1) Video sequence;
(2) Computer text;
(3) Computer graphics (with or without audio);
(4) Student choice;
(5) Tests.

A block comprises series of learning segments which form a unit of learning, as in figure 5. Note the use of a pre-test to assess whether a student needs to cover material in block 1. Complex branching can occur and this may be achieved by course structure, for example, following the results of tests or by giving selection menus for the student to explore areas of particular interest.

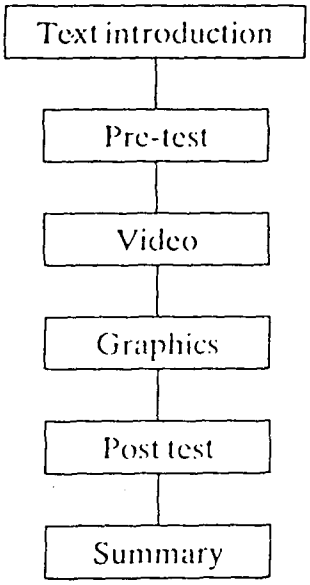


Figure 5. *The learning segments forming a unit of learning*

Preparation of software

A completed software package entitled "The use of the surveyor's level" is now being tested in the class tutorial situation. In its preparation, the following principles were considered.

An IAV course is essentially a library of teaching, testing or support *segments*, combined to form *blocks*. These are sequenced into order by the student or author. To create this library, it is essential that the course is designed logically and any desired branching determined.

Elements of the design of an IAV package may be expressed as:

(1) instructional analysis and design;
(2) production (graphics and video);
(3) course authoring.

These must be coordinated to ensure a logical progression towards the project's aims and objectives. It is also important at the first stage that any limitations which might follow are appreciated, and, more importantly, planned for.

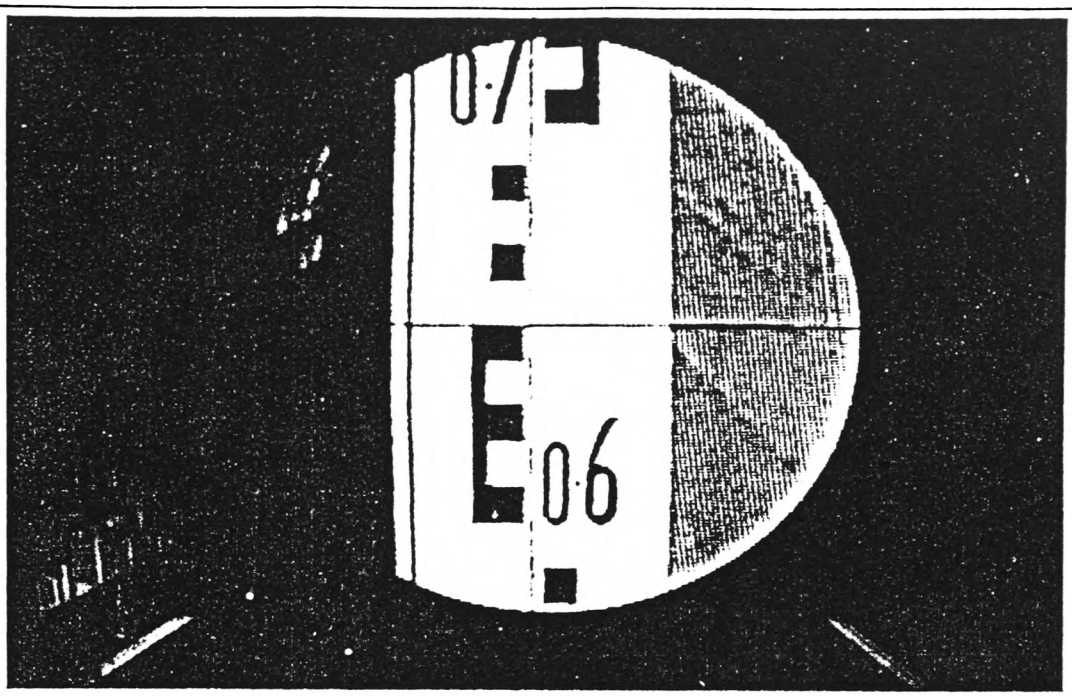


Figure 6. *Simulation of diaphragm on levelling staff*

Instructional analysis and design

Under this section were analysed the learning needs of the proposed student, how best these could be achieved and, also, how the learning could be tested:

o **Learning needs.** The learning needs for the IAV course were to present the students with a course which would teach the theory of levelling. Included in this would be the practical use of instruments, reading the staff, booking and calculating reduced levels. These tasks were to be presented as realistically as possible. This involved breaking them down into small steps;

o **Learning and testing of achievement.** This included specifying previous related knowledge of the student. As the course is aimed at mainly post "A" level entry it was felt that little such previous knowledge would exist. Thus no initial entry test was included;

o **Content and structure.** At this stage, the material required to meet the learning requirements was considered. Definitions and introductions were covered first, and utilised computer graphics with an audio description. Reinforcement was included and this normally involved computer text summaries. The areas where descriptions of equipment or the use of instruments were involved were to be covered using video material. The testing of the students' learning was then considered, and a series of questions devised. At this stage any constraints of the equipment on a course structure must be evaluated, and the final material and structure assessed. Finally, a flowchart was prepared and the sequence of learning, together with all necessary branching, decided upon.

Production

o **Video.** This involved extensive planning and script production. One of the early ideas was to try to represent the view of a levelling staff through an instrument for the student to read. Pointing the camera at the eyepiece of the instrument simply would not work as there are two focal planes produced. The solution which gave the most satisfactory result was a photograph of the staff with thread cross hairs (figure 6). This enabled numerous readings to be

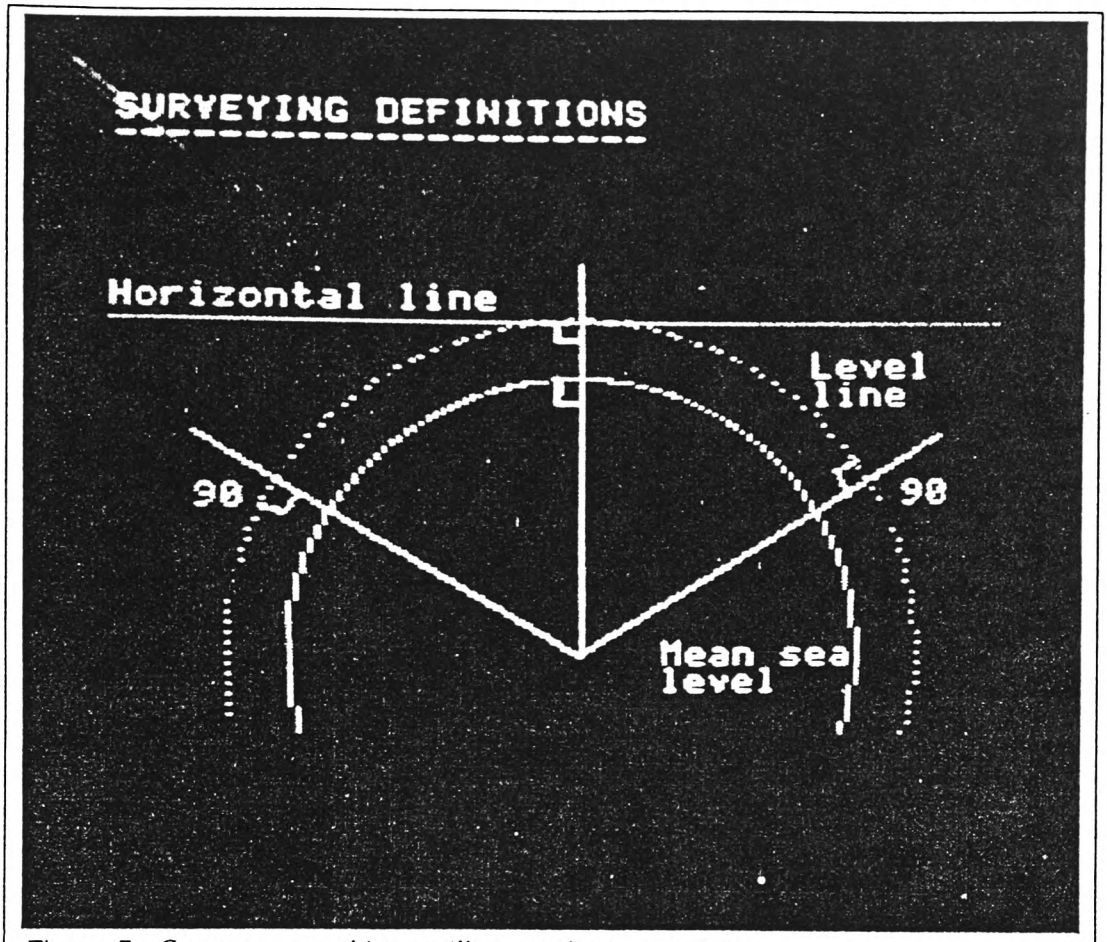


Figure 7. *Computer graphics to illustrate basic principles*

videoed from one photograph with scenes showing the temporary adjustments of various instruments (dumpy, tilting and quick-set). These were prepared with a simultaneous commentary, and were repeated with various staves. As the work progressed it was decided to explain the booking process using video material.

The complete video (approximately 22 minutes) was actually filmed in two-and-a-half days. Extra outside sequences were used to give a more realistic feel to the program, and were edited into the studio material. The tape contains short (by video standards) scenes which are in a linear sequence. Any scenes which were accessed frequently were repeated on the tape. This reduces the search time while the IAV program is being run.

○ **Graphics.** The graphics used were prepared using the Robo Stik graphics package for the Apple Computer. This is very simple to use, and quite complex graphics can be produced quickly with little computer expertise. An example is given in figure 7. Descriptive commentaries were written for inclusion on the audio track of the video tape.

○ **Text.** The final material preparations involved the content and layout of the computer text pages. These varied from main titles to summaries, instructions, as seen in figure 8, reinforcement and remedial sequences. The options available range from large coloured lettering on coloured screens to single white lettering where greater content was required.

○ **Additional material.** As the course is interactive, it involves student participation. This includes the student taking readings, calculating rises and falls and reduced levels, and carrying out arithmetic checks. A workbook has

been devised allowing the student to enter the answers as the course progresses with the computer testing the replies. The complete exercise consists of a set of results being entered into a level book, together with the necessary calculations to deduce the reduced levels of a series of points.

Authoring

This stage used the authoring software, producing the final student program on a floppy disc and a video cassette. The first operation was to record a series of electronic pulses on the video tape, (encoding), so that the computer can establish the positions of the various filmed sequences. The encoding is a simple procedure, achieved by following prompts given by the authoring program. This having been completed, the tape was played and the beginning and end of each video segment determined and logged. The various course segments, namely text, graphics and tests, were entered following appropriate prompts. At the completion of this stage, an IAV course was available for student use. The floppy disc and video tape were then duplicated to provide multiple copies for class use.

Conclusions

The introduction of video sequences into computer-aided programs adds an entirely new dimension. The effect is to "bring to life" material which would otherwise be uninspiring to the learner. The temptation to include video for the sake of video must be overcome, but this does not present too great a problem for the experienced teacher.

The first IAV course on levelling is now undergoing its initial testing. Early results were encouraging, and the new approach has been well received by students. In one particular case study, students were first presented with the IAV course, working through the material in pairs. This was followed by a practical session when students were asked to set up each of three different levels, and to determine the difference in level between two points. This was achieved by all students in the group without further instruction, regardless of the number of remedial branches followed in the learning program (This latter information is obtained by the tutor upon analysis of the floppy discs used by each pair of students, interacting again through the authoring program).

The Polytechnic project has proved to be very worthwhile, indicating that the IAV concept is suitable for technical subjects. Existing video material is unlikely to be satisfactory, and investigation, planning and clear definition of objectives are each essential at an early stage. It is to be hoped that many more software programs will be produced, not only in surveying, but in several other subject areas. The experience gained in program construction and in the preparation of video sequences, text pages and graphics will lead to greater efficiency and effectiveness in future productions. It may eventually be considered opportune to record the collective video material onto laser disc and to reappraise the hardware in what is still a rapidly changing market.

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Brian Collins and Rex Davies presented this paper at a meeting of the South Wales Branch Minerals Division held in February 1985.

Summmary of Results for the Levelling Package at Neath College.

Summary of Results for the Levelling Package at Neath College.

Results for Group during 1986/1987.

Group No.	Time on IV (minutes)	Time for exercise (minutes)
1	57	14
2	52	16
3	47	12
4	59	15
5	65	19
6	60	17
7	77	21

Results for Group during 1987/1988.

Group No.	Time on IV (minutes)	Time for exercise (minutes)
1	68	17
2	72	20
3	59	16
4	48	11
5	55	14
6	61	17

Results of questionnaire at Aberthaw.

QUESTIONAIRE - CEGB Aberthaw Interactive Video/Safety Procedures.

Payroll Number .Initial results from survey upto 24/7/87.

1) How many sessions did you take to complete?

One	Two	More
20	17	2.

2) How many times were you referred to your supervisor?

None	Once	Twice	More
31	5	1	2.

3) What is your opinion of the length of the training session?

0	Far too short
0	Short
15	Just right
19	Long
5	Far too long

3.74.

4) How familiar were you with the Safety Rules before you started?

1	Not at all familiar
1	Vaguely familiar
6	Slightly familiar
23	Familiar
8	Very familiar

3.92.

5) How difficult did you find the course?

0	Far too easy
11	Easy
23	Just right
5	Difficult
0	Very difficult

2.85

6) What did you think of the content of the course in coverage of the Safety Rules Procedures?

0	Very poor
0	Poor
11	Just right
21	Good
7.	Very Good

3.9.

7) What did you think of the accuracy of the course with regards to the Safety Rules Procedures?

0	Very poor
2	Poor
17	Just right
17	Good
3	Very good

3.54.

8) What did you think of the quality of the course from the point of view of the ease of understanding?

0	Very poor
2	Poor
10	Just right
16	Good
11.	Very good

3.32

9) What did you think of the quality of the course from the point of view of interest?

2	Very poor
6	Poor
15	Just right
13	Good
3	Very Good

3.23.

10) What did you think of the course as regards to usefulness?

0	Very poor
2	Poor
10	Just right
15	Good
12.	Very Good

3.95

11) To what extent do you think the course has increased your knowledge of the Safety Rules Document Procedures?

1	Not at all
4	Very little
22	A little
12	Greatly
0	Too a great extent

3.15

12) What do you think of Interactive Video as a means of instruction?

2	Very poor
2	Poor
0	Just right
14	Good
21.	Very good

4.28

13) Have you ever used Computer Assisted Learning before?

Yes	No
3	36

14) Have you ever used video in training before?

Yes	No
12	27

15) Would you like more training courses using this method?

Yes	No
35	4

90% Yes.

16) How difficult did you find the sets of questions at the end of the sections in the course?

0	Far too easy
9	Easy
29	Just right
1	Difficult
0	Very difficult

2.79.

17) What did you think of the frequency of questions inserted within the sections of the course?	/ Far too few 4 Too few 26 Just right 9 Too many / Far too many 3.13.
18) Have you any suggestions for improvements to this course? Suggestions in order of number of complaints.	Avoid repetition of course (14) Too long (7) Having to repeat questions (7) Wording of questions (5) Require some indication of progress. Amount to be completed.
19) Have you any suggestions for improvements for the work station?	Set in quiet surroundings (2) Keyboard layout
20) Have you any suggestions for topics that would benefit from this form of training?	General Safety (7) Plant operations (7) Contract Procedures (6) New Plant (5) Standing Instructions (3)

Note the results are based on the following data.

Engineering staff	Foremen	NJIC.
31	6	2.

Results extracted from Learncom system for the programme at Aberthaw.

Personnel Engineer 1 of 2

Test	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Atta Qu	Avg
1	2 7	1	4 6/5	1	1	2 5	1	3 7	2 5	1	1.8
2	1	1	1	1	2 11	1	1	2 11	2 11	1	1.3
3	1	1	1	1	1	1	1	1	1	1	1
4	2 30	1	1	1	1	3 26	3 26	1	1	1	1.5
5	1	1	1	1	1	1	1	1	1	1	1
6	1	1	2 40	1	2 43	1	2 43	2 43	1	1	1.4
7	1	1	1	2 50	2 50	1	1	2 50	44750	2 50	1.7
8	2 55	1	1	1	1	35556	2 55	1	2 55	1	1.5
9	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	2 71	1	1	1	1	1.1
11	1	1	1	1	2 78	1	1	1	2 75	1	1.2
12	2 84	1	1	2 84	1	2 84	2 84	2 84	2 84	2 84	1.7
13	1	1	1	1	1	1	1	1	1	1	1
14	2 97	1	1	2 97	1	1	2 97	2 97	2 97	1	1.5
15	1	1	1	1	1	1	1	1	1	2 105	1.1
16	2 114	1	2 114	1	1	1	1	1	2 114	1	1.3
17	1	1	3 116	1	1	1	1	1	1	1	1.2
18	1	1	1	1	2 127	1	1	1	1	1	1.1
19	1	1	1	1	1	1	1	1	2 133	1	1.1
20	1	2 140	1	2 138	1	2 140	1	2 137	33940	2 140	1.7
21	2 148	2 148	1	1	1	1	1	1	2 144	2 148	1.4
22	2 149	1	1	2 149	1	1	1	2 153	1	2 153	1.4
23	2 155	1	2 158	1	1	1	1	1	2 161	1	1.3
24	1	1	1	1	1	1	1	1	1	1	1
25	1	1	2 170	2 170	2 170	2 170	2 170	1	2 170	1	1.6
26	1	1	1	1	1	1	1	2 177	1	2 175	1.2
27	1	1	1	1	1	1	1	1	2 186	1	1.1
28	1	2 188	2 188	1	1	4 188	3 188	1	3 188	1	1.9
29	1	1	1	1	1	1	1	2 195	1	1	1.1
30	1	1	2 205	1	1	2 204	1	1	1	1	1.2
31	1	1	1	1	1	1	1	1	1	1	1
32	2 217	1	1	2 216	1	1	1	0	1	1	1.1
33	1	1	1	1	1	1	1	0	2 222	1	1
Time	4.7	3.5	5.6	4.3	2.9	4.5	3.6	3.9	4.4	3.3	avg 4.1

Personnel Engineer 2 of 2

Test	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Avg
1	2	7	1		2	1	1		1		2	5/6	1		2	5	1		1		1.4
2	1		2	16	1		2	11	1		2	11	1		1		2	15	2	11	1.5
3	1		1		1		1		2	23	1		1		1		1		1		1.1
4	2	30	1		1		2	27	2	30	2	30	32	630	2	30	1		2	26	1.8
5	1		1		1		1		1		1		1		1		1		3	36	1.2
6	1		2	43	1		1		1		2	42	2	40	2	43	1		2	43	1.5
7	1		1		2	50	2	50	1		1		2	50	1		1		1		1.3
8	2	55	1		1		2	55	1		2	55	45	560	2	55	1		2	60	1.8
9	1		1		2	66	2	61	1		1		1		1		1		1		1.2
10	1		2	74	1		1		1		1		1		2	69	1		1		1.2
11	1		2	77	1		1		1		1		1		1		1		1		1.1
12	2	84	2	83	2	84	1		1		2	82	28	384	2	84	1		2	84	1.7
13	1		1		3	94	1		1		2	89	1		1		1		1		1.3
14	2	97	2	97	2	97	2	97	2	97	1		1		1		1		1		1.5
15	1		2	109	1		2	105	2	109	1		1		1		1		2	109	1.4
16	2	114	3	114	2	114	2	114	1		2	114	2	114	1		21	145	2	114	1.9
17	1		1		1		2	121	1		1		1		1		2	116	1		1.2
18	1		1		2	127	1		1		1		2	128	1		1		1		1.2
19	1		1		1		1		1		1		1		1		1		1		1
20	1		1		1		3	140	2	139	2	140	3	139	2	136	1		1		1.7
21	3	147	4	147	1		1		1		1		2	145	1		2	144	1		1.7
22	1		2	149	2	149	3	149	1		1		2	153	2	153	1		1		1.6
23	1		1		1		1		1		1		1		1		1		1		1
24	1		1		1		1		1		1		1		1		1		1		1
25	2	170	1		1		1		2	170	2	170	2	170	1		1		1		1.4
26	1		6	179	2	177	2	177	1		1		1		1		1		1		1.7
27	1		1		2	184	1		1		1		1		1		1		2	187	1.2
28	2	188	2	188	2	188	1		1		2	188	2	188	3	188	1		3	188	1.9
29	1		1		1		1		1		1		1		1		1		1		1
30	1		1		2	205	3	205	1		1		1		1		1		1		1.3
31	2	207	1		1		1		1		1		1		1		1		1		1.1
32	1		1		0		1		1		0		1		1		2	216	1		.9
33	1		1		0		1		1		0		1		1		1		2	222	.9
Time	3.5		3.5		3.2		3.4		2.9		3.3		3.4		3		3.9		4	avg	3.4

Personnel Foremen

Test	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Atta	Qu	Avg
1	2	9	1		3	4/8	2	1	1		1		2	5	2	4/6	4	4/5	3	4	2.1
2	2	15	2	11	1		2	11	2	15	1		2	11	2	11	3	115	1		1.8
3	1		1		2	24	2	19	1		1		1		2	24	1		1		1.3
4	4	26	1		2	26	2	26	2	26	1		1		2	30	1		2	26	1.8
5	1		1		1		1		1		1		1		1		1		1		1
6	2	43	2	42	1		1		2	43	5	40	3	40	1		1		3	40	2.1
7	3	50	7	50	1		2	50	1		2	50	2	50	1		2	52	1		2.2
8	1		1		2	55	1		1		1		1		2	55	1		1		1.2
9	2	63	2	63	1		1		1		1		3	63	1		2	67	2	63	1.6
10	1		2	70	2	74	1		1		1		1		1		1		1		1.2
11	1		1		1		1		1		1		2	76	1		1		1		1.1
12	2	824	1		2	82	1		1		1		1		2	83	2	84	2	84	1.5
13	4	889	4	88	1		4	887	1		1		2	89	2	89	1		1		2.1
14	2	96	2	97	1		1		1		2	97	2	97	2	97	1		1		1.5
15	1		1		1		1		1		1		2	103	2	105	1		1		1.2
16	1		2	114	1		1		1		2	114	1		2	114	2	112	2	114	1.5
17	1		2	118	1		1		1		1		1		1		1		2	117	1.2
18	1		1		1		1		1		1		1		2	126	1		1		1.1
19	1		1		1		1		1		1		2		3	131	1		2	133	1.4
20	1		2	140	1		1		2	140	3	140	1		3	140	2	139	1		1.7
21	1		2	142	1		1		1		1		2		1		2	148	1		1.3
22	2	153	1		2	153	1		3	153	1		1		2	153	2	153	1		1.6
23	1		1		1		1		1		1		2		1		1		1		1.1
24	1		1		1		1		1		1		1		1		2	165	1		1.1
25	2	170	2	172	1		1		2	170	2	170	2		2	170	1		2	170	1.7
26	1		1		1		1		1		4	179	2		1		1		2	179	1.5
27	1		2	187	2	183	1		1		21	812	2		1		1		1		1.4
28	2	188	1		1		1		2	188	1		2		2	188	2	188	1		1.5
29	1		1		1		31	956	1		1		2		31	956	1		1		1.5
30	22	025	1		1		1		1		1		1		2	202	2	205	1		1.3
31	1		1		1		42	056	1		1		1		1		1		1		1.3
32	2	216	2	216	1				1		2	216			2	216	0		1		1.1
33	3	222	2	222	1				2	222	2	222			2	222	0		2	222	1.4
Time	4.7		4.6		3.1		4.2		3.3		3.9		3.2		3.8		3.6		5.5	avg	4.0