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ABSTRACT

A sequel to the booklet "A Review of the Different Types of Instructional Materials Available to Teachers and Lecturers," this booklet begins by looking at the various ways in which linked audio and still visual materials can be used in different instructional situations, i.e., mass instruction, individualized learning, and group learning. Some of the most important types of systems are then examined, including systems that link audiotapes with textual materials, sequences of slides, or photographic prints, and such combinations as tape-model, tape-microscope, and tape-realia. The main uses of each of these systems are identified and guidelines are provided for the design and production of the various components. Samples from scripts for audiotapes designed for use with a workbook and with slides are included, as well as a model of the design and production process for a tape-slide program and an annotated list of four items recommended for further reading. (MES)

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How to Produce Linked Audio and Still Visual Materials

Introduction

In this booklet, we will turn our attention to the fifth category of instructional materials that we identified in "A review of the different types of instructional materials available to teachers and lecturers" – *linked audio and still visual materials*.

We will begin by examining the various ways in which linked audio and still visual materials can be used in mass instruction, individualised learning and group learning – the three basic types of instructional situation that are identified in "A guide to the selection of instructional methods". Then, we will examine some of the most important types of system, looking first at systems that link audiotapes with textual materials, then at systems that link tape with sequences of slides or photographic prints, and finally at various other combinations such as 'tape-model', 'tape-microscope' and 'tape-realia'. In each case, we will identify the main uses of the system and then show how the materials can be designed and produced.

How linked audio and still visual materials can be used in different teaching/learning situations

Like the other types of instructional materials that are discussed in earlier booklets in the series, linked audio and still visual materials can be used in an extremely wide range of instructional situations. Let us now see what roles they are capable of playing in each of the three basic classes into which it is convenient to divide such situations.

Mass instruction

Linked audio and still visual materials have two main roles in mass instruction. First, they can be used to provide background and illustrative material within the context of a conventional 'live' expository lesson, media such as tape-slide programmes and filmstrips-with-sound being ideal for these purposes. Second, they can be used to provide fully-mediated presentations to a class, tape-slide programmes and filmstrips-with-sound again being ideal media for this, together with radiovision programmes. In both cases, the use of such media can introduce welcome variety into a course, thus helping to maintain stuoent interest and (when they are

incorporated into a lecture or similar expository lesson) helping to check the fall off in student attention span that is discussed in booklet number 3 in this series -- "A guide to the use of mass instruction techniques".

Individualised learning

Until the advent of computer-based learning, the various systems that use audio and still visual materials in combination were probably the most effective tools available to anyone designing an individualised learning course of practically any type. Indeed, there are a large number of cases where such systems are still the best medium for individualised instruction, as we will see later in this booklet. Systems such as tape-slide and filmstrip-with-sound have always been used in this role, and the great potential of other linked audio and still visual media such as 'tape-text'; 'tape-model', 'tape-microscope' and 'tape-realia' is only now beginning to be fully realised.

Group learning

Here, the main role of linked audio and still visual materials is probably the provision of illustrative and background material, although there is also scope for the use of such materials as a vehicle for small-group activities. Media such as 'tape-model' and 'tape-realia' certainly have potential in this area.

Linked tape and textual materials

Let us now turn our attention to the main systems that use audio materials in conjunction with different still visual materials, thus enabling multi-sensory stimulation of the learner to take place. We will start by looking at systems that use audiotapes linked with textual materials.

In "How to produce audio materials" (booklet number 15 in this series), we took a detailed look at one system of this type - the so-called *audio-tutorial* (or *AT*) system. Here, the audiotape forms the central 'managerial' component of the instructional system, providing the learner with information, directing him to various activities (reading passages from books or notes, examining materials, carrying out exercises, etc.) and providing aural back-up to and extension of these activities. Such systems can be used in the teaching of virtually any subject, and have the great advantage of getting the learner *actively involved* rather than simply being a passive receiver of information.

Another way of using tape in conjunction with text is to link it directly with a specific worksheet or workbook, so that the two media – audio and textual – are fully integrated. In such systems, the role of the tape may be to introduce the topic to be covered, explain and/or describe the content, periodically direct the learner to activities in the worksheet or workbook, and provide aural back-up and extension material related to these activities. The main role of the worksheet or workbook will probably be to provide questions, exercises, problems, etc, although it may also be used to give the student a permanent 'personal copy' of the material covered by the system, provide self-assessment tests, provide 'further reading' lists, and so on.

How to plan and design tape-text materials

When planning tape-text materials – or, indeed, any materials that make use of more than one sense or medium – the primary aim should be to produce a fully-integrated instructional system that makes optimum use of the different media being employed. Thus, each of the media should be used in a role that takes full advantage of its particular characteristics, and, most important of all, the different components should *complement* one another. When planning such a system, you will probably find it useful to go through the following stages

- Establish a clear set of *instructional objectives* for the system, preferably couched in behavioural terms.
- Taking full account of the relevant circumstances (target population, overall role of materials, etc) decide on the basic *content* of the system as a whole.
- Decide what *activities* would be appropriate for covering this content and achieving the instructional objectives, and establish the role of the different media in each activity; prepare an outline description of the system as a whole, clearly defining these activities and roles.
- Write the various textual components of the system, always bearing in mind the role that the accompanying audiotape is going to play when they are being used. (See booklet number 11 in this series, "How to produce printed and duplicated materials", for guidance in this work).
- Produce a detailed script for the audiotape, including pauses and recording instructions (see booklet number 15 in this series, "How to produce audio materials", for guidance in this work).
- Record the spoken material for the tape *without* pauses, preferably using an open-reel machine (again, see booklet on "How to produce audio materials" for guidance).

- Dub the spoken material onto a master tape (either open-reel or cassette), editing in the pauses and any other sound(s) required as you do so (again see booklet on "How to produce audio materials" for guidance).
- Produce as many copies of the tape as are required by copying the master tape onto one or more compact cassettes, preferably recording the material on both sides of the cassette (again, see booklet "How to produce audio materials" for guidance).
- Produce using copies of the textual materials after making any changes found necessary in the course of producing the tape (see booklet "How to produce printed and duplicated materials" for guidance).

An example of a script for the audiotape component of an audio-tutorial (on alternative energy) is given in figure 7 of "How to produce audio materials", and a further example of tape-text material is given in figure 1 below. This is the start of the outline description that was prepared when an audio-workbook on writing instructional objectives was being planned.

Writing Instructional Objectives - An Audio-Workbook

Audiotape	*Workbook*
	Title; instructions to start tape
Introduction to audio-workbook, stating overall aims and outlining content. (roughly 2 minutes) Instructions to study detailed objectives in workbook and to re-start tape when finished. *Bleep, followed by 5 second pause*	
	Full statement of instructional objectives of audio-workbook expressed in behavioural terms.
Recapitulation of first objective, relating to the role of objectives in a systematic approach to course or curriculum design; referral to schematic diagram of such an approach in workbook. (roughly 3 minutes)	Block diagram showing role of objectives in course or curriculum design process

Instructions to summarise 3 key functions of objectives just described in spaces provided in workbook, rewinding tape and replaying section if necessary, and to re-start tape when finished. *Bleep, followed by 5 second pause*	
	Labelled spaces for writing in 3 key functions of objectives.
Recapitulation of second objective, relating to the distinction between *aims* and *objectives*. Instructions to study examples given in workbook, and to re-start tape when finished. *Bleep, followed by 5 second pause*	Example of a typical aim (from the section of a secondary school chemistry course dealing with chemical bonding) followed by the start of the list of detailed objectives associated with that aim.
Discussion of the distinction between aims and objectives, with reference to the illustrative material in the text. (roughly 2 minutes) Instructions to summarise distinctions between aims and objectives in spaces provided in workbook, rewinding tape and replaying section if necessary, and to re-start tape when finished. *Bleep, followed by 5 second pause*	
	Labelled spaces for writing in distinguishing features of aims and objectives.
Recapitulation of third objective. - *and so on*	

ire 1: the start of the outline of a typical audio-workbook

The way in which the audio and textual components of an audio-workbook can be used to support and complement one another is clearly illustrated in this example.

Linked tape and photographic materials

The various systems that link audiotapes with sequences of photographic images are among the most widely used of all audiovisual media – particularly as vehicles for individualised instruction. Of the various types of system, the two that can most easily be produced 'in house' by practising teachers and lecturers are *tape-slide programmes* and *tape-photograph programmes*, so we will concentrate on these in this section.

Tape-slide programmes

Tape-slide programmes consist of linked sequences of photographic slides (usually of the compact 2" x 2" variety) that are accompanied by synchronised commentaries recorded on audiotape (usually on compact cassettes). In some cases, synchronisation of the advance of the slides with the sound is achieved by incorporating audible 'bleeps' in the actual sound signal, so that the user knows when to advance the slides manually. In more sophisticated programmes designed for display on fully-automatic equipment, the advance cues are recorded on a separate track of the tape, consisting of pulses of sound that trigger the 'advance' mechanism in the slide projection or viewing system. Both forms of programme can be used in virtually all types of instructional situation by using appropriate equipment. For showing a tape-slide programme to a class or large group, this usually consists of a slide projector and separate audiotape player, with the two being linked by an electronic synchronising unit if the programme is an 'automatic' one with inaudible advance cues. For individual or small-group use, the equipment can range from a simple manual slide viewer and cheap cassette player to a fully-automatic tape-slide unit incorporating linked audio playback and back-projection slide viewing facilities (e.g. a machine of the "Caramate" type).

Instructional uses of tape-slide programmes

As we have seen, tape-slide programmes can be used in virtually all types of instructional situation, both as self-contained units of mediated instruction and also in a secondary or supportive role (providing illustrative material, background material, and so on). When used in the former role, such programmes can be just as effective as a well-prepared, well-delivered lecture or expository lesson in helping students to understand the subject matter, but, like

the latter, constitute an essentially 'one-way' channel of communication in which the learner has no opportunity for active participation, so that long-term retention of the material tends to be low. Thus, it is now generally agreed that tape-slide programmes are most useful as a vehicle for giving a general introduction to a topic, or of stimulating interest and providing motivation for further or more detailed study, rather than as a vehicle for presenting the detailed content of a course. To teach this detailed content effectively, it is advisable to use methods that incorporate higher learner involvement (see booklet number 4 in this series – "A guide to the use of individualised instruction techniques").

How to design and produce tape-slide programmes

General guidelines

When designing a tape-slide programme for a specific educational or training purpose, it is obviously necessary to be quite clear what this purpose is, and to be satisfied that use of a tape-slide programme is likely to be an effective way of achieving it. Assuming that this is indeed the case, readers should find the following general guidelines helpful.

- Keep the programme simple. As we have seen, the tape-slide medium is best suited to providing general introductions to topics rather than to providing detailed coverage of their content.
- Keep the programme comparatively short – certainly no longer than the 80 slides that can be contained in the standard carousel-type magazines that are used with most automatic tape-slide equipment.
- Make sure that the programme has a clearly-defined structure, making appropriate use of 'signposts' and 'links' to ensure that the user has no difficulty in seeing what this structure is.
- Make sure that the visual and audio elements complement each other at all times (this is probably the most important rule of all).
- Do not compromise on quality; a tape-slide programme is only as good as its weakest component, so try to make sure that the photographs, the graphic slides, the narration, and (most important of all) the synchronisation are all of the same equally high standard.

The detailed design of the programme

This is best carried out by first producing a skeleton outline, listing the main sections of the programme, and then writing a detailed script for the programme – either in the form of a 'story board' (sketches of the individual frames with the accompanying text

alongside) or as a double-column script with the visual component described on one side and the audio element on the other.

Whichever form of script you decide to employ, you should try to make full and effective use of the different types of basic 'building bricks' that can be used to construct tape-slide programmes. These can be classified as follows:

Visual 'building bricks'

- *Signposts and links* (main title slides, titles for sections and sub-sections, and so on).
- *Photographs* (original or 'second hand' photographic images of all types).
- *Graphic illustrations* (schematic diagrams, graphs, bar charts, pie charts, tables and so on).
- *Verbal illustrations* (slides carrying simple verbal material designed to support or complement the narrative).

Audio 'building bricks'

- *Narrative* (the main component of the audio element of all tape-slide programmes).
- *Silence* (the pauses between frames, and any other deliberate pauses or periods of silence).
- *Music* (introductory or closing music, music used as a link between sections, background music, and so on).
- *Special effects* (claps of thunder, shots, sounds of machinery, or any other special sound effects thought appropriate at specific points in a programme).

Part of a typical script for a tape-slide programme is given in figure 2. This was written for the South-Eastern Drilling Company (SEDCO) as part of a distance learning package on non-destructive testing that was developed for the Company in 1982. The 75-slide programme from which the script extract is presented was used to provide a general introduction to the subject of non-destructive testing, being accompanied by a 68-page self-instructional manual that dealt with the subject in much greater detail.

SEDCO NON-DESTRUCTIVE TESTING APPRECIATION COURSE

Stage 1: Basic Concepts and Techniques

Slide sequence and commentary for tape-slide programme

Slides	*Commentary (pulses signified by •)*
1. Main title slide "SEDCO NON-DESTRUCTIVE TESTING APPRECIATION COURSE" Stage 1: basic concepts and techniques	*Silence* (10 seconds) followed by •
2. Photograph of SEDCO personnel (with SEDCO logo clearly visible on helmets) inspecting the flange on the end of a section of pipeline in their pipe yard prior to carrying out a test for cracks.	"The programme that you are about to see has been specially produced for SEDCO in order to give you and your colleagues an introduction to the field of *non-destructive testing*, or *NDT* as it is commonly called" (*1 second pause*; • ; *1 second pause*)
3. Photograph of front cover of self-instructional manual that accompanies programme, showing name of Company.	"You should also have received a copy of the SEDCO self-tuition manual that has been written to accompany the programme, and should read this carefully after you have finished studying the programme itself". (*1 second pause*; • ; *1 second pause*)
4. Caption slide listing first set of self-assessment questions in manual.	"At the end of each section of the manual, you will find a number of questions dealing with the material covered. These have been designed to help you tell whether you have mastered the material, or whether you will need to go over some of it again". (*4 second pause*; • ; *1 second pause*)
5. Photograph of SEDCO personnel carrying out magnetic particle inspection of flange on end of pipeline.	"Once you are satisfied that you can answer *all* the questions in the manual, you will be ready to move on to Stage 2 of the course, which examines some of the ways in which non-destructive testing is actually used by SEDCO". (*1 second pause;* •)

6. Section title slide: "NDT as a diagnostic tool"	*Silence* (10 seconds) followed by •
7. Caption slide "NDT -- examining materials for flaws without impairing their desirable properties".	"Non-destructive testing has been defined as the science of examining materials or manufactured articles in order to determine their fitness for a certain purpose, *without impairing their desirable properties in any way*". (*1 second pause*; • ; *1 second pause*)
8. Schematic diagram, showing two possible outcomes of NDT: (1) no serious defects ∴OK for use (2) serious defects ∴unsuitable for use.	"No material or manufactured article is ever *completely* free from flaws or defects, and the object of NDT is to detect any such defects and determine whether they are likely to be sufficiently serious to prevent the item from being able to do the job for which is was designed" (*3 second pause*; • ; *1 second pause*)
9. Schematic diagram of block of material showing surface and internal defects.	"Defects are of two basic types, namely, those that occur on the surface of an item, and those that are located in the interior, and are thus much more difficult to detect". (*1 second pause*; • ; *1 second pause*)
10. Caption slides listing three types of NDT tests: - surface tests - subsurface tests - internal tests	"We find it convenient to divide non-destructive testing methods into three broad groups, depending on the type of defects that they are designed to detect, namely, *surface tests*, which are used to detect defects that occur on the actual surface; *subsurface tests*, which are able to detect defects that are located just below the surface; and *internal tests*, which can be used to discover defects that occur deep in the interior". (*1 second pause*; • ; *1 second pause*)
11. Caption slide listing two main types of NDT methods to be covered in programme:	"A large number of different NDT techniques are available, but the ones that you are most likely to make use of in the course of your

- dye penetrant testing - magnetic particle inspection	work are *dye penetrant testing* and *magnetic particle inspection*. We will therefore take a detailed look at each of these methods". *(1 second pause; • ; 1 second pause)*
12. Caption slide listing other four types of NDT methods to be covered: - eddy current testing - ultrasonic testing - X-ray radiography - gamma radiography	"We will also examine four other important NDT methods with which you should be familiar, even though you are unlikely to have to use them yourself - *eddy current testing, ultrasonic testing, x-ray radiography* and *gamma radiography*" *(1 second pause; •)*
13. Section title slide; "Dye penetrant testing"	*Silence* (10 seconds) followed by •
and so on	

Figure 2: the start of the script of a typical instructional tape-slide programme

Figure 2 illustrates many of the basic principles of tape-slide programme design, and readers should note the following specific points:

- The clear division of the programme into sections using title slides and periods of silence; some people would no doubt prefer to fill the latter with suitable music.
- The explicit specification of the lengths of the pauses between slides and the timing of the slide changes. These are absolutely crucial to the success of a programme, which can easily be ruined if the pauses are too short (or too long), or if the slide changes are badly timed.
- The way in which the visual elements have been carefully designed to complement the narrative, which, in this particular programme, is the main vehicle of communication. Wherever possible, a photograph or schematic diagram is used, but, in cases where neither of these would be appropriate, a simple caption slide that reinforces the key points being made in the narrative is employed (see, for example, frames 7,10,11 and 12). The later sections of the programme, which deal with the various NDT methods, make use of a similar mixture of photographs, schematic diagrams and 'verbal reinforcement' slides to back up the

narrative – a technique that is suitable for most tape-slide programmes of this type.

- The way in which the various visual elements are explicitly described in the script – the verbal equivalent of the sketches in a 'story board' script.

Producing the programme materials

The two processes described above – producing the skeleton outline and producing the detailed script – constitute the first two stages in the development of a tape-slide programme. As can be seen from Figure 3, which shows the complete development process in flow diagram form, the next stage consists of the actual production of the audio and visual components of the programme – two processes that should be carried out in parallel.

The audio side of the work involves three separate processes:

- Recording the commentary for the programme in the way described in the booklet on "How to produce audio materials". It is advisable to engage the services of a professional presenter for this work it at all possible, particularly if the programme is an important one, but it is appreciated that this may not always be practicable. If it is not, make sure that the presenter used is capable of doing justice to the material.
- Recording or acquiring any other sound components needed for the programme (music, sound effects, etc). If you do decide to make use of music, make sure that you have proper copyright clearance, otherwise you could find yourself in severe legal difficulties.
- Dubbing the commentary and any other sound components onto a master cassette tape, in the way described in "How to produce audio materials", editing in the pauses and periods of silence as you do so. The easiest way to time such pauses is to 'count in thousands' ("one thousand"; "two thousand"; "three thousand"; and so on), which, with a little practice, can be used to time multiples of one second with considerable accuracy. Do *not* edit in the pulses at this stage, since this is best deferred until you have the complete set of slides available.

The visual side of the work involves five separate processes:

- Designing all the various graphic slides (main title slides, section title slides, schematic diagrams, graphs, caption slides, etc). When doing this, you should follow the same basic rules that are given for designing OHP transparencies in booklet number 14 in this series – "A guide to the use of the overhead projector" – only

more so! Thus, you should NEVER try to put too much information on a single slide, and should always aim to produce a clear, simple layout that will enable all the information on the slide to be easily distinguished by the viewer. In the case of slides that carry verbal information, a good rule of thumb is to restrict yourself to a maximum of 6 lines of print if the slide is to be screened horizontally (which it always should be in a tape-slide programme). It is a good idea to produce a rough version of the material to be contained in each slide on a separate sheet of paper, using coloured marker pens; this helps you to visualise what the final product will look like.

- Producing the finished artwork for the graphic slides. If you have to do this yourself, use the various graphics production techniques described in booklet number 13 in this series "A guide to the use of non-projected displays. If at all possible, however, it is obviously better to have the work done by a specialist graphic artist.
- Producing the photographic slides (i.e. those slides that consist of original photographs of actual scenes, objects, etc., rather than copies of photographs from books, etc., or photographs of original artwork.) It is advisable to have this work carried out by a photographic technician or other professional photographer if at all possible unless you yourself possess the necessary equipment and skills.
- Assembling the master set of slides. This is best done using a light box of some sort, or, better still, a rack in a slide storage/display cabinet of the type shown in figure 4. This has the advantage of allowing you to see the complete sequence of slides during the assembly process.
- Producing the graphic slides from the artwork. This is best left to a specialist photographic technician who has access to a proper copy stand. If you have to carry out the work yourself, however, this can be done by using a tripod-mounted camera to photograph the artwork on a caption stand or music stand. Alternatively, you can use a vertically mounted camera to photograph the artwork on a table, preferably under a sheet of glass. In both cases, the artwork should be illuminated from the sides, to avoid glare.

Once you have produced the edited master tape and assembled the full slide sequence for the programme, the crucial task of pulsing the master tape can be carried out. This can either be done using a suitable cassette tape recorder that possesses a pulsing facility or using an individual tape-slide playback/viewing machine that possesses a similar facility. Whichever method is used, check that

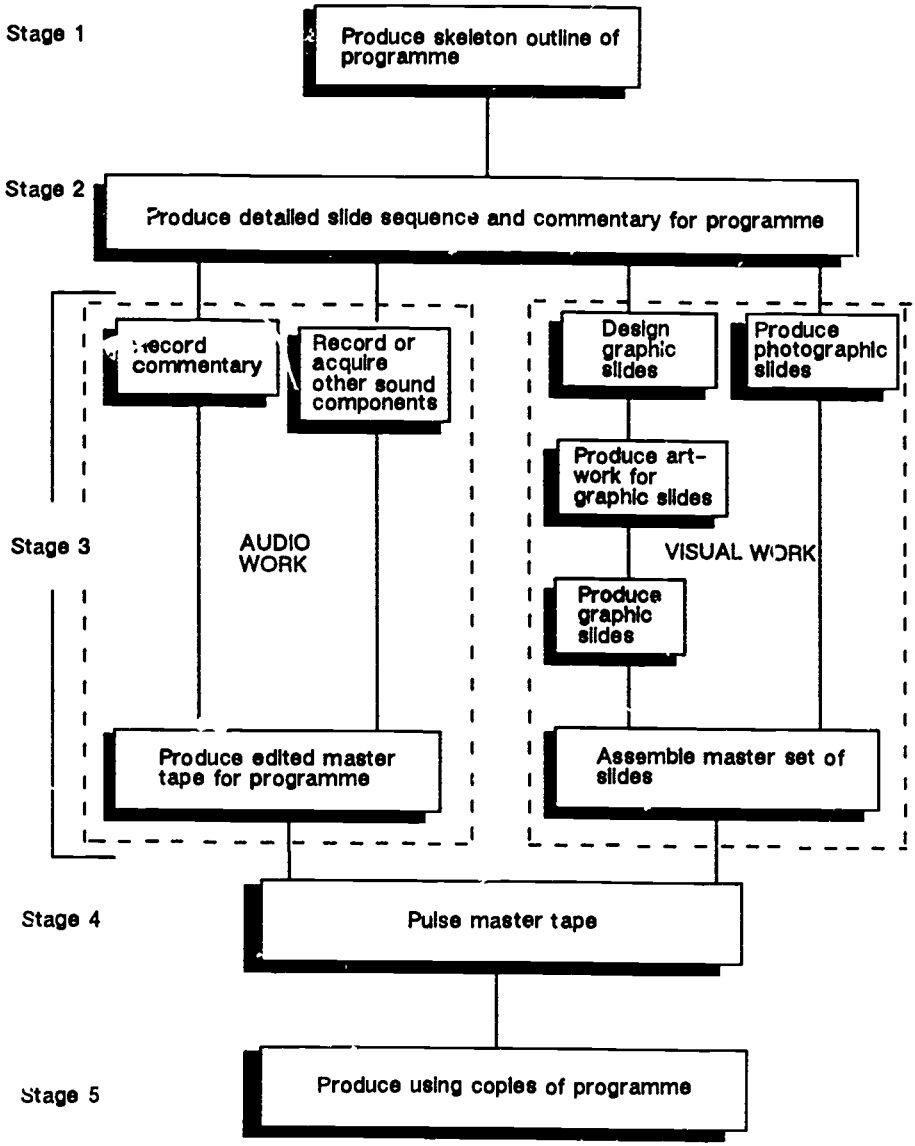

Figure 3: the various stages in the design and production of a tape-slide programme

the pulses will operate the equipment that you will be using to show the tape-slide programme, since pulses recorded on one type of equipment do not always work with another.

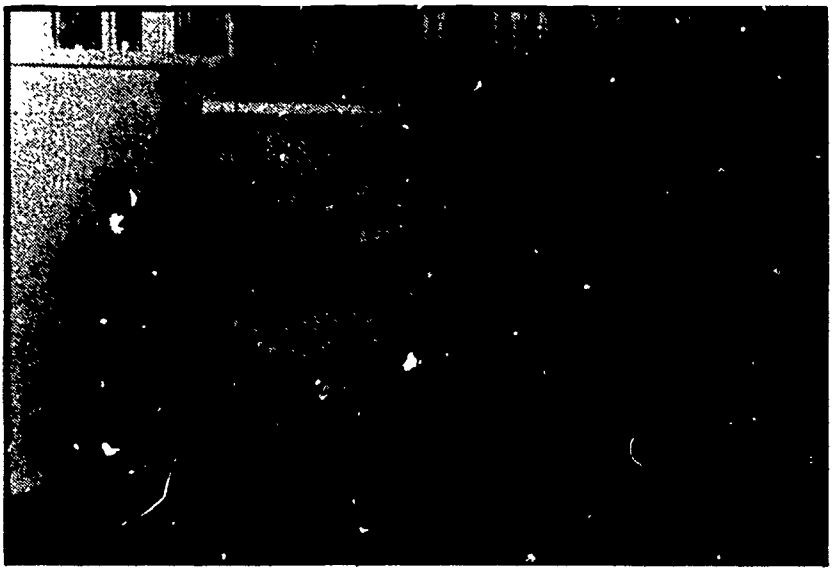

Figure 4:use of a slide storage/display cabinet for assembling a slide sequence

Finally, run off as many using copies of the programme as are required by producing duplicate copies of the master cassette (as described in the booklet on "How to produce audio materials") and having duplicate sets of the slides made up. The latter task is again best done professionally, e.g., by a photographic technician who has access to slide copying equipment or by putting the work out to a commercial firm.

Storing tape-slide programmes

One problem that has to be overcome by all users of tape-slide programmes is that of storing the programme materials – especially the slides. If the programme is a short one, it is possible simply to store the slides in a small box (e.g. an empty slide binder box) and to load them into the viewing or projection equipment one by one at the time of use. With longer programmes, however, this becomes very time-consuming, and it is much better to store the complete slide sequence in such a way that it is immediately ready for use. If the equipment that is to be used to show or view the programme employs a carousel-type magazine, the slides can either be stored in an actual magazine or else in a slide transfer storage box – a

circular box that enables an entire programme to be transferred to or from the projector magazine simply by placing one on top of the other and then upending the system.

Tape-photograph programmes

A *tape-photograph programme* is simply a linked sequence of photographic prints with an accompanying audiotape. Such programmes can be used to do virtually anything that a conventional tape-slide programme can do, and have two advantages over the latter. First, they require no projection or viewing equipment, since photographic prints, unlike slides, are completely 'free-standing'. Second, they are in some ways much more flexible and versatile than tape-slide programmes from an instructional point of view. It is, for example, very much easier to incorporate textual materials into a tape-photograph programme, and also to build in enactive components such as exercises or worksheets. Indeed, one very effective way of presenting the photographic component of tape-photograph programmes is to incorporate them into a re-usable workbook.

The principles that underlie the design of tape-photograph programmes are basically the same as those just described for tape-slide programmes, the main difference being in the structuring of the audiotape narrative. Indeed, the design of the latter is in many ways more like that of the audiotape component of a tape-text system (especially if the programme incorporates textual materials or enactive exercises), incorporating audible cues and instructions rather than the inaudible cues that characterise the tapes used in most tape-slide programmes. The production of the materials for tape-photograph programmes is again similar to the process just described for tape-slide programmes, albeit somewhat simpler.

Other systems that link tape and still visual materials

Although the systems described above are by far the best known of the instructional systems that link audiotapes with still visual materials, they are certainly not the only ones. It is, for example, possible to design a wide range of extremely useful self-instructional systems that make use of audiotapes in conjunction with tools, pieces of equipment, models, microscope slides, items of realia, and so on. Furthermore, such systems often incorporate a high enactive component that makes them much more effective than more passive systems such as tape-slide programmes in achieving certain types of objectives. Some examples of such systems are described below.

Tape-model

This makes use of an audiotape in conjunction with three-dimensional models of one form or another or kits from which such models can be constructed. The tape generally plays much the same role as in an audio-tutorial or audio-workbook system, presenting the learner with information and guiding him through an appropriate sequence of activities that involve handling and studying the models, and, in the case of systems that use construction kits, actually making up models. Such systems have a wide range of applications, obvious examples being in the teaching of chemistry (work with models of electronic orbital systems, molecules, complexes, crystal structures, and so on), biology (work with models of parts of animals and plants, physiological systems, and so on), physics (work with models of physical systems of various sorts) and engineering (work with models of machines, systems, plant and so on). Figure 5 shows a typical tape-model system in use (a student of chemistry using a 'ball and spring' kit to construct and study models of different organic molecules -- isomers of simple alkanes, in this case).

Figure 5: a student of chemistry studying the isomers of the simple alkanes using a tape-model system

Tape-microscope

When using a microscope, it is obviously difficult to read textual material (instructions, explanatory notes, etc) at the same time. Thus, there is obvious scope for the use of audiotapes to supply such information, since this enables the learner to work at the same time as he is receiving the information. Subjects that lend themselves to the use of this technique include all the various branches of biology and medicine, geology and metallurgy. The basic petrology revision unit described in the next section is a good example of the use of the tape-microscope technique.

Tape-realia

Audiotapes can also be used to provide instructions and information to learners who are studying *realia* of various forms – e.g. geological or biological specimens. As in the case of tape-microscope, use of an audiotape to provide such information can allow complicated enactive processes to be carried out without the distraction of having to refer to textual instructions or notes – obviously a great advantage in an individualised learning situation.

No doubt readers can think of many other instructional situations in which audiotapes could usefully be linked with still visual materials of various types.

Designing the courseware for such systems

The design of the courseware for a system that links an audiotape with the use of materials such as models or realia is basically the same as for an audio-tutorial system (see booklet on "How to produce audio materials"), except that no textual materials are generally involved. A typical example of the script for such a system is given in figure 6. This is for a self-instructional revision system in basic petrology (the branch of geology that involves the study of rocks), being designed to help students prepare for a practical examination that involves identifying hand specimens of different rocks and describing their composition as revealed by microscopic study of thin sections cut from them. As can be seen, it is in effect a combined 'tape-realia' and 'tape-microscope' programme.

Figure 6: start of the script of a typical instructional system that uses an audiotape in conjunction with enactive activities (study of geological specimens)

Basic Petrology – Revision Unit: Igneous Rocks	
Contents of audiotape	*Associated activities*
"This Unit is designed to help you to recognise hand specimens of the main types of igneous rocks, and to describe their mineralogical compositions as revealed by the study of thin sections of the rocks using a geological microscope. If you require any help with the use of the latter, study the accompanying instruction sheet. We will begin by studying the main types of acid plutonic rocks, i.e the *granites*. Please pick up and examine Specimen 1 in the tray of hand specimens when you hear the signal, stopping the tape when you do so. Make a note of what you think are the main characteristics of this specimen, restarting the tape once you have finished." *(Bleep, followed by 5 second pause).*	Instruction sheet on geological microscope available if required.
	Study of Specimen 1 (Normal Granite) and noting down of observed characteristics.
"This is a specimen of Normal Granite from the Rubislaw Quarry in Aberdeen, its main constituents being *quartz* (the clear, colourless mineral), *feldspar* (the gray material) and *mica* (the black and clear platy materials). Note the relatively coarse texture (indicating the plutonic origins of the rock) and uniform grain size."	

"Now let us take a look at a section of this rock using the geological microscope. Select Slide 1 from the box of slides provided and carry out a thorough examination of it, making a note of all the minerals that you identify in order of relative abundance. Stop the tape when you hear the signal, and re-start it once you have finished the work". *(Bleep, followed by 5 second pause)*	
	Study of Slide 1 using geological microscope.
"As you should have seen, the predominant mineral in this particular type of granite is *quartz*. This is colourless, free from alteration, shows fluid inclusion, has a low refractive index (close to that of Canada Balsam) and shows low double refraction. Stop the tape until you are satisfied that you can recognise all these features." *(Bleep, followed by 5 second pause)*	
	Re-examination of slide in order to identify the various features of quartz.
"Next in relative abundance are various forms of *feldspar*. Of these, the most important is *orthoclase*, recognisable by its alteration, low refractive index, and low double refraction; some crystals also show Carlsbad twinning. Stop the tape until you are satisfied ....."	Re-examination of slide as commentary proceeds.
and so on	

Producing the courseware

This should be done in the same way as for tape-text materials.

Further Reading

1. *The Audio-Tutorial Approach to Learning*, by S N Postlethwaite, J Novak and H Murray; Burgess, Minneapolis; 1972. (A standard text that anyone using audiotape for managing individualised learning should find extremely useful.)
2. The Audio Workbook, By D G Langdon; in Volume 3 of *The Instructional Design Library;* Educational Technology Press, Englewood Cliffs, NJ; 1978. (An extremely helpful guide to the production and use of tape-text materials of the audio workbook type.)
3. *Slide-Tape and Dual Projection*, by R Beaumont - Craggs; Focal Press, London; 1975. (One of the most useful standard texts on producing tape-slide programmes.)
4. *Tape-model: the lecture complement*, by A H Johnstone, K M Letton and F Percival; *Chemistry in Britain*, volume 13, no 11, pp 423-425. (The definitive paper on the subject.)