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ABSTRACT

A limited overview of some media related factors, this document should be helpful to the learning center manager who lacks extensive experience with media. It discusses important theoretical factors associated with media selection and summarizes research concerning the use of color and of motion in learning. Descriptive information concerning media often associated with a learning center program is provided. An appendix describes requirements and costs for acoustical control in learning center flooring materials. (DAG)

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OVERVIEW OF MEDIATED COURSEWARE IN LEARNING CENTERS

By

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June 1976
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MARTY R. ROCKWAY, Technical Director
Technical Training Division

Approved for publication.

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This report provides a companion document to AFHRL-TR-75-69 and includes supplemental information on media related factors, as suggested by field review of the original handbook. An overview of media related factors is provided for the learning center manager who does not have extensive experience with media and desires to explore this aspect of a learning center program more deeply. Discussion includes factors related to mediated courseware selection (such as motion or color requirements in training) and basic information concerning media commonly associated with learning center programs.

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SUMMARY

Problem

Determination and documentation of the current state-of-the-art in the establishment and operation of learning centers for use by Air Force personnel was reported in AFHRL-TR-75-69. Field evaluation and the resultant feedback showed a requirement for additional media-related information by some learning center managers. Mediated courseware selection (and design) and descriptive information relating to media were needed. The problem was to provide an overview of media related factors for the learning center manager who does not have extensive experience with media, supplementing the information contained in AFHRL-TR-75-69.

Approach

AFHRL-TR-75-69 was sent to selected personnel involved with Air Force learning centers in each of the major commands for evaluation and comment. Comments indicated the requirement for information including the actual operation of a learning center operation, guidance in selecting equipment, better guidelines on essential factors for selection or development of mediated courseware (such as research on color or motion requirements in training), and descriptions of media.

Results

A companion document to AFHRL-TR-75-69 was prepared. This report discusses important theoretical factors associated with media selection and summarizes research concerning the use of color and of motion in learning. Descriptive information concerning media often associated with a learning center program is provided. An appendix, describing requirements and costs for acoustical control in learning center flooring materials, is also included.

Conclusions

Media constitute an important and critical resource in a learning center program. The manager of a learning center may make a number of decisions involving media. A useful information base is provided by the present document. Fundamental information concerning media commonly associated with a learning center is discussed along with complex aspects associated with the selection of method/media. Personnel associated with learning center programs indicated the need for this companion volume to AFHRL-TR-75-69.

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OVERVIEW OF MEDIATED COURSEWARE IN LEARNING CENTERS

I. INTRODUCTION

A learning center is designed to encourage the best use of resources which enable efficient student learning. Media constitute an important and critical resource in the learning center. Managers are thus required to make key decisions involving media, which can seriously impact upon the efficiency of learning in the learning center program. The present document is intended to provide a limited overview of some media related factors which may be helpful to the learning center manager who does not have extensive experience with media. It deals primarily with those factors suggested for more detailed treatment by persons in the field who reviewed a companion document (AFHRL-TR-75-69) by Ronald Spangenberg and Edgar Smith. Specifically, additional assistance in media selection and principles related to mediated courseware selection is provided. In addition, research concerning the use of color and of motion in learning is summarized..Fundamental information is presented concerning media often associated with a learning center program.

A student learns by seeing, hearing, feeling, tasting, or smelling sensory inputs. What the student experiences through the senses is a basis for learning. Instructional media refers to the means of providing those selected sensory experiences which will enable the student to learn. Examples found in learning center programs would range from a programmed text, through a cockpit procedures trainer, television, a prenarrated slide presentation, to a computer terminal. No student can learn from a closed book or an unplugged television set. Instructional media refer to the *means* used to present sensory experiences to the student. The term courseware refers to instructional materials. Examples of courseware would be a filmstrip, an audio cassette, or a video tape. Thus, appropriately selected (or developed) courseware, when mediated, will supply the student with the information with which he interacts in order to learn.

A learning objective is achieved by applying a specific procedure or strategy. This strategy is usually composed of three elements combined in varying ways. These elements are (a) the presentation of information (for example, showing how to do a task or telling why doing it), (b) application or practice, and (c) evaluation providing an appropriate feedback to the student. Courseware in a learning center program should implement the selected strategy. Thus, the characteristics associated with the display of courseware must be evaluated as to whether they will implement the fine detail of the strategy intended to enable the student to achieve the learning objective.

In order for the student to perform as desired he must receive appropriate information. Presentation and feedback information are at the heart of learning. Principles and research results related to the student receiving information are grouped into three sets of factors which determine the nature of courseware requirements. These three sets of factors are: the type of information, information exposure and courseware design. Five groupings of instructional media (as discussed in AFM 50-2) are treated as representative of the large number of potentially available media. These five groups from AFM 50-2 are (a) Instructor/Single mode media, (b) Multi-modal media, (c) Print, (d) Peer, and (e) Simulation. However, only single mode media (still pictures, audio) multi-modal media (prenarrated projected still visuals, sound motion pictures, and television) and print (microform) will be discussed in this document which is oriented to the learning center manager. Portions of the material in the Courseware and Media section are taken from or based on Sullivan and Smith (1974). The present document cites manufacturers by name for clarity and illustration of specific points. This practice does not constitute an endorsement of any product by the author or the United States Air Force.

II. INFORMATION TYPE

This section considers the relationship between human sensory channels and the types of information to be presented to the student. Decisions (typically intuitive by most practitioners) are discussed concerning the necessary type of information which underlies courseware and media selection. The capability of various media to provide the required type of information is presented. Principles related to selecting the type of information best suited to particular cases are summarized.

The two basic types of information are symbols and signs. Symbols are arbitrary, separate and distinct from the referrent, and bear no resemblance to that which they represent. Words and numbers are prime examples of symbols. Signs are not unrelated to the referrent as they resemble in certain ways that which they represent. The picture is the most common example of a sign. The type of information and the sensory channel are important factors in instructional media selection, since it is difficult to play a lecture on a slide projector or to show a picture on a tape recorder. Words (written and spoken) and pictures probably account for over 90% of the information given to the student, and thus must receive the most attention.

Symbols and signs, typified by words and pictures, can be subdivided on the basis of the sense to which they appeal. The most commonly used sensory channels are seeing, hearing, and feeling. Table 1 shows the major subdivisions of these two major information types, symbols and signs. (Smelling and tasting are not considered in this discussion.)

Subdivisions of symbols (arbitrary, discrete information which carries no resemblance to that which it represents) are: written symbols, color symbols, gestural symbols, heard symbols and felt symbols. Words and numbers may be written or spoken depending upon the sensory channel selected. Written symbols and heard symbols are most used in this subdivision.

Subdivisions of signs (information resembling that which it represents) are: pictured signs, dynamic pictured signs, color signs, gestural signs, heard signs, and felt signs. Pictures signs are most important.

Nine general principles, or statements, related to the selection of the appropriate type of information follow:

1. The perceptual conditions for learning through one sensory channel (such as seeing) differ from those for another sensory channel (such as hearing) and the conditions for using one type of information differ from those that use another. For example, an air hammer operating outside a classroom may not affect learning from a picture, but will disrupt a lecture, while a darkened room will not permit reading a book.

2. Verbal or numerical information can be received through eyes or ears or both. Pictured information is received through the eye. The relative usability (by the student) of each type of information is determined partially by (a) the time span of perceptual availability, and (b) the student's effective performance capability. Words and numbers have advantages relating to student performances since not everyone is an adequate artist. Written words and numbers and pictorial presentations have an advantage based upon perceptual availability since they are available to the senses longer than spoken or recorded words which are heard once and then rapidly fade from the student's sensory perception.

3. A valuable aspect of pictures is that they can be, and usually are, converted by the student into words and in that form are readily reproduced. The recoding of pictures into words is so important that it should be encouraged. Long-term recall of pictures and objects is aided when the verbal label is repeated by the student. By providing names or descriptions of pictures and objects the probability is increased that the student sees and correctly interprets the desired information. Spoken words direct attention to pictures and objects and are a help in categorizing them. Combinations of spoken words and pictures may be extremely useful.

4. Where it is desirable to substitute a photograph or drawing for an actual object it is important to know how to provide adequate representation.

5. The basic decision of whether to use a word or picture is often based upon the degree of abstraction or concreteness of the information being represented. (The abstract/concrete dimension denoted by this decision rule is related to the degree of subordination/superordination of the referent category and not to the level of resemblance of the symbol/sign to the referent.) This distinction is useful and is easily and reliably made by most instructors. Similarly, pictures provide fewer referents than do words. A picture (to the student) will not represent exactly the same concept as a word.

6. Symbols and signs have significant similarities and differences. Ruesch (1966) suggests many similarities and differences between verbal and perceptual codification. Those distinctions of possible interest in selecting between symbols or signs are modified and summarized in Table 2.

7. In general, the sensory channel used in the final testing or application situation should be employed during instruction and practice.

8. In comparisons of identical words in reading or hearing during learning, the written message appears to convey more information than the spoken message. The more difficult or complex the level of

Table 1. Types of Information and Sensory Channel

Information Type	Sensory Channel				
	Observing				Hearing
	Graphic	Motion	Color	Gesture	Aural
Symbols (discrete, no resemblance to referent)	Written symbols (words, numbers)	Not applicable	Color symbols (color coded wire, signal flag)	Gestural symbols (finger spelling of deaf)	Heard symbols (words, numbers, telegraph messages)
Signs (resembles referent in non-discrete manner)	Pictured signs (pictures, schematics, diagrams, road maps)	Dynamic pictured signs (animated cartoon of 4-stroke cycle engine, time lapse of plant growth)	Color signs (paint chart, color key)	Gestural signs (hand signals)	Heard signs (recorded music, auditory pattern of ground surveillance radar)

Table 1. Types of Information and Sensory Channel

Sensory Channel					
Observing				Hearing	Feeling
Graphic	Motion	Color	Gesture	Aural	Tactual (Kinesthetic)
Written symbols (words, numbers)	Not applicable	Color symbols (color coded wire, signal flag)	Gestural symbols (finger spelling of deaf)	Heard symbols (words, numbers, telegraph messages)	Felt symbols (Braille)
Pictured signs (pictures, schematics, diagrams, road maps)	Dynamic pictured signs (animated cartoon of 4-stroke cycle engine, time lapse of plant growth)	Color signs (paint chart, color key)	Gestural signs (hand signals)	Heard signs (recorded music, auditory pattern of ground surveillence radar)	Felt signs (control of model airplane, control "feel" in simulation)

Table 2. **Contrasting Comparisons Between Symbols and Signs**

Symbols	Signs
(Separate and distinct from referent, arbitrary, no resemblance to referrent)	(Related to referrent, resemble referrent)
Influence thinking and may lead to acquisition of information.	Influence coordination and integration and may lead to acquisition of skills.
Evaluation is governed by rules of logic.	Evaluation is tied to appreciation of similarities and differences.
Cannot indicate space, save for a description of boundaries.	Some methods of denotation can represent space superbly.
Good for indicating elapsed time but poor for indicating time and coordination	Poor for indicating elapsed time but good for indicating timing and coordination.
Denotation unit (written or spoken) cannot be broken down. For example, there does not exist a meaningful fraction of the letter, word, or sound denoted by A.	Denotation unit can be broken down. For example, parts of a photograph can be cut out and the details are meaningful.
Must indicate simultaneous events successively (a written or spoken report consists of a serial alignment of words).	Can indicate successive events simultaneously (come and go signs can be given at the same time).
Temporally rather inflexible (words spoken too slowly or too quickly become unintelligible).	Temporally flexible (a movement can be carried out slowly or quickly).
Do not exist in own right (represent abstractions of aspects of events, the accuracy being a function of the human observer).	Actions and object exist in own right and usually can fulfill practical functions.
Produces fatigue when redundant.	Permits redundancies.
Necessitates somewhat long winded statements	Permit brief and succint statements.
Are predicate-oriented.	Are subject-oriented.
Have intellectual appeal.	Have emotional appeal.
Suitable for reaching agreements.	Suitable for understanding.
Understanding and denotion based upon prior verbal agreement (the word "pain" differs from the German word *Schmerz* or the French word *douleur* and the understanding of the significance of these words is bound to previous arrangements).	Understanding of denotation based upon empathic assessment of similarity (no explanation required for understanding what pain is).

the message, the greater the advantage of the written message over the spoken messages. (This statement assumes reading competence of the student.) Summaries related to these statements are contained in Hartman (1961), Hsia (1968), and Severin (1967a, 1967b).

9. Objects and pictures of objects are better remembered and recognized than names of objects. This has been found in a wide variety of learning conditions. One summary of the research as related to this principle is found in Gagne and Rohwer (1969).

Before selecting the instructional medium, the type of information required by the students must be clearly specified. No media device can insure learning or the mastering of a performance (although use of appropriate media courseware is assumed necessary in leading to improved performance). Instructional media devices can only deliver preselected information types to the selected sensory channel.

Table 3 represents the results of examining the characteristics of the instructional media currently discussed and charts their capability to present a specific type of information through a given sensory channel.

Table 3. **Information Presentation Capability of Selected Instructional Media**

Instructional Media	Written Symbols	Heard Symbols	Color Symbols	Felt Symbols	Pictured Signs	Dynamic Pictured Signs	Color Signs	Heard Signs	Felt Signs
Single Mode Media									
Photo print (B&W)	yes	no	no	no	yes	no	no	no	no
Photo print (color)	yes	no	yes	no	yes	no	yes	no	no
Slide (color)	yes	no	yes	no	yes	no	yes	no	no
Filmstrip (color)	yes	no	yes	no	yes	lim	yes	no	no
Audio cassette	no	yes	no	no	no	no	no	yes	no
Multi-Modal Media									
Film (16mm or Super 8mm)	yes	yes	yes	no	yes	yes	yes	yes	no
TV (color)	yes	yes	yes	no	yes	yes	yes	yes	no
Prenarrated slides or filmstrips (color)	yes	yes	yes	no	yes	no	yes	yes	no
Print									
Microfilm (B&W)	yes	no	no	no	yes	no	no	no	no
Microfilm (color)	yes	no	yes	no	yes	no	yes	no	no

III. MEDIA EXPOSURE

At the most fundamental level, simple physical exposure to the required information is necessary to achieve adequate training performance. Three media characteristics deal with providing an adequate level of exposure to information. These characteristics are called referability, ease of repetition and ease of operation. They are related to selected instructional media in Table 4.

Referability is defined as how long and how often can a student refer to a given bit of information. For example, once a word is spoken it can be retained in memory and it can be repeated. A spoken word cannot, however, provide the student a long exposure time since a characteristic of spoken language is its rapid fading. A book provides a high level of referability because a given word or message can be scanned any length of time or number of times. Thus, as previously stated, the written message is superior when more complex information is being learned.

Closely related to referability is *ease of repetition.* A lecturer may repeat a statement, but would be unlikely to repeat an entire lecture for the benefit of a single absentee. However, if recorded on audio tape

Table 4. **Information Exposure and Instructional Media Capability**

Instructional Media	Media Capability: Media permits Referability by Student	Ease of Repetition of Courseware for Student's Benefit	Ease of Student Operation of Media
Single Mode Media			
Photo print (B&W)	high	high	high
Photo print (color)	high	high	high
Slide (color)	medium	medium	high
Filmstrip (color)	medium	medium	high
Audio cassette	low	medium-w/review high	high
Multi-Modal Media			
Film (16mm or Super 8mm, (color)	low-w/stop-medium	medium	medium
TV (color cassette)	low-w/stop-medium	medium	high
Prenarrated slides or filmstrip (color)	low	medium-w/review high	high
Print			
Microfilm (B&W)	high	high	high
Microfilm (color)	high	high	high
Book	high	high	high

the lecture could be repeated for a student as needed. Media selected for use in a learning center should exhibit a high level of ease of repetition. A review feature is frequently desirable in the selection of a specific item of media equipment.

Ease of operation refers to the simplicity of using media devices by students. Individualized instruction usually will require student operation of media devices. Such approaches as the single topic film loop (now mostly on Super 8mm) are particularly suited to individualized learning and should receive emphasis. In a learning center program ease of student operation would normally be required.

IV. COURSEWARE DESIGN

This section will discuss and relate media equipment capability and courseware requirements. Certain courseware characteristic and media production variables provide one basis for media selection. The first criterion in selection is the capability of presenting the desired information type. If the desired information type is a dynamic picture sign, motion is usually mandatory. If the desired information type is a color symbol, then color is usually mandatory. Thus, any specific instructional medium would be eliminated from consideration if it cannot present the necessary information type. Some factors related to courseware design possibly influencing the selection of a medium are discussed in the following paragraphs. Selected research citations are provided so that primary documentation can be evaluated by the reader. The discussion concerning both color and motion generally do not deal extensively with that segment of courseware in which color or motion is an integral part of the information type selected (color symbols, color signs, dynamic pictured sign), since the selection of these information types could make the use of color or motion mandatory.

Color, Realistic

In general, there is no reliable difference in student performance when learning from color or from black and white (monochrome) materials. Documentation of this generalization is available from a variety of sources. Most recently, Bond (1974) compared post-test scores from 300 educable mentally handicapped children following exposure to 30 color or 30 monochrome films (chosen at random). The resulting analysis showed no significant differences attributable to the film characteristic (color/monochrome). However, observations of the attentiveness of the children suggested they were more attentive to color presentations as a slightly higher (but not significantly) percentage of the audience was observed to be watching. Differences would more likely appear in an abnormal population, so it should be assumed that no differences in learning would appear in a normal population.

The review of color versus monochrome in instructional television by Bretz (1970) concludes that for television instruction, monochrome will be fully sufficient for present instructional purposes (and compared with the level of color quality presently available for TV, definitely superior). Using television (and a military population), Rosenstein and Kanner (1961) and Kanner and Rosenstein (1960) found no consistent reliable differences attributable to color or monochrome presentations. Similar comparisons in film indicate nearly the same results. Vandermeer (1954) in an extensive comparison of monochrome versus color films found a preference for color films but no reliable learning differences. In film comparisons of learning performances based either on monochrome or color films, results such as May and Lumsdaine (1958), who found no reliable differences, are typical.

Scanlon (1970) compared reports of groups watching events (a national funeral and a sporting event) either on color or monochrome television. The author found that the group viewing color was more aware of color. He further found the group viewing monochrome television wrote longer and more detailed reports. Even when instructed to note only five highlights, the monochrome viewing group used 70% more words than the color group. It was strongly suggested that the monochrome viewing group was attending to the words of the announcer more than the color viewing group. Scanlon observed that the ability of color to create an awareness of depth and contrast resulted in different highlights between the two groups. Color TV leaves different impressions than monochrome TV. However, an earlier finding that color was more emotional (as indicated in viewing the funeral) was not indicated in the replication (when viewing the sporting event).

A different research approach used by Katzman and Nyenhuis (1972) clarified some problems in the color versus monochrome comparisons. These authors distinguished between central material (content relevant to basic information, message, plot, or theme) and peripheral material (material which is nc central). They found that while color does not improve learning of central material, color does improve learning of peripheral pictorial material. Studies of the use of color in advertising which show color displays superior to monochrome displays can now be interpreted, since a memory for all the details of the display is usually part of the experimental design. For example, Brandt (1925) concluded that recall of ads was helped by color; and further cited that adding color to one part of the display emphasized that portion of the display at the expense of the other portions. Similar results indicating superior recall of peripheral material in ads due to color have been reported by Kumata (1960) and Schaps and Guest (1968).

Color, Non-Realistic

Color can be used to provide cues which differentiate items and potentially aid learning. For example, facilitation of learning words and anagrams by the addition of background color cues has been reported by Peterson and Peterson (1957) Saltz (1963) and Weiss and Margolius (1954). However, when color cues are used only during initial learning and not on the retention test, interference has occurred. The interference effect has been reported by Underwood (1963) Mechanic (1962) and Bahrick (1954). The indiscriminate use of color without consideration of the conditions of instruction, practice and transfer can have negative learning effects while careful consideration of these conditions may result in substantially improved performance (Black, 1967).

According to Exton (1947) color is best used to distinguish or identify elements in graphic displays, to highlight significant features, to serve as a basis for codes and to clarify the display by providing increased visual contrast. The effectiveness of color coding in reducing search time in locating information on a display has been documented by many researchers, recently by Schontz, Trumm, & Williams (1971). They also found that color coding is most effective when (a) many categories of information are coded, (b) highly discriminable colors are used, and (c) the number of items per category is reasonably small.

Color backgrounds for projected black print material were studied by Snowberg (1973). For black print, he found maximum acuity for a white background, and reduced acuity for a blue background.

Preferences for colors were also noted. Wright and Gardner (1960) examined the effects of varying color backgrounds on monochrome pictures. They found clearcut indications of affective differences which could be attributed to color. More recently, Dwyer (1971) has reported the use of background color as helping improve student achievement in certain types of visuals. Berry (1975) using materials based on Dwyer's materials, has suggested that realistic color is more effective than non-realistic colors and that the concept of realism (to a limited degree) is a factor for consideration in designing visual material.

An extremely interesting study was performed by Chan, Travers, & Van Mondfrans (1965). They found that the addition of color to an embellished display increased visual learning; however, this increase was apparently at the expense of the audio channel. The results suggest that the use of color increases the sensory dominance of the visual channel.

It appears that the use of color evokes an increase in visual attention. While attention is important for learning, color does not insure adequate learning. No educational benefit is ensured by using realistic color. When designing instruction, color in visual displays can effectively be used to distinguish or identify key elements, highlight significant features and provide increased visual contrast. When the instructional sequence is overloaded with information (as is typical in many instructional films) increasing attention to trivial visual aspects by using colors may supplant critical oral information. Finally, displays using color will be perceived differently than similar monochrome displays.

Motion

True motion is provided in some simulations. However, the illusion of motion (in film and TV) is achieved through a succession of static frames or views of objects in different spatial positions normally presented at 18, 24 or 30 frames per second, a rate so rapid that the individual frames are not separately distinguished. For designing instructional materials, film and TV can be assumed as providing motion.

An excellent pilot study of the relation of motion to learning was performed by Allen and Weintraub (1968). They examined the learning of facts, sequences, and concepts and found that serial ordering was most influenced by the use of motion. Further they found that only when dynamic pictured signs are being learned does the portrayal of motion help learning. They recommended the use of motion for learning dynamic pictured signs and when the characteristics or content of learning is enhanced and differentiated by the cues provided in the action of the movement.

Previous studies relating to the use of motion in procedure learning were divided as to the possible benefit of motion. Roshal (1949) and Silverman (1958) had shown motion as assisting the learning of procedural tasks while Laner (1954, 1955) (see also Fortune, Petry, & Harding, 1970) was able to conclude from his pilot studies that motion helps those aspects of procedural learning requiring dynamic pictured signs—that is, cues or models for learning a novel response activity. Spangenberg (1973) examined the effect of motion on procedure learning using a weapon disassembly task. He reported three features associated with a potential benefit from motion displays as (a) the activity to be learned requires simultaneous motion in different directions, (b) the activity is unfamiliar to the student, and/or (c) the activity is not readily accurately described with words.

In concept identification problems conducted in the laboratory, Houser, Houser, & Van Mondfrans (1970) showed that when the concept was a dynamic pictured sign the use of motion aided identification. Troth (1972) showed motion representation of isolated action concepts superior to a single still picture mode of representation.

Wells, Van Mondfrans, Postlewait, & Butler (1973) presented materials (which were assumed to be based upon attributes of time, space, and motion) intended to teach biological concepts in formats comparing motion pictures, sequential slides, and sequential still pictures. Verbal objective questions were used to evaluate learning. Results indicated motion aided in time based concepts (using time lapse, slow motion, and unequal time periods). Significant results were not provided by the other attributes. Motion film can be effective for speeding up (time lapse) and slowing down (slow motion) the rate of movement of various phenomena. Altering normal time-place relationships can help indicate useful relations of objects and events in time; or clearly show the correlation of action effects.

Motion attracts attention and directs attention (Fleming, 1970). Hovland, Lumsdaine, & Sheffield (1949) found motion superior to filmstrip in teaching the measurement of contour intervals, while filmstrips were superior in other aspects. Dwyer (1969) has reported the use of motion (pointing out on a static display the critical elements of the information being presented) focusing the students attention on the important aspects of the instruction enhanced certain aspects of factual and conceptual learning. The advantage Dwyer found was only true for line drawings. His work suggests that the use of motion is not an effective instructional technique when the presentation uses realistic (full tone) visuals for predetermined limited amounts of time (as in a video presentation). However, Lumsdaine, Sulzer, & Kopstein (1961) found moving arrows and pop-on labels helped learning of micrometer reading skills (using realistic visuals).

The perceived meaning of visual displays which apparently move and those which do not is different. Studies in the affective importance of motion have been reported by Penn (1971) and Miller (1969). Fleming (1970) suggests that such affective effects (in addition to the dynamic pictured signs associated with human interaction) may justify the inclusion of motion even when no differences are shown of achievement tests.

In general, it can be assumed that motion requirements in training will not exceed 5% of the training materials. The actual requirements may be much less. Spangenberg (1973) suggested that even with motion requirements only a small percentage of students would be affected. Their needs could be met by using either buddy or instructor tutoring in conjunction with still visual materials and/or training equipment. It is estimated that only 10–25% of students would require tutoring assistance.

Other Courseware Design Factors

Courseware design factors discussed in the following section are related to selected instructional media in Table 5.

Many film formats provide effective *magnification* and *reduction*. The need for magnification and reduction lies in emphasizing critical cues, and providing appropriate visibility.

Either a fixed or a variable sequence for the presentation of material to the learner is determined by the media courseware used. A lecturer is able to vary his sequence, but television and many film devices (except for separate slides) do not provide this flexibility. Simulators and computers can be designed for use with either a fixed or a variable sequence. Emphasis can be shifted by changing a sequence.

Most film formats make it possible to *manipulate illustrations*. Normally, overlays and disclosures are suited for an overhead projector. Motion films are particularly suited for pop-ons, superimposures, animation, zoom, and camera angle effects. These techniques have all been shown to improve some learner performances under certain conditions. (See Davis, 1965; Lumsdaine, Sulzer, & Kopstein, 1961; Penn, 1971; Roshal, 1949; Rosonke, 1975; Sheffield, 1957; Sheffield & Maccoby, 1961; Sheffield, Margolius, & Hoehn, 1961; Silverman, 1958; Wulff & Kraeling, 1961).

Fidelity of sight or sound indicates the faithfulness of a reproduction to the original. Film reproduction is superior to the electronic reproduction currently available. However, when a crude pencil sketch story board of a film was compared with a finished color version, no reliable difference in performance resulted. (May & Lumsdaine, 1958; Zuckerman, 1954). Fidelity may not be a critical factor, although it has been studied extensively in connection with simulators. As long as the essential information or cue is presented, adequate performance (and transfer) is generally possible. Simple physical realism appears to have no inherent superiority in providing adequate transfer to job performance. However, testing is usually necessary to determine whether the training is transferred to job performance.

Cue summation, (simultaneously providing two or more channels of information) appears to be a powerful and efficient way to present information. While complete duplication of information through two channels, such as simultaneously presenting written and spoken words, has not been shown to be effective (for good readers), other information types may be combined to improve learning. In general, it is efficient to combine pictures with spoken words that emphasize, point out, interpret, or label significant information. Instructional media that simultaneously give information through two channels at once provide opportunities for cue summation. Television and the sound motion picture are two popular instructional media providing cue summation. However, many other combinations are possible, such as the filmstrip with a tape recorder.

Table 5. Courseware Display Factors and Instructional Media Capability

Instructional Media	Color	Motion	Slows Down Speeds Up	Magnifies Reduces	Manipulate Illustration	Fixed or Variable Sequence	Level of Fidelity
Single Mode Media							
Photo print (B&W)	no	no	--	yes	yes	fix/var	high
Photo print (color)	yes	no	--	yes	yes	fix/var	high
Slide (color)	yes	no	--	yes	yes	variable	high
Filmstrip (color)	yes	lim	lim	yes	yes	fixed	high
Audio cassette	no	no	lim	no	N/A	fixed	varies
Multi-Modal Media							
Film (16mm or Super 8mm, color)	yes	yes	yes	yes	yes	fixed	high
TV (color, cassette)	yes	yes	yes	yes	yes	fixed	med
Prenarrated slides and filmstrip (color)	yes	no	lim	yes	yes	fixed	high
Print							
Microfiche (B&W)	no	no	--	yes	yes	fixed	varies
Microfiche (color)	yes	no	--	yes	yes	fixed	high

Table 5. Courseware Display Factors and Instructional Media Capability

ıctional Media	Color	Motion	Slows Down Speeds Up	Magnifies Reduces	Manipulate Illustration	Fixed or Variable Sequence	Level of Fidelity	Cue Summation
lode Media								
print (B&W)	no	no	--	yes	yes	fix/var	high	no
print (color)	yes	no	--	yes	yes	fix/var	high	no
color)	yes	no	--	yes	yes	variable	high	no
trip (color)	yes	lim	lim	yes	yes	fixed	high	no
cassette	no	no	lim	no	N/A	fixed	varies	no
lodal Media								
(16mm or Super , color)	yes	yes	yes	yes	yes	fixed	high	yes
olor, cassette)	yes	yes	yes	yes	yes	fixed	med	yes
rrated slides ilmstrip (color)	yes	no	lim	yes	yes	fixed	high	yes
ofiche (B&W)	no	no	--	yes	yes	fixed	varies	no
ofiche (color)	yes	no	--	yes	yes	fixed	high	no

V. COURSEWARE AND MEDIA

Single Mode Media

Still Pictures

Learning by observing is important to a learning center program. According to MacDonald (1973), a person can visually observe ten times more information than he can hear. Observing is selected when the learning requirement involves: associating visual stimuli (symbols or signs), discriminating between visual stimuli, generalizing among visual stimuli, when using visual stimuli for a model or when visual stimuli provide appropriate feedback. Still pictures are the visual representation of an object or event produced by photographic means. These may be photographic prints or photographic transparencies locally produced. Acceptable instructional materials can easily be generated for a reasonably low cost. Still pictures will normally be associated with a learning center program.

Prints

Monochromatic photographic materials can easily be associated with textural materials and printed. No presentation device is required and the printed page provides a high level of portability. The page is easily reviewed. Current photographic technology permits a nonprofessional photographer to provide satisfactory images.

When special requirements dictate the use of color or an exceedingly fine level of detail, photographic prints can provide an economically satisfactory selection. However, the high per item cost when these prints are mounted for learning, may preclude their use for large numbers. Photographic prints also enjoy the advantages of print material. Recently good quality non-photographic full tone and color duplication capabilities have become available at a reasonably low cost and may require consideration.

When the captioned photo card art approach is utilized, photographic prints become a major and critical item. In addition to images from the field, photographic reduction will be used to standardize the size of all graphics. Acquisition of photographic prints can be performed locally with minimal training requirements.

Slides and Filmstrips

A set of slides and a filmstrip are identical in their information transmission characteristics. However, there are three factors which differentiate them.

1. The production of slide sets and filmstrips differ in the image formats and in the finishing procedures employed. The procedures for production and processing are almost identical.

2. The number of copies required of a given instructional presentation is a factor as to whether one adopts slides or filmstrips as the presentation media. If only a single copy is required, then slides may offer advantages in terms of cost, availability, and ease of acquisition. For copies of presentations which exceed six in number, the cost advantage of filmstrips in multiple copies plus their lower storage and distribution costs merit consideration (Trow & Smith, 1965). Once the required number of copies exceeds 10, filmstrips represent an efficient and cost-effective means of presentation.

3. The production of slides is a relatively simple procedure--it requires only relatively inexpensive and readily obtainable photo equipment and the services of any competent processing laboratory. Filmstrip production requires the use of special equipment. Thus, only with a serious long range commitment to filmstrip production is it efficient to consider locally producing them. Filmstrips can, however, be obtained by providing all required materials (flatwork or transparencies) to a commercial filmstrip producer.

Slides

Format. The most common transparency format used for instructional applications today is the 2 inch by 2 inch or as it is commonly called, the 35mm slide. The most common format for 2- by 2-inch slides contains a 35mm double frame (23 by 34mm) image. Figure 1 shows the relative size of the double frame slide image to the single frame (23mm by 17.5mm) image of the 35mm filmstrip, and to four other image formats which are possible within a 2- by 2-inch mount. The double-frame 35mm slide is the most common format of transparency presently in use and has decided advantages with respect to availability of production and presentation equipment. While 3-1/4- by 4-inch and 2-3/4- by 2-3/4-inch slides have the capability for greater fidelity in rendition and coverage, their use continues to be limited primarily to medical schools.

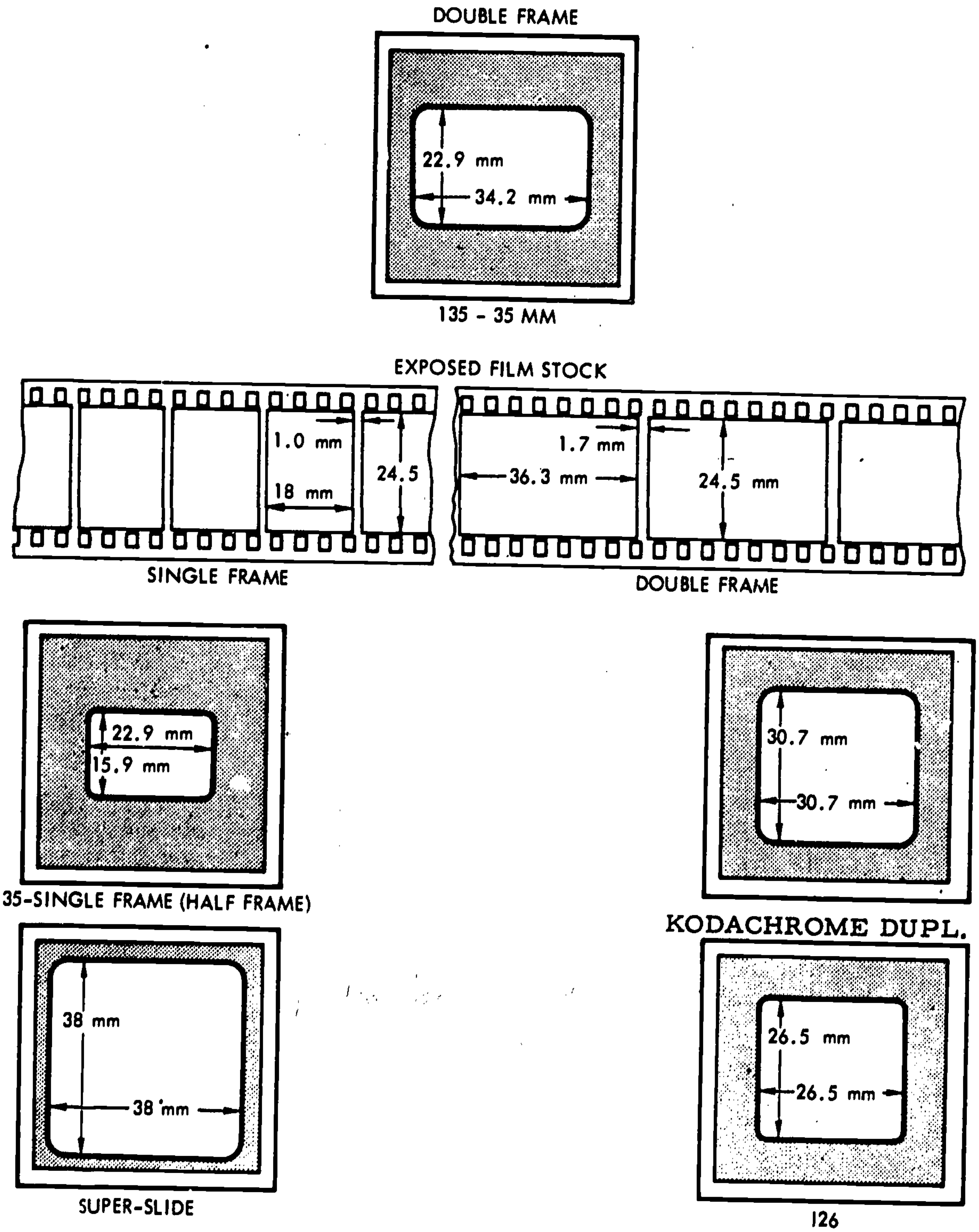

Figure 1. 2-inch slide formats (taken from Sullivan and Smith, 1974).

Resolution. The resolving characteristics of commercially available 35mm films exceed the resolving power of the human eye with all but the most powerful projection systems. The information transmission capacity of visuals far exceeds the information extraction capability of the eye. To maximize the effectiveness of the still visual in individualized instruction requires the clear display of a single concept in a given image, thus, the composition of a given slide is the limiting factor determining the utility of this form of presentation. (See Ball and Byrnes, 1960 for a more extensive treatment of visual communication.)

Filmstrip

The filmstrip is a strip of film preserving an organized sequence of images designed to present a specific message. The advantage of the use of filmstrips lie in their lower per frame cost and the diversity of the equipment available to present materials prepared as filmstrips. At the present time the most common filmstrip format consists of a series of 35mm single frame images ordered vertically on a single piece of film stock. However, there is an increasing use of 16mm and Super 8mm film strip systems. The specific technical characteristics of these formats are described as follows:

35mm. The 35mm filmstrip format employes a frame size of 17.5mm by 23mm with the larger dimension in the horizontal plane. This format is identical in dimension and orientation to a frame of 35mm movie film; it differs from 35mm slide frames in overall size, orientation (Figure 1), and in the proportions of the image area (2:3 vs 3:4). Since the same film stock is used for both formats, resolution and exposure characteristics are similar.

In comparison to a 35mm slide set, the required storage volume for filmstrips is minor. When one considers that each of the students in a given course, for example, would require a tray of slides per hour of instruction recommended for mediation, then the impact of storage requirements as a characteristic of mediated courseware becomes quite critical. Assuming that we have 16 students, then one hour of instruction would require that we have a storage capacity for 16 presentations, plus 20% for spares = 20 slide trays or 20 filmstrips. Thus, a single hour of instruction would require a storage area accommodating 4,400 cubic inches of slide trays alone (not including the storage required for accompanying audio materials) versus 70 cubic inches for 35mm filmstrips.

Projection devices for filmstrips intended for audio-visual applications are functionally similar to the equivalent categories of slide projection. The major difference is that single frame filmstrips are transported vertically with images descending into the aperture of the projector; this uni-directional vertical movement plus the short distance to be traversed may allow filmstrips to change images quickly enough so as to give the impression of animation of successive still frames as in a movie. At present, cassettes protecting filmstrips from handling have not yet become widely or economically available.

In addition to conventional projection devices for 35mm filmstrips, several stand-alone projection systems have been developed. These devices are particularly appropriate for individual study, since they are simple to operate, relatively low in cost and provide a degree of scheduling and assignment flexibility not possible with any other still visual format. In their simplest form these devices are hand operated viewers operating on penlight batteries. In their most sophisticated form they are audio-visual systems containing a projection system synchronized with an audio cassette system and its own rear projection screen. As a means of home study remedial, or supplemental instruction, these devices enhance the overall attractiveness of the 35mm filmstrip as an instructional medium.

16mm. The 16mm filmstrip format employs standard 16mm movie film. It is a length of film containing 350 to 440 frames which can be advanced singly or at rates up to 10 changes per second. The major advantages of 16mm filmstrips are the low cost of raw filmstock, the wide range of film types available, and the high storage density theoretically available. Disadvantages associated with the format are the limited availability of projection devices and systems, the requirements for special cartridges to hold the film and the high cost and sensitivity of 16mm filmstrip origination equipment (standard 16mm movie cameras are expensive devices; modifications which allow single frame exposures increase expense).

Resolution and image quality of 16mm original and duplicate footage are equal to that which the human eye can discern on 35mm. The entertainment film industry has maintained as its industry standard 35mm film. However, with increasing frequency 16mm footage is being used as original footage and optically blown-up for incorporation into or distribution as 35mm footage. The criteria and standards established for these applications are higher than is necessary for instructional filmstrips.

The technical characteristics of 16mm film, plus its low cost make it an attractive visual tool. However, the small number of projection and handling systems on the market limits both the availability and application of this format. Both of the available 16mm filmstrip systems presently being marketed use a separate audio tape (integrated into the film cartridge) as the source of sound to amplify or supplement their visual presentations. Synchronization of imagery and audio is attained by using cue commands on the tape.

Super 8mm. The Super 8mm film format retains the proportions of 16mm and 35mm (single frame) film. Its use as a filmstrip format has been limited to one relatively successful and several extinct projection systems.

The advantages of Super 8mm as a filmstrip format are based on raw stock cost, satisfactory image quality, low duplication costs and reduced storage density.

The disadvantages are the limited availability of presentation systems, the lack of standardization between systems, and the relative difficulty of generating original footage. The optical quality of Super 8mm is adequate for individual presentations. The cost of raw film stock is lower than that for 16mm and adequate camera equipment is available. The problems with expanded Super 8 filmstrip utilization come from two sources: the processing and editing of original footage and the refinement and standardization of presentation and display systems. However, as costs drop and camera technology advances, the Super 8 format may become more attractive.

Audio

Learning by listening is an important aspect of a learning center program. Listening is selected when the learning requirement involves: associating heard symbols or heard signs (usually to select and perform associated action, or to modify action), generalizing among heard symbols or among heard signs, as a model when using heard symbols as a cross model cue, or when heard symbols or heard signs provide appropriate feedback.

The design of listening activities into an instructional module fixes that segment of instructional material in time and space, thus permitting easy manipulation storage, scheduling and modification for a given block of heard instruction. This recording of audio materials would be important in a learning center. Two basic types of recording materials will be discussed: phonodiscs and audio tape.

Phonodiscs

Phonodiscs (more commonly called records) are sheets of plastic cut in a circular shape (7", 10", 12", or 16", or 16" D) on which audio information is either cut or pressed. Microscopic irregularities in the walls of the disc provide the audio. Audio discs can be acquired from many professional sources; the playback equipment is economical, reliable, and easy to operate. However, the normal disc life is limited (due to sound distortions after many playings) and the disc is easily broken (which makes handling and storage a problem). Local production of audio discs is not usually possible since expensive production equipment is required, and normal practice requires large quantity production for low cost.

Audio tape

Audio tape is one of several types of magnetic tape (a plastic backing material coated on one surface with a layer of magnetizable metallic oxide particles). During manufacture evenly dispersed crystals are oriented along the length of the tape. The base material for audio tape can be of three types and can be obtained in four common thicknesses:

1. *"Acetate" (Cellulose Triacetate or Diacetate)* is the base material which represents the original form of magnetic tape and is still used in professional applications. Its major advantage is also its primary drawback: under stress the tape will snap rather than stretch. This allows for clean splicing and simple repair. However, since these tears occur with some frequency, and since the tape is damaged by humidity, it is not particularly suited for instructional use.

2. *PVC (Polyvinyl Chloride)* is much stronger than acetate, but when subjected to stress, it will stretch too much for adequate repair. It is also sensitive to heat.

3. *Polyester* is the strongest form of tape backing available and in its "tensilized" or prestretched form its tendency to stretch is significantly reduced.

The coating material for magnetic tape is a metallic oxide (typically iron, but now also introduced are both chromium and cobalt oxides) and its performance as a recording medium depends on coating density and crystal orientation. The inherent signal to noise ratio of tape depends not only on the degree of dispersion of the oxide throughout the suspension medium (commonly 20–40%), but also on the surface quality. Audio tape thickness ranges from 1.5 mil to .5 mil with 1.5 representing so called "standard play" tapes, 1 mil "extended play" reel-to-reel tape and .75 mil being the standard tape thickness for tape cassettes.

The signal-to-noise ratio of audio tape is important. The audio output from quality tape should be at least 50 db from the inherent noise level to the point at which distortion (3% of the 3rd harmonic) occurs on playback. Signal-to-noise ratio is measured in the following manner. A known signal level (333 Hz for example) is recorded on the tape is played and the output level is measured on a waveform analyzer. Once the overall output level is established, the tunable filter on the waveform analyzer is set to filter out the known signal and the remaining audio output is measured. The ratio between the first and second measurements is the signal to noise ratio and, as stated above, should be at least 50 db for the gain setting at which audible distortion can be perceived.

A tape characteristic of direct consequence in modern instructional systems is the susceptibility of the tape to "cross talk" between tracks on a multi-track recording. Cross talk is the level at which a tone which has been recorded on one track can be heard on another. It varies for different frequencies and is prevented by physical separation of the recording tracks. This separation is referred to as a "guard track." Its presence on a tape has several effects: it reduces or eliminates cross talk and reduces the number of tracks (or the width of the tracks) that can be recorded. In the latter case, the signal to noise ratio of the recording track is reduced; however, a solution to this reduction in signal-to-noise ratio is to use tape of higher sensitivity (e.g., so-called "high energy" tape). Standards for maximum acceptable level of cross talk vary with different frequencies, tape formats, and applications. To prevent objectionable cross talk insure that the peak values are below the saturation level of the tape. A standard reference tape may be useful in doing this. However, most cross-talk difficulties are related to head alignment.

The format selected for audio tape recording is governed by several factors–functional requirements, industry standards, physical dimensions of the tape and available hardware systems in the development of audio tapes for instructional purposes standardization is imposed by the availability of recording and playback systems, economics, and certain basic functional requirements. In all cases, the actual tape format is determined by configuration of the recording head of the originating machine. In normal practice, the head configuration of all recording and playback units in a given system would be configured identically.

1. *Half-track monaural.* The most common format for audio tape recording in the instructional environment is half-track monaural (see Figure 2). In this format, signals are recorded on about 3/10th of the tape in one direction with another track occupying an equal amount of space available for recording in the opposite direction. The remaining tape area serves as edge spacing and a guard track between the recorded tracks.

2. *Quarter-track stereo.* Quarter-track stereo is the next most common recording format and its head configuration differs as a function of the tape packaging used. In reel-to-reel recording, tracks 1 and 3 are recorded in one direction while tracks 2 and 4 are read in the opposite direction. In the four track cartridge (in reality a quarter track stereo cartridge), all four tracks are recorded in the same direction; recently introduced "Quadrasonic" or "Quad" reel-to-reel machines use this format also. In stereo cassette machines, track 1 and 2 are recorded in one direction and three and four in the opposite direction (Figure 2).

3. *Dual-track stereo.* Two-track or dual-track stereo (see Figure 2) results when two tracks corresponding in size to the half-track mono tracks are recorded in the same direction.

4. Other formats, such as eight-track, are available. They require special recording equipment and are generally designed for specific non-instructional applications.

Audio tape is available in a wide range of "packages" in which it may be recorded, stored and played. For instructional purposes, two of the available packaging concepts (reel-to-reel tape systems and the

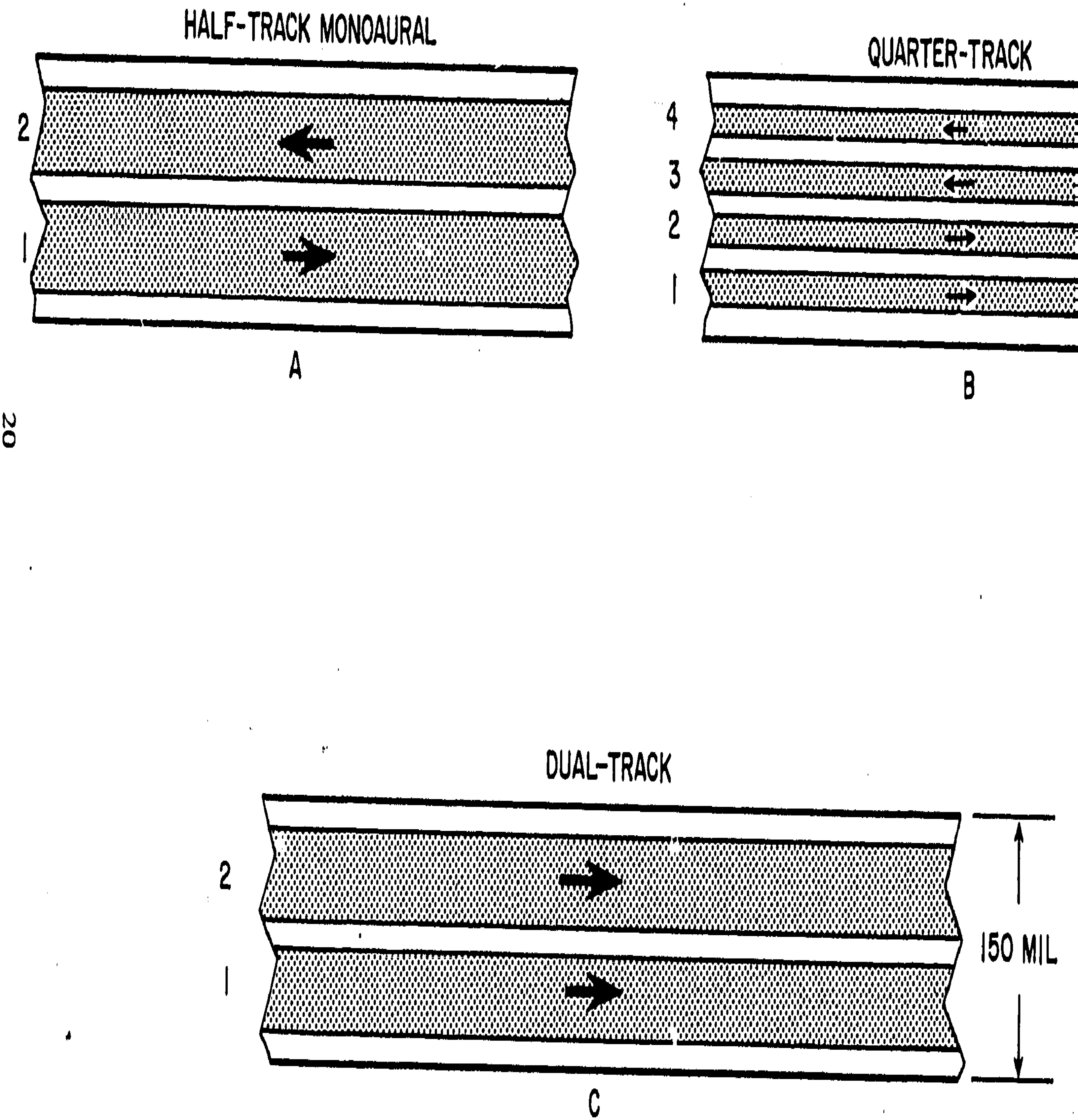

Figure 2. **Audio tape formats (taken from Sullivan & Smith, 1974).**

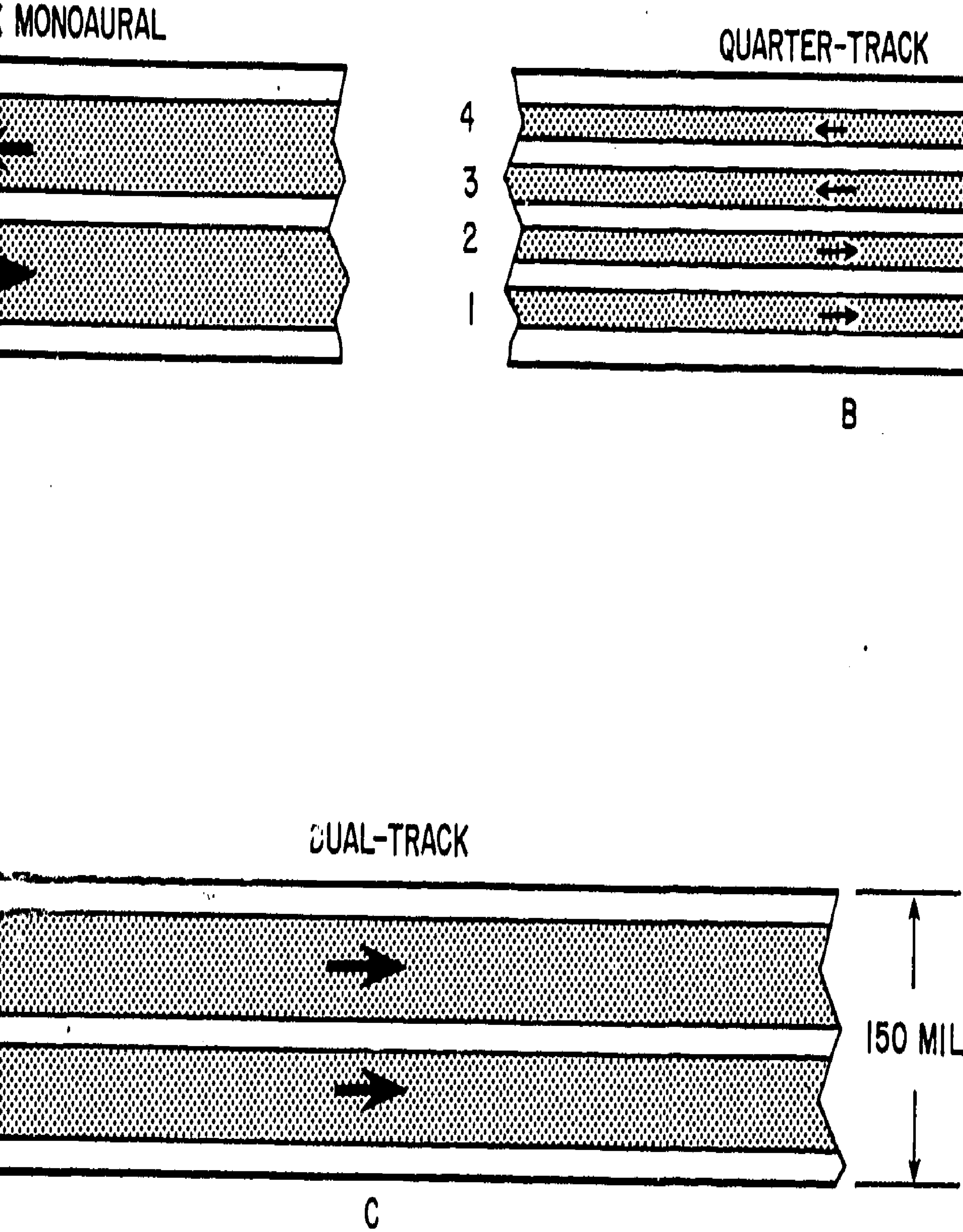

Figure 2. Audio tape formats (taken from Sullivan & Smith, 1974).

compact cassette) are standard techniques for audio production and presentation. The tape cartridge has achieved qualified acceptance as a storage, distribution and playback medium.

1. *Reel-to-reel.* Reel-to-reel tape handling systems, commonly using 1/4-inch tape, are quite common. The major advantages of reel-to-reel systems are greater capacity, higher fidelity on recording and playback (due to higher possible recording speeds) and more efficient editing capabilities. The major disadvantage is the requirement for the student to handle the tape in an individual oriented system. All previously discussed format are available on 1/4-inch machines. The major use seen for reel-to-reel systems in an individualized instructional system is in the initial production of audio masters for dubbing on cassettes.

2. *Cassette.* The compact cassette concept is regarded as a standard. The compact cassette is an encapsulated double-spool tape handling system for which a set of dimensional and functional standards has been accepted. Electronics Industry Association (EIA) Standards Proposal No. 1082 established the recognized U.S. dimensional characteristics for the compact cassette, while EIA Standards Proposal No. 1067 establishes the recording standards of the compact cassette. Tape width in standard compact cassettes is 150 mils and the length varies between five and sixty minutes of play at 1-7/8 inches per second. The size, ease of employment and the wide variety of equipment employing this packaging concept make it extremely attractive for use as an instructional presentation form in Air Force technical training. The simplicity of the procedures required to place it into or remove it from operation, provide significant advantages in individualized instruction.

3. *Cartridge.* Compact cassettes and cassettes as a generic class are distinguishable from cartridges, in that cartridges are defined as being single spool systems employing either an endless loop system or operating in conjunction with an external second spool. The primary use of the audio cartridge has been in automobile playback systems. The cartridge contains 1/4 inch tape spliced into a continuous loop is typically recorded in a 4- or 8-track format with each track containing a separate program. This approach to tape packaging, while offering the potential for higher quality sound reproduction than the compact cassette, has not achieved the acceptance of the cassette. The lack of acceptance can be attributed primarily to the few commercially available recording systems for this format and that the cartridge is uni-directional—it cannot be rewound.

Broadcast

The use of broadcast audio as an instructional medium is mentioned in the companion handbook. The elements which constitute a broadcast system are present in many instructional applications, however, these are not normally considered instructional broadcasting. The use of instructional broadcasting in individualized training environment is limited. Through the use of multi-channel broadcasting, it is possible to instruct simultaneously a class of up to sixteen students in separate tasks. It is possible to instruct individual team members in the particular aspects of the team effort that they are expected to perform, as well as having certain channels operating at the regular instruction level. Other channels may operate on a remediation level. In a wireless system this is all possible without any requirement that the student be at a particular instructional location. So long as the student is within range of the antenna, the receiver in his headset will pick up the signal for the channel selector.

Multi-modal Media

Multi-modal media are instructional media which appeal to more than one sensory mode. The instructional media which enable simultaneous seeing and hearing are the most important in terms of usage. Motion pictures, television, and prenarrated projected still visuals will be discussed in this section.

Motion Pictures

"People learn from films" is proposed as an axiom by Hoban (1960). He says that the evidence is overwhelming that factual, attitudinal, opinional, and perceptual motion learning occurs when people are exposed to films. The intent of the presentation and the logistics of employment distinguish films intended for individualized instruction from other films. The single topic film represents an efficient use of the motion picture film. Two motion picture formats (from the many available) are considered relevant for this purpose; 16mm and Super 8mm.

16mm format. The 16mm motion picture format has an image size of 12mm by 9mm and is one half the size of 35mm motion picture film. The 16mm format was developed some fifty years ago as a lower cost or even "amateur" alternative to 35mm film. It is the major development and distribution medium for classroom instructional films. As a documentary recording and audio-visual presentation medium, it is widely used. Its history as the format for military, industrial and other non-entertainment motion picture applications has led to a wide variety of equipment, films, and processing systems which are tailored to the specific characteristics and requirements of this format.

The availability of precisely engineered camera, film, and processing systems make the 16mm format technically very attractive as the motion picture production and distribution medium for instructional purposes. The fact that until recently there have been no competitive systems of equivalent technical quality or cost has, of course, helped to maintain the primacy of 16mm. There are, however, several major drawbacks associated with the use of this format, both as a production and as a distribution medium. Certain of these advantages and disadvantages and their implications for a program of individualized training are discussed in the following paragraphs.

1. *Cost.* The costs associated with the generation and duplication of 16mm film are diverse and varied. The cost of a given piece of 16mm footage is dependent on what is being recorded on the film, when and how. A straight recording sequence will be cheaper than one in which special graphics, titles or animation is required. The specific breakdown of costs associated with 16mm motion picture production are often quoted at $1,000 per minute (production cost) for a completed master copy, (although typical commercial rates would exceed $10,000 per minute, from scripting to master).

2. *Production:* The production, of quality 16mm film presentations is a complex and precise undertaking. As currently practical, film productions in the 16mm format are relatively large scale undertakings, requiring the services of personnel trained in the rather precise arts and sciences of script development, cinematography (motion picture photography), large volume film processing and the post-production tasks associated with finishing film generation. The availability of a varied spectrum of equipment, accessories and film stocks allows the production of 16mm footage under conditions that are difficult, in almost any other format.

3. *Presentation.* The image area of 16mm film dictates the number of frames that can occupy a given space (40 frames to the foot). Similarly, the speed at which images are projected dictates the amount of footage that is required to present a message of given duration. Sixteen mm sound motion picture film is typically projected at 24 frames per second (fps); thus, even for relative short sequences, 16mm films require a significant amount of footage. Presentation of 16mm films is presently limited to relatively standardized, noisy, vertically oriented projection systems of considerable size and bulk. With one or two exceptions, the available projectors are neither designed nor intended for stand-alone or study carrel use. Even the exceptions are primarily standard projectors fitted with right-angle projection optics. The rear-screen projection enclosures presently used are more suited for display or advertising purposes than for student use.

The display of 16mm presentations via television is a standard, well developed procedure. In most applications, it is done for one or more of the following reasons:

1. The 16mm footage is required to be viewed simultaneously by several groups in different locations.

2. There already exists a CCTV system servicing the various locations.

3. The footage represents instructional material which is frequently repeated (e.g., every week), thus, 16mm film represents a cost effective storage medium.

4. The material is used so infrequently that it does not warrant the production of additional copies.

5. The 16mm footage is a stable and cost effective long lived storage medium for material generated originally as videotape.

Super 8mm format. Just as 16mm film represented an attempt to retain the motion picture medium while reducing the size and complexity of the film and equipment required by 35mm, so 8mm (standard 8) was an attempt to divide 16mm film in half and produce similar results with equivalent savings in size, complexity and cost. First introduced in 1932, standard 8mm film was 16mm film exposed on one half of the film at a time. During processing the film was slit down the middle and shown as 8mm film. In 1965, Eastman Kodak introduced Super 8mm film as a replacement for standard 8mm film. While the dimensions of film stock is the same for both formats, Super 8mm provides a 35 percent greater image area per frame than standard 8 along with retaining the same aspect ratio of 16mm and 35mm frames.

Since its introduction in 1965, Super 8mm has virtually eliminated standard 8 from the amateur market and has made significant in-roads in instructional applications. One of the advantages of Super 8 is that the image area/aspect ratio allows images to be reduced from 16 or 35mm without any image loss. It has become an inexpensive release and distribution medium. Super 8's popularity and technical quality has produced a continuing series of developments and refinements in equipment and materials for its origination, production, processing and distribution. These developments and refinements have been made by some of the major firms in the photographic and audio-visual industries, indicating a long-term commitment to the development of Super 8 as a production and distribution medium.

Aspects having a bearing on individualized training are the continuing emphasis on the use of magnetic sound for Super 8, the development of several competitive packaging concepts for Super 8 distribution, and the development and/or modification of quality equipment for Super 8 photography, processing, editing and duplication. Of particular note is the commitment of the leading American film manufacturers to the concept of Super 8 as an "audio-visual system" and the associated development of more professionally-oriented film stock (allowing higher quality duplication from Super 8 originals) and projection equipment designed specifically for Super 8 w/magnetic sound. The Super 8mm motion picture format has the following advantages over 16mm and video in individualized instruction.

1. *Cost.* The cost of Super 8mm film stock, camera equipment and accessories required for the production of film sequences for instructional purposes are significantly less than that required for 16mm motion picture work. The mean production cost for Super 8mm is less expensive than the same sequence done as 16mm. This cost advantage permits the development of Super 8mm presentations which, because of their low cost, could be disposed of or replaced when the technical content of an instructional segment changed. With the adoption of Super 8, the instructional personnel can be used to generate their own instructional film sequences, thus further reducing the cost.

2. *Production.* The equipment required for the production, duplication, and finishing of Super 8mm film productions can be as complex and sophisticated as that required for 16mm motion picture work or it can be done with the equipment for a complete facility costing less than $500. The quality would vary, but not necessarily in direct proportion to cost. At the present time, camera equipment for Super 8mm work is available which will produce results equivalent to 16mm work. The problems that are present in Super 8mm production work are associated with the available filmstock and the processing and editing of Super 8mm film.

3. *Presentation.* The success of Super 8's acceptance by the amateur, audio-visual, and instructional community has led to a proliferation of manufacturers' models and techniques for presenting Super 8mm films. In order to select presentation equipment suitable for instructional purposes, one must first decide if an integral sound track is required and then select the packaging concept one wishes to adopt (a choice of at least six different packages, mostly not compatible).

4. *Packaging.* There are two basic approaches to packaging Super 8 film; cartridge systems and reel film. Film reels contain from 50 to 800 feet of Super 8 film. The film reel is not a satisfactory approach in an individual training environment where each student would be expected to load, thread and operate the projector.

Available cartridge systems are of two basic types: endless loop systems and self-threading cassette systems. Of the two, the endless loop system is the older form having been introduced in 1961 by Fairchild for regular 8mm film. At the present time, three major endless loop systems are available on the market. These are the Technicolor, Fairchild, and A.B. Dick systems. While continuous-loop cartridges have certain advantages with respect to simplicity of operation, they are handicapped by the lack of a standardized cartridge, and an inability to provide fast forward or reverse. The stop-frame operation is often of marginal quality.

Self-threading cassette systems for Super 8mm film are two-part systems; a packaging module which acts as the storage container for a given piece of footage and the handling module, integral with the projector itself, which automatically positions the film during the threading projection and rewinding. At the present time there are two major self-threading cassette concepts available; the European developed Easee Play (E.P.) cassette system and the Eastman-Kodak (EK) Cassette. In concept these systems are identical—the Super 8mm film is taken as it returns from the laboratory and placed, spool and all, into a container which will act as both a storage container and as an integral part of the projection system. In use they are also identical, the cassette is simply placed into or on the projector and the projector automatically threads itself and begins play. It is only in the detailed implementation of these concepts and the capabilities of available projection devices that the E.P. and EK systems differ. While the E.P. system was developed by a consortium of several European firms, only one firm markets projectors for the E.P. system and these are limited to the projection of 50 foot (3-1/2 minutes) cartridges. The EK cartridge system consists of four cassettes (50, 100, 200, and 400 foot capacity). Several manufacturers of projection equipment, have redesigned their Super 8mm product line around the EK cassette system.

The major advantage to the cassette system is that, depending on the sophistication of the projection equipment selected, the cassette can be stop-framed, reversed, fast forwarded or set to play a given sequence repeatedly. Continuous loop cartridges require special loading equipment and splicing prior to actual loading, while cassette production is only slightly more complex than loading the film into a storage box. In both forms, cartridge and cassette, some type of film lubricant needs to be used.

16mm and Super 8mm. In summary, it can be stated that the cost, production requirement, and lack of suitable display systems would limit the utility of the 16mm motion picture format as a medium for inclusion in an instructional environment intended for individually paced, mediated instruction.

The use of Super 8mm film as an instructional medium has assumed an integral sound track synchronized to the visual presentation. At the present time, the sound track technique used with Super 8mm film consists of a magnetic stripe printed onto the base side of the film. However, optical sound as a part of the Super 8mm system is now becoming available. For the instructional environment designed to support individualized technical training, the Super 8mm motion picture with magnetic sound in appropriate cassettes or cartridges are recommended at the present time.

Television

Television employs the use of electronic systems for recording, transmitting and displaying images by converting those images to electronic waves for transmission and reconverting them at the display point. In the U.S., the standard monochrome and color composite signals (composite video signals include horizontal, vertical, and synchronizing components) employed in industrial and instructional video systems are based on a scanning raster of 525 lines interlaced 2:1 at 30 frames per second.

Television and motion picture film are distinguishable in terms of technical performance. For example; film stores pictures while TV stores signals. Film requires processing, while video tape can be replayed immediately. The film cannot be re-used while video tape is re-usable. Contrast range and resolution also vary.

Television formats for educational purposes are varied. Video signals are capable of being recorded and retrieved in a large variety of ways. However, the most widely used technique is video tape. Video tape is magnetic tape with a composition and structure similar to audio tape. Differing in terms of quality and, in a limited sense, in size. Video tape is identified by its width (e.g., 1/2 inch, 1 inch, etc.) because its other characteristics are not prominent enough to be observed without special equipment. Available equipment for video recording is presently designed to handle five tape sizes, of which three have found broad application.

1. *2 inch.* The 2-inch format is the professional television format; this is the format used in all commercial broadcast television systems. Because of the complexity and cost of the equipment required to record and to playback material in this format, its application in instructional systems has been limited to production of masters for duplicating in other formats and those situations where the volume makes the cost reasonable, usually in a television broadcast system.

2. *1 inch.* The 1-inch format, while providing an inferior image to 2 inch, has been (until recently) the format towards which video manufacturers have guided their educational customers. The 1-inch format with its wider bandwidth (bandwidth seems to be function of tape width—1-inch tape has a bandwidth of 4 MHz while 1/2-inch tape runs about 3MHz), smoother editing, higher resolution and better duplication quality has been a yardstick against which most instructional users have compared their own products or

aspirations. While the tape is half the size of 2-inch tape, there are several other features which distinguish this format. In 1-inch video the tape is helically scanned (as opposed to being vertically scanned as in 2-inch machines) by a single head (as opposed to two in 1/2-inch machines). The major problems are the lack of standardization and lack of compatability between recording and playback equipment among different equipment manufacturers. These factors, coupled with the increasing quality of 1/2-inch equipment, have served to reduce the attractiveness of the 1-inch format, for individualized instructional applications.

3. *3/4 inch.* The video cassette uses 3/4-inch tape. The Sony U-Matic video tape system forced acceptance of this format. This system has been adopted by three other large audio-visual manufacturers and is based on 3/4-inch video tape conforming to a new EIA standard (the first EIA standard was for 1/2-inch reel-to-reel machines). The 3/4-inch tape format has been adopted to permit the packaging of one-hour's playing time in a reasonably sized package. The U-Matic format is a helical scan system with a field rate of 59.94 fields per second, providing 525 lines per frame, and is capable of both color and black and white recording and playback. It has performed quite reliably and the quality has been excellent for individualized instruction. The use of a cassette is suitable in many learning centers.

4. *1/2-inch.* This format was introduced as the "amateur" format for video recording in the same sense that Super 8 film is considered to be an "amateur" in film format. Half-inch video tape recorder (VTR) system quality has been raised to a level which allows it to offer picture quality and production flexibility equivalent to available 1-inch equipment and to come close to the levels achievable with a large percentage of the 2-inch systems in operation. Resolution in excess of 300 lines and signal-to-noise ratios of 40 db are available in models from several manufacturers. The increased quality of 1/2-inch equipment, the significantly lower cost of 1/2 inch video tape and 1/2-inch recording equipment, and (most importantly) the standardization between manufacturers with respect to recording and playback characteristics make it a format of interest for individualized instructional applications.

5. *1/4 inch.* This format is presently available from only one manufacturer and is a system based on 1/4 inch tape. All the characteristics available in the less sophisticated 1/2 inch equipment are available. The major characteristic of this format is that 1/4-inch video tape is identical to high quality audio tape and thus the cost of tape is almost 50 percent lower than equivalent 1/2-inch recording tape. The major drawback of the 1/4-inch format is that the bandwidth on 1/4-inch tape is quite restricted. As a result the resolution, signal-to-noise ratio and overall picture quality are not equivalent to present 1/2-inch equipment. Continued development in this format holds the promise of low cost, lightweight systems offering all the benefits of video recording and playback at a low cost.

Color versus monochrome television. Television systems have consistently been introduced as monochrome (or black and white) systems which then evolved into color presentation systems. This was true in commercial television, closed-circuit television, and in video tape systems. (An exception to this is the Sony cassette system which opened with color as an integral part of the system.) The acquisition, transmission, recording and display of color video signals is several orders of magnitude more complex than the same process for a monochrome system. This complexity, with its attendant development and sales cost, has retarded the adoption of color at each of the levels in the video hierarchy. The cost associated with color cameras (the most critical element in the video chain) until quite recently has restricted color production to commercial television—even though color recording and playback equipment is easily available in 1-inch, 1/2-inch and videocassette systems.

The complexity and cost of color video recording is based on the color video requirement of a minimum of the discrete images to be recorded (one in each of the three primary colors) and that these images by synchronized in such a manner that the appropriate color or color combination is dominant in each portion of the image as it is recorded or displayed. This requires, that three discrete imaging channels be used along with three discrete recording or display channels. The integration of these channels into a single camera, recorder, and/or display unit is the technical problem which has prevented the development of reasonably priced color systems except on a very slow evolutionary basis. Frequently a fourth (black and white) image is also recorded and displayed.

Kinescope

A Kinescope recording uses motion picture film to record the imagery generated by a video system. A Kinescope recording system consists of a suitably modified (to compensate for the difference in frame rates between video and motion picture films) motion picture camera focused on a television picture. The film resulting from this process is processed as motion picture film. Kinescope recordings are suitable for screen projection or they may be used to present video programs.

Generally speaking, 16mm Kinescope systems are the only ones that are commercially available. While Super 8mm film is capable of resolution in excess of what available video systems can produce, adequate systems for generating Super 8 Kinescopes are not widely available.

Prenarrated Projected Still Visual

Prenarrated projected still visuals describe the mediating systems which associate projected still visuals (such as slides or filmstrips) with a sound track. All of the presentation techniques described in this section are dependent on external sources of audio information. Most existing prenarrated still visual presentation techniques have the problem of establishing and maintaining synchronization between a series of discrete static images and a dynamic audio data store. In most presentations, this process is complicated by differential audio message lengths and varying image display times. In order to accomplish this synchronization for still-visual systems, three basic approaches to the still image-audio synchronization problem have been used.

1. *Superimposed system.* The superimposed visual/audio synchronization system consists of a low frequency (50 Hz) cue tone recorded with the audio program information. Manual systems where the viewer advances the visual also use a superimposed signal.

2. *Separate track system.* The separate track system has the audio program information recorded on one track and cue signals in the form of tones recorded on a second track.

3. *Digital system.* The digital system has the audio portion of the information on one track and the control information recorded as digitally encoded pulses on a second track.

Of these three approaches, the last two offer the greatest degree of flexibility with respect to the number of functions that can be controlled. The first two approaches have been tendered as national standards to be adopted by American National Standards Institute (ANSI). The compact cassette has become a standard in audio-visual applications. Most synchronization systems for individual audio-visual devices have adapted the cassette as well, thus, the configurations and constraints inherent to the proposed ANSI standard are partially attributable to the characteristics of the compact cassette. Considering the requirements inherent to a program of individualized technical training, the separate track system would seem to be the minimal acceptable synchronization capability.

Audio standard. The following standard included in its entirely, has become ANSI-PH 7.4 and is also incorporated into FED-STD 360, should be specified and used for all audio cassette applications in Air Force learning centers until revised by ANSI. (Taken from ANSI Task Force PH 7.4, 1974.) Note that not all the information contained in the recommended standard will be appropriate to your specific needs.

1. *Scope*

1.1 This standard specifies the audio-visual and educational application of the Compact Cassette to include learning laboratories and control of audio, slide and filmstrip media and specifies the technical characteristics of the recorded information.

2. *Definition*

2.1 *Learning Laboratory*—A system in which pre-recorded information may be reproduced while responses to this information may be recorded simultaneously or sequentially. The pre-recorded information is protected against erasure and is re-usable.

2.2 *Cue Tone*—A sinusoidal tone burst recorded on the magnetic tape for the control of peripheral equipment associated with the tape player.

2.3 *Superimposed Cue Tone*—A cue tone which is carried on the same tracks as the audio and is, usually, of a low audio frequency.

2.4 *Visual Synchronization*—The control of visual images from such devices as slide and filmstrip projectors so that these images are changed in step with the audio.

2.5 *Visual Advance*—The change from one visual image to another initiated by a cue tone.

2.6 *Program Stop*—The stopping of an audio program by a cue tone for didactic or other purposes, the program being restarted at a time determined by the user.

2.7 *Automatic Switch-Off*—The cue tone initiated removal of power to an audio-visual device at the end of a program. This may also include automatic rewind.

2.8 *Audio Comparative*—A learning laboratory system in which responses to pre-recorded information are recorded on a separate track and may be replayed and compared with the pre-recorded information.

2.9 *Break-Out Lugs*—Removable tabs at the back edge of the Compact Cassette used for the protection of recorded material from accidental erasure.

2.10 *Correct Answer Code*—A number of cue tone bursts of the same frequency used to indicate the correct answer to a multiple choice question posed by the audio or visual material.

3. *General Specifications*

3.1 *Cassette Dimensions*— The dimensions of the Compact Cassette shall be in accordance with EIA Standards Proposal No. 1082—Dimensional Standard Co-Planar Magnetic Tape Cartridge Type CP-II (Compact Cassette).

3.2 *Recording Standards*—The recording equalization standard of the Compact Cassette, as used for the audio-visual and educational applications specified in this standard, shall be that which produces on playback, with an "ideal" reproduce head, constant output voltage versus frequency, with reproduce equalization time constants of 1,590 and 120 microseconds.

4. *Learning Laboratory Application* (Language Lab)

4.1 *Track Utilization*—For learning laboratory application tracks 1 and 2 shall be pre-recorded for simultaneous reproduction for one direction of travel as the tape is first unwound from the supply reel. Tracks 1 and 2 may be recorded either monophonically or stereophonically. For monophonic recording tracks 1 and 2 shall be recorded with identical in-phase information. For stereophonic recording track 1 shall be recorded with the left channel and track 2 with the right channel and with the head gaps in line. Tracks 3 and 4 shall be non-recorded and be available for later recording by the user (Figure 3).

Note: For monophonic recordings, the space between tracks 1 and 2 may be utilized or omitted.

4.2 *Recording Protection*—To protect the pre-recorded master track (tracks 1 and 2) from accidental erasure Breakout Lug B, as shown in Figure 4 shall be removed.

NOTE: The use of Breakout Lug B, as shown in Figure 4, complies with existing standards for protection of tracks 1 and 2. Since on learning laboratory hardware tracks 3 and 4 are the active recording tracks, the breakout lug sensor must be located on the opposite side of the cassette as compared with hardware used for making recordings on tracks 1 and 2.

5. *Audio-Visual Applications*

5.1 *Description*—Two systems of visual synchronization are defined by the standard. One system has the visual control signal superimposed on the audio track of the Compact Cassette and allows use of both sides of the cassette for program material. The other system places the control signals on a separate track from the audio, using the cassette for a single direction of play, providing for use of a greater number of control functions and allowing for correction or modification of control signals without affecting the audio track.

6. *Superimposed System*

6.1 *Description*—The superimposed visual control system consists of a low frequency cue tone mixed with the audio program information on the same track. Separate recordings may be made on each side of the Compact Cassette.

6.2 *Track Utilization*—Tracks 1 and 2 shall be recorded for simultaneous reproduction in one direction of travel as the tape is first unwound from the supply reel. Tracks 3 and 4 shall be similarly recorded for play in the reverse direction. Tracks 1 and 2 and tracks 3 and 4 shall be recorded with audio and superimposed

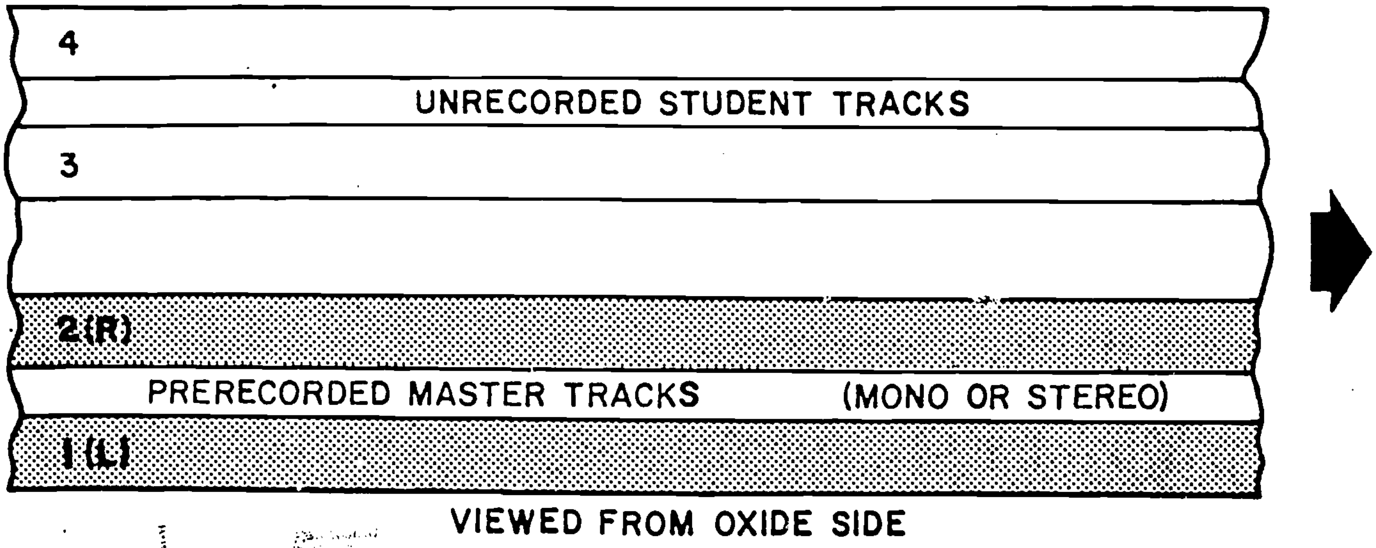

Figure 3. Track utilization, learning laboratories (taken from PH 7.4 proposal, 1974).

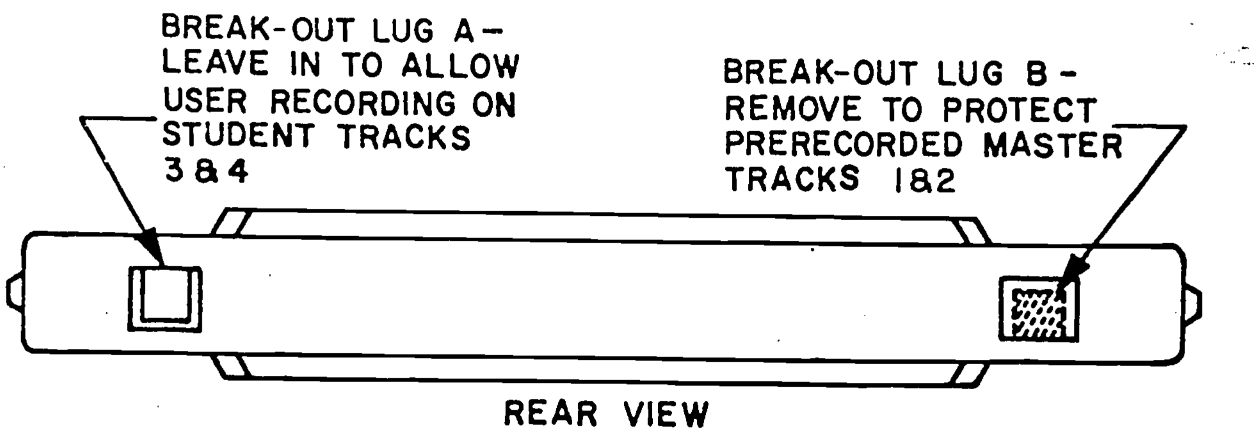

Figure 4. Recording protection, learning laboratories (taken from PH 7.4 proposal, 1974).

in-phase cue tone information. The audio recording may be monophonic or stereophonic. In stereophonic recording, tracks 1 and 4 shall be the left channel and tracks 2 and 3 shall be the right channel (Figure 5).

NOTE: For monophonic recordings, the space between tracks 1 and 2 and the space between tracks 3 and 4 may be utilized or omitted.

6.3 *Recording Protection*—The breakout lug on the back edge of the Compact Cassette shall be removed to prevent accidental erasure of a recorded side. The relationship between the sides of the Compact Cassette and breakout lugs is shown in Figure 6.

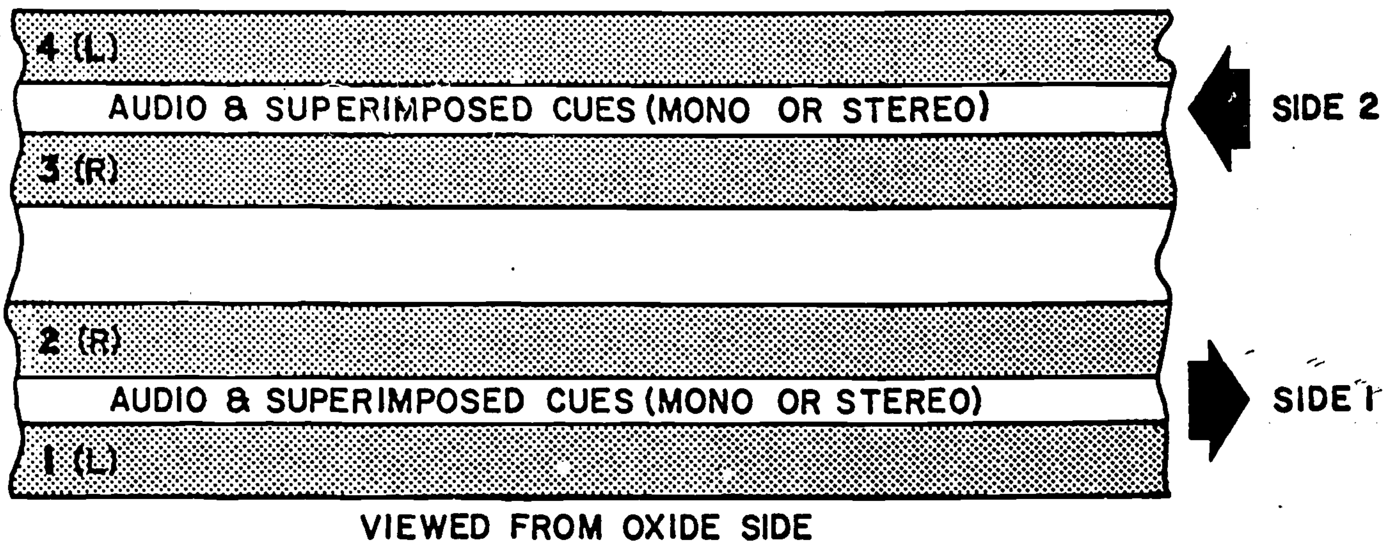

Figure 5. Track utilization, superimposed system (taken from PH 7.4 proposal, 1974).

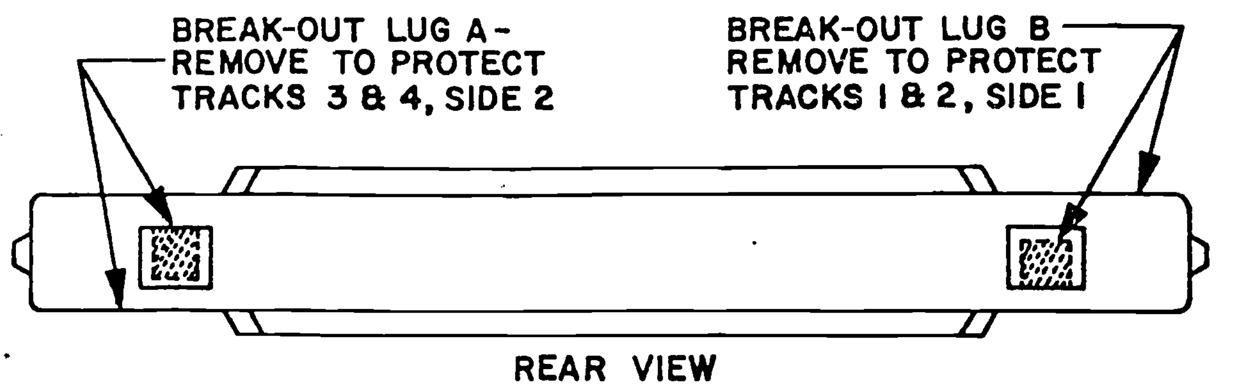

Figure 6. Recording protection, superimposed system (taken from PH 7.4 proposal, 1974).

6.4 *Recording Data*

6.4.1 *Tape Speed* 1.875 in/s (4.76 cm/s)

6.4.2 *Cue Frequency* 50 Hz + 5 percent. Total Harmonic Distortion not exceeding 2 percent (Measured after equalization as defined in 3.2).

6.4.3 *Cue Duration* (Figure 7)

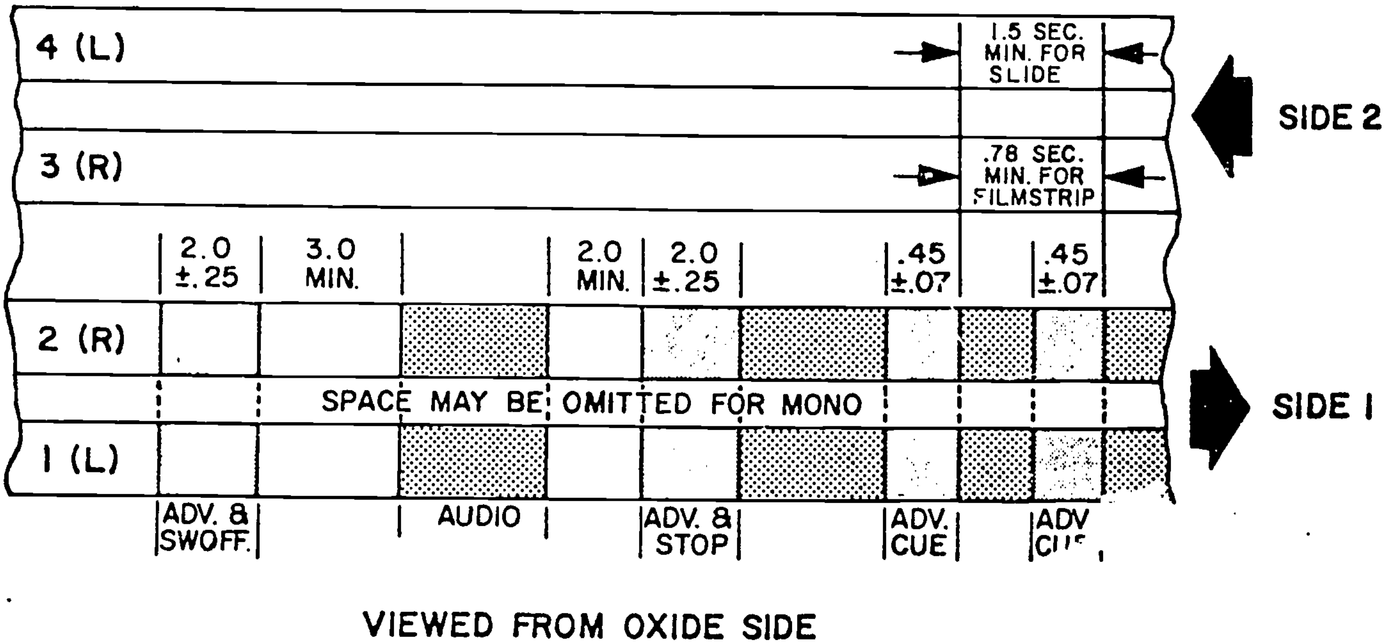

Figure 7. Cue duration and spacing, superimposed system (taken from PH 7.4 proposal, 1974).

a) *Advance Only* 0.45 ± 0.07 seconds

b) *Advance and Program Stop or Advance and Switch-off* 2.00 ± 0.25 seconds.

6.4.4 *Cue Spacing* (Figure 7)

a) *Advance Only* Between the start of two adjacent cues, filmstrip 0.78 seconds minimum, slides 1.5 seconds minimum.

b) *Advance and Program Stop* 2.0 seconds minimum between end of a stop cue and subsequent recorded material.

c) *Advance and Switch-Off* 3.0 seconds minimum between end of program audio and final advance and switch-off cue.

6.4.5 *Recording Level*

a) *Program Audio*—It is recommended that a nominal mean recording level of –4db with reference to 250 nW/m at 333 Hz be used.

b) *Cue Signals*— -10db ± 3dB with reference to 250 nW/m at 333 Hz with equalization as in 3.2.

6.4.6 *Record Equalization*—The recording response shall be as defined in 3.2 but with the addition of a maximally flat high pass network with a transition frequency of 120 Hz at −3dB and a minimum slope of 24dB per octave applied to the audio program element of recorded material.

7. *Separate Track System*

7.1 *Description*—The separate track system has the audio program information recorded on one track and cue tones for control of visual advance and other functions recorded on a second track. The Compact Cassette is recorded for playback in one direction of tape travel only.

7.2 *Track Utilization*—Tracks 1 and 2 shall be recorded with audio program information for simultaneous reproduction. The recording may be monophonic or stereophonic with track 1 carrying the left channel and track 2 the right channel. Tracks 3 and 4 shall be identically and simultaneously recorded with cue tones for control of visual advance and other functions as shown in Figure 8. Recording of track 4 alone is permitted with level in accordance with the note following 7.4.6 (b).

NOTE: For monophonic recordings, the space between tracks 1 and 2 and the space between tracks 3 and 4 may be utilized or omitted.

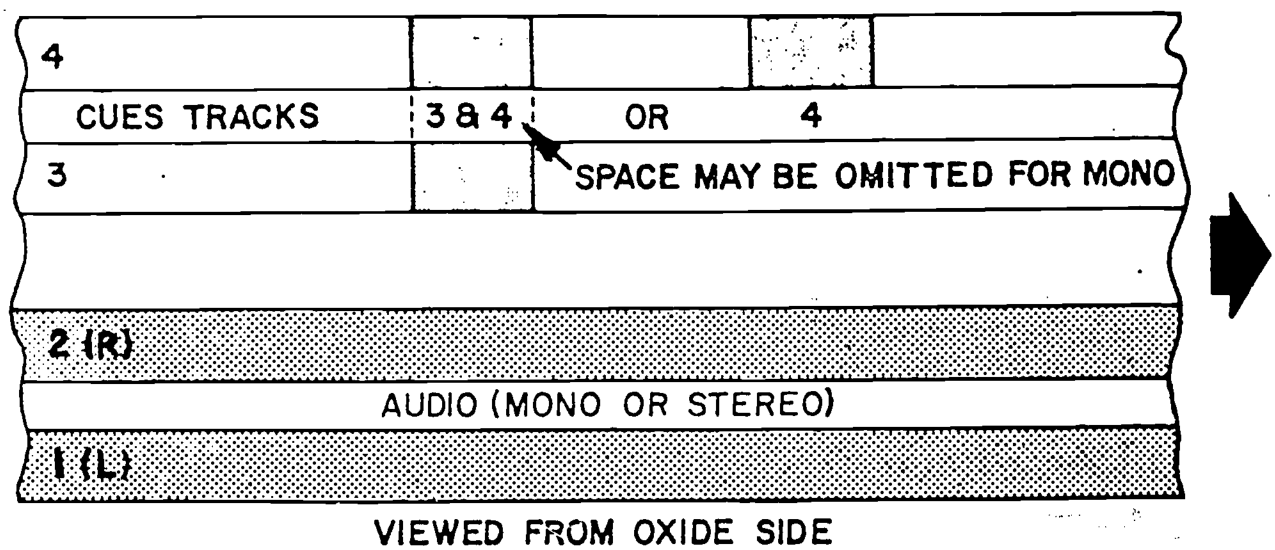

Figure 8. Track utilization separate track system (taken from PH 7.4 proposal, 1974).

7.3 *Recording Protection*—Both breakout lugs on the back edge of the Compact Cassette shall be removed to prevent accidental erasure of the recording.

7.4 *Recording Data*

7.4.1 *Tape Speed* 1.875 in/s (4.76 cm/s)

7.4.2 *Cue Frequencies*—Four cue tone frequencies are assigned: 150 Hz, 400 Hz, 1000 Hz and 2300 Hz, with recorded frequency tolerances of ±5 percent. The 150 Hz and 1000 Hz frequencies shall be used only for the primary control purposes as defined in the standard. The 400 Hz and 2300 Hz frequencies may be used for unassigned control purposes. Total harmonic distortion of cue tones not to exceed 10% (measured without equalization).

7.4.3 *Cue Frequency Utilization*

a) *100 Hz*–Visual advance. Each cue advances the visual program one frame or slide.

b) *150 Hz*–Program stop or automatic switch-off. The program stop cue may also include correct answer coding per Figure 10 and paragraph 7.4.4.b.

c) *400 Hz*–Secondary frequency– For other unassigned control purposes.

d) *2300 Hz*–Secondary frequency–for other unassigned control purposes.

7.4.4 *Cue Duration* (Figure 9)

a) *Advance* (100 Hz)

Slide and Filmstrip 0.45 + 0.07 second

b) *Program Stop or Automatic Switch-Off* (150 Hz) Slide and filmstrip 0.45 ± 0.07 second. For correct answer coding the program stop tone may be encoded by division into 0.050 ± 0.007 second tone bursts–the correct answer being indicated by the number of tone bursts.

NOTE: To insure hardware/software (courseware) compatibility playback equipment having Program Stop capability should be designed to respond to any of the codes shown in Figure 10.

7.4.5 *Cue Spacing* (Figure 9)

a) Between the start of two adjacent advance cues–slides 1.5 seconds minimum, filmstrip 0.78 seconds minimum.

b) Between end of a stop cue and start of the next advance or stop cue, or restart of audio 2.0 seconds minimum of tape time. (i.e., 3.75 inches or 9.52 cm of tape)

7.4.6 *Recording Level*

a) *Program Audio*–It is recommended that a nominal mean recording level of –6dB with reference to 250 nW/m at Hz be used.

b) *Cue Signals*– –6 ± 3dB with reference to 250 nW/m at 333 Hz with equalization as defined in 7.4.7.

NOTE: If cue signals are recorded on track 4 only, the level shall be increased to –3 ± 3dB.

7.4.7 *Record Equalization*–Cue signal recording equalization shall be as defined in Section 3.2. In said reproduce system, output voltage of cue signals shall be equal to that of 333 Hz, recorded at –6dB relative to 250 nW/m.

Sound Slide Systems

The Kalart-Victor System (Kalavox) employs small tape cartridges mounted with each slide. When a slide moves into position for projections its associated audio tape is picked up by the playback apparatus of the specially designed mounting and playback mechanism. When the tape sequence is completed the slide and tape is extracted and the next slide and t[illegible] module comes into place. The system has a definite advantage with respect to maintaining synchronization between audio and visual sequences; however, this advantage is seriously jeopardized by several other characteristics of this system. The system is presently available from only a single source and is not compatible with any comparable system. Audio materials for the system can only be generated on the system itself and are not suitable for multiple copy duplication. This system increases the storage volume for a slide set by at least a factor of three and is limited to use with 35mm slides. Reliability of early models has been less than adequate.

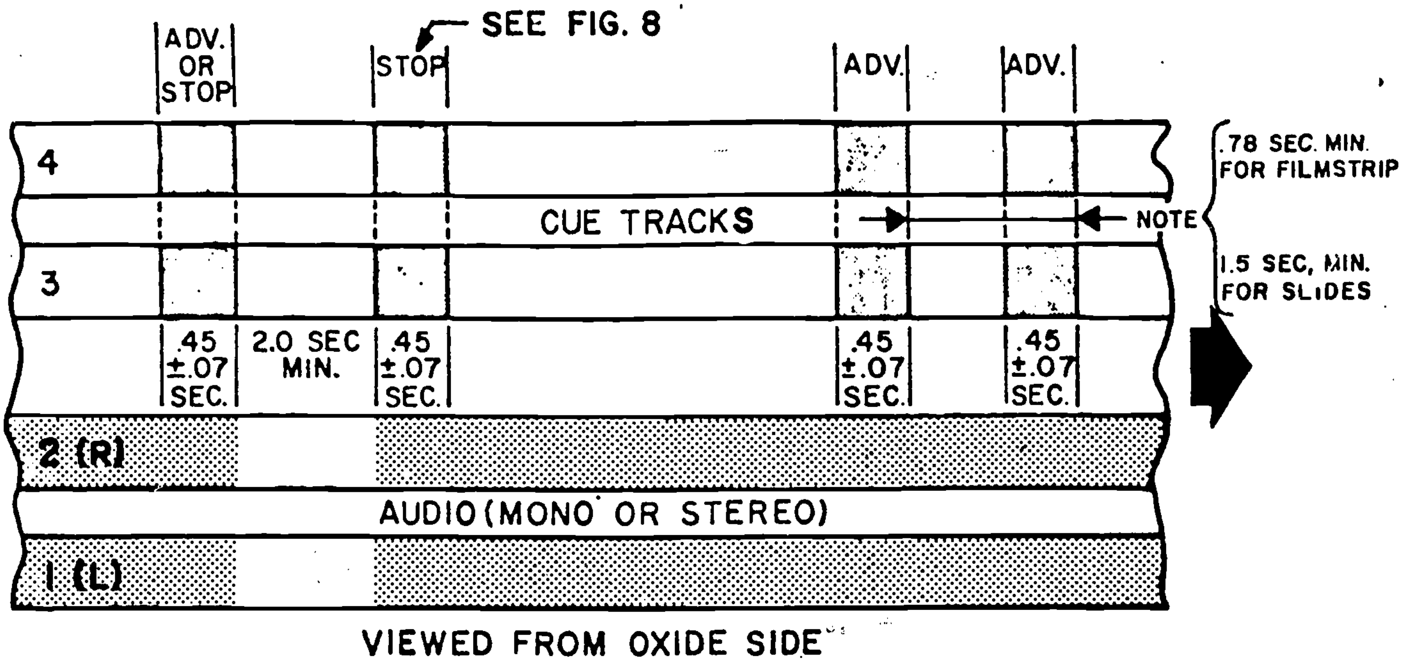

Figure 9. Cue duration and spacing, separate track system, slide and filmstrip (taken from PH 7.4 proposal, 1974).

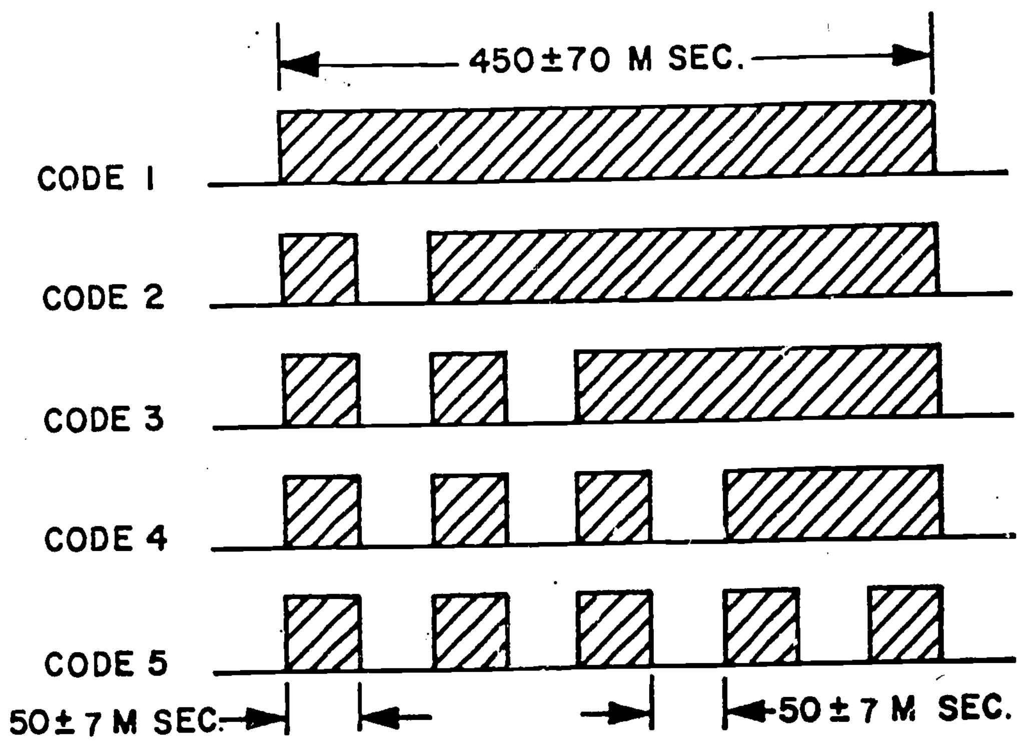

Figure 10. Correct answer coding for stop cue (taken from PH 7.4 proposal, 1974).

In the 3M Sound-on-Slide system, an audio disc is mounted in a frame which also holds the slide. This system is widely available and used in many places. The approach has the advantages and disadvantages that were ascribed to the Kalavox design described previously. This system is also limited to use with 35mm slides.

Print

Microform

A medium for storing and displaying print and still-visuals that has been employed with limited success as an instructional medium is microform. A generic term denoting any of several products of the microphotographic process, microform is essentially a synonym for microimage and includes both microfiche and microfilm. Microform is basically a sheet of film carrying rows and columns of microimages which through the use of suitable projection systems, can be made visible to the human eye. The primary application of microform has been as a high density storage medium for large masses of data. Under the auspices of the Air Force, however, certain innovative instructional applications for microform have been developed and demonstrated. (See Grausnick, West, & Kottenstette, 1971; Kottenstette, Morrison, West, & Grausnick, 1971.) These studies have shown that microfiche has unique instructional applications. The logistical and presentation hardware problems associated with the application of microfiche for instruction will delay its application.

A microimage is the filmed image of a document reduced in size to a point where it cannot be read by the unaided human eye. Magnitude of reduction depends on the detail, size, and contrast of the material printed on the original documents and the legibility required of the microimage. The size of microimages is commonly expressed as the ratio between the linear measurement of original document and the linear measurement of the copy. This is called the reduction ratio. Thus, if a reduction ratio is 24:1 then a document measuring 24 inches occupies 1 inch of film in length. (An 8 1/2" x 11" or 216mm x 279.4mm original would provide a 9mm x 11.6mm image.) DoD requires special authorization for use of low and mid-range reduction ratios other than 24:1 and 48:1.

Microfiche

Microfiche describes a flat sheet of film containing microimages. There are several types and several sizes of microfiche in existence today. All provide very compact storage.

1. *Unitized Microfiche.* The unitized microfiche uses 105mm film in a step-and-repeat camera capturing images in a precise grid pattern.

2. *Microfiche Jackets.* This form of microfiche uses 16mm film to record the document on a frame-per-page basis. The film is cut into strips of 10 or 12 frames and inserted into acetate jackets. These jackets are then used as masters and copied for distribution, or are distributed directly to the user.

3. *Microtape Systems.* This approach applies a special adhesive to the microfilm after it has been developed. The microfilm is then cut into strips and laid upon a sheet of acetate in the proper order. This sheet of acetate is thus a master from which copies may be made and distributed.

4. *105mm x 148mm (4 X 6 inches).* This size of microfiche is recognized as the standard size by the U.S. Committee of Scientific and Technical Information (COSATI) and is a standard size for microfiche. This standard was adopted by the U.S. government in 1964–65 and is one of the standard sizes recognized by the National Microfilm Association (NMA).

The format for the 4- x 6-inch fiche consists of two fundamental parts: the heading and the images. The heading contains a description of the document and may contain any or all of the following information: title, author, publisher, classification, identifying numbers, number of pages in the document, and number of fiche containing the document. This information is located at the top of the card and is readable with the naked eye. A 4- x 6-inch fiche (24:1) contains 98 images arranged in seven rows of fourteen columns or seven rows of nine columns for computer generated hardcopy. The individual pages are normally in sequence reading from left to right. Other formats are possible for educational applications.

5. *3 1/4 x 7 1/2 inches.* The tab or standard EAM card size microfiche or aperture card (so-called because the microimage appears in a cutout or aperture in the card) is recognized as a standard size by the NMA and has found a high degree of acceptance in the storage of large size single sheet documents such as

maps, charts, and engineering drawings and some automatic/mechanical retrieval systems in which superior handling is possible with the tab-card format as opposed to 4 x 6 inch size.

The major advantage of the 3 1/4 x 7 1/2 format is that it is retrieved or handled using conventional punch card equipment (modified to prevent contact brushes from damaging the film). While the aperture card represents a substantial improvement over manual techniques for handling outsize documents, its utility as a medium for handling report type documentation is limited by the restricted film area available on a per-card basis. Standard aperture cards contain a 35mm film frame 1 3/8 x 1 7/8 inches in size. The number of pages that can be accommodated in this area is restricted if standard recording densities are adhered to.

6. *3 x 5 inch and 8 x 10 inch.* The 3- x 5-inch (standard library card) format was used in many early microfiche applications. Using the old 18:1 reduction ratio it will hold approximately 40 to 50 pages. The major advantage of this size fiche is that it can be stored in standard catalog card files. The 8 x 10 inch can store large collections of information and enables use of unreduced indexes and key words. Within DoD, neither of these two formats can be used without justification and special authorization.

Microfilm, Roll

Roll microfilm is commonly available in two sizes: 16mm and 35mm (usually in 100 foot rolls). While 8mm, 70mm, and 105mm film are used for microfilm purposes, they are used for special purposes: 70mm for aperture cards, 8mm and 105mm for computer output microfilm (COM) and 105mm for fiche masters. While 35mm film is still used, 16mm film is the most common form of roll microfilm. Images may be formatted either horizontally or vertically on the roll of film, and in some cases two columns of frames are used. Ready-for-use roll microfilms are spooled into three basic types of containers.

1. *Reel.* The reel is a flanged holder that holds up to 100 feet of film. Reels should be stored in separate cardboard containers for film protection and identification. When used on most viewers, the reel is threaded manually (which is often troublesome). Reel microfilm can be converted to either the cassette or cartridge container at a small additional cost.

2. *Cartridge.* The cartridge (sometimes called a magazine) is an enclosed single-core container that eliminates many film handling problems with an attached leader and is self-threading when used in most motorized cartridge viewers. Location information is accomplished with the aid of a resettable odometer that is available on many readers. Cartridges for microfilm have not been standardized in design and may not be interchangeable with a different manufacturers reader.

3. *Cassette.* The cassette (sometimes called a cartridge) has many of the same characteristics as the cartridge. It contains a double core which provides both film supply and take-up. This feature allows the user to remove the cassette (without rewinding) for referencing the same frame at a later time.

Microcard

Microcards are positive opaque photographic prints 3 x 5 inches in size. Normally 40 letter-size (8 1/2" x 11") pages appear on each side of a microcard. Its major market as a medium is for a limited set of users having a requirement for frequently, revised detailed material (such as tech orders or spares manuals). A special reader is required which is not compatible with other types of microform materials. (Microcard is a trademark of NCR Inc., Dayton, Ohio.)

Microform Film Stocks

Microform film stocks are of three different kinds. The first (and most commonly used) is an acetate base and a photosensitive layer of silver halide bonded to the base. This is similar to film used in photography. The second stock is diazo film. Diazo differs from silver halide film in several important respects. The third type is called vesicular, and is entirely different in concept from either diazo or silver halide film.

1. *Silver halide* film is selected for archival purposes because it retains its image much better with time. It also has commonly been used for distribution. Since the image is recorded on the emulsion, it is susceptible to tearing, scratching, pinholing, and other physical damage. Master record copies of documents should be made on silver halide film, but duplicate negatives must be made for use in a working file. Cardboard cartons should not be used to store silver halide film, since products discharged during the aging of paper cartons attack the film.

2. *Diazo film* is a slow film. Development (by ultraviolet light, heat and ammonia), is a rapid-dry process that can take place in a lighted room. Because of the speed of development, the overall reproduction cycle for diazo is faster than for silver halide. The emulsion of diazo is incorporated into the base material as opposed to the emulsion, and exhibits high resolution qualities. Thus, the diazo image is less susceptible to damage during handling. The diazo image tends to fade over time in which it is exposed to light. This property makes it unwise to use diazo for archival purposes. Because of the resistance to physical damage during handling, diazo is better suited for use as working file copy. Diazo has the property of reversal development, making a negative image when contact-printed from another negative. A duplicate silver halide negative requires an intermediate paper positive to be made (unless one of the new commercially available nonreversal silver halide films is used). The duplicate silver halide negative is actually a third generation film, while the duplicate diazo negative is second generation. Each additional generation step incurs a loss of detail quality. Film costs are approximately the same for diazo and silver halide, but diazo now is cheaper to process in small quantitites.

3. *Vesicular film* works on an entirely different principle than either silver halide or diazo providing high resolution-low density images. Introduced by Kalvar Corporation in 1956, it has not gained any substantial share of the microfilm market until recently. This film derives its name from the bubbles or vesicles formed by the action of ultraviolet light on diazonium compounds in a crystalline plastic emulsion. The development process is more physical than chemical, and two exposures are necessary during the process for making a permanent image. Storage in plastic containers is recommended by some suppliers.

A small study of microfiche users compared quality of fourth generation images on silver halide, diazo, and vesicular film. All three microform stocks provided equal image quality. However, the fifth generation hardcopy produced from the fourth generation diazo was of slightly lower quality than from the other film stocks. Further, fifth generation microfiche produced by the users from the fourth generation materials showed that there were significant differences in quality between the three film stocks. The order in quality from best to worst was silver halide, diazo, and vesicular. It was noted that even the poorest quality in this comparison was perfectly readable (Prevel, 1973).

Recording Densities

New developments, including computer-output-microfilm (COM), laser recording, and two-step processing with photochromic and conventional photographic techniques, provide a capability for increasing packing densities on microfiche to encompass four ranges of storage.

1. *Low-range.* Conventional microfilm reduction of from 4 to 38X results in a maximum of 210 pages on a 4 x 6 fiche. The current low range standard reduction is 24:1 in either a 98 page (8 1/2" x 11") frame with seven rows and fourteen columns or a computer generated 63 page (11" x 14") frame with seven rows and nine columns, on 105mm fiche.

2. *Mid-range.* Reduction ratios of from 35 to 90X would provide up to about 900 pages. Present COM equipment provide the capability of generating microfiche at reduction ratios of 42-48X. This provides a claimed maximum of 450 pages. Indications are that the 50-90X range may be adopted for some text documents and books. For example, Encyclopedia Britannica has adopted that range for its Library of American Civilization, to be published on microfiche. At least one other company has elected to use that range for its planned book publishing effort. Mid-range standard reduction is 48:1 (15 rows x 18 columns).

3. *High-range.* Currently referred to as ultrafiche. Reduction ratios of from 90 to 210X provide capacities up to about 2,000 pages per fiche. Current film limits are estimated at about 280X, or just under 3,000 pages per fiche. The high-reduction range to date has not proven popular. This may change, as quality, price, and availability of equipment improves. The high-reduction fiche competes directly with cartridge film and with magnetic memory devices.

4. *Extreme-range.* Reduction ratios from 280X to 1,000X or even higher are possible. Capacity has been estimated at up to 10,000 pages per inch at this range of reduction. Recording densities in this range can only be achieved by laser recording, bubble techniques, or other exotic laboratory techniques.

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APPENDIX A: REQUIREMENTS AND COSTS FOR ACOUSTICAL CONTROL IN LEARNING CENTER FLOORING MATERIAL

SUMMARY OF RESULTS

Acoustical properties which should be considered in flooring material selection are impact noise and sound absorption. Carpeted floors (when properly designed) can nearly eliminate impact noise and can also provide excellent sound absorption. Learning center student performance can be adversely affected by random intermittent moderate intensity noise, thus providing the requirement for acoustical control. The need for sound suppression alone is "adequate grounds" for carpet insulation.

Cost comparisons show that while annual installed cost of carpet exceeds resilient tile by three to four times, the annual maintenance costs are less than half. It would seem expedient that existing learning centers calculate exactly what their costs would be for carpeting the learning space. The maintenance cost savings may be adequate grounds for carpeting a learning center.

SELECTION FACTORS

1. The two basic types of flooring material usually considered for learning centers are carpet and resilient (vinyl, vinyl asbestos, or asphalt tile).

2. Factors distinguishing between the basic types of flooring and which should be considered are cost, safety, acoustical properties, underfoot comfort, and indentation resistance. The major factors are cost, safety, and acoustical properties. Flooring materials will be discussed on the basis of each of these factors.

3. The acoustical properties which should be considered in flooring material selection are impact noise and sound absorption. Carpeted floors (when properly designed) can nearly eliminate impact noise and are better than most resilient floors regarding impact noise levels. However, resilient floors are better than wood or concrete. Carpet (especially when selected for this purpose) also can be an excellent sound absorber. Cork floor can also effectively absorb sound. Other resilient floors are not too effective in absorbing sound. In a learning center acoustical properties may be the most important factor in selecting flooring material. No flooring material should be considered which does not effectively absorb sound.

Laboratory studies (Weinstein, 1974; Theologus & others, 1974) concerning the effect of noise stress on human performance indicate that random intermittent moderate intensity noise negatively affects intellectual and perceptual-motor performance (while exposure to patterned or steady noise showed no reliable differences in performance). Another study (Glass & others, 1969) showed unpredictable noise (as opposed to predictable) resulted in lowered tolerance for subsequent frustration along with impaired performance in a proofreading task. A recent study (Dansereau & others, 1975) showed individual difference in impairment of learning performances under several conditions of continuous noise distraction. The differences seemed to be greatest with mid-range levels of noise distraction.

The studies here presented suggest that impact noise in a learning center could have quite deleterious effects on all students, and that even fairly low levels of noise distraction (such as are present in a learning center) lower the academic performance of some students. While better documentation of these effects in learning center like environments would be helpful, it seems clear that possible negative learning effects have been documented which would be eliminated by using properly selected carpet. Carpet is strongly recommended for use in learning centers solely for its acoustical properties and its elimination of potentially negative effects on students' learning.

4. The safety factor is composed of four elements. These elements are slip resistance, flammability, susceptibility to fire damage, and resistance to contamination. Carpet clearly is a superior floor covering with respect to slip resistance, especially when compared to a highly waxed or wet resilient flooring material. However, slip resistance is a function of how rough or smooth the floor covering material is. Carpet and asphalt will burn while vinyl products are classed as nonflammable. Most commercially available floor coverings are reasonably resistant to fire damage. However carpet may be less resistant than other

materials. Resistance to contamination, particularly in areas where food may be present, can be critical. The flooring surface should not nurture pathogenic growth. Evidence supplied by carpet manufacturers suggests that carpet can meet reasonable resistance to contamination standards. Carpet is superior in slip resistance, and less adequate in flammability and resistance to fire damage. Resistance to contamination should also be included in the specifications.

5. Indentation resistance depends not just upon the flooring material, but also the weight, the area exposed to the weight, and the length of time which it is exposed. Both carpet and resilient floor covering tend to be especially susceptible to marring or damage from loads such as caused by furniture. Women's stilleto heels will put permanent indentations in resilient floor surfaces.

6. Underfoot comfort impacts upon instructor fatigue, and is a measure of resiliency. Carpet and cork are best while concrete is quite poor. However, if a carpet is excessively resilient, a negative impact on the comfort/fatigue factor results.

7. Cost of flooring is composed of three elements: installation, durability (service life) and maintainability. Examination of recent cost information and durability provides the following chart: Using the arbitrary cost and service life figures results in the following annual installed cost for 1,000 square feet:

Floor Covering	$/ft² Cost Range	$/ft² Arbitrary Cost	Years Service Life Range	Years Arbitrary Service Life
Vinyl Tile	.55–.87	.70	20–30	20
Vinyl Asbestos	.39–.58	.45	16–20	18
Asphalt Tile	.30–.48	.40	10–20	15
Carpet	.85–2.25	1.20	6–18	12

Vinyl Tile	$ 35.00
Vinyl Asbestos	$ 25.00
Asphalt Tile	$ 27.00
Carpet	$100.00

These figures indicate that in general, carpet would have an annual installed cost three to four times that of the tabled resilient flooring materials.

Carpet is generally easier to maintain and is usually kept at a higher appearance level than tile. Maintenance costs are composed of labor time, capital equipment and expendable supplies. The costs of capital equipment and expendable supplies are assumed equivalent in the discussion of maintenance cost, which focuses upon the relative costs of labor to maintain the carpeted and the resilient tile floor. A learning center environment was used as the basis of the following two charts:

Chart 2. **Maintaining Carpet**

Operations	Time (min)/1,000 ft²	Annual Frequency	Total Time (min)/1,000 ft²
Picking up	5	260	1,300
Spot Vacuum	14	104	1,456
Complete Vacuum	20	52	1,040
Shampoo	90	2	180
Stain Removal	5	52	260
			4,236

Chart 3. **Maintaining Resilient Tile**

Operations	Time (min)/1,000 Ft²	Annual Frequency	Total Time (min)/1,000 ft²
Picking up	5	260	1,300
Sweep, Dust or Damp Mop	20	260	5,200
Wet Mop	35	52	1,820
Dry Buff	20	52	1,040
Strip and Refinish	90	2	180
			9,540

When the relative times are converted to labor maintenance cost per 1,000 ft² using a labor cost of \$2.40/hr, carpet (El labor cost is calculated as 2.77/hr) costs \$169.44 per year and resilient tile costs \$381.60 per year. The relative costs of carpet and tile in a learning center can be visualized in the following chart: (These costs assume a large footage of either carpet or tile, not just 1,000 square feet total footage).

Chart 4. **Relative Costs of Carpet and Resilient Tile**

	\$/1,000 Annual Installed Cost	\$/1,000 ft Maintenance	Total Annual Cost
Carpet	100	170	270
Tile	25–35	380	405–415

Using figures from Chart 4, consider the following scenario which assumes that you can maintain learning center floors for the indicated costs. In a 20 X 50 learning center which has resilient tile, you are annually paying \$210 each year for the privilege of maintaining it. If carpeted (with a carpet which would last at least 12 years) you could afford to spend \$21.60 per installed yard in carpet and be cost-effective. In a new learning center, (with the same maintenance assumptions) you could be cost-effective when spending over \$25 per installed yard for carpet. As maintenance labor costs rise, so will the cost which you can afford to invest i carpet installation.

Cost factors alone should not determine the flooring material selection. Functions, such as noise suppression which enable learning efficiency, should be mandatory.

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GLOSSARY

abstract – a kind of thought or concept apart from any particular instances or material objects, not concrete.

acetate – The generic family of plastics which have been used as the base material in magnetic tape. Technically cellulose triacetate or cellulose diacetate.

affective –. the class of mental processes associated with emotion, feeling mood, temperament and the like.

analysis – the process of reducing a complex display or event to its elementary parts.

animation – the creation of movement by sequential photography of individual drawings, each of which represents a perceptible advance in the action.

aperture – The diameter in the opening in a camera or projector (or other similar optical instrument) through which light passes.

application – phase of learning in which the concepts or ideas are used practically or specifically; also the act of putting something on a surface.

aptitude – potential ability or capacity to perform.

attention – the act or fact of bringing something into clear awareness.

attitude – a relatively stable predisposition to react positively or negatively to persons, objects, ideas, or issues.

audio – that which can normally be heard by the human ear; the sound portion of a learning program as distinguished from a picture portion.

audio-tape – a magnetic tape used to store sound information, composed of acetate coated on one surface with a layer of magnetizable particles.

audio-tutorial – a student learning program where the individual's self-paced activities are directed by audio tape.

camera angle – the viewpoint and area given the student by the angle and distance from which an object is photographed.

carrel – a specialized learning area enabling the performances involved in individualized (or small team) self paced instruction.

cartridge – an audio tape or film packaging concept which protects the roll or reel from handling.

cassette – audio or video tape cartridge in which a double spool tape handling system is encapsulated.

cinematography – art of making motion picture films.

coercivity, intrinsic – magnetic intensity of magnetic tape.

compatability – capability of different media devices to present the same courseware item.

concept – an idea or thought.

concrete – a particular or specific item; not general or abstract.

confirmation – used as equivalent to knowledge of correct results in training.

constructed answers – answering by filling in the blank as contrasted to multiple choice.

courseware – instructional materials.

covert – not evident; activities that are not observable or noted by an outside observer (contrasted to overt).

criterion performance – the behavior which indicates the mastery of an objective.

cross-talk – when a tone recorded on one audio track can be heard on another audio track.

cue – the stimulus used in guiding or controlling performance.

cue summation – the simultaneous availability and use of information through two sensory channels, such as simultaneous availability of words and pictures.

decibel (dB) – unit for measuring volume of sound.

denotation – the direct explicit meaning or reference of a sign or symbol.

differentiate – to perceive or express the difference between items.

discrimination – distinguishing differences between items.

display – an exhibit or manifestation of information through a sensory channel.

distractor – the extraneous stimulus which draws attention or interferes with attention.

dubbing – to make a duplicate magnetic recording from the original recording or adding audio to an existing sound track.

ease of operation – the apparent simplicity in using a piece of equipment by a student.

editing – to revise courseware for presentation.

evaluation – an appraisal (of learning performance).

extreme close-up – the photographical recording technique in which tiny objects or small areas fill the entire frame so that they appear greatly magnified when projected.

feedback – the evaluative information available to the student following a performance, useful in regulating present or future performance; specific information for continually improving the quality of the training program.

fidelity – faithfulness of reproduction.

film loop – film which is in a single loop; usually permanently stored in cartridges.

filmstock (raw) – unexposed film.

filmstrip – length of film containing still photographs arranged in sequence for projection separately.

filter (tunable) – an adjustable device that passes electrical currents of certain frequencies or frequency ranges while preventing the passage of others.

fixed sequence – where the information is provided to the student in a fixed order.

frame – a single photographic exposure.

frequency (audio) – number of vibrations or cycles per unit of time.

gaming – narrowly, a type of simulation in which human beings serve as decision makers in a simulated system. In general, an active inherently motivating learning experience which may use simulation.

guard track – the physical separation of parallel recording tracks to reduce or eliminate cross talk.

harmonic – a vibration or frequency which is some integral multiple of the fundament frequency.

Hertz (Hz) – unit of frequency (one cycle per second).

hologram – a three dimensional picture made on photographic film by the pattern of interference formed by light coherent (laser) reflected from the object. The picture is formed by passing light through the film.

humidity – amount of moisture in the air.

individual differences – the differences between students in initial abilities, attitudes, and skills.

information – sensory experience from which learning derives.

information load – the amount and rate of information presented.

instructional media – the basic means of presenting information (both print and non-print).

job aid – a device intended to assist in job performance; such as a handbook, procedural guide, or checklist.

job analysis – identified on-the-job performance requirements in terms of individual tasks and job characteristics.

job objective – the job entry behavior, with conditions, and standards required for satisfactory initial job performance.

kinescope – motion film record of a televised production.

learning center – an individual preplanned environment which enables learners to interface with the body of knowledge and activities upon which criterion performances are based.

learning environment – the place where the student practices those actions which will lead to the achievement of the learning objective.

learning objective – the statement of behaviors, with conditions and standards, which are to be achieved as a result of training.

line drawing – a drawing composed of lines rather than including shades of gray as in a photograph.

magnetic sound – the sound track associated with a motion picture film on a magnetic strip (to distinguish from optically recorded sound).

magnetic tape – a thin strip of plastic coated with magnetic particles on which electric signals can be recorded as magnetic variations.

magnification – an image made larger in size through some photo/mechanical means.

microfiche – a flat sheet of film containing photographic microimages.

microfilm – a strip of film on which documents etc. are photographed for convenience in storage and transportation, usually 100 foot rolls.

microform – a generic term referring to various microimage forms which when suitably projected are readily visible to the human eye.

model – that which may serve as an example for imitation; also a three dimensional representation.

monochrome – an image in one color or different shades of one color.

motivation – the concept used to account for factors within a student which arouse, maintain, and channel goal-directed behavior.

multi-channel broadcast – simultaneously broadcasting different audio materials to different students.

multi-image displays – the simultaneous use of two or more projected images.

multi-media – simultaneous use of several instructional media.

multi-modal media – the class of media which enable presentation of information through more than one sensory channel.

negative – an exposed and developed photographic film on which light and shadow are the reverse of reality.

noise – an unwanted signal in a communication system.

overlays – a transparent sheet containing graphic matter to be superimposed on other sheets.

overt – observable activities; something that can be detected by an observer (opposite of covert).

overlearning – learning in which practice is continued beyond the level of performance needed to ensure retention.

peer – of equal status, usually would refer to another student.

perception – process of sensing objects and objective events.

photosensitive – reacting to radiant energy especially light.

picture – an image or likeness.

pop-ons – the sudden appearance of new information on a display.

post-test – a test after a learning program or experiment.

practice – to do repeatedly so as to learn or become more proficient.

prenarrated slides – presentation composed of synchronized audio associated with sequenced slides.

presentation information – introductory and content information provided to the student.

print – graphic verbal material (as opposed to visual material).

print, photographic – a photographic image made by exposing sensitized paper to light passed through a photographic negative.

procedure – a series of operations followed in a regular, orderly, and prescribed way.

programmed text – a self-instructional booklet which the student works through in a carefully sequenced and pretested series of steps leading to the acquisition of knowledge or mental skills.

projection system – the lamps, lenses, and screens used to view film or opaque materials.

prompting – providing additional information intended to elicit the correct performance.

rapid fading – characteristics where the information does not linger for reception at the student's convenience; also a TV term for a special visual effect.

rate of presentation – amount of information per unit of time.

rear projection – a projection system in which the image is projected through a viewing screen.

recording speed – the set rate at which the magnetic tape is moving when recording audio or video signals.

redundant – providing duplicate information or capability.

referability – availability for perception over a time period; the characteristics that enable sustained scanning or rescanning of information (as contrasted with rapid fading).

referent – the object referred to by a term.

remediation – the process of correcting a student's performance.

resolution (film) – ability of a film to record detail measured in lines per millimeter.

response – reaction to a cue or other stimulus; an overt or covert behavior.

retention – capability of performing a learned act or experience following an interval of no practice.

second generation – a copy from the master copy (such as duplicate slides in audio tapes).

selective perception – perception of some types of objects and objective events better than others, or instead of others.

self-pacing – the student works at his own speed.

sensory channel – the modality of sensation; such as seeing or hearing.

set – readiness to perceive in a certain way or according to a certain frame of reference.

shaping – teaching a desired response by rewarding for acts progressively more like the act to be learned.

sign – information which resembles that which it represents in a non-discrete manner; such as a picture (contrasted with symbol as a type of information).

simulation – the technique of systematically abstracting and partially duplicating a phenomenon, activity, or operation to effect the transfer of training from a synthetic environment to a real environment.

single mode media – a means of presentation which is limited in a single mode, as seeing or hearing.

sixteen millimeter – film format with an image size of 9mm x 12mm. The total film width is 16mm. Other common film widths are 35mm and 8mm.

slow motion – a motion picture photographed so that when projected the portrayal appears much slower than the original action.

sound track – the sound record associated with a visual presentation.

splice – to join together pieces of audio tape, film, video tape or the like.

strategy, learning – a specific orderly process for the conduct of learning.

Super eight – film format with an image size of .158" x .209". The film width is 8mm.

superimpose – to add visual information on top of previously presented visual information (similarly in audio).

symbol – arbitrary, discrete information which bears no resemblance to that which it represents; such as a word (contrasted with sign as a type of information).

synchronization – to provide sound affects or dialogue so as to coincide with appropriate visual portrayal (of still frame or motion frames).

tape recorder – an audio recording device which uses a magnetic tape.

target group – the sub-population for which a specific training program is designed.

temporal – that which expresses time.

time lapse – a motion picture sequence exposed each so that when projected the portrayal appears much faster than the original action.

training – the process by which the student acquires the knowledge, skills and attitudes which will prepare him for job performance.

transparency – a piece of transparent and translucent material having a picture or design which becomes visible when projected.

tutoring – method of individualized instruction; typically involves one instructor teaching one student.

type of information – term used to characterize presentational aspects of information; the two basic types are distinguished as signs and symbols.

VTR – (videotape recorder) an electronic device which records audio and visual patterns.

vanishing cues – displays in which progressively less information is provided to assist the student to provide the correct performance.

verbal – of, in, or pertaining to words.

video tape – magnetic tape on which the electronic impulses corresponding to the video and audio portions of a television program can be recorded and played back.

visual – that which is or can be seen.

wave form analyzer – device used in measuring signal to noise ratio and to study wave characteristics.

zoom lens – a lens that can be rapidly adjusted for different distance views while keeping the image in focus.

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