TEMPORAL VISUAL-OVERLAPPING AS A VARIABLE IN MULTI-IMAGE INSTRUCTIONAL COMMUNICATION

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A THESIS
in
The Department
of
Education

Presented in Partial Fulfillment of the Requirements for
the Degree of Master of Arts in Educational Technology at
Concordia University (Sir George Williams Campus)
Montreal, Canada

APRIL 1975

ABSTRACT

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Comparisons were made among parallel single-image and multi-image tape-slide presentations. Multi-image treatments differed in the amount of time two images were simultaneously in view: three seconds, six seconds, or a complete temporal visual-overlap. The relationship between sex, scholastic ability, and visual format was also examined. A posttest-only control group factorial design was employed with 215 grade eight subjects. The results yielded no significant difference ($p < .05$) between single-image and multi-image for the transmission of pictorial information. However, multi-images were more effective ($p < .05$) for transmission of auditory information, and the most effective ($p < .01$) multi-image format was a six-second visual-overlap. For pictorial information, a complete temporal visual-overlap was more effective ($p < .05$) than a three-second overlap, but not more effective than a six-second overlap. Regardless of visual format, males learned more ($p < .05$) than females, and high scholastic ability students learned more ($p < .05$) than low scholastic ability students. Thus, when a tape-slide presentation is used to communicate factual information, a multi-image format with a six-second visual-overlap seems to be the most effective of the visual formats examined in this study.

ACKNOWLEDGEMENTS.

It is with sincere gratitude that I acknowledge my indebtedness to several people who substantially assisted the successful completion of this thesis. To the following persons I extend my appreciation:

Dr. Gary Coldevin, who as thesis supervisor patiently advised and constructively guided the neophyte researcher;

Dr. George Huntley, whose statistical advice and incisive criticisms of the research design were invaluable;

Dr. John O'Brien and Dr. Denis Dicks who, with Dr. Gary Coldevin and Dr. George Huntley, served as members of my thesis committee;

Tom Rich, friend and cohort, whose expertly modulated vocal chords produced a mellifluous narration;

The staff at the Centre for Instructional Technology and especially Mr. Leslie Takach who graciously provided both the advice and the facilities for the production of the tape-slide presentation;

Members of the Geography Department who verified the instructional content of the experimental presentation;

The administration staff and students of St. Thomas High School and the High School of Montreal, especially Dr. John Jones, whose willing cooperation made this study possible;

René Letourneau, Irving Ellenbogen, and Arthur Shears who sacrificed their free time to assist in the administration of the study. Finally, Julie Charney who struggled with the author's scribbles to produce an excellently typed thesis.

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CHAPTER 1
THE PROBLEM

INTRODUCTION

Multi-image communication is the technique of presenting simultaneously two or more images so that they appear side by side on a screen or screens. A variety of labels have been used to describe the technique: multi-media, multi-screen, wide-screen, multiple-image, multiple-screen, and non-linear projection. Lawson (1971) suggests that multi-image is the most appropriate nomenclature because it can be considered to indicate the use of more than one type of media--slides, film-strips, films, or other projections. Kinder (1973) makes an important distinction between multi-image and multi-media. He says that multi-image may involve two or more images from a variety of media, whereas multi-media implies employing more than one medium, not necessarily an image, for example, a tape-slide presentation.

Experimentation with multi-image goes back to the 1890's when it was used to combine several images into one composite panoramic picture. Perrin (1969a) provides an excellent theoretical and historical account of the development of multi-image communication. Separate multi-images were first used in the 1920's but they were not used regularly in cinema entertainment until the late 1960's. Since then, multi-image displays and presentations have become increasingly wide-

spread in the field of public-relations, business, military, entertainment, and education. Numerous applications of the technique have been made for educational and instructional purposes in a variety of different subject areas, such as history, geography, mathematics, health, education, educational psychology, art, environmental studies, and instructional methods.

Flexibility of visual combinations is an important advantage of multi-image communication. Visuals can be advanced in a variety of sequences. For example, different visuals may be projected cumulatively and regularly onto one or more screens. The same visual may be simultaneously replicated and projected side by side several times. The presentation can be programmed so that one or more images may be held in view while different images accumulate on other projectors. Visuals may be slides, films, over-head transparencies, opaque-projections, or other materials. They may be black and white or colour, originals or copies. Visual stimuli may be iconic, that is, they may in some way resemble their referents, for example, photographs and maps (Levie & Dickie, 1973). Or they may be digital, that is, they may in no way resemble their referents, for example, words and numbers (Levie and Dickie, 1973). Images can be projected front-screen or rear-screen, in a horizontal, vertical, diamond, or a multitude of other dimensional formats. Additional information may be superimposed onto an image already on the screen. Music, sound-effects, or a descriptive verbal explanation may accompany the visual presentation and may be presented 'live' or by synchronized pre-taped recording. "The combinations and varieties of projections with multiple-screen projec-

tions are endless and great flexibility is possible" (Benedict, 1964, p. 518).

The principle objective of this research is to determine the effectiveness of three different visual formats in a multi-image instructional tape-slide presentation. Specifically, empirical evidence is sought for the following questions:

1. Are multi-image audio-visual presentations more effective than single-image presentations for specific types of learning?

2. Does the duration of the temporal visual-overlap (that is, the duration two images are simultaneously in view) affect information acquisition in a multi-image communication?

3. What is the relationship between scholastic ability, sex, and visual presentation format in multi-image communication?

Context of the Problem

Several writers have recommended the use of multi-image in education. Hubbard (1961) points out that related segments of information can be simultaneously displayed with visual accent on important relationships. Benedict (1964) expresses the view that multi-images can illustrate the right and wrong approach to a given task or problem. Also, a finished product, general situation, concept or plan can be shown in one image, with illustrations of certain operations or details in another. Millard (1964) is quoted by Perrin (1969b, p. 369) to ennumerate classroom situations where multi-image techniques would be advantageous.

> The multiple-image technique enables the teacher to make comparisons, to illustrate the development of interrelated concepts, show relationships, and to otherwise combine the capability of several photographic aids either simultaneously or in some programmed pattern or sequence for instructional purposes.
>
> Using multiple-images, we can effectively treat comparisons of the physical, geographical, environmental, dimensional, and spatial characteristics of objects and events. Dichotomies, alternatives, differences, likenesses, and many other forms of comparison can likewise be efficiently handled by this method.

Perrin (1969b, p. 370) adds three further suggestions: relating questions and answers, actions and reactions, and alternative courses of action. "Such a listing can be expanded at length. . . . The possibilities are infinite."

Despite the enormous amount of descriptive and technical literature advocating the use of multi-image communication in education, there is limited empirical evidence to indicate its possible effectiveness, or to support the assumption that it can improve learning. There is some evidence that multi-image communication is effective with primary school children, but format of presentation has less effect on learning as the student grows older (Allen & Cooney, 1963; Roska, 1958; Scholl, 1967). The majority of studies indicate no significant difference between single-image and multi-image presentations (Bollman, 1970; Didcoct, 1972; Franklin, 1971; Lombard, 1969; Tam & Reeve, 1971). Personal evaluation by those who experience multi-image presentations are generally favourable (Lawson, 1971). However, Lumsdaine (1958) found a negative correlation between how much students liked a film and how much they actually learned from it. Didcoct (1972) demonstrated that although college level students may prefer a multi-image rather than a

single-image presentation, this preference may not result in increased learning.

The biggest difficulty with multi-image projection is how to effectively harness its potential. Discussing multi-modal presentations, Carpenter (1953) writes that the difficulty is to arrange the patterns of stimuli, pictures and sound, so that all the elements are integrated and mutually reinforcing for the intended responses and instructional objectives, and to ensure that interference, inhibition, and distractions do not occur. He also notes that stimulus processes even within the limits of a single sensory modality, e.g. vision, may interact to facilitate or inhibit appropriate responses. If theyare not used wisely, multi-images may conflict with each other producing a very incoherent picture (Atkins, 1973). Indeed, Twyford (1969, p. 372), proposes that visual format may not be the reason for the increased learning that a few multi-image studies have demonstrated, rather "the careful organization and presention of instructional content may make the greatest contribution to learning."

There is considerable theoretical and empirical evidence to suggest that multi-images may have a detrimental effect on learning. The assertion that "we can learn many different things from many sources at the same time" (Lawson, 1971, p. 59) is empirically unsound. Broadbent (1958) and Hartman (1961) have demonstrated that interference may occur when multi-channel information is simultaneously presented. Travers (1966) concludes from a number of different studies that multi-sensory modality inputs are likely to be successful only when the rate of input information is presented at such a slow rate that the learner can switch from channel to channel. Reid and Travers (1968, p. 210) found

a "significant depression in learning on a serial learning task when the sense modality of transmission of the stimuli was varied." Perrin (1969b) discounts the relevancy of Travers' experiments by pointing out that there are differences between the nature and function of multi-image presentations and the nature and function of the kind of materials and laboratory conditions used in Travers' research. The present evidence therefore appears inconclusive.

It is clearly evident that more research is needed to assess the impact and effectiveness of different methods of visual presentation. In the spirit of contemporary experimental design, such research should be implemented for specific types of instructional objectives with clearly defined population samples. The present study attempts to assess the effectiveness of selected formats of multi-image communication for one category of the cognitive domain of learning identified as information by Gagné and Briggs (1974) and knowledge by Bloom (1956). Grade eight level high school students are employed as experimental subjects.

STATEMENT OF THE PROBLEM

The principle objective of this research is to determine the effectiveness of three different visual formats in a multi-image instructional tape-slide presentation. Multi-images differ in the amount of time two images are simultaneously in view. In one condition, the complete temporal visual-overlap, an image remains in view, while the succeeding image is projected; however, it is replaced temporarily by a blank-slide until the third image appears to take its place. In

this way, two images are simultaneously in view for a portion of the total presentation only. As the technique of systematically varying the duration of the temporal visual-overlap has not been previously studied, there is little evidence to indicate the optimal duration. For this reason, three different durations of temporal visual-overlapping are tested. In addition, multi-image presentations are compared to a parallel single-image presentation. Comparisons between the four experimental treatments are made to assess differential effects on learning in terms of achievement scores on an immediate post-test.

The problem statement is formulated as follows:

> In large group high school instruction, are multi-image presentations of instructional materials more effective than single-image presentations of the same material when instructional objectives and criterion tests emphasize important visual relationships? And, to what extent does the duration of the temporal visual overlap affect learning from multi-image communication?

A secondary problem is to determine the relationship, if any, between sex, scholastic ability, and presentation format.

Importance of the Study

The answers to the research questions, hopefully, will extend the existing body of facts and principles for increasing the effectiveness of audio-visual materials for large group, high-school instruction (Allen, 1967). Such knowledge is of primary importance to those who plan, produce, or experience instructional communication. It further supports, through the design of learning environments, the development of a science and technology of education, that is, an educational technology (National Council for Educational Technology, 1969).

The practical significance of this study is evidenced by the fact that, although daily multi-image presentations may be impractical, teachers, from all grade levels 2-12 and representing sixteen different subject areas, who have used multi-image have "generally found it to be worthwhile, useful and beneficial as an education resource" (Westwater, 1973, p. 3976). The differential effectiveness of the various formats examined in this study may prove to be uniquely beneficial to media producers and educators engaged in the design and practice of audio-visual communication.

CHAPTER 2
REVIEW OF RELATED RESEARCH

COMPARATIVE EFFECTIVENESS STUDIES

The literature of experimental research is replete with literally hundreds of studies that have attempted to compare the relative effectiveness of one medium with another medium. The predominant findings have been no significant difference (Allen, 1971; Briggs, Campeau, Gagné and May, 1967; Campeau, 1974; Chu & Schramm, 1967; De Kieffer, 1965; Hoban & Van Ormer, 1950; Jamison, Suppes, and Wells (1974). Briggs et al, (1967) assert that these studies have tended to conceal real differences that do exist because most of them have been carried out independently of specific instructional objectives, and without analysis of the types of learning involved and the conditions or instructional events required. Several alternative research strategies have been proposed (Briggs et. al., 1967; Haskins, 1968; Lumsdaine, 1963; Tosti & Ball, 1969). Levie and Dickie (1973, p. 869), propose that "a more productive conceptualization of research related to media selection is one that specifies the relevant variables in terms of the attributes of media rather than in terms of media themselves." Thus, the research question is stated: What media attributes (capabilities) are most appropriate for a given task-learner situation? In the design and development of the present study, analytical attention is paid to the specific types of learning

involved, the specific behaviours to be shaped, and to the strategies that might accomplish these objectives with clearly delineated learner characteristics (Gropper, 1966).

Bracht and Glass (1968) and Snow (1974) criticize traditional educational research for its inadequate attention to external validity, that is, "the extent and manner in which the results of an experiment can be generalized to different subjects, settings, experimenters, and possibly, texts" (Bracht & Glass, 1968, p. 438). These writers recommend several procedures for the control of sources of external invalidity, many of which are employed in this study. In particular, Snow (1974, p. 274) states that research should be undertaken in relevant contexts, such as classrooms.

> At least, the institutional environment and the normal flow of everyday events is then represented. A far more important step is accomplished if the experiment can be embedded unobtrusively in this flow of events.

Experimentation in this study takes place under actual classroom conditions with meaningful instructional materials. Snow (1974) further recommends the adequate preparation of students who are to participate in the experiment. In this study subjects were provided with orienting stimuli in the form of instructional objectives (Mager, 1962), as recommended by Gagné and Briggs (1974). Empirical evidence in support of instructional objectives is reviewed by Duchastel and Merrill (1973).

It is hoped that the careful consideration and control of factors affecting external validity enhances the generalizability of the findings of this study.

MULTI-IMAGE STUDIES

Perrin (1969b) estimated that before 1969 there were only five research studies on the use of multi-images in classroom instruction. Between 1969 and 1975, at least nine further experimental reports have been published.

Malandain (n.d.; cited by Allen & Cooney, 1963, pp. 15-16) in a study measuring the relative effectiveness of showing filmstrips in single successive images and in grouped multi-images found that with primary school children "grouping the frames permits an increase in the number of recollections, but, above all, better organization of recollections."

Roshka (1958; cited by London, 1960, p. 85) examined conditions of learning from visual material which facilitate the process of abstraction and generalization and reported that "simultaneous presentation proves to be more effective than subsequent addition, especially with smaller children."

Allen and Cooney (1963) used filmographs to compare the relative effects on learning of visual images presented non-linearly (simultaneously) and linearly (sequentially). Immediate and delayed effects were measured for three categories of learning: knowledge, comprehension, and application (Bloom, 1956). Immediate test results showed that for six graders, mixed factual-conceptual content is better presented non-linearly; factual material is better presented linearly; neither format is efficient for conceptual treatment of subject matter. The latter two findings were replicated on a delayed test administered after four weeks. This delayed test revealed no significant difference

between single-image and multi-image presentations of mixed factual-conceptual content. With eight graders, the researchers found no significant difference between male and female performance on an immediate posttest. However, on the delayed test the researchers found that males retained the subject matter best in the linear format, and females retained the subject matter best in the non-linear format.

In a study of simultaneous non-redundant usage of two sensory channels (vision and hearing), Card (1966) found that in a paired-associate task, learning could be facilitated by the simultaneous displaying of words to be associated.

> It is evident that simultaneous learning is more rapid and complete than sequential learning in the visual modality (p. 131).
>
> If a high degree of transfer is sought, a simultaneous presentation appears to be most efficient (p. 132).

These conclusions, derived from experimental use of digital signs (words), might not be valid for the use of iconic signs such as photographs and drawings (Levie & Dickie, 1973).

Scholl (1967) discovered that the use of multi-images in visual concept attainment under certain conditions could have a positive effect on learning. He recommended that stimuli should be more complex for subjects at the undergraduate level.

Lombard (1969) presented two groups of eleventh grade students alternative tape-slide presentations: single-image and multi-image (three images). Multi-image proved to be significantly more effective for girls but not for boys. However, the sound track for the two versions of the presentation were similar, but not identical. The sound

track for the multi-image version contained more lengthy statements and questions and took two minutes longer than the single-image version. With this difference in the audio stimulus it is doubtful that the significant finding can be ascribed solely to the variation in visual format. Rather it may have been a function of the difference in narration.

Fradkin (1974) investigating three types of visual presentations, demonstrated that with tenth grade students there was a consistent decrease in recall in all treatment groups between the linear presentation, the two image presentation, and the four image presentation (p. 212).

Tam and Reeve (1971) compared five modes of tape-slide presentation with tenth-grade students. One mode used single-image, and four modes used multi-images: sequential accumulation of two, and three images; and programmed accumulation of two, and three images. In the first run of the experiment, 153 subjects were grouped by a computer according to the convenience of each individual's class schedule. These groups were randomly assigned to treatments. It is not certain that the different treatment groups were similar in important learner characteristics, such as scholastic ability. In a replication of the same experiment, subjects were randomly assigned to treatments, however, the size of the total sample was a mere sixty-one. When this sample was divided into treatment groups, and further divided into male and female subgroups for interactional analysis, experimental data for each variable was particularly small. The researchers used a two-part posttest. In part-one, visual materials were used to measure student comprehsion of image relationships; students had to relate a landscape to its location on a map. In part-two, multiple choice questions were used to measure comprehension

of the individual images and the taped narration.

> No significant differences at the .05 level were found in (1) the relative effectiveness among the five modes of visual presentation, (2) the mean scores between the males and females and (3) the interaction effects between the sex and the modes of presentation (Tam & Reeve, 1971, p. 18).

However, data from part-one of the test tended to favour the multi-image presentation more than the single-image presentation. The reliability of the thirty item posttest, according to KR-20, was 0.66. The authors suggest that the addition of more items might have improved its reliability.

> Perhaps if the length of Part 1 and the instruction period were increased and more appropriate subject materials were selected, the advantages of multiple-screen presentations might become significant (Tam & Reeve, 1971, p. 22).

Didcoct (1972) compared cognitive and affective responses of college students to single-images and multi-images. He found that students preferred multi-image presentations, but that multi-images impaired learning at the undergraduate level. In this experiment, although sound-tracts for the presentations were identical, sixty-two slides were used for the single-image presentation and seventy slides for the multi-image presentation. The experimental results may reflect the difference of visual material rather than the variation of presentation format.

Two studies have explored the non-cognitive impact of multi-image communication. Reid (1970) tested two parallel forms of a film, multi-image format and linear-format, and found that in specific geographic areas the multi-image format was significantly more effective as an agent of attitude change than the linear format. However, Bollman (1970) failed to find statistical evidence to suggest that a multi-image

presentation can cause greater positive shift in evaluative meaning than a parallel single-image presentation. All treatments were ten minutes in length. After such a short period of instruction, it was unrealistic, perhaps, to expect significant affective changes to result from exposure to either presentation formats.

Meyers (1972) and Nelson (1972) investigated audience viewing patterns (eye movement and fixations) during multi-image presentations. Subjects tended to turn to the new image when it first appeared and to direct their attention to either the centre, top-centre, or top-left region of the visual. Meyers (1972) notes that "a point may be reached when it may not be advantageous to leave an image on the screen" (p. 6688). This observation suggests that incomplete temporal visual-overlapping may be an effective presentation technique.

Ehlinger (1973) examined the number of projected visuals (alphabetic letters) recognized by students when exposed to a multi-image presentation in which two image projection rates (three seconds and one and a half seconds) were used. The results indicated that there were no significant differences between the image interval rates and the number of visuals recognized. This study is noteworthy for its attempt to define and evaluate some factors of audience characteristics which may be important for aptitude by treatment interactions "where different intellectual and conceptual abilities are hypothesized to interact with various instructional methods" (Levin, Rohwer & Cleary, 1971, p. 13). Several audience characteristics were examined such as grade point average, lateral dominance, speed reading, and sex, all of which produced statistically non-significant results.

SUMMARY

To date, several key attributes of multi-images have been investigated, such as the number of images presented simultaneously and the sequence and rate of presenting images with different types of visual materials. Cognitive and affective responses of learners at different grade levels have been determined for different domains of learning (Gagné, 1972) in a variety of subject areas. Also, viewer behaviour during presentations and the actual utility or worth of multi-images for classroom teachers have been examined.

Some of the research findings may be invalid due to methodological flaws. In general, sample sizes have been small. In most cases less than thirty subjects for each treatment condition were employed. In the present study there are 43 subjects in each experimental and control group. Hopefully, this sample is large enough to effectively assess significant differences between treatments and facilitate the results toward appropriate generalizations.

In many of the studies reviewed the number of distinct visuals had been few. Tam and Reeve (1971) used thirty-six slides in a twenty-minute presentation. The pace is assumed, therefore, to have been particularly slow. The present study projected almost three times as many slides (104) for a twenty-one minute presentation and is within the recommended pacing rate suggested by Isert (1972). This quickening of pace might have significant effects. There is empirical evidence to justify the conclusion that the pace of changes in visual images may be a prime determinant of attention, with high frequencies of visual change promoting greater increments in cognitive learning (Ainsworth,

1970; Aylward, 1960; Berlyne, 1951; Goldstein, 1975).

No satisfactory explanation has been offered to explain why multi-image communication is effective with young children but less effective with older students. Neither has an explanation been offered as to why female subjects, rather than male, tend to gain more from multi-images. There is also conflicting evidence as to the effect of sex on instructional stimuli presented in single-image and multi-image formats (Lombard, 1969; Tam & Reeve , 1971). According to Gropper (1966) one might expect scholastic ability to be a more significant index of student reaction to various treatments. For this reason, the present study probes possible relationships between presentation format, scholastic ability and sex.

NEEDED RESEARCH

Extant research does not provide conclusive evidence as to the instructional effectiveness of multi-image communication. Replication and follow-up studies employing tighter controls for validity and reliability are needed (Campeau, 1974; Bracht & Glass, 1968; Snow, 1974).

The present study is, in part, a replication of one aspect of Tam and Reeve's (1971) study. A single-image presentation is compared with a parallel multi-image presentation in which two images are "projected cumulatively and regularly" onto a single screen (Tam & Reeve, 1971, p. 8). This study further attempts to provide better controls for history and selection than did Tam and Reeve. The use of a control group who experience a sound film rather than a tape-slide

presentation and take the same test as experimental groups will control for history internal validity violation. Also, this group specifically provides for the control of the Hawthorne effect, that is, "the reactive effect of experimental arrangements" (Tuckman, 1972, p. 128), a possible threat to external validity. A post assignment check is made on scholastic ability measures to assure the equivalence of experimental and control groups. A two-part test similar to that used by Tam and Reeve (1971) is employed. However, as recommended by these researchers, the test contains more items in an attempt to increase its reliability.

Most experimental results favouring multi-images have been derived from research with grade six level students and below. Research is needed at all grade levels but especially with grade-seven and older students. Grade eight level students are therefore selected for the present study.

The flexibility of visual combinations inherent in multi-images provides numerous novel capabilities that warrant exploratory research. The experimental work completed thus far has been carried out without consideration of the duration of the temporal visual-overlap. There is empirical evidence to suggest that this is an important attribute of multi-image communication (Meyers, 1972). In the present study the novel technique of systematically varying the duration of the temporal visual-overlap forms an integral part of the experimental design.

CHAPTER 3
METHODOLOGY

HYPOTHESES

STATEMENT OF THE HYPOTHESES

The objective of this study is to test the following hypotheses:

1. When related visuals are shown cumulatively on the screen, a multi-image tape-slide presentation is more effective for large group instruction at the grade eight level than a parallel single-image presentation.
2. When related visuals are shown cumulatively on the screen a multi-image tape slide presentation using an incomplete temporal visual overlap is more effective for large group instruction at the grade eight level than a parallel multi-image presentation employing a complete temporal visual-overlap.
3. Tape-slide presentations (multi-image and single-image) for large group instruction at the grade eight level are more effective with students of high-level scholastic ability than with students of low-level scholastic ability.
4. Tape-slide presentations (multi-image and single-image) for large group instruction at the grade eight level are equally effective with male and female students.

RATIONALE FOR HYPOTHESIS

Logical justification for hypothesis can be drawn from a variety of theoretical formulations. Hubbard (1961, p. 132) quotes a speech by John Fowles to suggest that multi-images "enable us to capitalize on the Gestalt theory of learning, learning by configuration or pattern rather than by isolated elements." This application of synergistic principles is expanded by Kappler (1967, p. 28).

> One picture, seen by itself, impresses a fact on the mind. Two or three together, and often with continuously changing juxaposition, conjure a complexity of ideas and relationships in which the whole is more than the sum of its parts. Since so much learning is subliminal, such multiple images accompanied by sound and changing lights can cram ideas into the mind. Later they can be recognised and retained.

Perrin (1969b) states that images are especially rich in information content and in the range of associations they stimulate. He cites Gagné (1965) to support the view that multi-images foster learning by association and that simultaneous visual association is especially crucial to memory and conceptual learning.

> The theory of multiple image suggests that for making contrasts and comparisons, and for learning relationships, simultaneous images reduces the task of memory (a dimension of visual task) and enable the viewer to make immediate comparisons (Perrin, 1969b , p. 376).

This application of Gagné's theory is tenuous and needs elaboration. A more valid theoretical foundation for hypothesis may be derived from Hebb's (1966) arousal analysis of learning and retention. Hebb theorises that attention is associated with physiological arousal during learning, with high-level arousal leading to better retention than low arousal. The importance of attention in learning can scarcely be overestimated (Gagné and Rohwer, 1969). It may be theorised that multi-images

are more physiologically arousing than single images, thus improving the instructional effectiveness of stimuli transmitted by both auditory and visual modalities.

Empirical justification for hypothesis (1) is limited but may be deduced from the work of Allen and Cooney (1963), Card (1966), Lombard (1969), and Scholl (1967).

Meyer's (1972) finding that "a point may be reached where it may not be advantageous to leave an image on the screen" (p. 6688) is the principle justification for hypothesis 2. Multi-image communication multiplies learning opportunities (Severins' cue summation theory, 1967), however, by limiting the amount of additional stimuli, the possibility of multi-modal interference is reduced (Hartman, 1961; Travers, 1966).

Hypothesis 3 is supported by several research studies which have shown that no matter how instructional stimuli are transmitted to students, high-ability students learn better than low-ability students (Briggs, 1968; Kanner & Rosentein, 1961; Kraft, 1960; Lublin, 1969; Snow & Salomon, 1968). Although it is hypothesized that increased psychology arousal (Hebb, 1966) may result in better achievement by students at all levels of scholastic ability, nevertheless, single-image or multi-image presentations are not expected to reduce individual differences in performance due to scholastic ability.

The findings of Allen and Cooney (1963), Dwyer (1972), and Tam and Reeve (1971) are congruent with hypothesis 4. Dwyer (1972, p. 90), found that

> Boys and girls in the same grade level (high school) learn equally well from identical types of visual illustrations when they are used to complement oral instruction.

OPERATIONAL DEFINITIONS OF VARIABLES

Multi-image - Two images are projected so that there are two images simultaneously in view adjacent to each other.

Accumulation of images - The multi-image effect is achieved by cumulating each succeeding image for at least three seconds so that two images appear side by side on the screen.

Related images - It is assumed that some images can be more closely related than others (Tam & Reeves, 1971, p. 10). For example, a picture of a landscape has a high degree of relatability to an illustration which depicts its location on a map.

Single-image - "Images are presented separately on the screen, each image disappearing as the succeeding image appears" (Allen & Cooney, 1963, p. 2).

Temporal Visual Overlap - The duration two images are simultaneously in view.

Complete Temporal Visual Overlap - An image remains in view while the succeeding image is projected, and it will remain in view until the third image appears to take its place.

Incomplete Temporal Visual Overlap - An image remains in veiw while the succeeding image is projected. The first image will be

temporarily replaced by a blank-slide until the third image appears to take its place. Two different durations of incomplete temporal overlap are used. The first image is replaced by a blank-slide after three seconds of visual-overlap in one presentation and after six seconds of visual overlap in another.

Tape-slide presentation - A series of 35 mm slides with accompanying taped narration. A tape recording uses one track for speech, and the other to control the slides by using a synchronising pulse which operates a fully automatic slide projector. The narration complements the visuals and was judged to be essentially non-redundant (Travers, 1966) by subject matter experts.

Effectiveness - Effectiveness is measured in terms of achievement scores on an immediate posttest with pictorial and verbal (audio and visual) materials as the testing stimuli. Multiple-choice test items measure student recognition of related images and recognition of facts transmitted by individual pictures and the narration.

Scholastic ability - Student mean scores on school term examinations. These were provided by the school's records' office on computer-print-out sheets. The "median split" technique (Tuckman, 1972, p. 230) was used to con-

vert the scores from interval to nominal measurements.

OPERATIONAL RESTATEMENT OF HYPOTHESES

The hypotheses are operationally restated in the following predictions:

1. When related visual are shown cumulatively on the screen and when an immediate posttest is based on the recognition of related pictorial images, individual pictures and narration, a multi-image tape-slide presentation will be more effective for large group instruction at the grade eight than a parallel single-image presentation.
2. When related visuals are shown cumulatively on the screen and when an immediate posttest is based on the recognition of related pictorial images, individual pictures and narration, multi-image presentations using an incomplete temporatl visual overlap of three seconds or six seconds will be more effective for large group instruction at the grade eight level than a parallel multi-image presentation employing a complete temporal visual overlap.
3. Tape-slide presentations (single-image and multi-image, for large group instruction at the grade eight level will be more effective, in terms of achievement scores on an immediate pictorial and verbal posttest, with students of high scholastic ability than with students of low scholastic ability.
4. Tape-slide presentations (single-image and multi-image) for large group instruction at the grade eight level are equally

effective, in terms of achievement scores on an immediate pictorial and verbal posttest, with males and females.

Population and Sample

The population selected for this study consisted of grade eight students between thirteen and fourteen years of age. The choice of students at this grade level was an arbitrary decision, however, it does reflect the current need for further research with grade seven and older students.

The sample was comprised of 215 students from ten grade eight classes at St. Thomas High School in the Montreal suburb of Pointe Claire. Situated in a middle class and upper class community, St. Thomas has approximately 3000 students. The school was particularly suitable for experimental purposes because audio-visual communications equipment and facilities were present in the school and the introduction of tape-slides into the classrooms was not a foreign occurance to the students. In addition, administrators and teachers were keenly interested in the study and offered willing co-operation in meeting the requirements for access and control.

As the school administrators prefer not to subdivide classes for experimental purposes, normally distributed intact classes were used. Special attention was paid to ensure that assignment to classes occured on an essentially random basis (Tuckman, 1972). Participation in the experiment was required by teachers. Because intact classes were of unequal size, the stimulus conditions had an unequal number of subjects at the conclusion of the experiment. Student data was cast out

by random selection of data cards to equalize the number of subjects in treatment groups (Scholl, 1967). Forty-three subjects remained in each condition. A control group of forty-three subjects who did not experience tape-slides viewed a sound film and took the same posttest as the experimental groups to provide test norms. Two classes were randomly assigned to treatments and each class viewed a presentation during regular class hours. Approximately 74.9% (N = 161) of the sample was thirteen years of age, 23.7% was fourteen years of age (N = 51), while the remaining few were 12 (N = 1), and 15 (N = 2). Of the 215 subjects, 111 were female (52%) and 104 were male (48%). The distribution of subjects by treatment (n = 43), scholastic ability and sex are shown in Table 1 on the following page.

INSTRUCTIONAL MATERIALS

A special twenty-one minute audio-visual presentation entitled "Focus on Zambia" was developed and used in this study.

The visuals were 104 iconic slides (Levie & Dickie, 1972). Twenty were simplified outline maps produced in colour and photocopied. Two slides were introductory ("Focus on Zambia") and end ("The End") titles. One slide was a photocopy of a sixteenth century map of Africa extracted from Davidson (1966, p. 166). These materials were produced by the investigator in the Centre for Instructional Technology, Concordia University (Sir George Williams Campus) in Montreal. The remaining slides were original photographic representations of the Zambian population and various geographical features in Zambia.

TABLE 1

DISTRIBUTION OF SUBJECTS BY TREATMENT, SCHOLASTIC ABILITY AND SEX

	MALE		FEMALE	
	HIGH SCHOLASTIC ABILITY	LOW SCHOLASTIC ABILITY	HIGH SCHOLASTIC ABILITY	LOW SCHOLASTIC ABILITY
Single-image	6	17	10	10
Multi-image: Complete overlap	4	19	15	5
Multi-image: 3" overlap	9	11	13	10
Multi-image: 6" overlap	11	9	14	9
Control	6	12	20	5
TOTALS	36	68	72	39
	104		111	

A 1550-word commentary was written to accompany the visuals. Information in the audio and visual channels were essentially non-redundant (Travers, 1966). Additional descriptive information was presented orally to complement the visuals.

The audio-visual materials were processed into automated tape-slide presentations in single and multi-image formats. Identical sound tracts and slides were used in all experimental conditions. The only experimentally manipulated variable was the type of presentation format, namely, single-image or multi-image.

The control group viewed a sound film entitled "Rock Paintings of Zambia". This film was produced by the investigator while in Zambia. It could not have been seen by subjects before the control presentation.

SELECTION OF SUBJECT MATTER

A geographical introduction to Zambia was chosen as the experimental subject matter based upon the following criteria:

SUITABILITY

In order to carry out the experiment, the topic chosen had to be appropriate for presentation in single-image and multi-image formats. Not all subject matter lends itself to multi-image treatment (Allen & Cooney, 1963). Visual materials are especially suitable for introducing topics which are far removed from the experiences of the student (Williams, 1963), as was the case with the selected topic. Multi-images have been used successfully in geography instruction. Buley (1965) describes how multi-images were developed for geography

instruction at the Connecticut State College. An 8 foot by 18 foot rear projection screen,

> serves as the focal point for the simulatanegus use of contiguous visual images of related, comparative, and component information. It permits direct cross-reference data. It gives flexibility, impact, and retention (Buley, 1965, p. 391).

In providing a rationale for the use of geography pictures in their research, Tam and Reeves (1971, p.2) state that multi-images should have particular appeal for geography instruction.

> In many cases, students need to study the context of individual pictures, to make comparisons of them, and to identify the locations they depict.

In combining geography pictures with related maps, the present study is similar to that of Tam and Reeve (1971).

RELEVANCY

The experimental subjects were grade eight students and the topic selected had to be educative, interesting, and at an appropriate level of comprehension for this target population. After discussion with teachers in the experimental school, it was decided that a geographical introduction to Zambia would be a worthwhile novel educational experience for the students and would fall within the purview of their course requirements.

ORIGINALITY

The visual materials and content had to be original to ensure that members of the experimental sample were not familiar with the topic. All picture-slides were selected from the investigators private collection of photographs taken in Zambia. In addition, the audio

element of the presentation was an original production. It is certain that none of the subjects would have been exposed to these particular stimulus materials before this experiment.

FEASIBILITY

Of necessity, the stimulus materials had to be produced within stringent time and financial constraints. As most of the visual materials were already available without charge, additional production requirements (map-making, photocopying and taping narration) were not excessive in terms of time or expense. These production procedures were accomplished by the investigator with the kind voluntary assistance of friends.

PREPARATION OF INSTRUCTIONAL MATERIALS

In accordance with current instructional design (Gagné & Briggs, 1974) instructional objectives were written and classified according to a taxonomy of domains of learning developed by Gagné (1972). Objectives were specifically written for the information domain, operationalized as the learning of statements which express a relationship between two or more objects or events (Gagné & Briggs, 1974, p. 58). The tape-slide presentation was designed to achieve the following objectives:

1. Given twenty different projected pictures of places, people, or animals of Zambia viewed during the presentation, the student will be able to choose from four possible alternatives the correct location of each picture on an outline

map, within ten minutes (thirty seconds for each picture).

2) The student will be able to answer correctly within ten minutes, twenty multiple-choice (four options) questions designed to elicit information presented by individual pictures and taped-narration in a tape-slide presentation.

The presentation was developed in accordance with the principles and procedures of instructional product design recommended by Baker and Schutz (1967), Gagné and Briggs (1974), and Wittich and Schuller (1973). There is considerable empirical evidence (Ausubel, 1968; Mandler, 1962; Rohwer & Levin, 1968) to support the contention that

> . . . the most important prerequisite for the learning of information is the provision of a meaningful context within which the newly learned information can be "subsumed," or with which it can be in some meaningful sense "associated" (Gagné & Briggs, 1974, p. 143).

Specific information on the production of multi-image presentations was obtained from Benedict (1964), Lawson (1971), Perrin (1969a), and Trohanis (1971).

Visual material was selected according to criteria (clarity, composition, colour balance, exposure, impact, unique contribution, and other factors) established by previous research in visual literacy (Allen, 1967; Atkins, 1973; Dwyer, 1972; Levie & Dickie, 1973). Recommendations of expert photographers were also taken into account (Isert, 1972). The visuals were viewed by four experienced photographers and were rated acceptable in terms of composition, technique, and impact.

The script was developed and written, and then checked by subject matter experts in geography and instructional design at the university level. Recommended alterations of the script were made. The narration was recorded on 1/4 inch audio-tape by a professional narrator in the sound studios of the Instructional Communications Centre, McGill University. Opening and closing music, as well as two pieces of music to accompany slides within the presentation, were added. The sound recording was edited and the finished product was 23 1/2 minutes long.

TRYOUT OF INSTRUCTIONAL MATERIALS

A pilot study was carried out prior to the experiment on samples of the target population who did not take part in the final study to determine whether the material was suitable in terms of time and difficulty for the majority of students, and to determine the reliability and the validity of the criterion test. Thirty grade eight students at the High School of Montreal were used as subjects.

A single-image presentation was prepared for the pilot study. As the narrative and the music played on one track of the tape, a sixty cycle pulse was recorded on a second-track so that the tape would automatically advance the slides in synchronization with the narration. This was accomplished using a Kodak Dissolve Control Model-2, a Kodak Carousal 750H projector, and a Sony TC-270 stereo tape-recorder.

As a result of the pilot test, considerable alteration of the original tape-slide presentation was judged necessary. Fourteen slides and an accompanying 3 1/2 minutes of narration were removed,

reducing the length of the presentation to twenty minutes. A single relocation of two slides and twenty seconds of narration was necessary to preserve a reasonable flow of narration. Three identical copies of the re-edited tape were made using two Sony TC-270 stereo tape-recorders. A copy of the final script is provided in Appendix A.

The materials were processed into automated tape-slide presentations in single and multi-image formats. The same procedures employed in the preparation of the pilot presentation were used to pulse a single tape to control the single-image and multi-image complete overlap presentations. For each multi-image incomplete overlap presentation it was necessary to record two different pulse tones on the same audio track to control the advance of slides at the right time and in the correct sequence. A MacKenzie Tri-Tone Program Unit was used to pulse a separate tape for the three-second and six-second visual-overlap presentations.

Each presentation was monitored several times to establish correct programme synchronization and operation.

CRITERION TEST

Data consisted of scores on items selected from a criterion test (Appendix B) administered immediately after each presentation. The test was based on the visual and audio content of the presentation alone. It was divided into two parts. In Part I, projected and printed materials (pictures and maps) were used to measure student recognition of image relationships. According to Tam and Reeve (1971, p. 21)

> In order to score high, the students need to have related one image with another occassionally during the

presentation; for example, relating a landscape to its location on a map.

In Part 2, printed multiple-choice questions were used to measure student recognition of facts transmitted by individual pictures and the narration.

Test items were classified either as measures of Visual Learning (Dwyer, 1971), that is, information received by the visual perceptual system) or measures of Aural Learning, that is, information received by the auditory perceptual system. Measures of Visual and Aural Learning were grouped into two separate tests which were analyzed independently. There were 18 items in the Visual Learning test and 16 items in the Aural Learning test.

Content validity was verified by selecting all test questions and visual materials directly from the audio and visual portions of the tape-slide presentations. In addition, content was verified by a subject matter expert, and by two judges after they had viewed the presentation.

The Kuder-Richardson 20 method was used to establish reliability and internal consistency (Ebel, 1965). Measures of reliability were based on data from thirty completed tests selected at random from the final experiment. The Kuder-Richardson 20 formula revealed a reliability of .71 for the Visual Learning test and .65 for the Aural Learning test. KR-20 reliability procedures and item analysis for indices of difficulty and discrimination are provided in Appendix C.

PREPARATION OF CRITERION TEST

The dependent variable in this study was learning. In order to enhance the generality of the findings, measures of learning were based on Bloom's (1956) categories within the cognitive domain. The instructional objectives were classified as knowledge. Bloom (1956, p. 78) states that

> The major behaviour tested in knowledge is whether or not the student can remember and either recite or recognize accurate statements in response to particular questions.

Bloom's recommendations for the construction of items to test knowledge were followed in the design of the criterion test.

There is empirical evidence to indicate "that processing and storage mechanisms for materials received visually or auditorially are fundamentally different" (Levie & Dickie, 1973, p. 869). This suggests that the assessment of learning should be divided into at least two categories dependent on whether instructional stimuli are transmitted by the visual or auditory modality. Consequently, test items in this study were designed to measure independently the aquisition of information received by the visual and auditory perceptual systems.

In addition, Hartman (1961) points out that experimental results may be distorted by testing the learning of pictorial information by means of verbal descriptions approximate to it. Also, he concludes that "the learning of information presented in several channels is more likely to be demonstrated if it is tested in several channels" (p. 126). Cue-summation stimulus-generalization theory (Severin, 1967) postulates that the learning of presented information increases as the testing situation becomes more similar to the

presentation situation. For this reason, the criterion test in this study was comprised of pictorial and verbal (visual and audio) test items.

VALIDATION OF CRITERION TEST

The pilot study used to validate the instructional materials (see p. 32) was used also to determine the reliability and validity of the criterion test. For this study the test contained 21 items in Part 1 and 33 in Part 2. Instructions to subjects and testing conditions were the same as those supplied to all subjects in the final experiment.

Reliability of the test was determined by computing item discrimination and item difficulty (Appendix C). Items which did not reach a reasonable standard were deleted from the test or were considerably changed (Ebel, 1965).

The final version of the test after pretesting (Appendix B) contained 43 multiple-choice items with four choices available for each answer. There were 18 items in Part 1 and 25 in Part 2. Test items 1 through 18, 32, 41, 42, and 43 were designed to measure acquisition and retention of information transmitted by the visuals. These items were classified as measures of Visual Learning. All other items on the test were considered measures of Aural Learning, that is, information received through the auditory channel.

RESEARCH DESIGN

A posttest only control group (5 x 2 x 2) factorial design

(Tuckman, 1972) is used. There are five levels of the independent variable (presentation format), and two levels for each of two moderator variables (scholastic ability, and sex). The design is illustrated in Figure 1 on the following page.

VARIABLES

Independent - There is one discrete independent variable: visual presentation format. There are five levels of this variable:

(1) single-images (X_1)

(2) multi-image complete temporal visual-overlap (X_2)

(3) multi-image incomplete temporal visual-overlap of three seconds (X_3)

(4) multi-image incomplete temporal visual-overlap of six seconds (X_4), and

(5) alternative film presentation (X_0).

Moderator - The moderator variables are two levels of sex--male(Y_1) and female (Y_2), and two levels of scholastic ability--low level (Z_1) and high level (Z_2) student mean scores on term examinations.

Dependant - The dependent variable is learning as measured by achievement scores (O) of the subjects in an immediate posttest. Test items which measure

FIGURE 1
RESEARCH DESIGN

Level 1	X_1	Y_1 Y_2	Z_1 Z_2	O_1
Level 2	X_2	Y_1 Y_2	Z_1 Z_2	O_2
Level 3	X_3	Y_1 Y_2	Z_1 Z_2	O_3
Level 4	X_4	Y_1 Y_2	Z_1 Z_2	O_4
Level 5	X_0	Y_1 Y_2	Z_1 Z_2	O_5

R

Where:

R = randomization of classes to treatments

X = treatment

O = appropriate observations

X_1 = single-images

X_2 = complete temporal visual overlap

X_3 = incomplete temporal visual overlap of three seconds

X_4 = incomplete temporal visual overlap of six seconds

X_0 = Hawthorne control group, unrelated film

Y_1 = male subjects

Y_2 = female subjects

Z_1 = low-level scholastic ability

Z_2 = high-level scholastic ability

--- = intact groups

Visual Learning and Aural Learning are grouped into two separate tests which are analyzed independently.

Control - (1) Scholastic ability and sex of the subjects. Note that these two variables are both control and moderator variables.

(2) The total time span of the presentation.

(3) The same slides and the same narration are used in exactly the same sequence.

(4) The same or nearly the same physical conditions, such as sound level, viewing and lighting conditions, and screen brilliance, are maintained.

(5) Preknowledge of the experimental material.

(6) The conditions for completion of the post-test.

TESTING PROCEDURES

STUDY SETTING

This study was designed to assess the comparative effectiveness of multi-image and single-image presentation formats. In order to control environmental variables, all treatment groups were exposed to the stimulus materials under very similar viewing and listening conditions.

Testing took place during three days in three regularly assigned classrooms in the same wing of the experimental school. Two

grade eight classes were randomly selected for each treatment. Each class viewed a presentation during scheduled class periods. As there were ten classes, each treatment presentation was repeated twice with the order of presentations being randomly assigned.

FACILITIES AND EQUIPMENT

Before each presentation the projection equipment was set up as planned. Levels of reproduced sound and ambient light were taken, and the equipment was checked for perfect operation. An illustration of the projection equipment arrangement can be found in Appendix D.

The equipment employed consisted of a Sony TC-270 stereo tape recorder with one extension speaker, two Kodak Carousel 750H 35mm slide projectors fitted with 4- to 6-inch, f/3.5 Ektanar zoom lenses, a Kodak Dissolve Control, Model 2, and a MacKenzie Tri-Tone Program Unit. A single 9 foot by 12 foot matt projection screen was used for all treatments. The control presentation, a sound-film, was projected by a Kodak Pageant AV126TR 16mm optical sound film projector fitted with a 2-inch, f1.6 Ektanar lens.

The video and tape equipment was mounted on a three and a half foot high trolley, 13 feet from the screen. The size of each projected image was 36 inches by 28 inches. The bottom edge of slides in a horizontal format was 45 inches from the floor. In multi-image presentations images were projected parallel to each other and were separated by 1 1/4 inches. Both projectors were mounted on the same stand, this resulted in a slight keystoning effect during multi-image projections, with the external edges of images being approximately one inch longer than corresponding internal edges.

Although controls over the environment were desirable, the physical situation allowed for very little control. The rooms were darkened by drawing curtains that were not completely lightproof. They permitted a considerable amount of light to leak in around the sides and bottom. As a result, ambient light levels present in the rooms varied according to exterior weather conditions and time of day. A Sekonic Studio light meter was used to measure incident light falling onto the projection screen. Readings varied from two foot candles to eight foot candles. The preponderance of extraneous light made it necessary to place the projector thirteen feet from the viewing screen to maximise the brightness of the projected images. New quartz-halogen lamps were inserted into the slide projectors and the optics were cleaned to ensure equivalent light production. Many of the subjects were seated parallel to, or behind the projection equipment. It is possible that some subjects may have been distracted by the equipment. However, this distraction existed across treatments and was not considered a serious threat to internal validity.

All subjects were seated not less than two image widths and not more than five image widths from the screen. Thus, all subjects were located within an angle of thirty degrees on either side of a perpendicular line from the projector to the screen. This seating pattern provided for optimum viewing by all subjects (Taylor, 1966).

In single-image presentations there were 104 slides mounted in glass. Two Kodak 750H slide projectors linked to a Kodak dissolve unit enabled an uninterrupted visual transition from slide to slide.

In multi-image presentations there were the same 104 slides,

and an additional 104 blank slides. The presentations were set up in four trays with two projectors. It was a simple task to switch trays while a blank slide was being projected. In this way the presentation continued as planned without interruption.

The audio-tape for each tape-slide presentation was played on the same Sony TC-270 tape recorder. Volume and tone controls were the same for all treatments. Ambient noise was minimized by asking the subjects to refrain from talking during the presentation.

PRESENTATION

The investigator controlled the lights, monitored the audio level, administered test-booklets, and answered questions.

Prior to experiencing the audio-visual presentation, each experimental group was given the same short verbal introduction in order to reduce the possibility of any variable occuring from the use of different test administrations. The instructions read as follows:

> For the next twenty minutes you will be watching and listening to a tape-slide show about Zambia, a colourful independent African country. Hopefully, you will enjoy the show and find it interesting. Its purpose is to give you an idea of what a country south of the Sahara looks like.
>
> When the presentation is finished, I will ask you to complete a written test. Your answers on the test will not count towards a grade but will be analyzed so that we can find out what parts of the tape-slide show ought to be improved. To do well on the test all you have to do is to look carefully at the pictures and listen carefully to the commentary. The test will ask questions about geographical locations and other factual information presented in the show.
>
> After the presentation you should be able to do at least two things:
>
> First, when shown pictures of Zambia that you have seen during the tape-slide show, you should be able to choose from

four different places marked on the outline map of Zambia, the correct location of each picture.
Secondly, you should be able to answer correctly multiple-choice questions on information you have seen and heard during the show.

To do well on the test all you have to do is to look carefully at the pictures and listen carefully to the commentary during the show. Please do not talk or take notes. Let's begin.

The subjects then viewed the slides with the accompanying synchronized taped narration. The sequence of slides in each presentation is illustrated in Figure 2 on the following page.

The control group were given a similar introductory statement which made no reference to the tape-slide presentation.

POSTTEST

As soon as the presentation ended, the test booklets were distributed (Appendix B). Subjects were instructed to write their name, age, sex, and class code number on the top of the title page in the spaces provided. Instructions for completing Part 1 and Part 2 of the test were read to the subjects and an example question from each part was explained. After answering only procedural questions for clarification, the testing began.

The investigator projected the first test slide and started the tape recorder. Each slide was shown for exactly thirty seconds. The tape automatically advanced the slide projector to the next slide and the narrator asked the accompanying verbal question. After all eighteen test slides had been shown the narrator informed the subjects that Part 1 of the test had come to an end. They then proceeded to answer Part 2 of the test at their own pace. Time was not found to be a

FIGURE 2

SEQUENCE OF SLIDES

SINGLE IMAGE Screen Center	MULTI-IMAGE COMPLETE VISUAL OVERLAP Screen Right	MULTI-IMAGE COMPLETE VISUAL OVERLAP Screen Left	MULTI-IMAGE INCOMPLETE VISUAL OVERLAP Screen Right	MULTI-IMAGE INCOMPLETE VISUAL OVERLAP Screen Left
1	1	0	1	0
			1	0
2	1	2	1	2
			0	2
3	3	2	3	2
			3	0
4	3	4	3	4
			0	4
5	5	4	5	4
			5	0
6	5	6	5	6
			0	6
7	7	6	7	6
			7	0
8	7	8	7	8
			0	8
9	9	8	9	8
			9	0
10	9	10	9	10
			0	10
11	11	10	11	10
-	-	-	-	-
103	102	103	102	103
			0	103
104	104	103	104	103
			104	0
0	0	0	0	0

0 = blank slides

total number of slides = 104

hindering factor in completing the test. The completed booklet from each subject was checked to ensure that it was correctly labelled.

TEST SCORING

All tests were hand scored by the investigator with a random check of scored tests to verify scoring procedures. Each question on the test was multiple-choice and only one answer was accepted as correct. Each correct answer was awarded one point. Wrong, missed, or doubtful ratings were scored as zero. Scores were recorded for each item and each student on computer coding sheets. A total score for each student was also recorded.

STATISTICAL PROCEDURES

Marginals were first generated for measures of scholastic ability to produce means and standard deviations for each group. A three-way analysis of variance (Tuckman, 1972) was used to determine if significant differences existed between treatments as a result of subject assignment to treatments.

A Pearson r (Tuckman, 1972) was calculated to establish the extent of the relationship between measures of Visual Learning and Aural Learning.

Marginals were produced for all data and a three-way analysis of variance was used to analyze the results. This indicated:

1) the effect of the independent variable (presentation format) on the dependant variable (learning)
2) the effect of the moderator variable (sex) on the dependent

variable (learning)

3) the effect of the moderator variable (scholastic ability) on the dependant variable (learning)
4) the interaction between presentation format and sex
5) the interaction between presentation format and scholastic ability
6) the interaction between sex and scholastic ability
7) the interaction between presentation format, sex, and scholastic ability.

The Newman-Keuls multiple comparison test was used to compare the levels within significant factors. Significant differences were reported at the .05 level.

Computer facilities at Concordia University (Sir George Williams Campus) and McGill University in Montreal were used for statistical analysis of data. The AV1234 program was used for the analysis of variances. For verification purposes analyses were replicated with the Isis (Facexp) sub-programme. Identical results were reported by each computer programme. The Statpak programme was used to generate the scatter diagram shown on page 50 .

CHAPTER 4
RESULTS

Forty-three subjects for each experimental and control group were sampled (N = 215). To determine whether subjects were randomly distributed in equivalent groups, a three-way analysis of variance was performed using measures of scholastic ability. Means and standard deviations for measures of scholastic ability are shown in Table 2 on the following page. The analysis of variance presented in Table 3 on page 49 shows no significant difference ($p < .01$) between groups. The groups are assumed therefore to be equivalent in terms of scholastic ability. Table 3 does indicate that female subjects had a significant higher scholastic ability ($p < .05$) than males.

In order to determine the extent to which subject performance the Visual Learning and Aural Learning components of the test were related, a Pearson r (Runyon and Haber, 1971) was calculated using raw scores. This resulted in a moderate linear correlation ($r = .61$) which is illustrated in the scatter diagram depicted in Figure 3 on page 50 .

The square of r (r^2) indicates the coefficient of determination, that is, "the ratio of the explained variance to the total variation" (Runyon and Haber, 1972, p. 122). With an $r = .61$, the coefficient of determination is 0.37. In other words, only 37% of the total variance was in common. As the proportion of common variance was so low, separate analyses of variance for Visual Learning and Aural Learn-

TABLE 2

SCHOLASTIC ABILITY MEANS AND STANDARD DEVIATIONS FOR FIVE GROUPS

TREATMENT GROUP	SEX	SCHOLASTIC ABILITY	N	MEAN	STANDARD DEVIATION	TREATMENT MEAN	SEX MEAN		SCHOLASTIC ABILITY MEAN	
Single-Image	Male	High	6	76.5	4.32	71.41	Male	69.93	High	78.35
	"	Low	17	63.4	8.98		Female	72.90	Low	64.48
	Female	High	10	80.2	4.44					
	"	Low	10	65.6	8.57					
Multi-Image Complete Overlap	Male	High	4	75.2	9.57	71.36	Male	69.89	High	79.06
	"	Low	19	64.5	5.67		Female	72.83	Low	63.66
	Female	High	15	82.9	4.73					
	"	Low	5	62.8	4.66					
Multi-Image 3" Overlap	Male	High	9	78.7	5.70	71.60	Male	70.88	High	79.10
	"	Low	11	63.1	6.64		Female	72.32	Low	64.10
	Female	High	13	79.5	4.59					
	"	Low	10	65.1	6.06					
Multi-Image 6" Overlap	Male	High	11	78.2	2.89	72.44	Male	72.31	High	78.56
	"	Low	9	66.4	5.17		Female	72.53	Low	66.33
	Female	High	14	78.9	3.83					
	"	Low	9	66.2	7.21					
Control	Male	High	6	78.7	4.80	73.41	Male	71.67	High	79.38
	"	Low	12	64.7	10.6		Female	75.15	Low	67.43
	Female	High	20	80.1	4.73					
	"	Low	5	70.2	1.64					

$N = 215$ $\bar{X} = 72.05$ $\sigma = 8.70$

TABLE 3

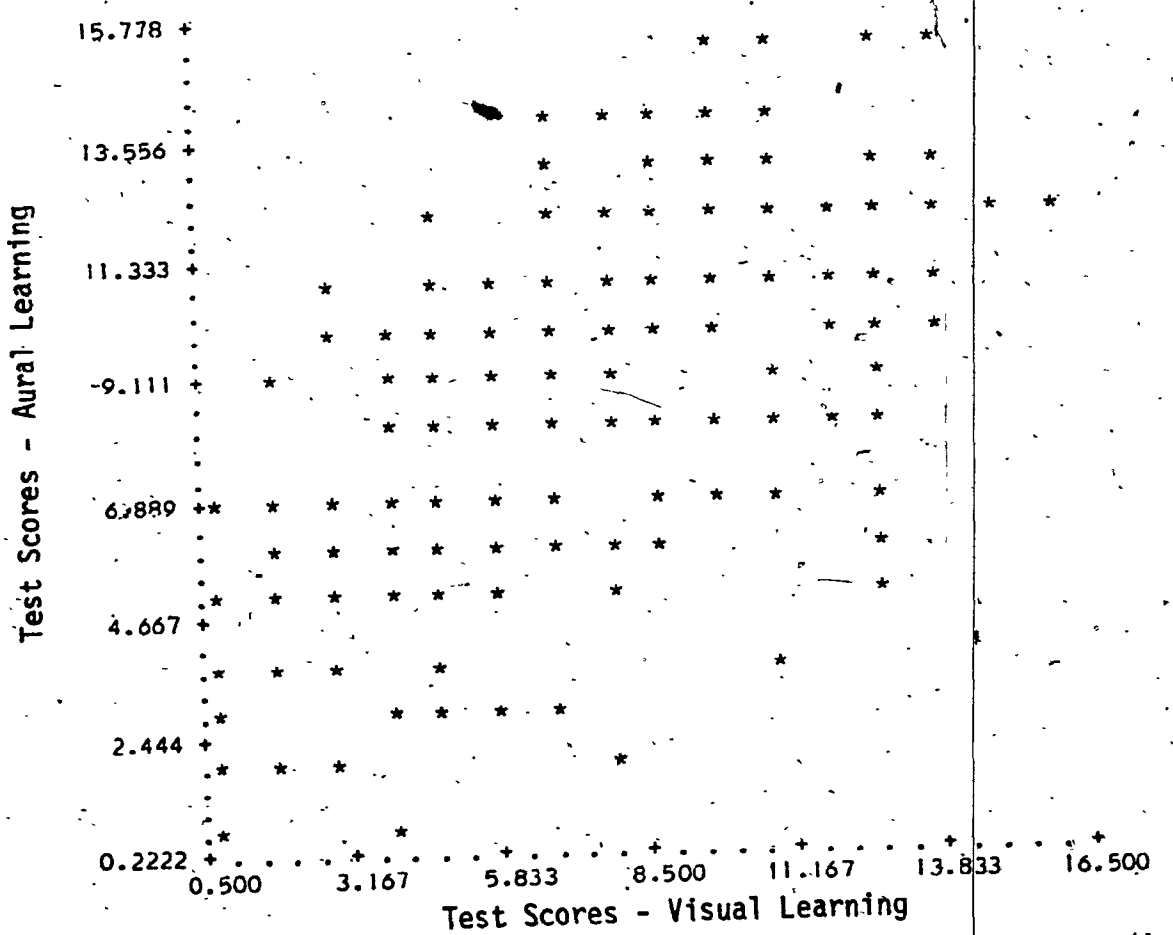
ANALYSIS OF VARIANCE OF FIVE GROUP SCHOLASTIC ABILITY MEANS

SOURCE OF VARIATION	SUM SQUARES	DEGREES OF FREEDOM	F-RATIO	PROBABILITY
Treatments	109.264	4	.7425	.5665
Sex	218.422	1	5.9376*	.01[illegible]
Scholastic Ability	8298.458	1	225.5838**	.0000
Treatment by Sex	63.148	4	.4291	.7897
Treatment by Ability	87.316	4	.5934	.6712
Sex by Ability	18.868	1	.5129	.5182
Treatment by Sex by Ability	221.236	4	1.5035	.2015
Error	7173.465	195		
TOTAL	*16190.149*	*214*		

* $p < .05$
** $p < .0001$

FIGURE 3

SCATTER DIAGRAM OF THE RELATIONSHIP BETWEEN STUDENT PERFORMANCE ON VISUAL AND AURAL COMPONENTS OF THE CRITERION TEST



ing seemed warranted. Further justification for this procedure was provided by the finding of significant differential treatment effects on Aural Learning that were not evident in measures of Visual Learning.

VISUAL LEARNING

Mean scores and standard deviations for Visual Learning are shown in Table 4 on page 52. This data is reported for each cell within each treatment.

The three-way analysis of variance summary presented in Table 5 on page 53 shows significant overall effects ($p < .0001$) between the five treatments. Significant overall effects were also found between sexes ($p < .001$), and between high and low scholastic ability ($p < .05$). Examination of overall means revealed that males ($\overline{X} = 8.229$) did significantly better than females ($\overline{X} = 6.903$) and subjects of high scholastic ability ($\overline{X} = 7.948$) did significantly better than subjects of low scholastic ability ($X = 6.903$). No significant interactions were found between treatment, sex, and scholastic ability.

Since a significant difference between treatments was found, the Newman Keuls test was applied to validate significant mean comparisons (Table 6, page 54). All experimental treatments were significantly better ($p < .01$) than the results achieved by the control group. All tape-slide presentations were thus found to be effective teaching instruments for Visual Learning. The multi-image complete temporal visual-overlap treatment, however, was significantly better ($p < .05$) than the three-second visual-overlap treatment. No significant difference was found between the complete visual-overlap and the six-second

TABLE 4

VISUAL LEARNING MEANS AND STANDARD DEVIATIONS FOR FIVE GROUPS

TREATMENT GROUP	SEX	SCHOLASTIC ABILITY	N	MEAN	STANDARD DEVIATION	TREATMENT MEAN	SEX MEAN		SCHOLASTIC ABILITY MEAN	
Single-Image	Male	High	6	10.0	3.63	8.20	Male	9.29	High	8.95
	"	Low	17	8.59	3.48		Female	7.10	Low	7.40
	Female	High	10	7.90	3.96					
	"	Low	10	6.30	2.11					
Multi-Image Complete Overlap	Male	High	4	9.25	2.99	9.34	Male	9.31	High	9.99
	"	Low	19	9.37	4.14		Female	9.37	Low	8.69
	Female	High	15	10.7	2.89					
	"	Low	5	8.00	1.87					
Multi-Image 3 Second Overlap	Male	High	9	9.00	3.67	7.35	Male	8.32	High	7.92
	"	Low	11	7.64	3.41		Female	6.37	Low	6.76
	Female	High	13	6.85	2.91					
	"	Low	10	5.90	2.47					
Multi-Image 6 Second Overlap	Male	High	11	10.6	2.11	8.68	Male	10.10	High	8.93
	"	Low	9	9.56	1.59		Female	7.27	Low	8.44
	Female	High	14	7.21	3.56					
	"	Low	9	7.33	3.04					
Control	Male	High	6	4.50	1.97	3.56	Male	4.13	High	3.95
	"	Low	12	3.75	2.38		Female	3.00	Low	3.18
	Female	High	20	3.40	2.04					
	"	Low	5	2.60	1.14					

$N = 215$ $\bar{X} = 7.43$ $\sigma = 3.57$

TABLE 5

ANALYSIS OF VARIANCE OF FIVE GROUP VISUAL LEARNING MEANS

SOURCE OF VARIATION	SUM SQUARES	DEGREES OF FREEDOM	F-RATIO	PROBABILITY
Treatments	735.704	4	20.4102***	.0000
Sex	114.181	1	12.6706**	.0008
Scholastic Ability	48.340	1	5.3643*	.0203
Treatment by Sex	43.736	4	1.2133	.3058
Treatment by Ability	6.064	4	.1682	.9520
Sex by Ability	.960	1	.1066	.7435
Treatment by Sex by Ability	20.704	4	.5743	.6849
Error	1757.145	195		
TOTAL	2726.834	214		

*$p < .05$
**$p < .001$
***$p < .0001$

TABLE 6

APPLICATION OF NEWMAN KEULS TEST TO DETERMINE SIGNIFICANT DIFFERENCES BETWEEN FIVE TREATMENT MEANS FOR VISUAL LEARNING

	MEANS	X5	X3	X1	X4	X2
Control	X5 = 3.56	---	3.79**	4.64**	5.12**	5.78**
Multi-Image: 3" Overlap	X3 = 7.35		---	.85	1.33	1.99*
Single-Image	X1 = 8.20			---	.48	1.14
Multi-Image: 6" Overlap	X4 = 8.68				---	.66
Multi-Image: Complete Overlap	X2 = 9.34					---
	Wr (.05) = 1.27	1.52	1.66	1.77		
	Wr (.01) = 1.67	1.89	2.02	2.11		

* $p < .05$
** $p < .01$

visual-overlap treatments. This preliminary analysis of temporal visual-overlapping suggests that the optimal duration is between a six-second and a complete visual-overlap for Visual Learning measured in this study.

AURAL LEARNING

Mean scores and standard deviations for aural learning are shown in Table 7 on page 56. This data is reported for each cell within each treatment.

The three-way analysis of variance summary presented in Table 8 on page 57 indicates significant overall effects between treatments ($p < .0001$), between sex ($p < .05$), and between scholastic ability ($p < .005$). The Newman Keuls test was applied to all treatment means to determine which were in fact significant (Table 9, page 58). Examination of the means for sex and scholastic ability revealed identical findings to those obtained for visual learning. Males ($\bar{X} = 9.315$) did significantly better than females ($\bar{X} = 8.561$), and subjects of high scholastic ability ($\bar{X} = 9.469$) did significantly better than subjects of low scholastic ability ($\bar{X} = 8.561$). No significant interaction effects were found.

The application of the Newman Keuls test indicated that all experimental treatments were significantly better ($p < .01$) than the results achieved by the control group. Similar to the former Visual Learning result, all tape-slide presentations were also effective in communicating novel audio instructional content. All multi-image presentations were significantly better ($p < .05$) than the single-image

TABLE 7

AURAL LEARNING AND STANDARD DEVIATIONS FOR FIVE GROUPS

TREATMENT GROUP	SEX	SCHOLASTIC ABILITY	N	MEAN	STANDARD DEVIATION	TREATMENT MEAN	SEX MEAN		SCHOLASTIC ABILITY MEAN	
Single-Image	Male	High	6	10.5	3.51	8.53	Male	9.01	High	9.60
	"	Low	17	7.53	3.10		Female	8.05	Low	7.46
	Female	High	10	8.70	3.16					
	"	Low	10	7.40	2.22					
Multi-Image Complete Overlap	Male	High	4	10.7	.500	9.92	Male	10.16	High	10.64
	"	Low	19	9.58	2.43		Female	9.67	Low	9.19
	Female	High	15	10.5	1.96					
	"	Low	5	8.80	2.59					
Multi-Image: 3" Overlap	Male	High	9	11.0	2.69	9.79	Male	10.36	High	10.46
	"	Low	11	9.73	2.49		Female	9.21	Low	9.11
	Female	High	13	9.92	2.69					
	"	Low	10	8.50	1.96					
Multi-Image: 6" Overlap	Male	High	11	12.5	1.97	11.39	Male	11.95	High	11.44
	"	Low	9	11.4	2.70		Female	10.83	Low	11.33
	Female	High	14	10.4	2.41					
	"	Low	9	11.2	2.28					
Control	Male	High	6	5.50	1.38	5.07	Male	5.08	High	5.20
	"	Low	12	4.67	1.61		Female	5.05	Low	4.93
	Female	High	20	4.90	2.40					
	"	Low	5	5.28	2.86					

$N = 215$ $\bar{X} = 8.94$ $\sigma = 3.14$

TABLE 8

ANALYSIS OF VARIANCE OF FIVE GROUP AURAL LEARNING MEANS

SOURCE OF VARIATION	SUM SQUARES	DEGREES OF FREEDOM	F-RATIO	PROBABILITY
Treatments	808.716	4	33.5687***	.0000
Sex	25.202	1	4.1844*	.0396
Scholastic Ability	49.948	1	8.2930**	.0047
Treatment by Sex	8.192	4	.3400	.8515
Treatment by Ability	25.932	4	1.0764	.3696
Sex by Ability	6.718	1	1.1154	.2923
Treatment by Sex by Ability	10.260	4	.4258	.7921
Error	1174.485	195		
TOTAL	2109.453	214		

*$p < .05$
**$p < .005$
***$p < .0001$

TABLE 9

APPLICATION OF NEWMAN KEULS TEST TO DETERMINE SIGNIFICANT DIFFERENCES BETWEEN FIVE TREATMENT MEANS FOR AURAL LEARNING

TREATMENT	MEANS	X5	X1	X3	X2	X4
Control	X5 = 5.07	---	3.47**	4.72**	4.85**	6.32**
Single-Image	X1 = 8.53		---	1.26*	1.39*	1.86**
Multi-Image: 3" Overlap	X3 = 9.79			---	.13	1.60**
Multi-Image: Complete Overlap	X2 = 9.92				---	1.47**
Multi-Image: 6" Overlap	X4 = 11.39					---
	Wr (.05) = 1.04	1.24	1.36	1.44		
	Wr (.01) = 1.36	1.54	1.65	1.72		

* $p < .05$
** $p < .01$

presentation. The multi-image six-second visual-overlap presentation, however, was significantly more effective ($p < .01$) than either the three-second or complete visual-overlap. No significant differences were found between the latter two treatments. The same condition held for significant interaction effects between treatments, sex and scholastic ability.

CHAPTER 5

DISCUSSIONS, CONCLUSIONS, RECOMMENDATIONS, SUMMARY

DISCUSSION AND CONCLUSIONS

This study was conducted to explore the effectiveness of different visual formats in tape-slide presentations for large group instruction at the grade eight level for one type of cognitive learning, identified as information (Gagné & Briggs, 1974) and knowledge (Bloom, 1956). The only experimentally manipulated variable was the presentation format, namely, single-image and multi-image. A secondary problem was to examine the relationship, if any, between visual format, scholastic ability, and sex.

The discussion and conclusions which follow are organized under a re-examination of each original hypothesis in the light of experimental results.

In general, measures of Aural Learning indicate that a multi-image presentation employing an incomplete temporal visual-overlap of six seconds is the most effective visual format for the instructional conditions existent in the present study. This finding was not replicated in measures of Visual Learning which yielded no significant differences between the single-image and multi-image presentations. Trends in the descriptive data, however, favour multi-image presentations. This difference may become significant under different experi-

mental conditions. Finally, measures of Visual Learning and Aural Learning revealed that, regardless of visual format, tape-slide presentations were more effective with high-level scholastic ability students than with low-level scholastic ability students, and more effective with male students than with female students.

HYPOTHESIS 1

> When related visuals are shown cumulatively on the screen, a multi-image tape-slide presentation is more effective for large group instruction at the grade eight level than a parallel single-image presentation.

The results affirm hypothesis 1 showing that where significant differences between single-image and multi-image treatment groups do occur, these differences favour a multi-image format. However, as has been previously noted, different results were obtained by separate analyses of Visual and Aural Learning.

Visual Learning

A variation in visual presentation format did not produce a difference in immediate recall of information received by the visual perceptual system. Subjects recalled visual information equally well presented single-image or multi-image. This is consistent with the findings of Allen and Cooney (1963) and Tam and Reeve (1971). Didcoct (1972) and Lombard (1970) observed similar results but, as these researchers did not use pictorial testing stimuli, it may be inappropriate to compare their findings with those of this study. The different testing situations may have been assessing different types of learning.

Hartman (1961) points out that verbal testing of pictorially presented information may distort the results.

Descriptive data comparisons, however, indicate that differences between experimental group mean scores favour multi-image presentations. Allen and Cooney (1963, p. 109) propose that

> . . . these differences become important, even though not statistically, when it is remembered that they were produced by variation in the visual component only.

The particular experimental materials utilized in this study and the limitations of the experimental situation may have diluted potential advantages of multi-image presentation. Perrin (1969, p. 369) provides a relevant theoretical framework.

> In sequential montage the meaning of each new image is determined by the context of what has gone before. In its temporal aspects, sequential montage is analogous to verbal language, where several elements in series determine the total meaning. Simultaneous images may interact upon each other at the same time, and this is of significant value in making comparisons and relationships. An important contributing factor is screen size. On small screens, the overall identity of the image is most significant. On large screens (or screens side-by-side), the viewer makes his own montage of different comparative information. The immediacy of this type of communication allows the viewer to process large amounts of information in a very short time. Thus information density is effectively increased, and certain kinds of information are more efficiently learned.

The visual materials in this study were kept at a low level of simplicity. For the most part, they were outline maps and close-up photographic views of relevant objects. These materials may have been sufficiently simple, therefore, to be effectively presented either by single-image or multi-image projection. More important, the simplistic nature of the criterion task may not have required the visual reinforcement and referability opportunities offered by simultaneous projection of related visuals. Subjects in the single-image experimental group

appear to have effectively accomplished the learning task associated with the accumulation of sequentially projected visual stimuli. The advantage of multi-image presentation within this context may be significant with more complex materials and a more demanding criterion task.

It is further possible that the novelty of the multi-image presentations may have been a disadvantage, confusing the subjects rather than helping them. Lombard (1969, p. 82) points out that multi-image communication

> requires a grammer which writer and perceiver can both appreciate, code and decode, and requires conventions and principles. It is clear that the message designer must encode in such a way that his message will be decoded with accuracy; therefore, certain conventions must be used and interpreted similarly. . . However, one cannot hope to design instructional messages using some of these newer projected visual techniques unless the viewer is familiar with the techniques and their implications.

Few of the experimental subjects claimed to have seen a multi-image presentation before this experiment. They have been confused by information presented in such a novel instructional format.

In multi-image presentations images were projected cumulatively and regularly on the screen. A regular sequence of slide changes was used to isolate the effects of different visual presentation formats. This may have hindered one important attribute of multi-image communication, namely, flexibility of visual combinations. Tam and Reeve (1971) found evidence to suggest that programmed image accumulation (where some images are accumulated for a longer period and others are shown sequentially) is more effective than regular image accumulation. A more flexible and idiosyncratic sequence of visual-overlapping may produce a significant difference between single-image and multi-image presentations.

Aural Learning

Measures of Aural Learning indicated that multi-image presentations are significantly better ($p. < .05$) than a parallel single-image presentation. This finding is consistent with previous research conducted with subjects at the grade six level and below (Allen & Cooney, 1963; Card, 1966; Maladain, n.d.; Roshka, 1958). It is not supported by the research of Didcoct (1972), Lombard (1969) or Tam and Reeve (1971). The finding of a significant difference is particularly important when it is remembered that the audio stimulus was identical for all experimental groups. The learning of information presented in the auditory modality was significantly improved by the simultaneous projection of successive images.

It is possible to explain the superiority of multi-image over a single-image presentation in a simple proposition, namely, simultaneous projection of accumulated images in an audio-visual presentation provides a visual-bridge between past and present narrative, which reinforces the acquisition auditory information and offers additional opportunities for inter-channel referability. Levie and Dickie (1973) outline a number of propositions which may be translated into a rationale for the concept of visual-bridging in audio-visual presentations.

> Auditory signals are finite in duration and relatively difficult to preserve. Visual displays are long lasting and have high referability, that is, they are available for long periods so that they can be referred to repeatedly (p. 867).

McCormick (1957, p. 427) cites empirical evidence for the conclusion that

> auditory stimuli...have poor referability; meaning that they usually cannot be kept before the observer, although they can be repeated periodically. Visual stim-

uli offer good referability, because the information usually can be stored in the display.

It can be theorized that auditory stimuli can be 'stored' in the visual component of an audio-visual presentation. Auditory and visual information become associated by being simultaneously presented. This association may persist after a change of stimuli in one of the modalities. Thus, the sustaining of an image on a screen while a new image appears may provide a visual link between auditory information presented recently and currently. This assumption is congruent with the practice of sound bridges supporting visual transitions in television and film productions.

Multi-modal Interference

It is not sufficient to examine the effects of the experimental presentations merely in terms of separate visual and auditory components. The composite message has its own characteristics (Allen & Cooney, 1963).

The Visual Learning test had a total of 18 items, two more than the Aural test, yet the total mean score for the Visual test was lower than that obtained for the Aural test. Subjects did comparatively better on the Aural test ($\overline{X}$ = 8.94) than they did on the Visual test ($\overline{X}$ = 7.43). The different K-R reliability scores obtained for the Visual Learning test (.71) and the Aural Learning test (.65) may account for the difference in test achievement scores. Also, the novelty of using projected slides and accompanying auditory questions in the Visual Learning test may have had a detrimental effect on student performance. However, the differences may be explained in terms of audio-visual modality interference.

Hartman (1961, p. 255) concludes from a number of studies of interchannel interference that

> Interference among information simultaneously presented by multiple channels may be expected when...the cognitive difficulty or rate of presentation is such that successful alternation of attention among channels is not possible...the obvious expectation is for additional information to result from additional information. However, the probability of interference resulting from the additional cues is very high The hoped-for enhanced communication resulting from a summation of cues occurs only under special conditions.

Hartman also found that pictorial information was the least affected by interference when information was also coming over another channel. He suggests that "when information presented in the channels is of unequal difficulty, the less difficult information suffers the greatest loss" (p.249). Dwyer (1973) concurs with the proposition that the most difficult information in an audio-visual presentation is the pictorial component. Didcoct (1972, p. 58) further writes that "it seems likely that the audio portion, while intelligible when communicated in a single channel, became difficult to comprehend when combined with simultaneous visual images." An alternative viewpoint, which is consistent with the findings of the present study, is proposed by Franzwa (1973, p. 20).

> ...when words and pictures are combined, at least in the visual field, words command attention over pictures. This tendency to focus attention on the word rather than pictorial details may indicate words, as abstract symbols are richer in meaning than pictures (concrete symbols) and that attention tends to be attracted by that which is richest in meaning...This same relationship should hold for words, presented aurally in combination with pictures.

This study supports the conclusion that the auditory channel in a tape-slide communication commands greater attention than the visual channel, regardless of visual presentation format. The delicate balance needed for cue summation (Severin, 1968) in a multi-media presentation is in

need of further research.

HYPOTHESIS 2

> When related visuals are shown cumulatively on the screen, a multi-image tape-slide presentation using an incomplete temporal visual-overlap is more effective for large group instruction at the grade eight level than a parallel multi-image presentation employing a complete temporal visual-overlap.

No general statement can be made in support or rejection of hypothesis 2. For measures of Visual Learning, a complete temporal visual-overlap was shown to be more effective than a three-second visual-overlap. Measures of Aural Learning yielded results in favour of an incomplete temporal visual-overlap of six seconds. The results for both parts of the test show that the length of the incomplete visual-overlap is of critical importance.

The conclusion to be deduced would seem to indicate that there is an optimal duration of temporal visual-overlapping and, for the materials utilized in this study, the optimal overlap is somewhere between a complete and a six-second incomplete overlap.

Visual Learning

The duration of the temporal visual-overlap makes a significant difference in learning from visual materials. Results show that a complete temporal visual-overlap is significantly better ($p < .05$) than an incomplete visual-overlap of three seconds. Equally important is the finding of no significant difference between a complete visual-overlap and a six-second visual-overlap. Descriptive data, however, favour complete temporal visual-overlapping.

The combination of two images would seem to increase the complexity of the instructional message, thus increasing the visual task factor (Perrin, 1969), that is, the work the learner must do to extract relevant information. As has been previously mentioned, the probability of interference resulting from a summation of cues is particularly high (Hartman, 1961). In multi-image presentations additional visual cues were provided by simultaneously projecting two images. Three seconds of visual-overlap appears to provide students with insufficient time to extract information from simultaneously projected images. In a study of viewing patterns in multi-image presentations, Meyers (1971) found that viewers turned to a new image when it first appeared. The disappearance of an image after three seconds of simultaneous projection in the present case may have been a distraction. Generally, the longer the maintenance of the visual-overlap, the greater will be the increment in Visual Learning.

Aural Learning

With measures of Aural Learning a six-second visual-overlap was significantly more effective ($p < .01$) than either a complete temporal visual-overlap or a three-second overlap. The sustaining of simultaneous images on a screen for more than six seconds seems to interfere with the acquisition of information. Also, a three-second visual-overlap seems to limit the effectiveness of multi-image communication. Whatever advantages are offered by multi-images for transmitting auditory information, the greatest positive effect is achieved after six seconds of visual-overlap.

HYPOTHESIS 3

> Tape-slide presentations (multi-image and single-image) for large group instruction at the grade eight level are more effective with students of high-level scholastic ability than with students of low level scholastic ability.

Results support hypothesis 3 showing that students of high level scholastic ability performed significantly better ($p < .01$) on the criterion test than students of low level scholastic ability. No interaction between scholastic ability and presentation format was observed. This is consistent with studies which have reported that students of high level ability learn more than students of low ability regardless of instruction or format of presentation (Briggs, 1968; Kanner & Rosenstein, 1960; Lambert, Miller & Wiley, 1962; Lublin, 1969; Snow & Salomon, 1968).

This study clearly indicates that scholastic ability influences the effectiveness of audio-visual materials. However, this study did not reveal specific techniques of visual presentation which might interact with different levels of scholastic ability.

HYPOTHESIS 4

> Tape-slide presentations (single-image and multi-image) are equally effective for large group instruction at the grade eight level with male and female students.

This study found that students with high scholastic ability learn more from tape-slide presentations than subjects of low scholastic ability. In addition, female subjects had a significantly higher scholastic ability than male subjects. Nevertheless, significant sex differences ($p. < .05$) in favour of males were revealed by the Visual and Aural Learning tests. These results do not support Hypothesis 4. In addition, they are inconsistent with Allen and Cooney (1963), Dwyer

(1972) and Tam and Reeve (1971). It is important to note that no interaction effects between presentation format and sex were found. The sex difference in favour of males does not seem to have been caused by a variation in visual format but by some variable which was constant across treatments.

It has been a commonplace finding that males and females perform differently on various learning tasks. For example, females are generally better readers than males, and males are generally superior to females in tasks involving numerical reasoning and spacial relationships (Dwyer, 1974). In the present study the reason for the observed sex difference is not known, however, several explanations can be advanced as causal factors.

The content of the instructional materials may have had differential effects on male and female arousal levels (Hebb, 1966) during presentations. Tam and Reeve (1971) found no significant difference between male and female performance with materials dealing with Hong Kong. However, it is possible that the African topic used in this study influenced male motivation to learn more than female motivation.

A second tentative explanation of the results may be based on the particular appeal the presentation equipment had for males. This equipment was elaborate and impressive. The presentation may have had different meanings for the two sexes, capitalizing on the male interest in hardware.

Finally, the finding of a significant sex difference may have been a chance occurence. The .05 level was considered an acceptable level of confidence to reject the null hypothesis of equal means between sexes. It is possible that a more rigorous confidence level may

eliminate the finding of significant sex differences.

Recommendation for Further Research

Extant research does not provide conclusive evidence as to the instructional effectiveness of multi-image presenations. The results of this study demonstrate the need for further research into the area of multi-image, multi-media communication.

Primarily, this study should be replicated at all age levels, kindergarten through college, to determine at what age and for what reasons multi-image presenations result in increased learning. Findings should be based on an immediate posttest and on a delayed test administered several weeks after the experimental presentation so that comparisons between short and long retention can be made.

Snow (1974, p. 281) states that "generalizations about school learning need to be built on research using substantial samples of learning time." The present findings are derived from subjects with a single exposure to multi-image communication. Examination of multi-images as an instructional device over several months of repeated use may be a more appropriate measure of their effectiveness.

This study indicates that the effectiveness of the auditory and visual elements of a tape-slide presentation should be assessed independently by different tests. For example, if pictorial materials are used, than a pictorial test format also should be used. The whole question of appropriate test format needs investigation.

The present study was confined to the information domain of cognitive learning (Gagné, 1972). Further research should examine

additional domains of learning and assess which content area and subject materials are more likely to benefit from the utilization of multi-image communication. The advantages of multi-images may be extensive with different levels of learning and with more complex instructional materials and learning tasks.

A variety of multi-image formats might well be studied so as to determine which are instructionally advantageous. The duration that two images are simultaneously in view is of crucial importance. Different durations of temporal visual overlapping should be investigated. A flexible and idiosyncratic sequence of visual-overlapping may produce significant differences between single-image and multi-image presentations. Research using visuals projected in a horizontal, vertical, diamond, or a multitude of other dimensional formats may discover optimal visual patterns of multi-image projection.

The novelty of simultaneous images appears to limit their effectiveness. As more and more multi-image presentations are experienced, individuals may become more sophisticated about what to expect from these productions. Further research should compare the criterion performance of students who have viewed multi-images previously with the performance of students who have never been exposed to a multi-image presentation prior to testing.

The extent to which various sequences of multi-images effect learning warrants investigation. Also, the length of time each image is projected should be investigated to assess the effects of different pacing rates. An attempt should be made to define optimal sequencing and pacing patterns of visual change for students of a wide range of age and aptitude.

Further research should cover a broad range of audience characteristics and discover which attributes of multi-image presentation are appropriate for specific learner characteristics. For example, an initial study might identify "visual attenders" and "aural attenders" according to a procedure outlined by Ingersoll (1971) and Levin, Rohwer and Cleary (1971). An individual's preferences for a particular modality (auditory or visual) may affect the acquisition and retention of information presented in the visual and auditory modalities of a multi-image presentation. Such research should be related to a consideration of the ways in which verbal and pictorial stimuli are internally coded and retrieved. The identification of important aptitude by treatment interactions should enable instructional product developers to vary interactional materials to fit student characteristics (see Koran, 1972).

This study indicated that the combination of two channels, audio and visual, may result in multi-modal interference. Hartman (1961) states that the level of difficulty in each channel must be such that it permits the learner to switch attention between channels. Reid and Travers (1968) found that there was a significant depression in the learning of digital signs (words) when sense modality (visual and auditory) was varied. The time lost for each channel switch was estimated to be 168 milliseconds. It is doubtful, however, if these findings can be generalized to learning from iconic (pictorial) visual materials. Research should be conducted to estimate the amount of time necessary to switch attention between an auditory-verbal message and a visual-pictorial message. Future studies also should determine which channel demands the most attention when audio-visual materials (verbal and pictorial) are transmitted in a multi-image format.

Other variables which should be explored are the image size, the distance and angle of the audience from the screen, and the technique of cropping or simplifying images to reduce the complexity of irrelevant information. Indeed, procedures for codifying the amount of information in visual stimuli deserve critical attention (see Goldstein, 1975).

The novel concept of visual bridging is proposed. This postulates that simultaneous projection of accumulated images in an audio-visual presentation provides a visual-bridge between past and present narrative which reinforces auditory information and offers additional opportunities for inter-channel referability. The conceptual boundaries of visual-bridging need further development. Additional empirical justification for visual-bridging may be provided by treating it as an independent variable in replication studies.

Twyford's (1969, p. 372) observation that the superiority of multi-image presentations is more related to the design and development of the instruction than to multi-image format should be investigated. For example, are multi-image presentations more effective than standardized lecture procedures?

Finally, how practical is the idea of multi-images for regular instructional purposes? Principle advantages of tape-slide presentations are their low cost and simple technical requirements. The facilities required for the production and presentation of multi-images are relatively more complex and expensive. Further research should compare the cost effectiveness of multi-image communication with alternative production and presentation methods.

In sum, the flexibility of visual combinations enabled by multi-image communication provides novel capabilities that warrant exploratory research.

SUMMARY

This study was concerned with the presentation of information utilizing audio-visual single-image and multi-image formats. The questions investigated were:

1. Are multi-image audio-visual presentations more effective than single-image presentations for specific types of learning?

2. Does the duration of the temporal visual-overlap (that is, the duration two images are simultaneously in view) affect information acquisition in a multi-image communication?

3. What is the relationship between scholastic ability, sex, and visual presentation format in multi-image communication?

The study was conducted at the grade eight level and effects were measured for one category of learning, identified as information (Gagné, 1972) and knowledge (Bloom, 1956).

A review of related literature revealed numerous theoretical advantages for the presentation of information in multi-image format. However, empirical research indicated that while multi-image communication is effective with primary school children it has less effect on learning as the students grow older. The experimental work completed had been carried out without consideration of the duration of the temporal visual-overlap, that is, the amount of time images are simultaneously in view. There was empirical evidence to suggest that this was an important attribute of multi-image communication. In the present study the novel technique of systematically varying the duration of

the temporal visual-overlap formed an integral part of the experimental design.

The subjects were 215 grade-eight level students at St. Thomas High School in the Montreal suburb of Pointe Claire. Normally distributed intact classes were randomly assigned to one of five treatment conditions. A post-assignment check of student mean scores on term examinations indicated that subjects were randomly distributed in equivalent groups. Girls were found to have a significantly higher level of scholastic ability ($p < .05$).

A geographical introduction to Zambia was chosen as the experimental subject matter based upon the criteria of suitability, relevancy, originality, and feasibility. The specially prepared 21 minute presentation consisted of 104 iconic slides (Levie & Dickie, 1972) and an accompanying 1550-word narration. Information in the auditory and visual modalities was essentially non-redundant (Travers, 1966). Additional descriptive information was presented orally to complement the visuals. Identical sound tracks and slides were used in all experimental conditions. The only experimentally manipulated variable was the type of visual format, single-image and multi-image. Multi-image presentations varied in the amount of time two images were allowed to remain simultaneously in view. A Hawthorne control group was exposed to an unrelated 20 minute sound film.

The dependent variable was cognitive learning identified as information (Briggs & Gagne, 1974) and knowledge (Bloom, 1956). Data consisted of scores on a criterion test administered immediately after each experimental and control presentation. The test was divided into two parts. In Part 1, projected and printed materials (that is, pictures

and maps) were used as the testing stimuli to measure student recognition of image relationships. In Part 2, printed multiple-choice questions were used to measure student recognition of facts transmitted by individual pictures and the narration. The questions and testing stimuli were selected directly from the narrative and visual portions of the instructional materials.

A pilot study was carried out prior to the experiment on samples of the target population who did not take part in the final study to determine the reliability and validity of the test, and to determine whether the instructional materials were suitable in terms of time and difficulty for the majority of subjects. Results of this test indicated the need for major alterations which were incorporated in a reconstruction of the instructional presentation and the criterion test.

For analysis purposes, test items were classified either as measures of Visual Learning or Aural Learning depending on whether they were measuring information received by the visual or auditory perceptual systems. There were 18 Visual Learning test items, and 16 Aural Learning test items. A K-R reliability score of .71 and .65 was obtained for the Visual Learning and the Aural Learning tests respectively.

Experimentation was conducted during normally scheduled class periods in three classrooms, all very similar, under approximately normal classroom conditions. Each treatment group was composed of 43 subjects who saw one presentation and wrote an immediate posttest. As there were ten classes, each treatment presentation was repeated twice with the order of presentations being randomly assigned.

The tests were handscored by the investigator with a random check of scored tests to verify scoring procedures. The data was organized and run through computer programmes at Concordia University (Sir George Williams Campus) and McGill University in Montreal.

A Pearson r (Tuckman, 1972) was calculated to establish the extent of the relationship between measures of Visual and Aural Learning. This resulted in an $r = .61$. The coefficient of determination (Runyon and Haber, 1972) was 0.37. As the proportion of the common variance was only 37% separate analyses were performed on Visual and Aural test items.

Marginals were generated for data to produce means and standard deviations for each treatment cell. A three-way analysis of variance was computed for each part of the test. The Newman-Keuls test was used to compare significant means. Significant differences were reported at the .05 level.

Significant differences ($p < .0001$) between groups were found. All experimental treatments were shown to be superior ($p < .01$) to the Hawthorne control group. With measures of Visual Learning no significant differences were found between single-image and multi-image presentations. However, a multi-image presentation with a complete temporal visual-overlap was shown to be significantly better ($p. < .05$) than a parallel multi-image presentation with a three-second visual overlap. With measures of Aural Learning significant differences ($p. < .05$) in favour of a multi-image presentation with a six-second overlap were observed. Regardless of visual format, males learned more ($p < .05$) than females, and high scholastic ability students learned more ($p < .05$) than low scholastic ability students.

Comparisons of single-image and multi-image tape-slide presentations permitted the following general conclusions for the student population, learning tasks, and instructional materials utilized in this study.

1. Multi-image and single-image presentations are equally effective for transmitting visual information.

2. Multi-image presentations are more effective for transmitting auditory information.

3. The optimal duration of the temporal visual-overlap in multi-image communication is somewhere between a complete and a six-second overlap.

4. When verbal (audio) and pictorial materials are combined in a tape-slide presentation, words command attention over pictures.

5. Multi-image projection of accumulated images in an audio-visual presentation provides a visual-bridge between past and present narrative which reinforces auditory information and provides additional opportunities for inter-channel referability.

6. Students of high scholastic ability learn more from tape-slide presentations than students of low scholastic ability.

7. Male students learn more from tape-slide presentations

(single-image and multi-image) than female students.

In sum, comparisons of single-image and multi-image tape-slide presentations indicated that a multi-image communication with a six-second visual-overlap is the most effective for the experimental conditions of this study.

Areas suggested for further research are replications of existing studies with all age levels and with different types of learning, instructional content, and audio-visual materials. Additionally, variety of visual formats and a broad range of audience characteristics should be examined to discover which media attributes are appropriate for specific learner characteristics. Finally, future research should dtermine how practical multi-image communication is for regular instructional purposes.

REFERENCES

Ainsworth, T.D. Frequency of visual change in multi-channel communication as a factor in maintaining attention and creating attitudes to media and message: an experimental study. Dissertation Abstracts, 1971, 31, 3158.

Allen, W.H. Media stimulus and types of learning. Audiovisual Instruction, 1967, 12, 27-31.

Allen, W.H. Instructional media research. Past, present, future. A V Communication Review, 1971, 19, 5-18.

Allen, W.H., and Cooney, S.M. A study of the non-linearity variable in filmic presentation. Los Angeles: University of Southern California, 1963. (National Defense and Education Act. Title VII Project No. 422).

Atkins, R.J. The use of slides: Practical answers to key questions. Visual Education. 1974, January, 27-30.

Ausubel, D.P. Educational psychology: A cognitive view. New York: Holt, Rhinehart & Winston, 1968.

Aylward, T. A study of the effect of production techniques on a televised lecture. Dissertation Abstracts, 1960, 21, 1660.

Baker, R.L., & Schutz, R.E. (Eds.). Instructional product development. New York: Van Nostrand Reinhold, 1971.

Benedict, J. Programming for multiple screen showmanship. Audiovisual instruction, 1964, 9, 518-519.

Berlyne, D. Attention to change. British Journal of Psychology, 1951, 42, 269-278.

Bloom, B.S. (Ed.) Taxonomy of educational objectives: Handbook I: Cognitive domain. New York, McKay, 1956.

Bollman, C.G. The effect of large screen, multi-image display on evaluative meaning. Unpublished doctoral dissertation, Michigan State University, 1970.

Bracht, G.H. & Glass, G.V. The external validity of experiments. American Educational Research Journal, 1968, 5, 437-474.

Briggs, L.J., Campeau, P.O., Gagné, R.M. and May, M.A. Instructional media: A procedure for the design of multi-media instruction, a critical review of research, and suggestions for future research. Pittsburgh: American Institutes for Research, 1967.

Broadbent, D.E. Perception and communication. New York: Pergamon Press, 1958.

Buley, H.C. Multi-media systems of instruction. Audiovisual Instruction, 1965, 10, 391-392.

Campeau, P.L. Selective review of the results of research on the use of audiovisual media to teach adults. A V Communication Review, 1974, 22, 5-20.

Card, R.D. An extention of the studies of simultaneous vs. sequential conformation to the learning of foreign vocabulary. In R.M.W. Travers (Ed.), Studies related to the design of audio-visual teaching materials. U.S. Department of Health, Education and Welfare, Office of Education Contract, No. 3-20-003, Ed 017 169, Final Report, May, 1966.

Carpenter, C.R. A theoretical orientation for instructional film research. A V Communication Review, 1953, 1, 38-52.

Chu, G., and Schramm, W. Learning from television: what the research says. Washington: National Association of Educational Broadcasters, 1967.

Cook, J.O. Research in audiovisual communication. In J. Ball and F. Byrnes (Eds.), Research principles and practices in visual communication, National Association of State Universities, and Land Grant Colleges, Washington, D.C. (Ed 025 159) Washington, D.C.: Department of Audiovisual Instruction, National Education Association, 1960, pp. 91-106.

Davidson, B. African kingdoms. New York: Time Incorporated, 1966.

De Kieffer, R.E. Audiovisual instruction. New York: The Center for Applied Research in Education, Inc., 1965.

Didcoct, D.H. Comparison of the cognitive and affective responses of college students to single-image and multi-image audio-visual presentations. Unpublished doctoral dissertation, University of Wisconsin, 1972.

Duchastel, P.C. and Merrill, P.F. The effects of behavioural objectives in learning: A review of empirical studies. Review of Educational Research, 1973, 43, 53-69.

Dwyer, C.A. Sex differences in reading: an evaluation and critique of current theories. Review of Educational Research, 1973, 43.

Dwyer, F.M. A guide for improving visualized instruction. Pennsylvania: Learning Services, 1972.

Ebel, R.E. Measuring educational achievements. New Jersey: Prentice-Hall, 1965.

Ehlinger, C.J. A comparison of presentation rates in a multiple-image presentation. Unpublished doctoral dissertation, Northern Illinois University, 1973.

Fradkin, B.M. Effectiveness of multi-image presentations. Journal of Educational Technology Systems, 1974, 2, 201-216.

Franzna, D. Influence of meaningfulness, picture, detail, and presentation mode on visual retention. AV Communication Review, 1973, 21, 209-223.

Gagné, R.M. Domains of learning. Interchange, 1972, 3 (I), p. 1-8.

Gagné, R.M. The Conditions of learning. (2nd. ed.) New York: Holt, Rhinehart, and Winston Inc., 1970.

Gagné, R.M. & Briggs, L.J. Principles of instructional design. New York: Holt, Rinehart and Winston, 1974.

Gagné, R.M. & Rohwer, W.D. Instructional psychology. Annual Review of Psychology, 1969, 15, 233-246.

Goldstein, E.B. The perception of multiple images. AV Communication Review, 1975, 23, 34-69.

Gropper, G.L. Learning from visuals: some behavioural considerations, A V Communication Review, 1966, 14, 37-69.

Hartman, F.R. Single and multiple channel communication: a review of research and a proposed model. AV Communication Review, 1961, 15, 235-262.

Haskins, J.B. How to evaluate mass communications. Syracuse: Advertising Research Foundation, Inc., 1968.

Hebb, D.A. A textbook of psychology. (2nd. ed.) Philadelphia: Sanders, 1966.

Hoban, C.F. & Van Ormer, E.B. Instructional film research 1918-1950. Technical report No. ADC 269-7-19, Navexos P-977 College Park, Pa.; Pennsylvania State College, 1950.

Hubbard, R.D. Telemation: AV automatically controlled. Audiovisual Instruction, 1961, 437-439.

Isert, G. The art of colour photography (2nd ed.). New York: Van Nostrand Reinhold, 1972.

Ingersoll, G.M. The effects of presentation modalities and modality preferences on learning and recall. Dissertation Abstracts International, 1971, 32, 240-A.

Jamison, D., Suppes, P., & Wells, S. Effectiveness of alternative instructional media: a survey. Review of Educational Research, 1974, 44, 1-67.

Kanner, J.H. & Rosenstein, A.J. Television in army training: colour vs black and white. A V Communication Review, 1960, 8, 243-252.

Kappler, F. The mixed media-communication that puzzles, excites, and involves. Life, 1967 (July 4th), 28.

Kinder, J.S. Using instructional media. New York: Van Nostrand, 1973,

Kirk, R.E. Experimental design: procedures for the behavioural sciences. Belmont, California: Brooks/Cole, 1969.

Koran, M.L. Varying instructional methods to fit trainee characteristics. A V Communication Review, 1972, 20, 135-147.

Lambert, P., Miller, D.M., & Wiley, D.E. Experimental folklore and experimentation: The study of programmed learning in the Wanwatosa Public School. Journal of Educational Research, 1962, 55, 485-491.

Lawson, B.R. Motivating with multi-image at the US Military Academy: the medium of the seventies--and its public relations side effects. Audiovisual Instruction, 1971, 16, 55-59.

Levie, W.H. & Dickie, K.E. The analysis and application of media. In R.M.W. Travers (Ed.), Second handbook of research on teaching, Chicago: Rand McNally, 1973, pp. 858-875.

Levin, J.R., Rohwer, W.D. & Cleary, T.A. Individual differences in the learning of verbally and pictorially presented paired associates. American Educational Research Journal, 1971, 12, 11-23.

Lombard, E.S. Multi-channel, multi-image teaching of synthesis skills in eleventh grade United States history. Unpublished doctoral dissertation, University of Southern California, 1969.

London, I.D. Abstract of conditions facilitating abstraction and generalization by A.U. Roshka. Psychological Abstracts, 1960, 34, 85.

Lublin, S.C. Reinforcement schedules, scholastic aptitude, autonomy need, and achievement in a programmed course. In R.C. Anderson (Ed.), Current research on instruction. New Jersey: Prentice-Hall, 1969, pp. 202-210.

Lumsdaine, A.A. Live dialogue and off-stage narration. In M. A. May and A. A. Lumsdaine (Eds.), Learning from films, New Haven: Yale University Press, 1958, 31-45.

Lumsdaine, A.A. Instruments and media of instruction. In N. L. Gage (Ed.), Handbook of research on teaching, Chicago: Rand McNally, 1963, pp. 583-682.

Mager, R.F. Preparing instructional objectives. Belmont, California: Fearon, 1962.

Mandler, G. From association to structure. Psychological Review, 1962, 69, 415-427.

McCormick, E.J. Human engineering. New York: McGraw-Hill, 1957.

Meyers, J.R. A study of eye movements and fixations in a multi-image presentation. Dissertation Abstracts International, 1972, 32, 6688-A.

Millard, W.L. Visual teaching aids: Production and use. The Encyclopedia of photography. New York: The Greystone Press, 1964.

Moore, D.M. and Sasse, E.B. Effect of size and type of still projected pictures on immediate recall. A V Communication Review, 19, 437-450.

National Council for Educational Technology. Towards more effective learning. London: Council and Education Press, 1969.

Nelson, M.J. An investigation of audience viewing patterns during multi-image presentations. Dissertation Abstracts International, 1972, 33, 4247-A.

Perrin, D.G. A history and analysis of simultaneous projected images in educational communication. Unpublished doctoral dissertation, University of Southern California, 1969.

Perrin, D.G. A theory of multiple-image communication. A V Communication Review, 1969b, 17, 368-382.

Reid, I.E. & Travers, R.M.W. Time required to switch attention. American Educational Research Journal, 1968, 5, 203-211.

Reid, R.O. A comparison of a multi-image and a linear film format as agents of attitude change. Unpublished doctoral dissertation, Syracuse University, 1970.

Rohwer, W.D. Jr., Levin, J.R. Action, meaning and stimulus selection in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 137-141.

Roshka, A.U. Conditions facilitating abstraction and generalization. Voprosy Psikhologii, 1958, 4, 89-96. As reported by I.D. London Psychological Abstracts, 1960, 34, 85.

Runyon, R. P. & Haber, A. Fundamentals of behavioral statistics. Massachusetts: Addison-Wesley, 1972.

Scholl, P.A. Visual concepts attainment as affected by stimulus complexity and selected communicator strategies. Paper read at the Nato Convention of Department of Audiovisual Instruction (NEA), Convention Center, Atlantic City, N.J. (Ed. 064 879), 1967.

Severin, W. Another look at cue summation. A V Communication Review, 1967, 15, 233-246.

Snow, E.S. Representative and quasi-representative designs for research on teaching. Review of Educational Research, 1974, 44, 265-2.

Snow, R.E. & Salomon, G. Aptitudes and instructional media. A V Communication Review, 1968, 16, 341-357.

Tam, P.T.K. & Reeve, R.H. The image accumulation technique as a variable in multi-image communication. Paper presented at the Annual Meeting of the Association for Educational Communications and Technology. Philadelphia, Pa., (Ed 048 734) 1971.

Taylor, E.A. A manual of visual presentation in educational and training. London: Pergamon Press, 1966.

Tosti, D.T., Ball, J.R. A behavioral approach to instructional design and media selection. A V Communication Review, 1969, 17, 5-25.

Travers, R.M.W. Studies related to the design of audiovisual teaching materials. U.S. Department of Health, Education and Welfare, Office of Education Contract No. 3-20-003 (Ed 017-169) Final Report, 1966.

Trohanis, P. Environmental ecological education via simultaneously projected multiple-images with sound. Audiovisual Instruction, 1971, 16, 19-26.

Tuckman, B.W. Conducting educational research. New York: Harcourt, Brace, Jovanovich, 1972.

Twyford, L.C., Jr., Educational communications media. In R.L. Ebel (Ed.), Encyclopedia of educational research. (4th ed.). Toronto: Collier Macmillan, 1969, 367-380.

Westwater, J.N. A wide-screen multi-image presentation used as a multidimensional resource for environmental education: a study of teacher-user perceptions. Dissertation Abstracts International, 1973, 33, 3976-A.

Williams, C.M. Learning from pictures. Washington, D.C.: National Education Association, 1963.

Wittich, W.A. & Schuller, C.F. Instructional technology: its nature and use. New York: Harper and Row, 1973.

APPENDIX A

TAPE-SLIDE SCRIPTS

EXPLANATION OF THE TAPE-SLIDE SCRIPTS

The only manipulated treatment variable in this study was the visual format. Identical slides and sound tracks were used in all experimental conditions. Also, the exact moment when each slide first appeared on the screen was the same in all presentations. The scripts, therefore, were all very similar. For this reason, although four scripts were used in the actual production, only the script for the single-image presentation is provided in complete form. Scripts for the first three minutes of the six second visual-overlap and the complete temporal visual-overlap presenations are provided. These illustrate the modifications required to transform a single-image script into scripts for multi-image presentation with either an incomplete or a complete temporal visual overlap.

SCRIPT SYMBOLS AND ABBREVIATIONS

An Arabic numeral placed flush with the left margin designates each visual change and the audio for the new visual presenation. If this number is level with a blank audio portion, there was no sound for the duration of the corresponding visual portion. Visual changes are sequentially numbered and each slide is briefly identified by a short verbal description.

The audio portion of all the scripts was written to clearly designate the spoken word. Thus, numbers and percentages such as 2,200 and 96% were spelled out to indicate they were to be read respectively as "two thousand two hundred" and "ninty-six percent."

The conventional signals used to describe the framing of pictorial slides and to indicate directions for the sound are as follows:

VLS	= very long shot	LS	= long shot
MLS	= medium long shot	MS	= medium shot
CU	= close-up	TCU	= tight close-up
OS	= over-shoulder shot	F-Under	= fade under
FU	= fade up		
FO	= fade out		

SINGLE-IMAGE PRESENTATION

SLIDES	TIME (min/sec)	TAPE
1. CU hands beating drums	00 00	FU KALELA DRUMS
2. MS drummers	00 10	
3. CU old man	00 20	FU NARRATOR/F-UNDER DRUMS NARRATOR: Africa covers one quarter of the earth's landmass and contains three hundred and fifty million inhabitants, one tenth of the world's population.
4. MS 16th century map of Africa	00 30	For hundreds of years so little was known about its interior that ". . . geographers in Afric maps, With savage pictures filled their gaps, And o'er unhabitable downs Placed elephants for want of towns."
5. LS model of European explorer at the Luangwa River	00 45	Fables only gave way to reality when penetration into the interior began after the Industrial Revolution when European countries were seeking raw materials for their finished products.
6. CU monotone plague of African chief held captive	00 57	By the end of the nineteenth century Africa was almost completely colonized by European powers. In 1945 only four African states were independent.

	SLIDES	TIME (min/sec)	TAPE
7.	LS colour mosaic of African in traditional costume	01 09	Today, more than forty African states are independent with black African governments. One of these is Zambia.
8.	TCU elephant's eye	01 19	CROSSFADE NARRATOR AND DRUMS TO THE NATIONAL ANTHEM OF ZAMBIA WORDS OF ANTHEM: Stand and sing of Zambia, proud and free, Land of hope and joy in unity,
9.	CU Zambian flag, titled "Focus on Zambia"	01 29	Victors in the struggle for the right, We've won freedom's fight. All one strong and free.
10.	Map of Africa with Zambia marked and titled	01 46	CROSSFADE ANTHEM TO NARRATOR NARRATOR: Zambia is a land-locked country about the size of Texas, extending over an area of nearly two hundred ninty thousand square miles.
11.	Aerial view of Zambezi river.	01 59	Most of the country is on a three thousand to five thousand foot plateau which is broken by the great river valleys of the Zambezi and its tributaries. The Zambezi river, one of Africa's great rivers,
12.	Map of Zambia with Zambezi marked and titled	02 15	begins its two-thousand two hundred mile journey to the Indian ocean at a tiny spring in the Zambian bush.

	SLIDES	TIME (min/sec)	TAPE
13.	Outline map of Zambia	02 27	The curious butterfly shape of the country is the result of the nineteenth century scramble for Africa when Britain carved out for herself the new colony of Northern Rhodesia.
14.	Map of Zambia with neighbouring countries marked and titled	02 43	On the twenty-fourth of October, nineteen-sixty-four, Northern Rhodesia became the independent Republic of Zambia.
15.	CU baby	02 57	Compared to her size, Zambia has a very small population, four million six hundred thousand.
16.	LS woman sieving grain	03 08	English is the official language but there are seventy-three different tribes speaking as many different languages or dialects.
17.	CU Tonga woman	03 22	Zambia's largest tribe is the Tonga who were the first Bantu-speaking people in Zambia.
18.	Map of Zambia with Tonga tribal areas marked and titled	03 33	They entered Zambia sometime between the fifteenth and sixteenth centuries.
19.	CU woman	03 45	Despite similarities there is a great variety between the seventy-three tribes, in their way of life, their culture, their traditions, customs and beliefs.
20.	CU national crest	03 56	It's with good reason that when Zambia became independent in 1964 she took as her motto "One Zambia, One Nation." In 1973, the country became a one-party democracy.

	SLIDES	TIME (min/sec)	TAPE
21.	CU President Kaunda	04 12	Her president is Dr. Kenneth Kaunda.
22.	LS Victoria Falls	04 22	Although Zambia is land-locked, it has a number of waterfalls, dams and lakes. Its greatest natural monument is the mile wide curtain of water of the Victoria Falls, plunging three hundred and fifty-five feet into the gorge beneath.
23.	Map of Zambia with Victoria Falls marked and titled	04 38	For thousands of years only African peoples knew of them. Some tribes lived on islands above the Falls.
24.	MS Victoria Falls	04 49	David Livingstone, the Scottish explorer and missionary, was the first white man to see them. He arrived here in 1855 and named them after Queen Victoria of England.
25.	LS Kariba Dam	05 10	The four hundred and twenty foot high Kariba Dam holds back Lake Kariba, one of the largest man-made lakes in the world.
26.	Map of Zambia with Lake Kariba marked and titled	05 23	More than fifty thousand primitive Tonga tribesmen were moved against their will from their traditional homelands to allow the trapped water to flood an area of two thousand square miles.
27.	Outline map of Lake Kariba with Kariba Dam marked and titled	05 38	

	SLIDES	TIME (min/sec)	TAPE
28.	MLS Kariba Dam	05 48	The dam was completed in nineteen-sixty-one to provide hydro electric power for central African industry.
29.	LS Lake Tanganyika	06 03	One-eight of Lake Tanganyika falls within Zambia's boundaries.
30.	Map of Zambia with Lake Tanganyika marked and titled	06 14	It is one of the world's largest lakes and is four hundred and twenty miles long.
31.	LS ships at Mpulungu	06 25	On the shores of the lake is Zambia's only port, Mpulungu.
32.	Map of Lake Tanganyika with Mpulungu marked and titled	06 36	More than seven thousand tons of fish leave Mpulungu each year for markets in Zambia's main towns.
33.	LS fishermen in boats	06 50	Individual fishermen can be seen using traditional fishing techniques that have not changed for centuries.
34.	VLS tourist lodge at Kasaba Bay	07 00	Also on the shores of Lake Tanganyika is Kasaba Bay, one of Zambia's main tourist attractions.
35.	Map of Lake Tangyanyika with Kasaba Bay marked and titled	07 13	Here you can go on walking safaries, or water safaries and view the game from motor boats.
36.	LS elephant and man	07 23	The big elephant named "Zambia" is a tourist favourite. He is wild but not aggressive, unless you feed him a salami sandwich, then
37.	LS elephant hitting man	07 33	

SLIDES	TIME (min/sec)	TAPE
38. LS tourists taking pictures of elephant	07 44	National Game Parks in Zambia cover one-twelfth of the country, and are the principal attraction for tourists.
39. VLS animals and habitat	07 55	FU AND UNDER INSTRUMENTAL MUSIC: KALIMBA NARRATOR: Probably the largest variety of game in the world is packed into the six thousand square miles of Luangwa Valley National Park in the crowded valley of the Luangwa river.
40. Map of Zambia with Luangwa Park marked and titled	08 09	Here, the dry savanna countryside makes an excellent place for game.
41. LS elephant charging	08 19	FU MUSIC/FO NARRATOR
42. MS lion	08 28	Music
43. CU zebra	08 38	Music
44. CU monkey	08 47	Music
45. LS Waterbuck	08 57	Music
46. LS white-rhino	09 07	CROSSFADE MUSIC TO NARRATOR NARRATOR: The white-rhino is the world's second largest land mammel.
47. Map of Zambia with Livingstone Game Park marked and titled	09 17	This part of Zambia is one of the few places in the world where it can be found.
48. CU white-rhino	09 28	The white rhino's name is derived from the Boer word "wyt" meaning wide and refers to its broad square jaws adapted to grazing.

	SLIDES	TIME (min/sec)	TAPE
49.	MS wild dog	09 40	Tourism is a lucrative source of income. However, most of Zambia's wealth comes from mining copper.
50.	Map of Zambia with the Copper-belt marked and titled	09 50	In the copperbelt of Zambia are seven copper mines and seven towns. It is the most densely populated part of Zambia.
51.	Aerial view of Kitwe	10 02	By location and size Kitwe is the hub of the copperbelt.
52.	Map of the Copperbelt with Kitwe marked and titled	10 15	It is Zambia's second largest town.
53.	LS interior view of Kitwe's smelter	10 29	Zambia is the third largest producer of copper in the world, after the United States and the Soviet Union.
54.	Aerial view of open-pit at Chingola	10 41	Forty miles from Kitwe at Chingola is one of the largest open-pit mines in the world.
55.	Map of the Copperbelt with Chingola marked and titled	10 55	
56.	CU copper pouring	11 08	Copper accounts for ninty-six per cent of Zambia's exports and sixty per cent of government revenues.
57.	Aerial view of Cairo Road, Lusaka	11 18	Lusaka is Zambia's capitol and is the centre for government and business.
58.	Map of Zambia with Lusaka marked and titled	11 28	It is situated in good farming country and began as a railway siding in 1913.

	SLIDES	TIME (min/sec)	TAPE
59.	LS government offices	11 38	It was made capital of Zambia, then known as Northern Rhodesia, in 1935.
60.	LS swimming pool	11 48	Lusaka has all the amenities of a modern city, including an olympic size swimming pool.
61.	MS University of Zambia	11 58	Its university opened in 1968.
62.	MS pupils in class	12 08	It is through education that the government is trying to ease Zambian peoples into the twentieth century.
63.	LS group in fields working	12 19	Modern developments have not changed the way of life of most Zambians, two-thirds of whom are engaged in subsistance farming, producing barely enough for their own needs.
64.	MS children eating	12 35	The standard of health is low. At the root of most diseases is the real problem, malnutrition, the lack of enough food, or the right type of food.
65.	MS malnurished baby	12 48	Four out of every ten Zambian babies born, die before they reach the age of five because of malnutrition.
66.	Aerial view of bush hospital	13 00	Isolated mission hospitals and clinics operated by Christian churches are scattered throughout the country.

	SLIDES	TIME (min/sec)	TAPE
67.	LS Niamakolo Church	13 15	Zambia has seven hundred thousand Christians. Niamakolo church is the oldest surviving stone built church in Zambia.
68.	Map of Zambia with Niamakolo Church marked and titled	13 26	Protestant services were held here from eighteen ninty six until nineteen eight when the whole area was evacuated because of a serious epidemic of sleeping sickness.
69.	CU lady	13 40	The vast majority of Zambians are non-Christian, many adhering to tribal, animistic, and other beliefs.
70.	LS group with witch doctor	13 50	When ill or in trouble most still resort to the witch-doctor, a very influenctial man. He prays and prescribes herbal medicine to cure and ward off illness and evil spirits.
71.	MS witch-doctor against storm-clouds	14 06	The witch-doctor is an important link with the ancestors of the tribe. He prays for rain and good harvests:
72.	MS woman with large box on her head	14 20	FU AND UNDER INSTRUMENTAL MUSIC: LYRE NARRATOR: Most Zambians live patterns of tribal life that have not changed for hundreds of years. Traditional crafts and skills survive in a developing Zambia.

SLIDES	TIME (min/sec)	TAPE
73. LS blacksmiths working	14 37	The blacksmith, who makes hoes, spears, and other metal tools, can still be seen working in most villages.
		FO NARRATOR/FU MUSIC
74. MS artist wood-carving	14 49	Music
75. CU artist's hands and wood-carving	14 59	Music
76. CU artist making clay pot	15 09	Music
77. LS group watching basket-weaver	15 19	Music
78. LS girl grinding	15 29	Music
79. LS man with bow	15 39	Music
80. LS Chief Mukuni and group	15 49	CROSSFADE MUSIC TO NARRATOR
		NARRATOR: At the principle of traditional government was the Paramount Chief, still retaining many of his customary powers in the new political order.
81. LS man kneeling	15 59	Kneeling, and even lying in the dust, is the respectful greeting to a Zambian chief.
82. CU Chief Mukuni	16 10	Chief Mukuni is of the Leya tribe and holds customary power
83. Map of Zambia with Mukuni's territory marked and titled	16 20	over this part of Zambia.

SLIDES	TIME (min/sec)	TAPE
84. VLS Zambezi flood-plain	16 30	During Zambia's rainy season, November till March, the tributaries of the Zambezi bring too much water and the Zambezi Plain is flooded.
85. Map of Zambia with Zambezi Flood Plain marked and titled	16 42	A layer of impermeable clay, which does not allow water through, is found beneath the flat and sandy surface of the Flood Plain. As a result
86. LS water-logged hut	16 53	water floods an area one hundred and twenty miles long and twenty-five miles wide.
87. LS family in dug-out	17 13	The Lozi people who live on the plain are forced to leave their water-logged homes for the safety of higher ground.
88. LS group with the Litunga	17 25	The Lozi Paramount Chief, the Litunga, transfers his residence to his winter capital thirteen miles away.
89. CU Litunga	17 36	The annual migration of the Litunga across the Zambezi Flood Plain is called the Kuomboka and is Zambezi's most colourful traditional festival.
90. LS woman	17 49	It is difficult to find out the origins and history of the different tribes because in Zambia continuous written history begins only after the arrival of the British South African police in the eighteen-ninetees.

SLIDES	TIME (min/sec)	TAPE
91. LS archaeological excavation with skeleton	18 03	The work of the archaeologist is therefore very important to Zambia.
92. LS Kalambo Falls	18 13	Evidence of early Man in Zambia are stone tools found near Kalambo Falls.
93. Map of Zambia with Kalambo marked and titled	18 24	Men were living here during the early Stone Age sixty thousand years ago.
94. CU rock-painting	18 35	On the walls of rock shelters and caves are found paintings which have been drawn during the past ten thousand years.
95. CU paintings	18 45	We can only guess why early Man in Zambia painted. There must have many reasons, as part of initiation ceremonies, to decorate their homes, or to make magic for successful hunting or good rains.
96. Map of Zambia with rock-painting sites marked and titled	19 00	Rock-paintings are limited to those parts of Zambia where large, smooth and sheltered rock faces gave suitable surfaces for painting.
97. LS Kalemba rock-shelter	19 14	Kalemba is the largest rock-shelter so far discovered.
98. Map of Zambia with Kalemba marked and titled	19 25	Excavations were carried out here from nineteen seventy-one till nineteen seventy-three.
99. CU rock-painting	19 37	Knowledge of peoples past is essential to the appreciation of its present and future. That is one reason why all nations treasure the relics of its ancestors.

	SLIDES	TIME (min/sec)	TAPE
100.	CU old man	19 49	There's another too. It has been said that the proper study of Man is man. Every discovery adds to our knowledge of him.
101.	LS bush road sunset	20 01	FU AND UNDER INSTRUMENTAL MUSIC: KALIMBA NARRATOR: Archaelogists, historians, and anthropologists are showing that Zambia's contribution to that fund of knowledge is so rich, that it has made Zambia a focus of world wide interest. FO NARRATOR/FU MUSIC
102.	LS hippo in river, sunset	20 26	Music
103.	LS boats, sunset	20 36	Music
104.	LS silhouette of village huts, titled "The end".	20 46	Music
105.	Blank	20 56	FO TAPE

MULTI-IMAGE: COMPLETE VISUAL-OVERLAP PRESENTATION

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)	TAPE
1 CU hands beating drums	Blank	00 00	FU KALELA DRUMS
2 "	MS drummers	00 10	FU NARRATOR/F-UNDER DRUMS
3 CU old man	"	00 20	NARRATOR: Africa covers one quarter of the world's landmass and contains three hundred and fifty million inhabitants, one tenth of the world's population.
4 "	MS 16th Century map of Africa	00 30	For hundreds of years so little was known about its interior that: ". . . geographers in Afric' maps, With savage pictures filled their gaps, And o'er inhabitable downs, Placed elephant for want of towns."
5 LS Model of European explorer	"	00 45	Fables only gave way to reality when penetration into the interior began after the Industrial Revolution when European countries were seeking raw materials for their finished products.

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)		TAPE
6 LS Model of European explorer	CU montone plaque of African chief held captive	00	57	By the end of the nineteenth century Africa was almost completely colonized by European powers. In 1945 only four African states were independent.
7 CU Mosaic of African in traditional costume	"	01	09	Today, more than forty African states are independent with black African governments. One of them is Zambia.
8 "	TCU elephant's eye	01	19	CROSSFADE NARRATOR AND DRUMS TO THE NATIONAL ANTHEM OF ZAMBIA.
9 CU Zambian flag, titled "Focus on Zambia".	"	01	29	WORDS OF ANTHEM: Stand and sing of Zambia, pround and free, Land of hope and joy in unity, Victors in the struggle for the right, We've won freedom's fight. All one, strong and free.
10 "	Map of Africa with Zambia marked and titled	01	46	CROSSFADE MUSIC TO NARRATOR NARRATOR: Zambia is a landlocked country about the size of Texas, extending over an area of almost two-hundred ninty thousand square miles.

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)	TAPE
11 Aerial shot of Zambezi River	Map of Africa with Zambia marked and titled	01 59	Most of the country is on a three thousand to five thousand foot plateau which is broken by the great river valleys of the Zambezi and its tributaries. The Zambezi river, one of Africa's great rivers,
12 "	Outline map of Zambia with Zambezi marked and titled	02 15	begins its two thousand two hundred mile journey to the Indian ocean at a tiny spring in the Zambian bush.
13 Outline map of Zambia	"	02 27	The curious butterfly shape of the country is a result of the nineteenth century scramble for Africa when Britain carved out for herself the new colony of Northern Rhodesia.
14 "	Outline map of Zambia with neighbouring countries marked and titled	02 43	On the twenty-fourth of October, nineteen-sixty-four, Northern Rhodesia became the Independent Republic of Zambia.

MULTI-IMAGE: SIX SECOND VISUAL OVERLAP PRESENTATION

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)	TAPE
1 CU hands beating drums	Blank	00 00	FU KALELA DRUMS
2 "	MS drummers	00 10	
3 Blank	"	00 16	
4 CU old man	"	00 20	FU NARRATOR/F-UNDER DRUMS NARRATOR: Africa covers one quarter of the earth's landmass and contains three hundred and fifty million inhabitants, one tenth of the world's population.
5 "	Blank	00 26	
6 "	MS 16th Century map of Africa	00 30	For hundreds of years so little was known about its interior that: ". . . geographers in Afric' maps,
7 Blank	"	00 36	With savage pictures filled their gaps, And o'er inhabitable downs, Placed elephant for want of towns."

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)	TAPE
8 LS Model of European explorer	MS 16th Century map of Africa	00 45	Fables only gave way to reality when penetration into the interior began after the Industrial Revolution when European countries were seeking raw materials for their finished products.
9 "	Blank	00 51	
10 "	CU monotone plaque of African chief held captive	00 57	By the end of the nineteenth century Africa was almost completely colonized by European powers. In 1945 only four African states were independent.
11 Blank	"	01 03	
12 CU Mosaic of African in traditional costume	"	01 09	Today more than forty African states are independent with black African governments.
13 "	Blank	01 15	One of them is Zambia.
14 "	TCU elephant's eye	01 19	CROSSFADE NARRATOR AND DRUMS TO THE NATIONAL ANTHEM OF ZAMBIA.
15 Blank	"	01 25	WORDS OF ANTHEM: Stand and sing of Zambia, proud and free, Land of hope and joy in unity.

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)	TAPE
16 Cu Zambian flag, titled "Focus on Zambia"	TCU Elephant's eye	01 29	Victors in the struggle for the right, We've won freedom's fight.
17 "	Blank	01 35	All one strong and free.
18 "	Map of Africa with Zambia marked and titled	01 46	CROSS-FADE MUSIC TO NARRATOR
19 Blank	"	01 52	NARRATOR: Zambia is a landlocked country about the size of Texas, extending over an area of almost two hundred ninty thousand square miles.
20 Aerial shot of Zambezi River	"	01 59	Most of the country is on a three thousand to five thousand foot plateau which is broken by the
21 "	Blank	02 05	great river valleys of the Zambezi and its tributaries. The Zambezi river, one of the Africa's great rivers,
22 "	Outline map of Zambia with Zambezi marked and titled	02 15	begins its two thousand two hundred mile journey to the Indian ocean at a tiny spring in the
23 Blank	"	02 21	Zambian bush.

SLIDES APPEARING ON LEFT OF SCREEN	SLIDES APPEARING ON RIGHT OF SCREEN	TIME (Min/Sec)	TAPE
24 Outline map of Zambia	Outline map of Zambia with Zambezi marked and titled	02 27	The curious butterfly shape of the country is a result of the nineteenth century scramble for Africa when Britain carved out for herself the new colony of Northern Rhodesia.
25 "	Blank	02 33	
26	Outline map of Zambia with neighbouring countries marked and titled	02 43	On the twenty-fourth of October, nineteen-sixty-four, Northern Rhodesia became the Independent Republic of Zambia.

APPENDIX B

CRITERION TEST

CLASS CODE
Number: _____

PLEASE PRINT
Your Name: _____

What is your sex? Male ____
Female ____

What is your age? ____

TEST INSTRUCTIONS FOR PART 1

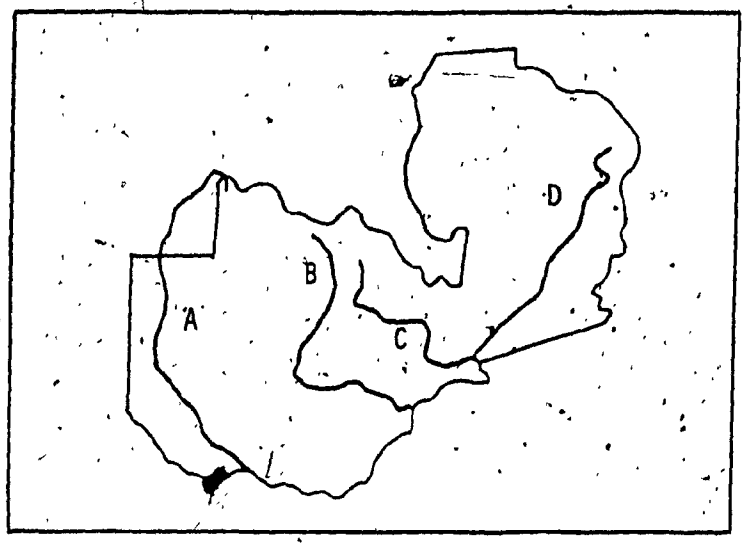
On the following pages there are 18 figures each of which has four locations identified as A, B, C, D. For each figure a slide will be shown for just half a minute.

Each slide will represent ONE of the locations A, B, C, D. You are to select the proper location A, B, C, or D, and CIRCLE the CORRECT ANSWER on this test paper.

Please be certain that only ONE answer is marked. If you cannot decide on an answer for any question, please make the BEST GUESS you can. Equal scores will be awarded to each correct answer.

Let's begin.

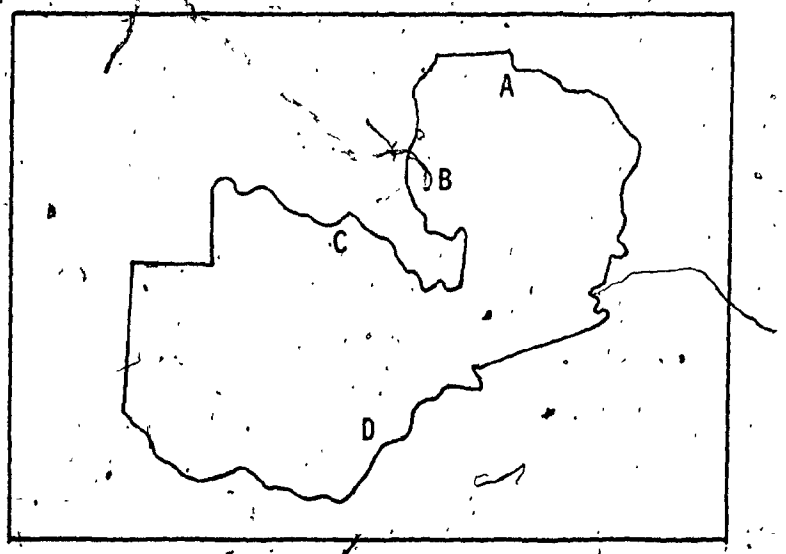
Figure 1



1. Which letter in Figure 1 corresponds to the location on the screen?

   A.
   B.
   C.
   D.

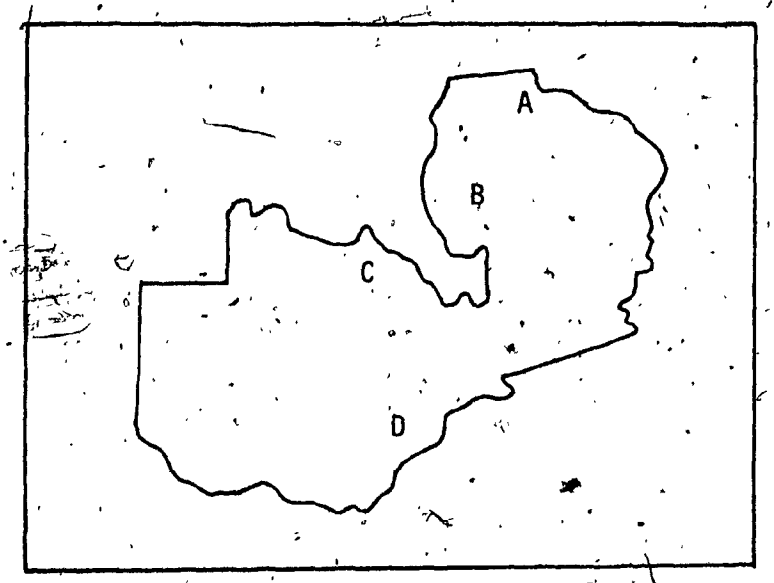
Figure 2



2. Which letter in Figure 2 corresponds to the location of the picture on the screen?

   A.
   B.
   C.
   D.

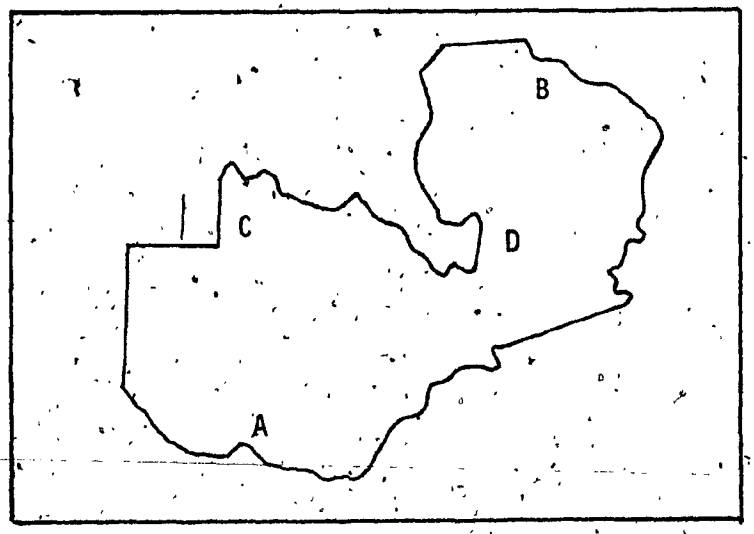
Figure 3



3. Which letter in Figure 3 corresponds to the location of the picture on the screen?

   A.
   B.
   C.
   D.

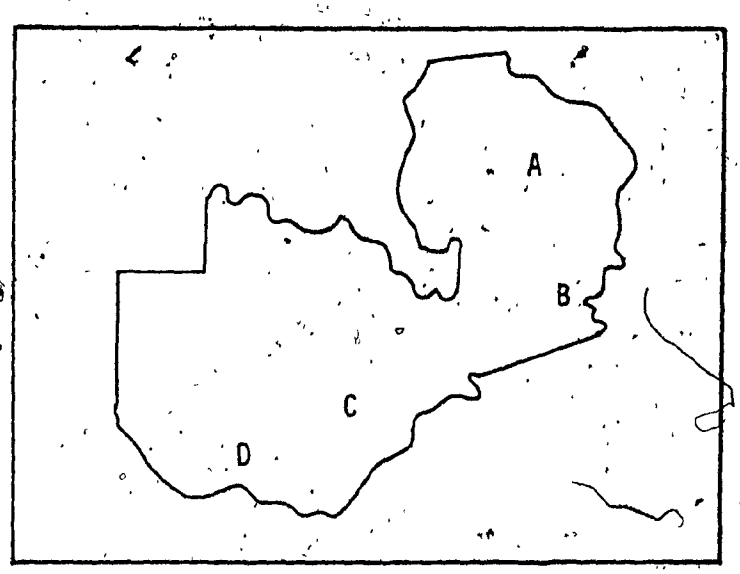
Figure 4



4. Which letter in Figure 4 corresponds to the location of the picture on the screen?

   A.
   B.
   C.
   D.

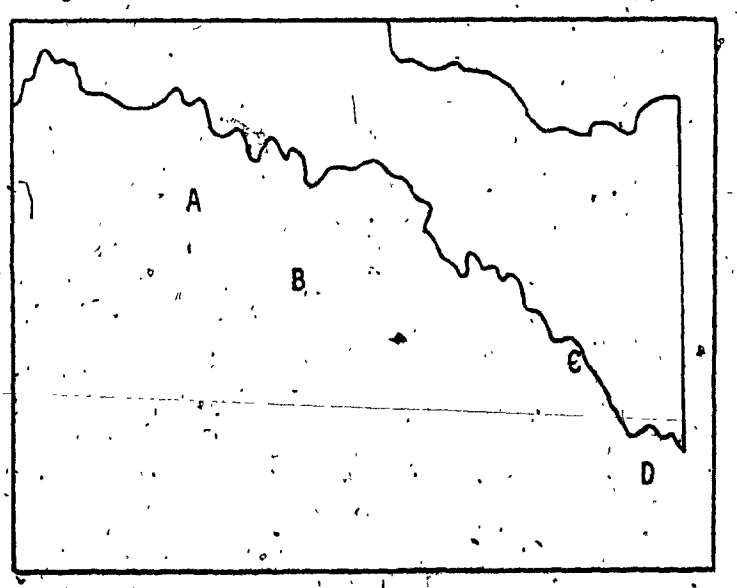
Figure 5



5. Which letter in Figure 5 corresponds to the location of the picture on the screen?

   A.
   B.
   C.
   D.

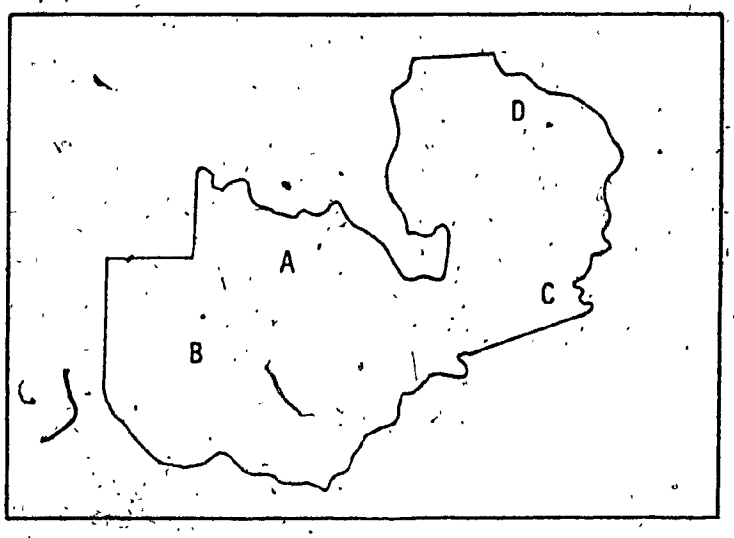
Figure 6



6. Which letter in Figure 6 corresponds to the location of the picture on the screen?

   A.
   B.
   C.
   D.

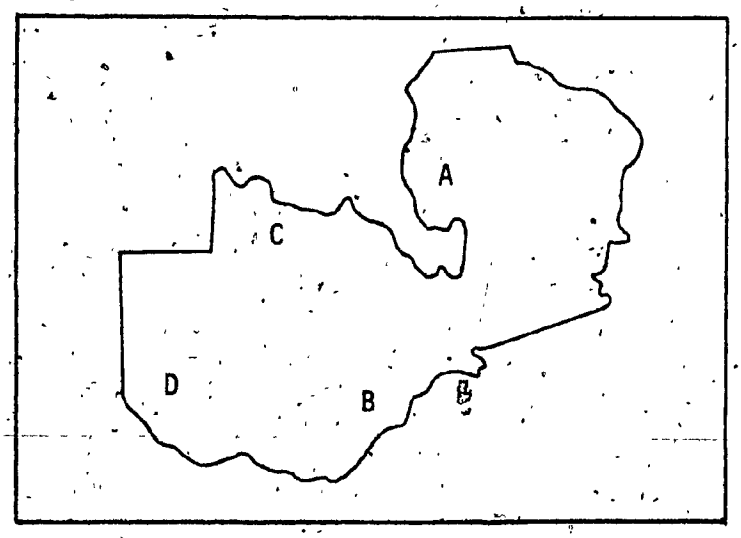
Figure 7



7. Which letter in Figure 7 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

Figure 8



8. Which letter in Figure 8 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

Figure 9

9. Which letter in Figure 9 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

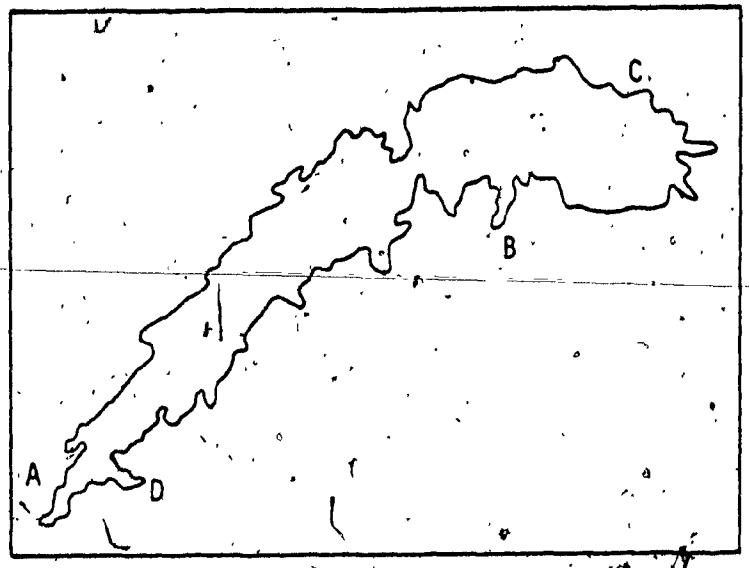


Figure 10

10. Which letter in Figure 10 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

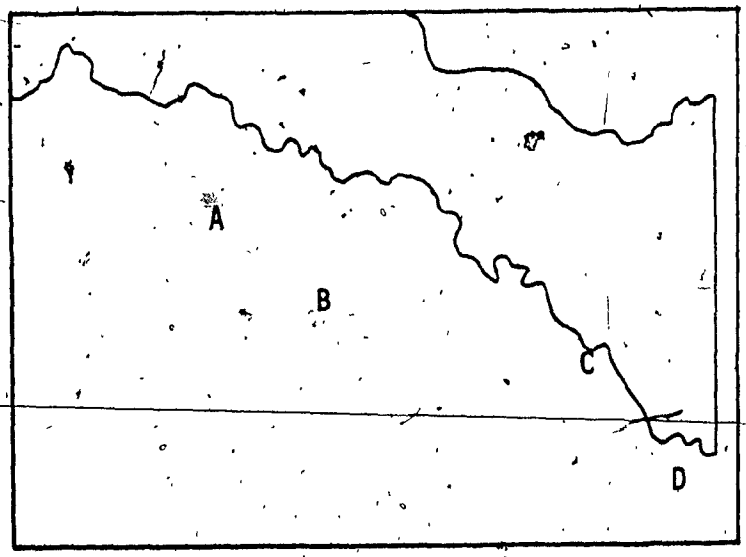


Figure 11

11. Which letter in Figure 11 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

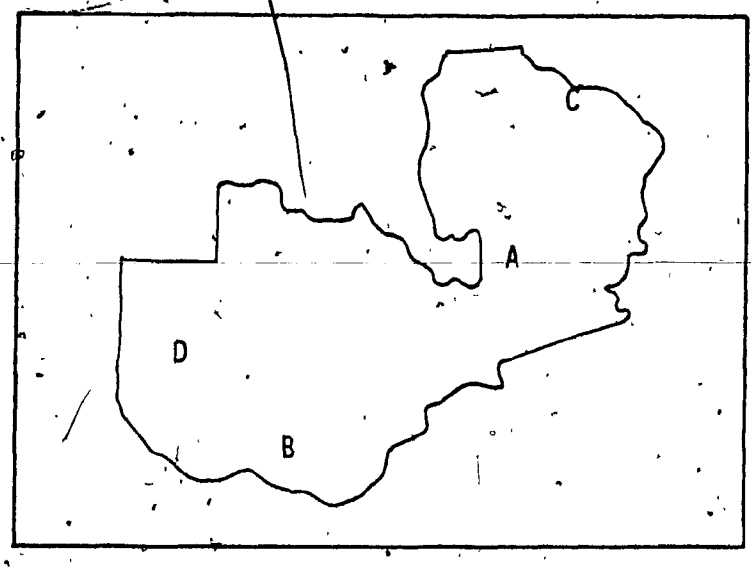


Figure 12

12. Which letter in Figure 12 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

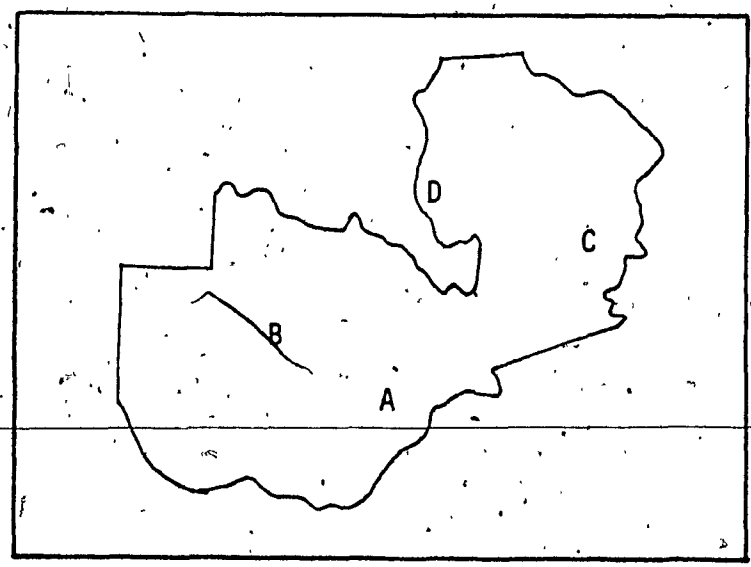


Figure 13

13. Which letter in Figure 13 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

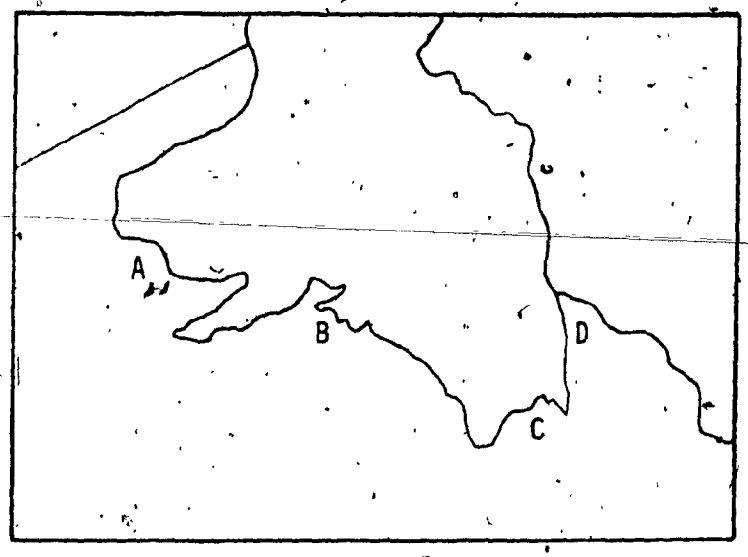


Figure 14

14. Which letter in Figure 14 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

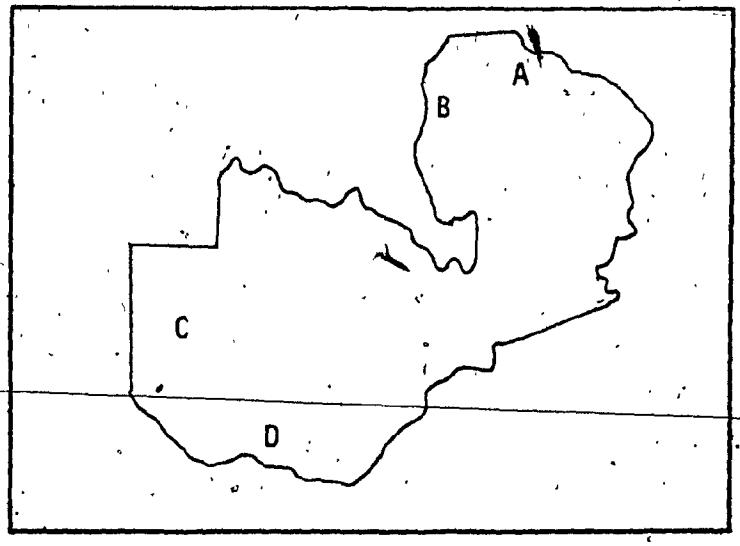


Figure 15

15. Which letter in Figure 15 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

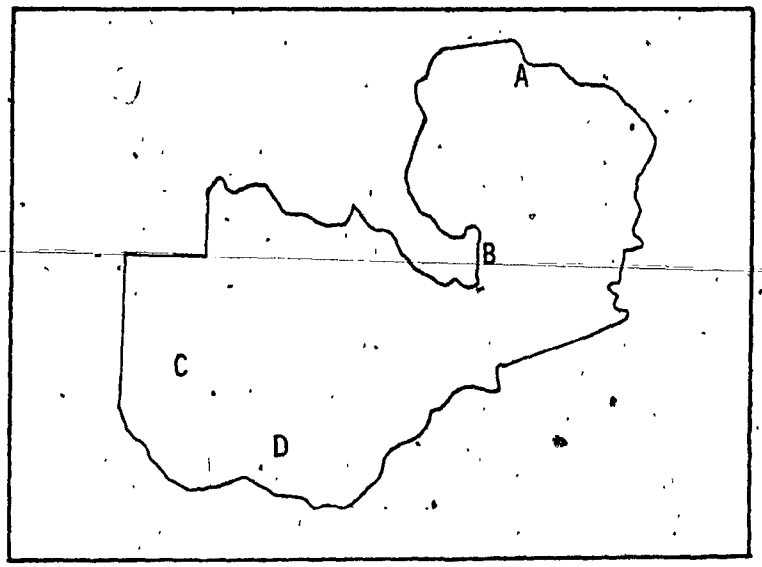


Figure 16

16. Which letter in Figure 16 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

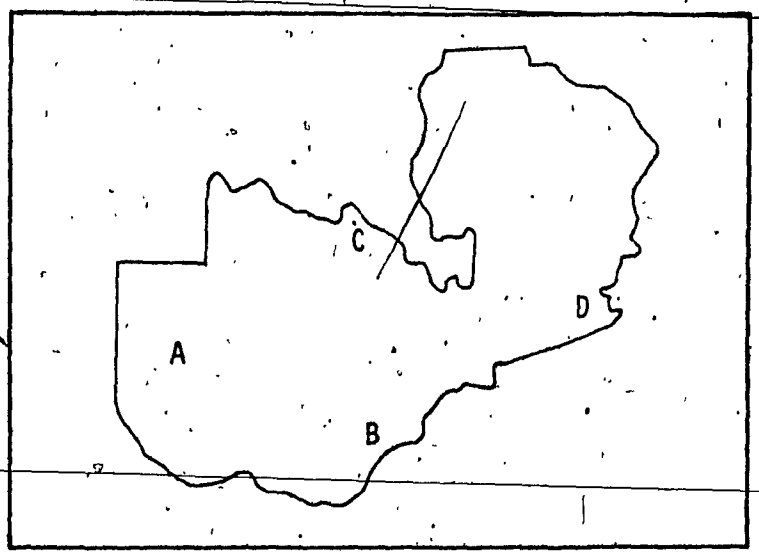
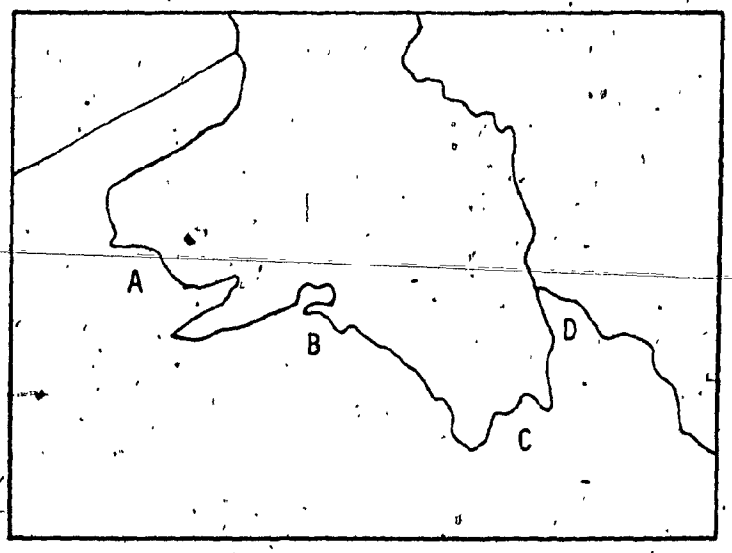


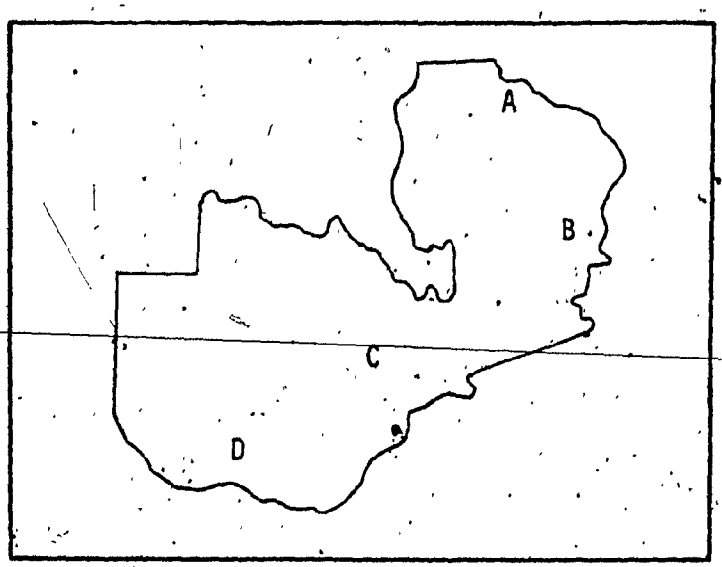
Figure 17



17. Which letter in Figure 17 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

Figure 18



18. Which letter in Figure 18 corresponds to the location of the picture on the screen?

A.
B.
C.
D.

TEST INSTRUCTIONS FOR PART II

In the following section there are four possible answers for each question. After reading each question carefully, select the correct answer and Circle the proper letter. Only one answer is correct for each question. If you cannot decide on an answer for any question, please make the BEST GUESS you can. Equal scores will be awarded to each correct answer.

PLEASE ANSWER THE FOLLOWING ITEMS:

19. What is the size of Zambia?

    A. 250,000 square miles
    B. 290,000 square miles
    C. 330,000 square miles
    D. 370,000 square miles

20. In what year did Zambia gain her independence?

    A. 1956
    B. 1960
    C. 1964
    D. 1968

21. Before she became independent Zambia was known as -

    A. Bechuanaland
    B. Northern Rhodesia
    C. Nyasaland
    D. Tanganyika

22. The population of Zambia is -

    A. 4,600,000
    B. 5,400,000
    C. 6,200,000
    D. 7,000,000

23. Kariba Dam was completed in -

    A. 1961
    B. 1965
    C. 1969
    D. 1973

24. Which of the following contributes most to the economy of Zambia?

A. Farming
B. Fishing
C. Mining
D. Tourism

25. Who was the first white man to discover the Victoria Falls?

A. Richard Burton
B. David Livingstone
C. John Speke
D. Henry Stanley

26. How much of Lake Tanganyika falls within Zambia's boundaries?

A. 1/4
B. 1/5
C. 1/7
D. 1/8

27. How many different tribes are there in Zambia?

A. 59
B. 66
C. 73
D. 80

28. The President of Zambia is -

A. Hastings Banda
B. Julius Nyrere
C. Jomo Kenyatha
D. Kenneth Kaunda

29. What is the altitude of Zambia?

A. 1,000 feet to 3,000 feet
B. 2,000 feet to 4,000 feet
C. 3,000 feet to 5,000 feet
D. 4,000 feet to 6,000 feet

30. The capital of Zambia is -

A. Chingola
B. Kitwe
C. Livingstone
D. Lusaka

31. How many Zambian children out of ten die before the age of five because of malnutrition?

A. 2
B. 4
C. 6
D. 8

32. Which of the following is a neighbour of Zambia?

A. Kenya
B. Malawi
C. Switzerland
D. Uganda

33. What is the name of Zambia's largest tribe?

A. The Bemba
B. The Leya
C. The Lozi
D. The Tonga

34. What percentage of Zambia's exports is copper?

A. 36%
B. 56%
C. 76%
D. 96%

35. Zambia's rainy season lasts from -

A. September till January
B. October till February
C. November till March
D. December till April

36. Zambia's only port is -

A. Chipata
B. Kitwe
C. Lusaka
D. Mpulungu

37. It is difficult to find out about Zambia's history because -

A. in Zambia continuous written history began in the 1890's
B. it is difficult to understand the writings of early Zambians
C. most of the writings of early Zambians have been destroyed
D. historians have not been interested in Zambia's past

38. Stone tools of Stone Age Man have been found near -

A. Kalambo Falls
B. Kundalila Falls
C. Lumangwe Falls
D. Pungwe Falls

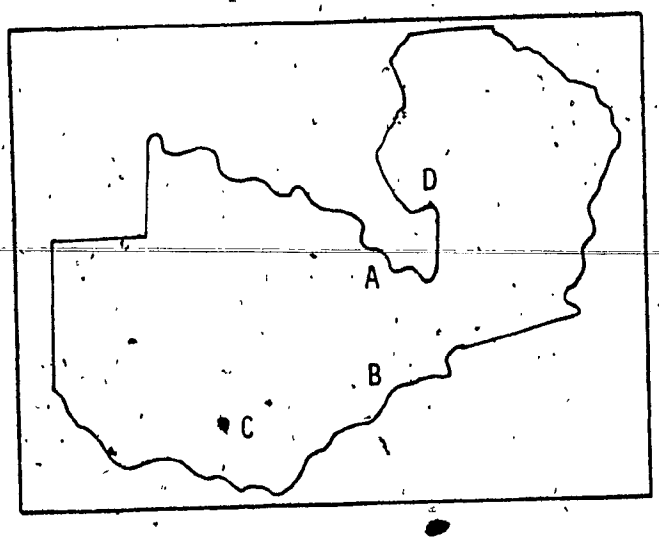
39. Early Man in Zambia painted on the walls of caves -

A. to frighten away the wild animals, who might shelter in the caves
B. to make his temporary home easier to find
C. to have a painted record of his activities
D. to make magic for successful hunting or good rains

40. What type of political state is Zambia?

A. a multi-party democracy
B. a one-party democracy
C. a military dictatorship
D. a monarchy

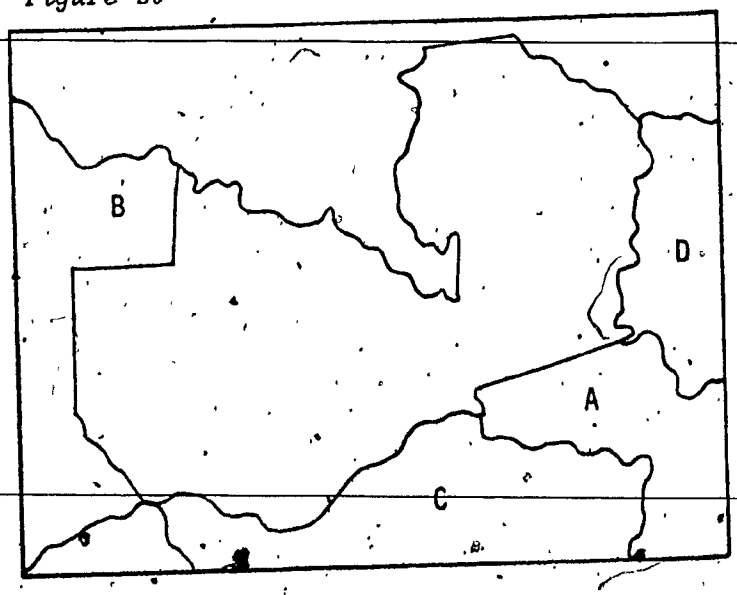
Figure 19



41. Which letter in Figure 19 marks the location of the Copperbelt of Zambia? Circle the letter you choose.

A.
B.
C.
D.

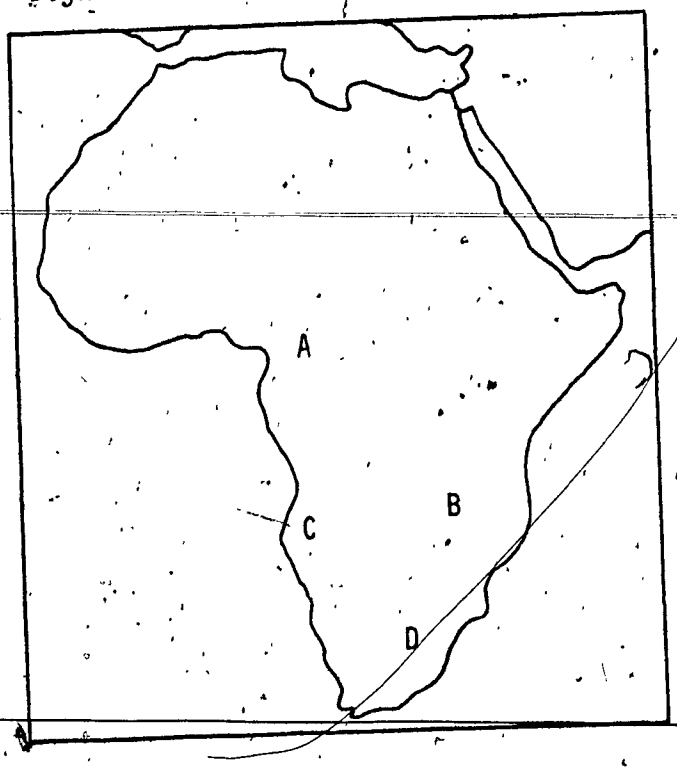
Figure 20



42. Which letter in Figure 20 marks the location of Rhodesia? Circle the letter you choose.

A.
B.
C.
D.

Figure 21



43. Which letter in Figure 21 marks the location of Zambia? Circle the letter you choose.

A.
B.
C.
D.

APPENDIX C

ITEM ANALYSIS AND TEST RELIABILITY

TABLE 1

ITEM ANALYSIS FOR PRELIMINARY TEST

VISUAL LEARNING					AURAL LEARNING				
ITEM	Upper	Lower	Difficulty Index	Discrim-inability Index	ITEM	Upper	Lower	Difficulty Index	Discrim-inability Index
3	5	5	0.63		22	1	1	.13	00
4	4	3	0.44	.125	23	2	2	.25	00
5	3	0	0.19	.375	24	5	1	.38	.50
6	6	0	0.38	.75	25	5	6	.69	-.13
8	6	1	0.44	.625	26	2	0	.13	.25
9	5	2	0.44	.375	27	6	2	.50	.50
10	2	0	0.13	.25	28	6	3	.56	.38
11	3	4	0	-.125	29	2	2	.25	00
12	3	2	0.31	.125	30	3	0	.19	.38
13	4	3	0.44	.125	31	4	0	.25	.50
14	2	1	0.19	.125	32	2	2	.25	00
15	2	0	0.13	.25	33	2	0	.13	.50
16	3	0	0.19	.375	34	2	5	.44	-.38
17	2	1	0.09	.125	35	5	2	.44	.38
18	1	1	0.13		36	4	4	.50	00
19	2	3	0.31	-.125	37	8	0	.50	1.00
20	5	0	0.31	.625	38	4	1	.31	.38
21	3	3	0.38		39	5	2	.44	.38
42	3	4	0.44	.125	40	5	3	.50	.25
52	7	2	0.56	.625	41	6	2	.50	.50
53	4	3	0.44	.125	43	1	0	.06	.13
54	3	1	0.25	.25	44	2	1	.19	.13
					45	6	3	.56	.38
					46	6	4	.63	.25
					47	3	0	.19	.38
					48	5	3	.50	.25
					49	2	2	.25	00
					50	6	3	.56	.38
					51	6	2	.50	.50

Note: Difficulty and discriminability indices are based on division of upper 27% and lower 27% scorers correctly responding to each item according to the system outlined in Ebel (1965, p. 347).

TABLE 2

ITEM ANALYSIS FOR FINAL TEST

VISUAL LEARNING					AURAL LEARNING				
ITEM	Upper	Lower	Difficulty Index	Discrim-inability Index	ITEM	Upper	Lower	Difficulty Index	Discrim-inability Index
1	6	1	0.44	0.63	19	3	2	0.31	0.13
2	7	5	0.75	0.25	20	2	2	0.25	
3	6	1	0.44	0.63	21	8	5	0.81	0.38
4	4	2	0.38	0.50	22	8	3	0.63	0.63
5	7	4	0.69	0.38	23	3	3	0.38	0.00
6	3	3	0.38		24	7	4	0.69	0.38
7	7	3	0.63	0.50	25	5	2	0.44	0.38
8	7	0	0.44	0.88	26	4	2	0.38	0.25
9	6	1	0.44	0.63	27	6	2	0.50	0.50
10	3	2	0.31	0.13	28	3	2	0.31	0.13
11	7	4	0.69	0.38	29	3	0	0.19	0.38
12	7	2	0.56	0.68	30	2	1	0.19	0.13
14	5	1	0.38	0.50	31	7	2	0.56	0.63
15	5	4	0.56	0.13	33	6	2	0.50	0.50
16	6	2	0.50	0.50	34	5	2	0.44	0.38
17	4	1	0.31	0.38	35	4	2	0.38	0.25
18	3	0	0.19	0.38	36	6	1	0.44	0.63
32	2	1	0.19	0.13	37	7	1	0.50	0.75
41	6	2	0.50	0.50	38	4	2	0.38	0.13
42	4	3	0.44	0.13	39	6	1	0.44	0.63
43	7	0	0.44	0.88	40	4	1	0.31	0.38

Note:- Difficulty and discriminability indices are based on division of upper 27% and lower 27% scorers correctly responding to each item according to the system outlined in Ebel (1965, p. 347).

TABLE 3

K-R RELIABILITY FOR FINAL TEST - VISUAL LEARNING

S[a]	Variance Unit			S	Variance Unit			ITEM	K-R Unit			ITEM	K-R Unit		
	SCORE (X)	$X - \bar{X}$	$(X - \bar{X})^2$		SCORE (X)	$X - \bar{X}$	$(X - \bar{X})^2$		p_i[b]	q_i[c]	$(p_i)(q_i)$		p_i	q_i	$(p_i)(q_i)$
1	13	4.433	19.651	16	5	3.567	12.723	1	.467	.533	.249	12	.567	.433	.246
2	12	3.433	11.785	17	4	4.567	20.857	2	.500	.500	.250	14	.233	.767	.179
3	16	7.433	55.249	18	5	3.567	12.723	3	.400	.600	.240	15	.467	.533	.249
4	14	5.433	29.517	19	3	5.567	30.991	4	.300	.700	.210	16	.433	.567	.246
5	8	.567	.321	20	6	2.567	6.589	5	.667	.333	.222	17	.267	.733	.212
6	10	1.433	2.053	21	8	.567	.321	7	.600	.400	.240	18	.267	.733	.212
7	9	.433	.187	22	10	1.433	2.053	8	.500	.500	.250	41	.600	.400	.240
8	13	4.433	19.651	23	6	2.567	6.589	9	.567	.433	.246	42	.533	.467	.249
9	6	2.567	6.589	24	7	1.567	2.455	11	.667	.333	.222	43	.467	.533	.249
10	5	3.567	12.723	25	10	1.433	2.053								
11	4	4.567	20.857	26	10	1.433	6.589								
12	11	2.433	5.919	27	6	2.567	2.053								
13	8	.567	.321	28	12	3.433	11.785								
14	5	3.567	12.723	29	13	4.433	19.651								
15	5	3.567	12.723	30	13	4.433	19.651								

[a] Note: Calculations proceed as shown below

Calculation of variance:

$\Sigma x = 257 \quad N = 30 \quad \bar{X} = 8.567 \quad \Sigma(x-\bar{x})^2 = 367.352$

Variance = $\Sigma(x - \bar{X})^2/N-1 = 12.667$

$= \sigma^2$ = unbiased estimate.

[c] Subjects were randomly numbered.

[b] p_i designates the proportion of subjects responding correctly to the item.

[c] q_i designates the proportion of subjects responding incorrectly to the item.

Calculation of r_{K-R} using K-R 20:

$K = 18 \quad \Sigma(p_i)(q_i) = 4.211$

$r_{K-R} = (K/K-1)(\sigma^2 - \Sigma p_i q_i)/\sigma^2$

$= .71 = r_{K-R}$ = acceptable reliability

TABLE 4
K-R RELIABILITY FOR FINAL TEST - AURAL LEARNING

S[a]	Variance Unit: Score (x)	X-$\bar{X}$	$(X-\bar{X})^2$	S	Variance Unit: Score (x)	X-$\bar{X}$	$(X-\bar{X})^2$	ITEM	K-R Unit: pi[b]	qi[c]	(pi)(qi)	ITEM	K-R Unit: pi	qi	(pi)(qi)
1	10	2.467	6.086	16	5	2.533	6.416	21	.700	.300	.210	33	.600	.400	.240
2	11	3.467	12.020	17	5	2.533	6.416	22	.767	.233	.179	34	.300	.700	.210
3	12	4.467	19.954	18	7	.533	.284	24	.700	.300	.210	35	.333	.667	.222
4	11	3.467	12.020	19	4	3.533	12.482	25	.533	.467	.249	36	.433	.567	.245
5	11	3.467	12.020	20	6	1.533	2.350	26	.267	.733	.212	37	.400	.600	.240
6	14	6.467	41.822	21	9	1.467	2.152	27	.600	.400	.240	38	.367	.633	.232
7	11	3.467	12.020	22	7	.533	.284	29	.133	.867	.115	39	.433	.567	.246
8	10	2.467	6.086	23	8	.467	.218	31	.533	.467	.248	40	.433	.567	.245
9	3	4.533	20.548	24	8	.467	.218								
10	4	3.533	12.482	25	8	.467	.218								
11	5	2.533	6.416	26	10	2.467	6.086								
12	4	3.533	12.482	27	9	1.467	2.152								
13	5	2.533	6.416	28	8	.467	.218								
14	3	4.533	20.548	29	7	.533	.284								
15	3	4.533	20.548	30	8	.467	.218								

Note:- Calculations proceed as shown below.

Calculation of variance:
$\Sigma x = 226$ $N = 30$ $\bar{X} = 7.333$ $\Sigma(x-\bar{x})^2 = 261.464$
Variance = $\Sigma(x-\bar{x})^2/N-1 = 9.016$
$= \sigma^2$ = unbiased estimate.

[a] Subjects were randomly numbered.
[b] pi designates the proportion of subjects responding correctly to the item.
[c] qi designates the proportion of subjects responding incorrectly to the item.

Calculation of r_{K-R} using K-R 20:

$K = 16$ $\Sigma(Pi)(Qi) = 3.545$
$K\text{-}R = (K/K-1)(\sigma^2 - piqi)/\sigma^2$
$= .65 - r_{K-R}$ = acceptable reliability

APPENDIX D

PROJECTION EQUIPMENT ARRANGMENT FOR EXPERIMENT

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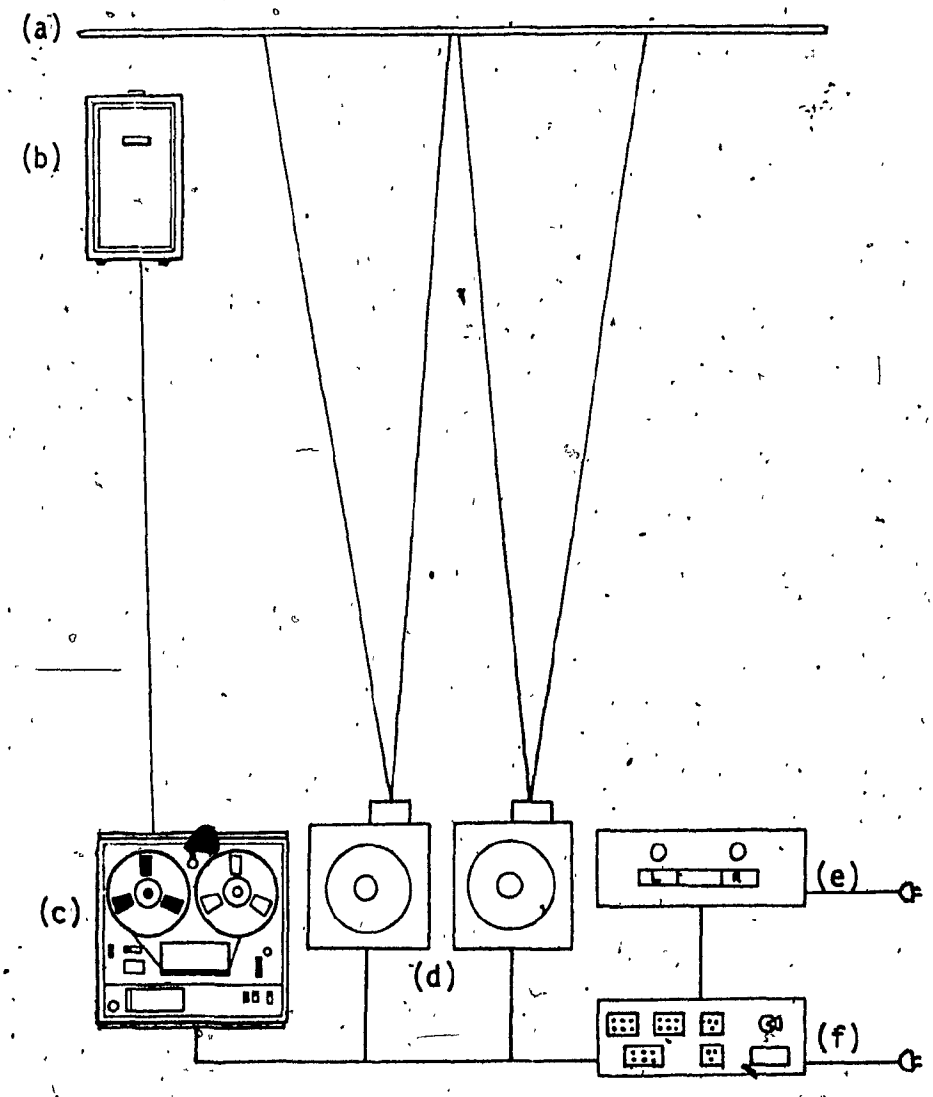
PROJECTION EQUIPMENT ARRANGMENT FOR EXPERIMENT



Equipment:

a) Matt Projection Screen, 12' by 9'
b) Hi-Fi Speaker
c) Stereo Tape Recorder
d) 2 Carousel 35 mm Slide Projectors
e) Tri-tone Programme Unit
f) Dissolve Unit