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ABSTRACT

As a part of a course on leadership, psychology and management developed for the United States Naval Academy (the final report appears under EM 010 484, EM 010 418, and EM 010 419) this report proposes a new model for presentation design and media selection which distinguishes between media and presentations. Presentation Design is discussed in detail, and five dimensions of presentation are proposed: stimulus encoding, response demand, management of presentation, duration of presentation, and distribution of presentation. Finally, present media research trends are discussed briefly, and where possible, their methods are compared to the new model. Continuing research dedicated toward producing an operational system is discussed. EM 010 418 through EM 010 447 and EM 010 451 through EM 010 512 are related documents. (Author/RH)

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Westinghouse Learning Corporation

A BEHAVIORAL APPROACH TO INSTRUCTIONAL DESIGN AND MEDIA SELECTION

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A BEHAVIORAL APPROACH
TO
INSTRUCTIONAL DESIGN AND MEDIA SELECTION

Behavior Systems Division

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Abstract

This report proposes a new model for presentation design and media selection. The model uses an engineering approach which is consistent with current procedures in instructional systems design. The total system includes behavior analysis methods of engineering students' behaviors, an explicit presentation design, and the implementation design for an operating system.

A significant feature of this model is the distinction between media and presentations. Presentation design is discussed in detail, and five dimensions of presentation are proposed: stimulus encoding, response demand, management of presentation, duration of presentation, and distribution of presentation. The design of an operational system which includes media selection can proceed efficiently after the presentation design is complete. Media limitations are proposed as the basic selection criteria instead of media advantages.

Finally, present media research trends are discussed briefly, and where possible, their methods are compared to the new model. Continuing research dedicated toward producing an operational system is discussed. Specific problems for research are in the areas of presentational design and media selection criteria.

1. Introduction

According to Webster, a medium is "...a means of affecting or conveying something," i.e., a medium is a conductor.

In the experimental learning laboratories, researchers attend to the "something" being conveyed and, for the most part, ignore the "conveyor." In educational research, however, the reverse seems to be true -- the "conveyor" is usually given more attention than the "something" being conveyed.

Discussions of media usage for instruction have been favorite pastimes in education circles, and with the coming of popular writing on media by Marshall McLuhan and others, these discussions are now common in the popular press.

Organizations devoted to the spread of new media information and excitement have appeared. The defense of the traditional media of lecture, laboratory, and text is also voiced. However, when their literature is examined from the standpoint of what is actually known about the learning process, unreliable data, faulty generalization from learning theory, and appeals to emotional or artistic basis are apparent.

Proponents of broad and undefined media classes, such as audiovisual (AV), team-teaching, and computers (CAI, CMI), also seem to delight in throwing up some smoke to shroud their claims, and the other camps often respond emotionally. For example, if it were stated that most computerized instruction is a second-class imitation of tutoring or vice versa, various groups would immediately respond in anger. However, there is no current valid research that can support either claim.

The only media group which has made some effort to back up its claims with sound data has been the programed instruction (PI) group. Furthermore, the group is even rather humble today, since its initial deification of the linear PI workbook medium has not proved to be a sustainable religion, although the data indicate that PI has held its own.

The major fault in instruction design today is the frequent failure to appreciate the distinction between three separate design elements: the medium, the presentation, and the method used in preparing the presentation. The authors have taken the position in this report that the medium is no more than the "can" in which the presentation is delivered and that every medium or media mix is superior to every other one for conveying some specific presentation form.

This is of particular importance in the design of an education system, since the quality of such a system can not be defined in terms of its content or aspects of information delivery but only in terms of change in student behaviors.

This report assumes that the behavioral approach to instructional design has been adequately validated. However, the authors have modified this approach by separating the design of the presentation from the design of the operational system (which includes considerations of the medium) and have included student repertoire shaping as a parallel development. The developmental procedure is shown in Figure 1.

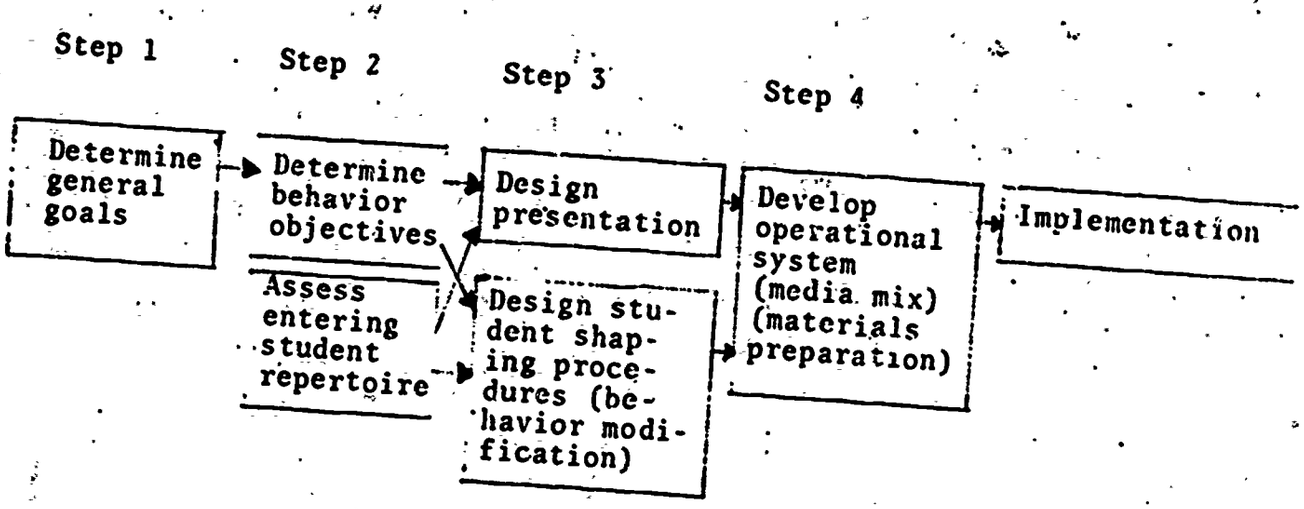


Figure 1 -- Developmental procedure

Particular emphasis is given to the model used in Steps 3 and 4. The most significant proposed departure from conventional methods in Step 4 is the decision to select media on the basis of their limitations rather than advantages. It is important to note that media selection is considered only after presentation design is complete.

Three design possibilities for overcoming media limitations are discussed:

1. the mixing of media simultaneously or sequentially to overcome the limitations of a single medium (derived from presentation design)
2. the modification of the behavior of the student to compensate for the limitations of the medium (derived from student shaping design)
3. employing whatever is available and being willing to settle for the resulting attenuation of the learner's output (null case)

A significant part of the behavioral approach to instructional design is the engineering of presentation (Step 3). Presentation design is discussed in terms of the following five dimensions:

1. the encoding form for the information
2. response demand characteristics of the presentation
3. management of presentation
4. duration of presentation
5. distribution of presentation

Present media research trends are then surveyed relating their methods where possible to the new design model.

Finally, the areas of system implementation, system maintenance, and continuing media research is briefly discussed

2. The Engineering Approach to Developing Operational Instructional Systems

The instructional design model stated below relies on three informal hypotheses for its strength.

1. Behavior engineering is a practical science.
2. Media are best characterized in terms of limitation as opposed to advantages.
3. Presentation form and media-mix are independent.

These hypotheses are amplified throughout this report, but first the instructon systems approach is considered.

There are several approaches to the development of an operational instructional system. Some designers follow formal methods. Others, like most teachers, use intuitive methods. But rather than continuing to ask such questions as "What media are best for this

subject area or this kind of student," it is proposed that an engineering approach rather than a psychometric approach be taken in the development of instructional systems. That is, rather than measuring students and selecting those who best fit, it is more advantageous to design in which necessary presentation is available for anyone.

The developmental system may now be stated with specific emphasis on the two important areas that are concentrated on in this paper: presentation design and media selection.

Step 1. Determine the nature of the problem by interview, observation, or research. Establish general goals to solve the problem.

Step 2. Determine the specific behaviors to be established and the entering behavior of the students.

Step 3. Deduce the presentation factors which produce the desired behavioral effect employing established evidence in learning. Then analyze or synthesize the generalized response sets which may be employed by the student in his response to the presentation.

Step 4. Select media which fit the presentation requirements. Media selection must be done in terms of eliminating media which limit or otherwise adversely affect the presentation design rather than specifying advantageous media. Then assemble an operational instructional systems package (media mix).

Step 5. Determine strategy for introduction of the operational system into the instructional environment.

If possible, each step should impose as few constraints as possible on the preceding step. The final system must be extended

to handle all constraints, but the fewer constraints imposed, such as prior medium selection, etc., the better and less expensive will be the resulting system.

2.1 Presentation Versus Medium

Media researchers to date have not chosen to distinguish a presentation form from the media which carry it. The new model requires that such a separation be made.

The media in instructional systems carry not only the data of the instructional message but also data on students' responses and various other bits of data necessary to maintain the operating systems. It is this conglomerate of information carried by a medium which will be called the presentation.

Presentation forms will be explicitly structured to communicate all data (stimulus, response, system control, student control) necessary for an efficient student-system interface. A student does not learn from the media. He learns from the presentation form. Media do little more than deliver the information to be learned in whatever presentational form previously decided upon. Some media organizations have maintained that media choice may contribute to learning efficacy because of a student's media preference characteristics or because of media dependant cues. However, the importance of these two ideas is minimal when a separate presentation design is implemented.

To be discussed later are the limitations which specific media choices may impose upon the presentation design and the subsequent mechanism for overcoming any such limitations.

As a specific example of the existing confusion between presentation and medium in program preparation, the technique called programed instruction (PI) can be examined.

The term programed instruction is used both for the presentation and as a label for the modified workbook often employed as a medium. There are, in fact, several presentation forms which have been called PI. The typical PI presentation is structured as follows:

1. The stimuli are presented in a verbal or illustrated form.
2. A demand of a written or selection response is made.
3. The presentation lasts as long as the student desires.
4. The student must make some response before proceeding to the next item.

Such a presentation form is known to be useful in teaching as are an infinite variety of other forms.

Although all pertinent stimulus forms, response demands, and timing have been specified in the PI presentation form, no mention was made of the medium to be employed.

An obvious medium is the printed frame workbook. However, the PI designers have used many other media mixes, such as slide-tapes, laboratory-workbooks, TV-problem booklets, peer-tutor scripts, and sound films. Of course, many of these media choices have limitations which may require modifications of the fine detail of the basic PI presentation form.

Current media research will be discussed in section 7 of this paper, and in many of the specific examples it can be seen that presentation variables are either ignored, confused with content,

or controlled by grouping them under gross media classifications such as "printed" or "projected". Results of such experiments cannot be generalized to produce reliable course designs. As examples of the disuse of presentation variables, two types of media experiments can be summarized.

One usual approach in media experiments is to use the same or similar course content with an experimental and a control medium. Usually the control medium becomes a human lecturer. Such a situation ignores the different presentation factors present in the lecture session and the experimental media session which may influence learning. A direct comparison of these two situations is analogous to an engineer considering two pipe materials for a delivery system without knowing that flow rate is dependent on pipe diameter and the friction coefficient of the inner surface. Such media studies cannot be analytical nor extendable.

Yet researchers seem blissfully unaware of these implications as can be seen in a recent experiment by Warner (1968) in which a mechanical medium, the Language Master, is compared to the human medium, the teacher. In Warner's discussion, she admits that the two presentations are not equivalent by the statement:

> ...the teacher allowed for assessment of the learning situation and appropriate modification of the pacing of the teaching program to suit individual difference.

However, later in the implication section she says:

> For first-graders in the initial phase of reading instruction, prompting and

reinforcing may be more effective when provided by the teacher than by a mechanical device..

Another media research technique is the large-scale correlational study. In this psychometric approach, a considerable amount of data on students, IQ, achievement, and personality is assembled in one file and instructional media in a second file, and perhaps general curriculum goals in a third file. This allows correlation to be made between various student attributes and performance data in different kinds of courses after exposure to various media. This technique is potentially analytic, but in practice, consideration of behavior objectives and presentation design are ignored. Just setting up a series of media events for a course and parading a number of students by them to obtain correlation will provide little to be generalized. Results of these experiments cannot be used for efficient instruction design.

2.2 Presentation Design

After experience in developing programed materials for several years and using them in Behavior Systems Division (BSD) classroom activities, the need for a separate presentation design became overwhelming.

Immediately after the need was realized, a presentation design incorporating contingency management principles and PI (Homme 1965) was implemented.

The resulting operational system employed PI texts, group discussions, progress check tests, and various high probability motivation activities, such as chess, as the instruc-

tional media. The system was so successful that almost any medium could be thrown in -- books, lectures, exercise sheets -- in place of the PI workbooks, and the system still worked. After such long devotion to the careful analysis of the stimulus and the response aspects of presentation, it was amazing to find that other factors, such as instructional management, could compensate for poor design. This forced the designers to cease considering PI as being synonymous with the workbook medium and to consider PI as a presentation form. Today, presentational designs are employed at BSD which allow a variety of media to be utilized in operating instructional systems.

Behavioral engineers, working with presentational design and the techniques for behavior modification, have been able to develop technology to work around most limitations of a particular medium. This effort has been so successful that today almost anything can be taught to anyone over the age of 6 using printed text with illustrations as the sole medium. Of course, there is a danger of the overgeneralization of this success, since this does not mean that such an operating instructional system will be efficient in terms of cost of preparation, student effort, or other criteria. But, it does not indicate the engineering power of the behavioral sciences, which may be equal to that of the physical sciences. The real breakthrough will come only when these two technologies are brought together.

2.3 Media Limitations

On the surface, considering the limitations of media may seem

to be nothing more than the reverse of stating the advantages of media. The difference is subtle but important. Two media may fit the general requirements of the presentation, but each has different limitations. It may be easier to compensate for the limitations of Medium A than of Medium B. Hence Medium A should be selected. Quite often, however, Medium B has an aura of advantage surrounding it. It is multi-sensory, it is new, it has been successfully used in other settings, or it has gotten great press reviews, etc. The novice designer may, therefore, incorrectly select Medium B because of its intrinsic advantages.

Since few researchers have even recognized the distinction between media and presentation, it is not yet known just what attributes of media may constitute inherent advantages. However, presentational analysis allows the limitations of media to be easily discriminated. Such media attributes might be structured in behavioral terms, in operational terms, or in terms of inherent syntactical cures.

Research dedicated to specifying media attributes must proceed in parallel with presentation design research to insure common purpose and terminology.

The assertion that media limitations are the key to proper media selection does not outlaw at least two special cases where media advantages should be used. Suppose the situation arises where at least two media have almost equivalent limitations for a given presentation design. Then, if one medium has the advantages of greater student experience or preference over the other medium, this should be a consideration in the actual media selection.

A second special case is similar in that it also assumes two media more or less equivalent from the standpoint of limitations. Here, the accompanying advantages are considered differently. A common practice in manufacturing is to compare a suggested product improvement in two situations: factory added or to be acquired by the consumer at a later date. In the media situation, the presentation design may call for a particular component to be added by the student from other media or at another time. However, a consideration of the advantages of the media may suggest that this component may better be provided now. To use an analogy, if salt enhances the flavor of asparagus, it is easier to add salt during processing of the asparagus when it is delivered to the consumer by the medium of the can than when delivered fresh. It is also interesting to note that the person who prefers canned asparagus over fresh may really be responding to salt which is not inherent in the medium of the can nor impossible to implement via the fresh medium. Many learners and educators are similarly superstitiously conditioned to prefer one medium over another because one "packager" may have added a desirable form of presentation not used by the other.

When media limitations are such that the presentation design must be compromised, other solutions are possible.

Three classes of solutions can be stated now:

1. the mixing of media simultaneously or sequentially to overcome the limitations of a single medium (system engineering)

2. the modifications of the behavior of the student to compensate for the limitation of the medium (student engineering)
3. employing whatever is available and being willing to settle for the resulting attenuation of the learner's output (null case)

The first two solutions have been profitable research areas at BSD. The second solution using behavioral engineering can be a very powerful solution and will be discussed in section 3.

3. Designing Student Shaping Procedures

Engineering of student behavior is considered to be an important part of an instructional system by BSD.

Perhaps the basic reason that student engineering assumed such prominence is connected with the equipment used in early instruction experiments. Typically available equipment was unreliable, frequently was out of service, had poor resolution, and often required additional simulation support by humans behind a curtain. Since these media limitations were so obvious and because human simulators are lazy, many ways were found to engineer the students's behavior to compensate for the limitations of the devices.

In designing equipment for educational purposes, two ideas are important. First, equipment doesn't necessarily have to be sophisticated. That is, equipment does not need to be designed around the limitations of human behavior as the equipment engineers might see them. Many equipment features, such as embellishment of student response modes, are bad because they attempt to replace simple behavioral tasks which could be more easily handled

with a behavioral engineering approach. Second, many of the design engineers apparently assume that the conventional classroom is an ideal medium since most educational devices could be considered simulations of a teacher, blackboard, and writing tablet. This is not necessarily bad since the information receptors that students possess are standard equipment and don't change when the student is moved from the classroom to media devices. However, such devices usually and unnecessarily carry over the same bias for or against certain presentation forms as exist in the classroom. Two examples of this carryover are the classroom preference for constructed rather than selective responses and sequential display of content rather than simultaneous media usage.

It is not unusual to find that individuals, even psychologists, who have specialized in automated learning and learning aids, overemphasize the mechanical aspect of their system and ignore all but the most obvious behavioral considerations as a result. Their actions have not been so much to design an integrated instructional system as to simulate the desirable features of an individual tutor. This tendancy is not without precedent. In most cases, the first attempt to automate in any industry usually produces machines which perform simple operations almost identical to those performed by a human for the simple reason that the human executes physically possible tasks quite well. However, with increased sophistication, automation provides functions which could never be done by a single human. The instructional system of the future will be neither a machine to replace a human tutor as the computer literature might imply, nor a beautiful reproduction of the natural environment via films as the audio-visual proponents might lead one to believe.

BSD personnel have had considerable experience in the modification of student behavior. Almost all of the instruction programs implemented at BSD have included some engineering of the student. Some of the student's more easily modificable behaviors are overt (Tosti, 1964). However, there are other behaviors, such as attending responses or processing behaviors, which are covert (and, therefore, inferred) but can be conditioned (Homme, 1964; Wychoff, 1952). Covert operants, including observing behaviors, mediating behaviors, and even joy, can be brought under stimulus control of the specific stimulus elements within the presentation (Tosti, 1967).

The fact that there are already stimulus elements, which as a function of the student's history may evoke certain kinds of observing and processing behaviors, may account for what has been described as differences in learning styles. The construct learning style has been used to explain the failure of some members of the observer population to acquire some behavior. The assumption that the student's individual learning styles are fixed and cannot be modified within the learning stiuation has arisen because most relevant experimental situations are designed to observe the effects of existing habits, not to teach new learning styles. Those who have prepared programed learning exercises, however, are aware that attending and processing can be shaped within the learning situation. This is done every time the studen is taught how to observe and respond to the frames.

Many programs go further and set as a behavioral objective the shaping of attending behaviors concerned with perception, i.e. observing responses, differential sensory selection, and perception. It has been shown that the shaping of observing responses

is an important component of the instructional process (Evans, 1961). Students must not only know what to do. but they must know where and how to look.

When designing a presentation, those stimuli already controling such covert behaviors must be found. If they are not or if those which now exist are not pleasant, the establishment of artificial ones can be engineered. Such stimuli have been labeled the formal syntax of the presentation.

Syntactical[1] cues are specific stimuli which control the emission of various processing behavior and control the observation sequence which then affects the order in which stimuli are attended to and responses emitted. For example, in PI the configuration of the frame itself has been used to control the tendency of the student to emit the mediation operant. Thus, within one frame configuration, the student was more likely to mediate than under another configuation, and this was found to be independent of the content of the frame (Tosti, 1967).

Each medium has its own natural syntactical cues, i.e., those conditioned by long exposure to their usual presentation forms. Many syntactical cues have been conditioned by motion pictures. Anyone raised on a diet of grade B movies can recognize the formal cues which were used to indicate flashback, transition scenes, etc. The hero had only to gaze at the horizon after carefully studying a trivial object for us to know we were about to look into his past.

Obviously, a new formal syntax could be established, and the student could be shaped to respond appropriately to it. This new

1 Syntactical cues can be differentiated from contextual cues. The former are not content dependent.

syntax could then be used in the presentational design. This has been done successfully by Lewis, Horabin, and Gane (1967), who first teach the student the syntax of the flowchart and then employ this syntax in the presentation. The general practice of bringing existing student response sets under an artificial syntax for the presentation may be one of the most significant contributions which PI development has made.

4. The Engineering of Presentation

For effective presentational design, it would be convenient to have a classification system of presentational factors which makes psychological sense. The use of medium classifications which employ display-mechanics categories such as print, projections, audio-visual, etc., are totally worthless. While there may be little behavior difference between a photograph printed in a book and a slide projected on a screen, there may be great differences between that slide and a motion picture of the same event.

A five-dimension classification scheme of presentational factors has been devised as a first attempt at proper presentational engineering. These dimensions are:

1. encoding forms. Data must be encoded in some stimulus form. Although this dimension is nominal, the categories can be arranged in a hierarchy according to an increasing level of abstraction.
2. response demand characteristics of the presentation. This is another nominal dimension which includes covert, selective, constructed, verbal, motor, or affective responses.

3. presentational management. This dimension is ordinal and is ordered according to the relative frequency of the decision to modify the presentation. The activity of management in deciding to modify the presentation is made on the basis of some assessment of the student or his environment. One may manage objective-oriented activities by providing learning tasks, remedial exercises or enrichment activities, or one may manage motivation by providing high probability contingency activities.
4. duration. Presentation varies on this ordinal dimension from transient to persistent depending upon the duration of the stimulus. Movies usually are conveyors of more transient presentation, and texts display relatively presistent ones. In a classroom, presentation by lecture is more transient than one which is delivered by the blackboard.
5. distribution. This is the ordering, grouping, and sequencing of behavioral items and the temporal spacing between such items.

Each of these dimensions has a certain importance for presentation design. It would not be possible to consider all the factors implied by each of these dimensions in this report, so only a brief analysis of some of the more important aspects of the five dimensions of presentation follows.

It is important to note these five dimensions of presentation are considered independent of media, although prior specification of media to be used could greatly restrict the freedom of some of these dimensions and vice versa.

The dimensions may be summarized as follows:

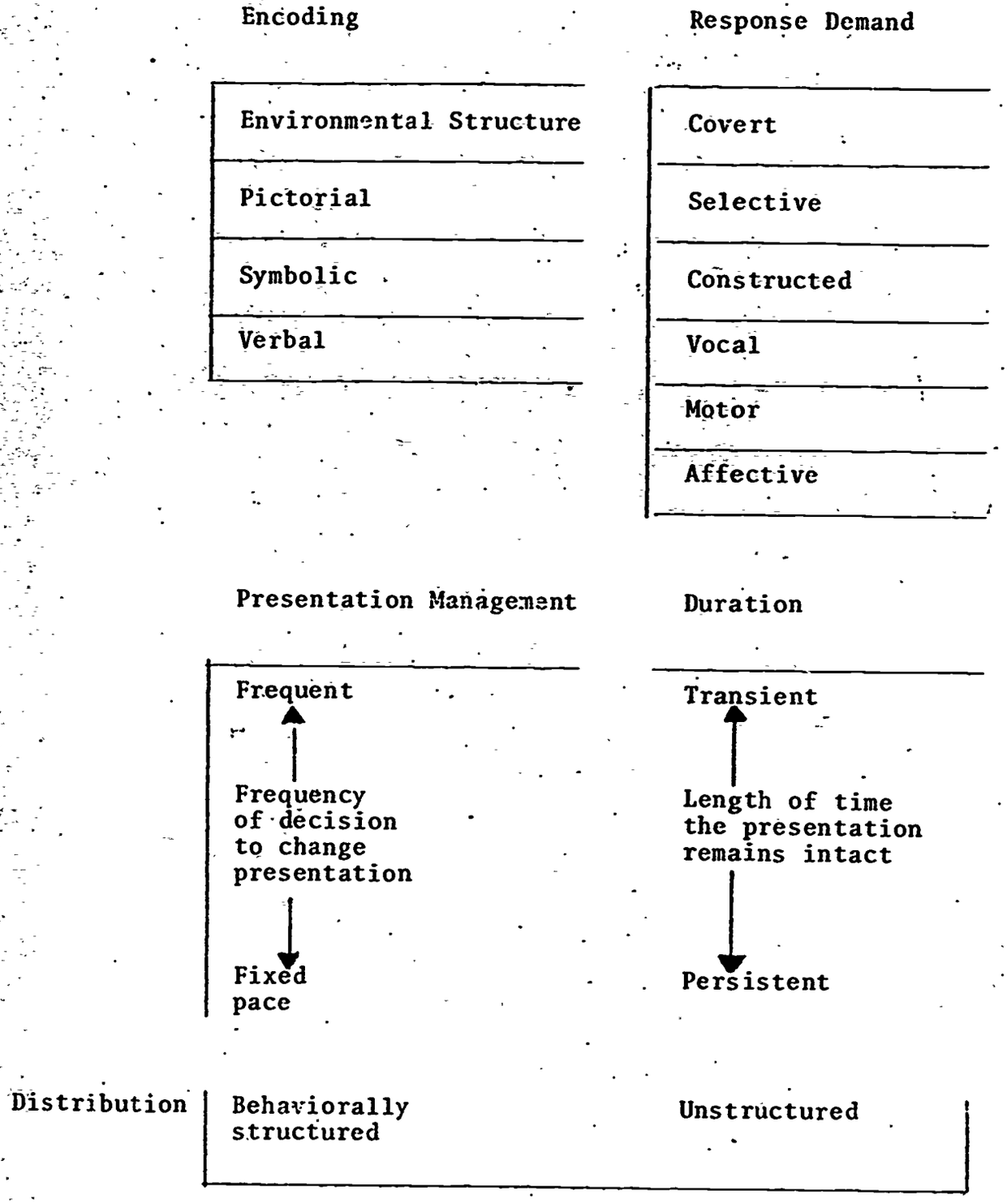


Figure 2 -- The dimensions of presentation

An explanation of each dimension follows.

4.1 Encoding Dimensions

Stimulus encoding is probably the most obvious of the presentational dimensions. The reason man has invented encoding forms are many. These include his being able to convey data about the real world without the necessity of having objects available, to condense data and eliminate noise, to allow more rapid delivery of data, and to reduce the cost of data transmission, etc.

Although there are many ways in which data have been encoded, the more important forms can be categorized as:

1. environmental structure. This category requires real objects either alone or in certain combinations. In an operational system, the student may be examining a flower or counting a row of blocks. The flower and the row of blocks constitute media for the environmental structure which was selected. The media employed for the environmental structure may allow the student to utilize other senses or combinations of senses. He can see it, feel it, smell it, taste it, etc. There are, however, no data which indicate that a multiplicity of sensory events is necessarily superior to one sensation alone. The decision for requiring a medium which demands the student use more than one sensorium should depend on the behavioral objectives.
2. pictorial. Pictorial encoding is the requirement for the reproduction of the visual aspects of objects that are either real or imagined. The media used to convey pictorial encoding always distort the various visual dimen-

sions, e.g., resolution, color fidelity, size, etc. Some media used for pictorial presentation, such as paintings and illustrations, eliminate or exaggerate various parts of an object. There exists no vocabulary of seeing - no visual communication language.

3. symbolic. Man has created many stimuli which stand for other stimuli which may be more complex, less abstract, or more difficult to manipulate. (A very important class of such symbols is the verbals which are considered separately below). Symbols range from graphics to schematics, from numerals to equations. Most symbolic encoding is in the visual dimension, but some, such as that delivered by fire sirens, is aural. But again, the sensory demand should be related to the external systems constraints and their objectives.

4. verbal. Words and verbal syntax[2] are the stimuli of the verbal encoding form. These may be either aural or visual. Some of the media most often employed to carry verbal presentations are humans (lectures) and books (prose).

An important and familiar criterion used in presentational design is a measure of the degree of similarity of the stimulus employed in the learning task to that of the criterion situation. Since transfer of training is usually to a large extent dependent on the degree of such similarity, it is best to use the highest level of simulation possible. In practice,

2 There are syntactical stimuli associated with all the encoding forms. However, primarily in verbal encoding, and to a lessor extent in symbolic encoding, has much effort for the systematic analysis of syntax being undertaken.

however, extensive constraints, such as cost, media availability, etc., often require a lower level simulation be designed.

Meaningfulness is a factor which may offset some of the disadvantages of lower level simulation. Because of the generalization that can occur via mediated transfer, the more familiar the criterion situation, i.e., the more the student has many associations to the criterion stimulus, the greater the potential transfer from lower levels of simulation. Thus, pictorial encoding of familiar objects, such as levers, may be as effective as encoding them in environmental structure. However, less familiar objects, such as chemical solutions, may require the kind of environmental structure which can only be conveyed in laboratory experiments. A compensating factor often used to offset the effect of the lack of a high association strength is the use of "sources of strength" (Homme, 1964) such as models or the establishment of analogies between what is being taught and some more familiar system.

In most presentations, two or more encoding forms may be used simultaneously. A book may display both illustrations and prose. An education television program conveys both the picture and lecture. Such presentations often require media mixes such as the teacher-blackboard combination. Less common is the simultaneous employment of two variations of the same encoding forms, i.e., requiring the student to read and listen to the same verbal presentation.

4.2 Response Demand Dimension

Responses have been classified into the following categories:

1. covert. This includes those behaviors that are normally not directly observed. Examples are attending (listening, reading, observing), mediation, imagining, thinking through, etc.
2. selective. The selection between alternatives as in multiple-choice or the pairing of alternatives as in matching.
3. constructed. Writing, drawing, or typing.
4. vocal. Saying something. Vocal is also a constructed response, but it is of sufficient importance to justify a separate listing.
5. motor. All other nonvocal activities which employ the striped muscles but are not included under constructed.
6. affective. Emotional respondings primarily defined in terms of the smooth muscles but often inferred from certain subcategories of the vocal, selective, and motor forms. Thus, it is often said that the student is making a positive affective response toward an activity if he says he likes it, he selects it or rates it over several other alternatives, or he engages in it enthusiastically.

Some of the more important factors in structuring and using the response demand dimension are summarized as follows:

4.2.1 Response Integration. Responses already well-learned require less effort to be hooked up with stimuli than those which are less well-integrated. Well-learned responses also allow for greater response-form equiv-

alence. Thus, with familiar responses, it may make little difference if the student writes it, types it, chooses it from among others, or thinks it to himself.

4.2.2 Response-Produced Stimuli. The act of responding always makes modifications in the environment. Chaining, where the response-produced stimuli control the emission of further responses, is one outcome of this. Other response-produced stimuli have feedback properties, ie., they act to modify the form of the response on its emission. External confirmation is one such class of response-produced stimuli. (See feedback, page 29)

4.2.3 Discrimination. Feedback discrimination tasks have recently been used in place of response practice. Evans (1961) hypothesized that discrimination practice could shape the student's ability to guide his own behaviors into the desired response pattern. He gave preschool children practice on discriminating well-formed numbers from those badly formed. It was found that these children were able to write the numbers much sooner than those who had been given either response guidance or response practice. Similar techniques have been employed to teach machine operation. By using discrimination training to show proper equipment setup, the students first learn the proper appearance of the outcome and thus are able to monitor their own behavior in acquiring the skill.

This same procedure has been applied to problem solving in mathematics. Instead of requiring students to solve many problems, students were given discrimination practice on both setups and outcomes of problems. They were able to discover the subtleties of 50 problems in the same length of time it would have taken them to complete five problems (Tosti, 1964). This technique allows the student to interact with the uniqueness of each problem and avoid the redundancy of problem solving. It is necessary that at some time the student actually solve problems, but since he has learned all the component behaviors of problem solving, the actual response practice phase can be reduced.

The factors considered above only scratch the surface of the many parameters associated with response demands which must be accounted for. But, the specification of a response demand dimension at least allows the grouping of such factors for comparison.

4.3 Management of Presentation Dimension

In designing an educational system, one of the most important dimensions one must attend to is the presentational dimension of management. Management refers to the decision to alter the presentation as a function of some assessment of the student or the environment. Management involves three activities:

1. appraisal of data
2. selection of some assignment as a result of some decision based on the data

3. specification of the various actions that may be assigned.

These three activities take place in every instructional system within the classroom or with computer-assisted instruction (CAI) in varying degrees of frequency and precision. Fortunately, since there is only a finite number of classes of actions which may be performed by a student and finite kinds of data which may be collected for appraisal, the number of selection decisions one can make is correspondingly limited.

The class of actions includes:

1. instructional tasks which are related to the objective.
2. remediational tasks which are designed to get the student to be able to handle the instructional tasks.
3. enrichment tasks which are related but not required for meeting the objectives.
4. other tasks not necessarily related to the objectives.
5. other activities which are motivating to the student.
6. termination of the presentation.

Of course, even though the classes of actions are finite, there are practically an infinite number of alternatives within each class, dependent on the variety of the objectives of the learning system.

The kinds of data which may be collected to make these decisions are also finite.

Some of the reasons for presentational management are considered below.

4.3.1 Management For Need. This type of management usually takes two forms:

1. Selection of these activities which will allow

the student to achieve some long-range aspirations. For example, a student who wants to be an engineer should receive mathematics instruction.

2. The bypassing of those activities which would only strengthen already acquired behaviors. Some of the simplest forms of this management can be seen in the skip ahead options on material the student may already be familiar with or the more complex prescriptive testing procedures which indicate proper placement in the presentation sequence.

This is a summary typical of need management, activities in an operational instruction system.

Appraisal	Selection Decision	Action
Examination of student repertoire	Comparison of student achievement scores with prescriptive flowchart	Student shifts to those instruction tasks appropriate for him
Medium - diagnostic, pre-tests	Medium - teacher or teacher aid	Medium - workbooks and exercise sheets

4.3.2 Management for Attainment. What happens when the student is responding to the presentation but not in a manner which allows him to reach the objective? This situation requires some management to aid him in attaining the objectives. There are four strategic subclasses of responses to such situations.

1. Redundancy. If the student fails to reach the objective, repeat the same or similar presentation until he does, e.g., individual programed instruction. Continuous practice is one variation of this strategy.

2. Multiform. If the student fails to reach the objective with one presentation form, select a parallel but different form, e.g., Project PLAN (Flanagan, 1967).
3. Multilevel. If the student fails to reach the objectives with the presentation form, select a lower level (more expanded) form, e.g., PROMOD (C'de Baca, 1968).
4. Error-Diagnostic. If error is made at any point within presentation, action designed to correct that specific error is selected, e.g., intrinsic program presentation or CAI presentation. It is necessary when using this error-diagnostic strategy to classify errors as:
   a. input error - poor presentational design
   b. processing error - the student's lack of the assumed appropriate repertoire on which the learning material was built, or the student's use of an inappropriate approach to the solution.
   c. output error - carelessness - poor attention - chance error (failed to attend to a significant stimulus).

This is a summary typical of attainment management activities.

Appraisal	Selection Decision	Action
Examination of student error	Comparison of present level of achievement to final behavior objective	Student goes through alternate form of instructional task
Medium - curriculum, embedded tests	Medium - teacher or teacher aid	Medium - text or workbook

As with all other forms of management, there are many options on what medium to use to monitor and make the selection decision on the basis of data appraised. One medium often overlooked is the student. For example, output errors (carelessness) which may possibly account for the largest percent of error, can often be remedied by allowing the student to re-examine the original presentation. Hence using the medium of CAI to decide in such error situations is an excessive expense.

The role of feedback in learning tasks is still a point of controversy among learning psychologists. However, there is general agreement that the law of contiguity is a primary force operating on learning in a given presentation, i.e., the student must make the response while attending to the relative elements of the stimulus for there to be a tendency for him to repeat that response when presented with that stimulus in the future. If the continguous association is made, it is argued that the effect of positive confirmation will neither further increase nor decrease this tendency. However,

the occurrence of negative confirmation (disconfirmation) evokes certain operants leading to the re-examination of the presentation (if it is still available), which may tend to suppress the just emitted wrong response. In other words, the disconfirmation becomes the control stimulus for the subject to engage in some form of error management. The possibility of teaching students how to monitor their own behavior and how to correct their errors of carelessness is a conceivably more economical and universal solution than providing other decision media such as machines or teacher aids. In addition, one can conclude that it is not necessary to confirm every response.

4.3.3 Management for Enrichment. This refers to the selection of presentations which are designed to produce behaviors which, although related to the specific behavioral objectives, are not required for the attainment. Some reasons for enrichment management which have been given are that it provides for time fillers, it aids to motivate the student, and provides for greater generalization of the behaviors. This type of management will undoubtedly become more important as systems become more refined.

4.3.4 Management for Motivation. To keep the student in the learning environment or to keep him responding at a satisfactory rate, his learning activity should lead to some positive consequence. Laboratory studies of reinforcement typically use the positive consequence

of eating or drinking to motivate animal behavior. Equivalent kinds of reinforcement can be used with children. However, it is awkward to use this kind of payoff for learning activities in the classroom. Students cannot be starved, nor can candy be placed in their mouths for correct responses. This creates the impossible position that standard laboratory rewarding consequences are necessary but impractical. There are, however, many other kinds of preferred activities which can be employed in the classroom. The formal administrative technique employed to provide positive consequences for learning activities has been termed "contingency management" (Homme & Tosti, 1965). Appropriate procedures have been developed by Westinghouse Learning Corporation and have been employed in many diverse settings.

In a recent experiment, fourth-grade children were allowed to either read or listen to the same story content (Berger, 1965). Most students in this age group preferred to read rather than listen, indicating that the visual presentation produced a high probability response. When a contingency was established with such students requiring them to listen for a while before having an opportunity to read, the probability of listening was greatly increased. Although this experiment is confounded with presentational variables associated with reading and listening, these data tend to indicate that the pre-

sentation should be available in a variety of media, and the student should be allowed to select his own medium for maximum motivation.

Motivational management uses the same approach as other management forms. That is, a decision for the student to engage in some activities is made on the basis of some data. In motivation management, those data are usually the student scores on some progress check test, and the selection possibilities include those activities the student may prefer, e.g., playing games, talking with his friends, working on algebra, viewing an entertaining movie, reading a novel, or engaging in a guided-group discussion with his peers and the teacher.

This is a summary typical of motivation management activities:

Appraisal	Selection Decision	Activities
Examination of satisfactory task completion	The student may take a break	Student engages in high probability activity
Medium - progress check test	Medium - contingency contract or class on management	Medium - conversation, games, etc.

Motivation management is the most neglected form of presentation management.

.4.4 Duration Dimension

Duration is an ordinal dimension that varies according to the length of time a given presentation remains unchanged.

Presentations vary from transient to presistent . Persistent implies that the presentation can last unchanged for an indefinite period. Certain media convey transient presentations better than others. For example, the presentation conveyed by motion pictures is usually transient although persistent presentations (such as a 6-hour movie of the Empire State Building) can also be conveyed with movies. The primary disadvantage of transient presentaions is the requirement for the student to store information since it is no longer available in the environment. This creates difficulties in situations in which the presentation demands a response be made to several stimuli simultaneously. It also limits those media which employ transient presentation in their ability to generate new learning, particularly if the tasks involve both discriminations and new information to be processed or where the student must combine the new information with associations from his existing repertoire. There are further implications in this limitation such as when dynamic sequence is being portrayed in which the individual behavioral links of the chain are unfamiliar or at low strength. The storage level required of the student is too great unless the individual links have been previously established in a more persistent presentation. Second, although transient media have potential, they do not usually use a presentational design which provides for simultaneous discriminations of stimulus conditions in behavioral sequences. This is probably because of the un-

willingness of the presentation designers who work with the media to interrupt the realtime sequence.[3] It is, therefore, predicted that discrimination learning in a more persistent medium prior to exposure to the dynamic medium would shape up observing behaviors necessary to more greatly insure the use of the association between the covert response emitted in the presence of the transient medium and the correct stimulus elements of those presentations.

Although a more transient presentation may be a higher level simulation, it may be preferable to specify a presentation which uses a more persistent presentation. Often when a situation is duplicated, the sequence is too rapid or too complex to allow the student to discriminate the subtasks and their controlling stimuli. By going to a more persistent presentation, the action can be stopped, and the operation can be simplified to isolate those particular stimuli to which the student should attend. This storage-demand disadvantage is offset somewhat where the information is already at some strength, i.e., where the presentation is already familiar. As is discussed in the encoding dimension section, the meaningfulness of the presentation can be enhanced via mediated transfer by relating the new information to familiar analogies. The storage limitation indicates why there are no films teaching calculus. However, it may be practical to use a film presentation to teach an understanding of calculus by relating principles

3 This implies that educational film makers should neither follow the techniques of the lecturers nor the techniques of the entertainment producers but develop a new form based on a knowledge of learning conditions

of calculus to analogous situations which are highly familiar. The two main considerations in selecting more transient presentation are:

1. the possible greater simulation of the criterion situation.
2. the increased speed with which information may be presented.

A disadvantage of persistent media is its inability to indicate real time contiguous associations between individual member links of a behavioral sequence chain. In some cases, this has been overcome by employing syntactical cues to indicate time or motion. Illustrations, such as showing arrows or providing a fixed sequential pattern as in comic books, have the potential of providing a contiguous association between behavioral links. Even in these cases, however, there are no real time constraints imposed on the system, and in many cases, the response speed is the desired conditioned component.

Another way to overcome this disadvantage is to combine persistent and transient presentations. The lecture and blackboard are the most common example. In teaching a behavioral chain such as welding, it is best to strengthen the individual behavioral links with a persistent presentation as in a PI workbook followed by a transient one displayed by a slide-tape device. (A motion picture which could give a truthful reproduction of the real-time events would have allowed a superior presentational design to that conveyed by the slide-tape medium.)

A second disadvantage of most persistent media is their lack of any time demand. This, however, can be compensated for by presentational management techniques such as contingency management.

However, if other constraints are placed on the system which prevent manipulation of other dimensions, such as the inability to collect sufficient data to do attainment or contingency management, then such controversy as whether it should be film or book becomes critical.

Relating to the familiar or building on existing behaviors is a consideration in any presentation. However, it is especially critical in more transient presentations. If one can invent a general rule, then it should be: The less the familiarity of the concept, the more persistent should be the presentation. With very difficult material, one should use a presentation that lasts as long as the student requires, i.e., a student-paced presentation.

The decision on the duration of the presentation is probably the least critical (but most often debated) one to be made in presentation design, since there are so many ways to compensate for it by manipulation of the other dimensions.

4.5 Distribution Dimension

The fifth dimension of presentation is distribution. Distribution refers to the ordering, grouping, and sequencing of behavioral items and the temporal spacing between such items. Distribution includes such items as the distribution of practice, the frequency of review, and the hierarchy of presenting content. Distribution differs from the other four dimen-

sions in that it tends to affect the interface with behavioral analysis more than the interface with operational systems. Considerations of distribution may have almost no bearing on media selection with the exception that considerations of distribution are often made to coincide with greater utilization of a given medium over a time period. Thus, items are grouped together which best fit a medium to be taught at one time for no other reason than to decrease the frequency of media changes.

The two primary behavioral considerations in the determination of sequence are the necessity for establishing behavior on which new behaviors can be built and the establishment or disruption of generalized response sets.

There are two additional minor rationales for considering distribution. These are distribution for practice and distribution for relief of boredom or motivational purposes.

On the surface, it seems that many of the aspects of distribution overlap with those of management. This is true. The difference is that all considerations of presentational change in distribution are made before instruction and are not based on any ongoing evaluation of either the student or the environment. It could be said with great justification that management is a special case of distribution.

4.5.1 Review and Relearning. The most familiar concept in distribution for review and relearning concerns those experiments done with mass versus distributive practice where it has usually been found that distribution of practice with time intervals of inaction or action

on unrelated tasks between practice intervals are superior to the equivalent number of trials with no such time lapses.

A second consideration somewhat related to the above is the frequency of distribution of paired-associate review within trials. It has been found (Tosti, 1961) that when distribution of review items are on an approximate geometric increasing base, there is an extremely efficient review schedule. For example, behavior A might be presented on frames 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1,024, etc. Difficulty in material design using such schedules has prompted a decision to review not only at the end of well-defined blocks but also within these blocks.

Review cycles may repeat themselves within blocks, and then on occasion the blocks may also appear in review cycles. Thus, within a block of 50 frames, behavior A would appear on frames 1, 2, 4, 8, 16, 32, and at the end of the block. Then there would be a general review, including Behavior A. In the next trial block, Behavior A would not appear. Behavior A might reappear in the above geometric progression in subsequent blocks, i.e., in blocks 3, 8, 12, 17, etc. Such a schedule was used successfully to generate a multiplication and a division course (Tosti. 1961).

The rule, "All else being equal, teach the harder first," is also a special case of review and relearning, since in normal instructional sequences, teach-

ing harder items first gives more opportunity for review within the given fixed-length total course. It is clear why such a rule exists. For example, in the construction of a decimal program, the concepts of decimal, multiplication, and division are relatively independent. But since among these concepts, division of decimal numbers is considerably more complex in the number of discriminations to be made, division of decimal numbers should be taught before multiplication of decimal numbers contrary to current practice. This would give more opportunity for review of the concepts throughout the length of the course.
Of course, this is contrary to another rule "Teach easy items first," since it provides the immediate success which will motivate the student to continue. One could also make a good case for a relatively homogeneous distribution of difficulty throughout an instructional sequence. The relative merits of each of the above considerations should be made for each course.

4.5.2 Behavioral Hierarchies. It is known that behavior which can be built onto already existing behaviors is generally facilitated in its acquisition, retention, and generalization. This is one of the primary differences between the application of modern behavioral theory and the application of behavior theory in the twenties. Thus, if we are going to

install a new S-R pair, it would be most advantageous for us to have certain other S-R pairs previously established. Of course, such antecedent behaviors may have been established before the instructional setting, or the distribution decision to create and establish such behaviors within this instructional setting might be made before the establishment of the new behavior. There are several classes of such behaviors which must be considered. These include stimulus discrimination, response differentiation, existence of mediators such as understanding, analogy, or mnemonic, and those response sets concerned with observing and covert responding sequence.

5. Designing the Operational Instructional System

Once the presentation has been designed, it is necessary to design the operational instructional system which will carry it. This involves selection and sequencing of the media. It is essential to use a medium that can carry the specified presentation with as little distortion as possible. Of course, every medium will limit the presentation in some effect or fine detail, and when the presentation is stuffed into the "can" of a particular medium, it is often necessary to sacrifice some of the effectiveness.

Using the dimensions of presentation, media can be classified with some psychological sense. Figures 3 and 4 show the classification of some instructional media in two-dimensional

matrices. It may be noted that many media appear in several places since several encoding forms can be carried by those media. For example, flash cards can have words on them or equations, texts may display pictorial and verbal presentation, and sound motion pictures usually convey both pictorial and verbal presentation simultaneously.

Also, with enough prior instruction and followup, one can demand almost any response to any medium. Figure 4 indicates those responses most frequently demanded in practice.

Often there is no one best medium or media mix for a given objective. Several alternative operational systems may convey equivalent presentational designs within the constraints specified. The final selection between these operational systems should be based on behavioral consideration and on:

1. cost. This includes developmental costs, purchase costs of media devices, initial setup cost, and cost of maintaining the system.
2. availability of various media, e.g., tutors, AV devices, etc.
3. market or user preference.

Perhaps the model can be extended to include these dimensions but only after more is known about the existing five dimensions. Conceivably, sets of curves or even linear programing techniques could be developed to optimize the instructional design for various operational constraints.

Let us consider an exercise in media selection. Suppose we have determined from our behavioral analysis that the best pre-

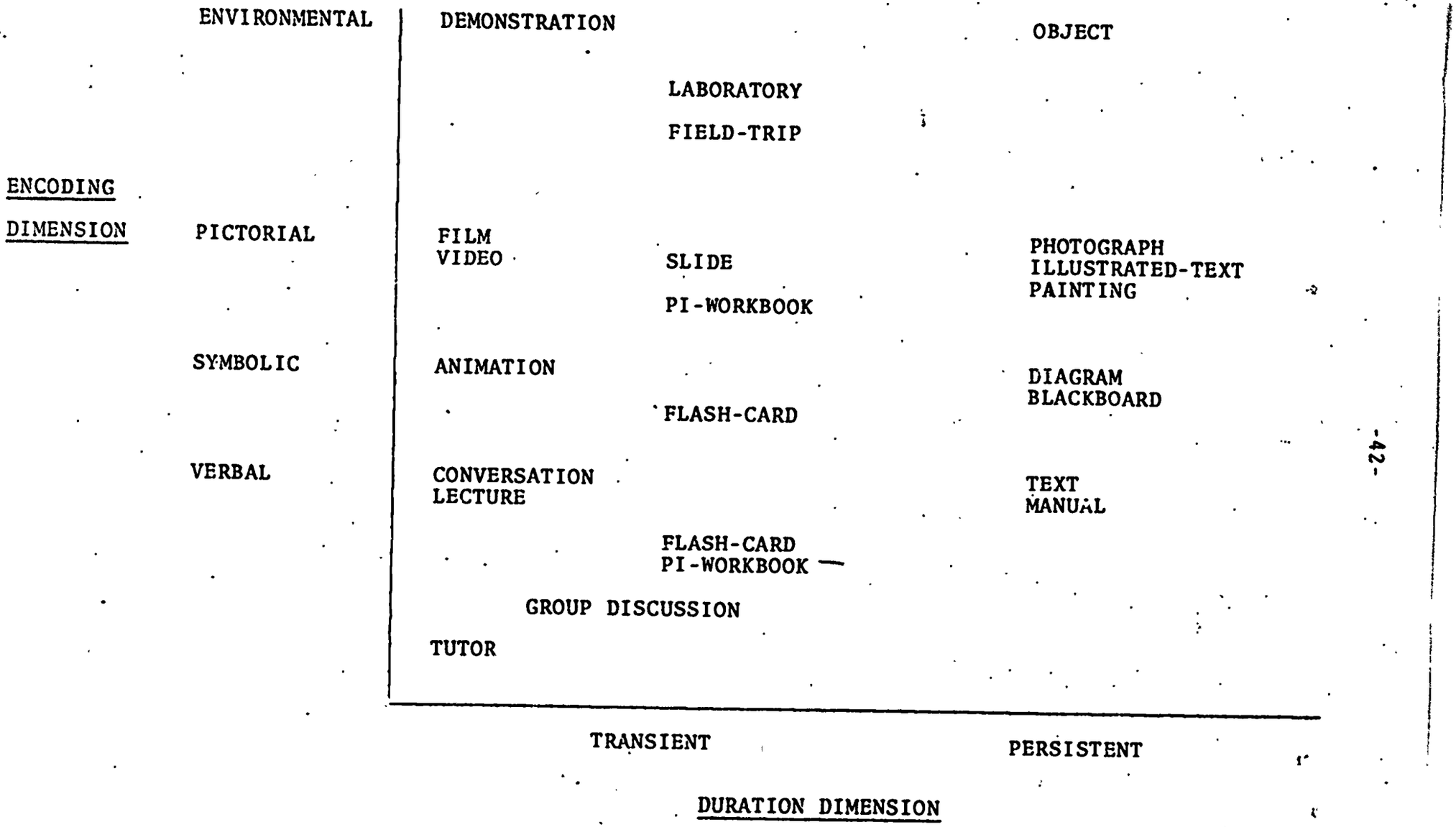


Figure 3 -- Media classified by encoding versus duration

ENCODING DIMENSION						
	ENVIRONMENTAL	DEMONSTRATION FIELD-TRIP	ITEM-SORT			
	PICTORIAL	FILM VIDEO SLIDE PAINTING PHOTOGRAPH	MULTIPLE-CHOICE- TEACHING MACHINE		ILLUSTRATED- PI-TEXT	LABORATORY
	SYMBOLIC	BLACKBOARD DIAGRAM	CARD-SORT		FLASH CARD	DIAGRAM
	VERBAL	LECTURE AUDIO-TAPE	PI-WORKBOOK		CONVERSATION ROLEPLAYING AUDIO-TAPE	
		TEXT	TUTOR	TUTOR	TUTOR	TUTOR
		COVERT	SELECTIVE	VOCAL	CONSTRUCTED	MOTOR

RESPONSE DEMAND DIMENSION

Figure 4 -- Media classified by encoding versus response demand

sentation design to meet our objectives can be summarized as follows:

1. The stimuli are to be presented in a verbal and illustrated form.
2. A demand of a written or selection response is to be made.
3. The presentation must last as long as the student desires it.
4. The student must make some response before proceeding to the next item.

Figure 5 shows the limitation of the medium of motion pictures against our requirements. The presentation is by necessity distorted.

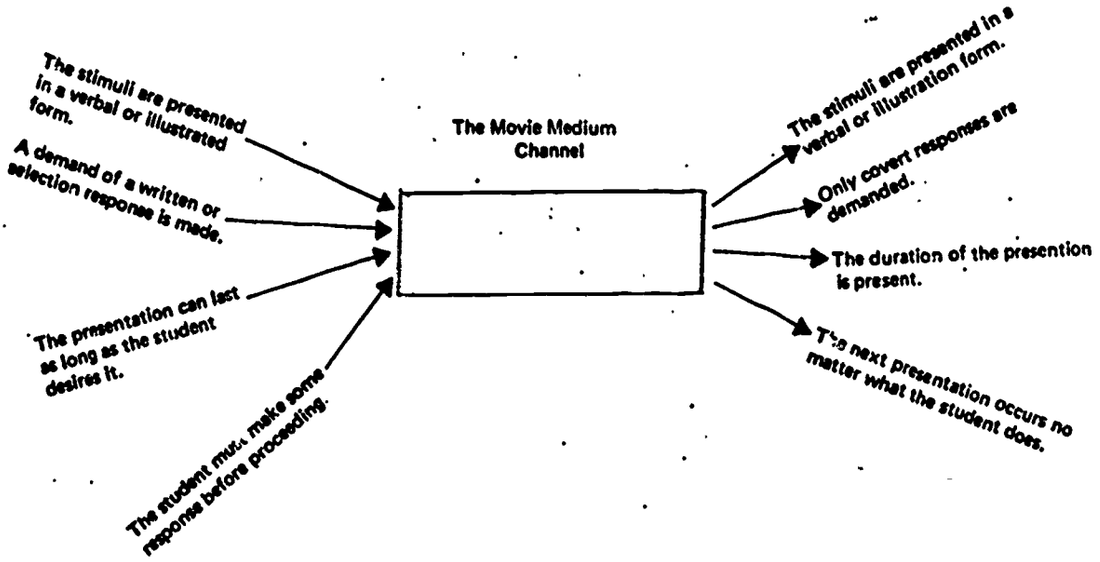


Figure 5 -- Distortion of the presentation by the single medium of motion pictures

A better fit in some areas can occur if a human tutor is uded, but still there is much distortion.

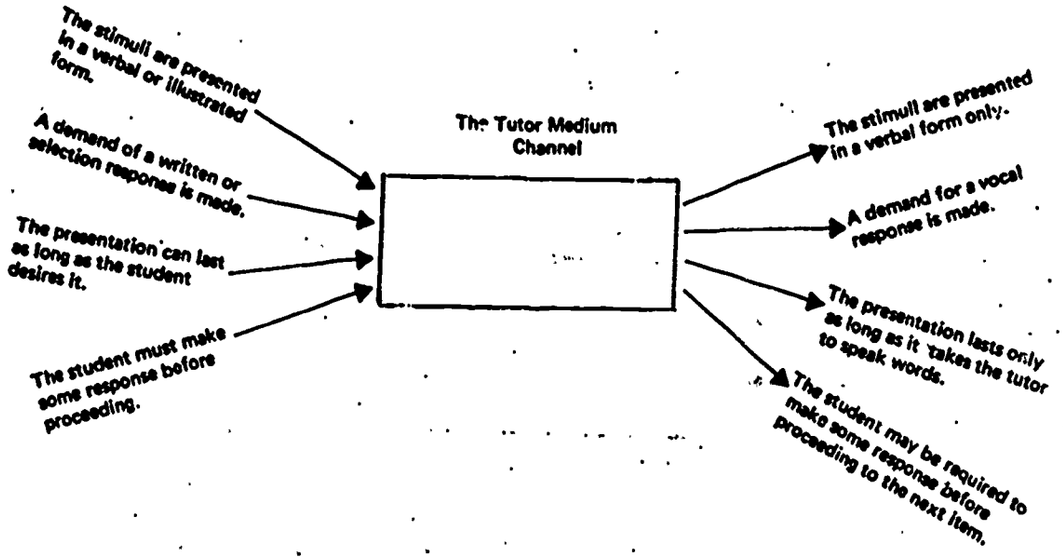


Figure 6 -- The presentation by the single medium of tutor

If a mixed media system is used the presentation remains intact.

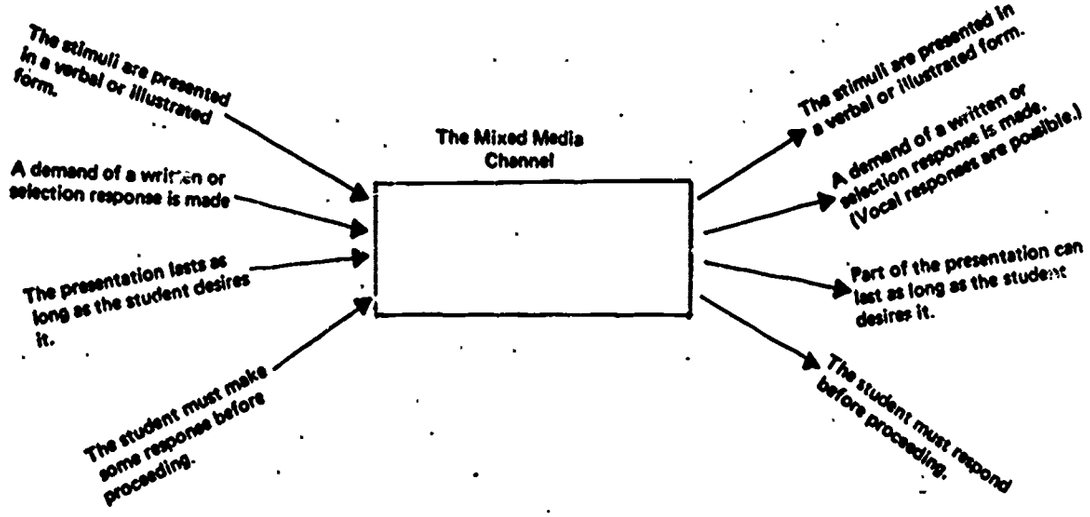


Figure 7 -- The PI presentaion by the mixed media instruction system of tutor + blackboard + writing tablet

There are other considerations. Such factors as the cost of making the movie, the instructional reliability of the tutor, or whether we can adjust the presentational design to fit any of the media have to be considered. But this model allows us to examine on a systematic basis most of the important tradeoffs which are possible.

6. Maintaining the Instructional System

Perhaps the most difficult task in instructional systems is the maintanance of that system after implementation. This difficulty arises because systematic instructional design, by its nature, breaks down information into disgestible hunks in which it is easy to lose the overall structure and purpose of the instruction. This almost always happens to the student and frequently to the instructor or manager.

In a conventional classroom, this is not as often true. The stability of such a classroom occurs, because the instructor acts as the main instructional medium and is aware of the total course objectives and content. However, in multimedia systems, where the instructor plays less of a role as an instructional medium and more as an instructional manager, overall course structure may become lost, resulting in disintegration of the instructional system. In such cases, there are three alternatives.

First, and most usually preferred by people with background experience in education, is to teach the instructor the structure of the system so that each item has relevance to him. But the result of this is for the teacher then to subvert the system and substitute himself as an instructional medium in place of other instructional media.

The second alternative is to teach someone only the structure. No content knowledge or interpretative ability is required. This is the approach which is used in the Westinghouse Learning Corporation Education Advancement Center. The emphasis is on building classroom managers instead of educating people to be teachers. They only know how to operate the system, and they do this by following a set of guidelines and rules which have been established and laid down. Of course, in this situation the instructional personnel have no knowledge of the content and cannot take over if the other media fail.

A third alternative is to use a media mixture. An instructional manager trained to maintain the system and a tutor who is familiar with the subject matter are combined with one instructional group. The tutor only acts as an instructional medium and performs no systems management functions.

There are many variations on these themes. For example, one could use a computer as the manager of the system paired with an off-line tutor. Another alternative is to teach the student to manage all or part of the system. This technique is traditionally frowned on by many teachers, although there is no behavioral reason why students cannot manage their own activities quite well, provided their contingencies are arranged properly. Still another alternative is to use peer-managed events.

BSD personnel have had considerable practical experience in these and other instructional maintenance tasks. Further work in this area must parallel work on a media model and presentation design techniques.

7. Current Media Research

In this overview of media research, current efforts will be categorized by the impact of media upon societies, the psychology of media, learning models, creativity and media, and applied media experiments.

None of the topics in this section will be covered completely or even consistently, but enough ideas will be presented to denote current research trends. Also, where opportunity exists, current research ideas or tasks will be compared to the new model proposed in this report.

General discussions of media and mass communication range from the historical place of media, especially print, in shaping cultures to modern experiments concerning the flow of information. Cultural media discussions tend to be philosophic in their explanation of past media effects and predictions for the future.

Carpenter (1960) gives a tribal character to a media-infected world:

> After the advent of printing, colonial America had a huge advantage over Europe. It was able to develop and apply swiftly, all of the consequences of printing, books, newspapers, assemply lines, because there was no backlog of obsolete technology to be liquidated first. Europeans had this backlog and had to struggle through a long painful period in order to clear enough room to exploit the new trend in technology. Today, America has the largest back-

> log of obsolete technology in the world, based on print and methods derived from print. As such, backward countries have a definite advantage over us; they stand in relation to electronic technology as we once stood in relation to print technology. Post-literate man's electronic media will contract the world to a village or tribe where everything happens to everyone at the same time, and there is complete knowledge and participation. Television gives this quality of simultaneity to them in a village or tribe, creates a definite tribal outlook and puts a premium on togetherness. Nobody can longer strive for individual excellence for it would be socially suicidal, therefore, tabu.

On the same tribal theme, Hall (1959) says that people reared in different cultures learn to learn differently. "Education and educational systems are about as laden with emotion and as characteristic of a given culture as its language." This is an example of confusing the presentation with the medium.

McLuhan (1964) and others worry also about the information to be conveyed.

> The fundamental flaw in this communications miracle (Telstar) is the same one that has bugged every communications miracle since they started carving hieroglphyics on stone tablets. What do you say on it?

Occasionally, the writers mention mass communication in an educational context and in doing so always bring up a problem which bothers cognitive psychologists today. How do children acquire observing responses, particularly visual orientation? How do they learn to process patterns? The behavior engineering approach says that such questions are irrelevant. The real question is how can the desired visual orientation or what controls the already established observing response by engineering. New technology, most notably television, has changed the framework of society, not just the picture within the frame, and it is this fallacy of thinking only about the picture that has hidden the true relation of television to education. We tend to think of television as an incidental aid while it has already transformed the learning process of the young, independent of home and school. (McLuhan 1964). It has accomplished this effect not so much by introducing a new presentation form (which is quite similar to movies) but by becoming the predominant remote presentational medium. This idea is reinforced by Schramm, as will be seen later in this section.

Even though apparently television does effect some observing behaviors, it has failed to improve the visual orientation and imagery of its viewers and students. Dr. John R. Hayes at Carnegie Mellon University is studying existing patterns in the lack of pattern acquisition of various student populations. Our deficiencies in teaching visual perception is one factor that ties us so firmly to print as an instructional media. It is unusual today that any periodical reaches a consistent mass audience without including pictures in its format. Would it not seem logical that people should receive as much training in graphic perception as they do in reading?

McLuhan (1964) is also concerned with an aspect of media that is similar to presentation versus media aspect of the proposed model. McLuhan (1964) asserts that media and content must be considered separately and that content is the more powerful entity. (It is obvious he does not consider presentation independent of either content or medium.) He claims content, which may itself be a medium, can actually blind us to the character of the medium used for its transmission. It is also apparent that content and media can blind us to the presentation form.

He further tries to characterize media in terms of hotness and coolness. Media which are high definition and which do not allow much empathy or participation are hot. Cool media demand participation, filling in. He says that it is interesting to note the change in children's reading posture since the advent of television. "Children now, regardless of eye condition, average about 6-1/2 inches from the printed page. Our children are striving to carry over to the cool printed page the all-involving sensory mandate of the hot TV image".

With all the recent emphasis on new media we tend to overlook that in a typical 16-hour day about 3 hours or less than 20 percent of the day is spent with these media. Far more time is spent receiving presentation from the environmental and human media.

One more philosophic idea should be mentioned before proceeding to another direction of media research. There appears to be a balance between the senses within any fixed technological era. However, if a new technology is introduced which gives stress to any of our senses, the overall ratio among our senses is altered.

In today's mechanical media-oriented world, the quantity of information transmitted by press, radio, and television exceeds that relayed by lectures and text. These media have destroyed the old balance based on text and have possibly led to a basic confusion of education and entertainment. But then Carpenter (1960) says, "It is misleading to suppose there is any basic difference between education and entertainment. This distinction merely relieves people of the responsibility of looking into the matter".

Turning to another research topic, that of the psychology of media, there are many interesting experimental trends.

A significant amount of work on the syntax of media is presented by Mialarat (1966). Several experiments have dealt with interpretation and effectiveness of different sequential and paired media presentations.

For example, in several film sequences each with different emotional overtones, the same closeup of a face is inserted. Depending on context, this face is seen as expressing sadness, joy, anger, etc. Pairing of media can alter emphasis in a film of an auto accident. If the sound track of the crash is kept the same but at the moment of impact and pictures of one of the driver's feet on the brake, the driver's face, a pedestrian victim, or a demolition derby sign is shown, the effect is different.

Mialarat says there is usually a correlation between the richness of meaning intended by the producer of an audiovisual message and the richness of perception and mental activity which results from it. This may be true from an artistic standpoint but could hardly provide a sound basis for instructional material preparation.

Films developed for children by Mialarat make it possible for a child to develop his perceptual activities step-by-step. The intellectual activity, which is inseparable from perceptual activity, must take place at a rhythm which is proper to the child, not the to medium nor to the adult preparers. Experiments have been conducted to determine when a child is capable of synthesizing the numerous images of film: components, an object, a scene, an episode. What are the rhythmic constraints of a child which should affect the speed of presentation? Mialarat found that when shown identical pictures in photograph and in projection, more detail was observed from the photograph and more detail was picked up by girls than boys. The adult accomodates easily to the inherent difficulties of perception from a screen, but this is not true of a child. A child's vision is not the same as his teachers. A child can be very confused when asked later to tell a film story in his own words. Even when told in advance that the film is going to tell a story, the impression of reality given by the moving picture soon eliminates the impression of fiction.

Another series of experiments discussed in Mialarat concern various types of commentary on sound film. The three components of commentary considered were length or density of commentary, presentation manner, first person, second person, passive, imperative, and the visual-aural relationship -- before, during, after. The results of this experiment on one particular training film showed that there is an optimum commentary density which should be imperative in style and should commence before visuals are presented or become necessary. These researchers are concerned with the above and other problems of form or cinematographic language or

syntax of film from a psychometric not an engineering approach. A film message must be interpreted before it can give rise to perception. Many unknown factors remain in both areas.

Experiments which try to design optimum syntax for various media forms should be very profitable. If results, such as the commentary density of selected training films, can be generalized over all training situations, then this fact constitutes another valid entry into the media attributes list. Another direction of hoped-for generalization would be to other media-mixes. For example, does the commentary density optimum for films also apply to a slide-tape media mix? Where syntax is found to be constant over any presentation dimension or dimensional attribute, than that syntax rule may be considered in presentation design instead of only contributing to media selection.

An almost philosophical commentary concerning a child's perceptual expansion is made in Boulding (1956):

> As the child grows, his image of the world expands. He sees himself in a town, a country, on a planet. He finds himself in an increasingly complex world of personal relationships. Everytime a message reaches him, his image is likely to be changed to some degree by it, and if his image is changed, his behavior pattern will be changed likewise. We must distinguish carefully between the image and the messages that reach it.

The meaning of any message is the change which it produces in the image. When a message hits an image, one of three things can happen: The image may remain unaffected, the message may change the image in some rather regular well-defined way that might be described as simple addition, i.e., clearing up something that was vague, and the message might produce a revolutionary change in the image.

Presentation design should involve considerations of the image possessed by the student before a media exposure and the desired change to be produced in the image. This is analogous to the attainment of behavioral objectives except involving lower level learning behavior.

A recent research paper by Savage (1968), which was prompted by personal conversations during the formulation of the concepts discussed in this paper, is concerned with media limitations.

Savage characterizes media limitations in terms of motivation, discrimination, performance, and affectivity, which determine changes in behavior. He uses Dale's (1957) "core of experience" as a guide to media forms and Muenzinger's (1942) concept of behavior as a model for the psychological aspects. Media limitations are discussed in behavioral terms instead of their popular objective characteristics.

For example, concerning media, which is limited in the discrimination element, he says:

> Perception breaks up the psychological situation into elements. Well-prepared film, television presentations, and programed learning

> devices tend to be able to do this breaking up of the elements of a particular subject, but because perception depends upon analysis and this analysis is made by the producer, the change in behavior of the students frequently never take place.

Savage also comments on the construction of instructional models and suggests dimensions which are often overlooked.

> The model disregards certain inputs such as the present curriculum based system, the instructor and his role, and the educational system as a whole (college school, department, and course). Another aspect which appears to have been overlooked in the strategy which will decide on group size, teacher-student ratio contact, communication methods and evaluation.

Another area of media inquiry is in the development of models of learning and models of media selection. Gagne'(1956) has identified eight types of learning, and Briggs (1967) has proposed a media model using them.

The eight learning types are:

1. signal learning.
2. stimulus-response learning.
3. chaining.
4. verbal association.
5. multiple discrimination.

6. concepts.
7. principles.
8. problem solving.

Torrance (Taylor, 1966) does not feel that so many learning types are necessary, for he has said: "The ability to make decisions comprises man's only essential behavior. I don't want to atomize this behavior." However, Briggs, et. al., have used these eight learning types as a component of their six-step media selection model.

1. State the behavioral objectives for the course or unit of instruction in the sequence in which they should be taught.
2. For each objective, identify the type of learning involved.
3. Using the required conditions of learning as a guide, design a "media program" for each objective which lists the instructional events, identifies the characteristics of required stimuli, and states the media options which would be acceptable.
4. Prepare a summary of the media options for a group of objectives making up a sequence of instruction, and scan these to identify frequently occurring media options.
5. Assign the media in which the instruction should be packaged to achieve the best tradeoff with respect to effective stimulus display, convenience in changing from medium to medium, and economy in terms of size of unit in which each sequence is to be prepared in the given media.

6. Write specifications for the preparation of the instruction by the various media producers.

Briggs (1967) details the application of this model with several examples.

The model completely bypasses presentation design by going directly from learning type to media options. A beautiful course could probably be constructed by Briggs and other similarly qualified people using this model, but this is not sufficient. Out of consideration for the antonomy of educators, course engineering must be teachable and not depend solely on individual insight and genius. The engineering model below offers more potential to be routinely taught than does Brigg's model, although many details remain to be completed in both models.

Another less formalized model is proposed by Taylor (1966), as an outgrowth of an OE project to develop a series of perspectives for viewing any educational program and evaluating its features. Taylor says that new instructional media could be invaluable in overcoming educational weaknesses uncovered through these perspectives. In his fifth perspective, which involves the media model, the emphasis is on overcoming a supposed trouble with previous curriculum work. Taylor suggests that in curriculum work the focus is often on the means of presentation and the matter to be presented. The problem with this approach is that it fails to focus directly upon the student and upon what is occurring within him while subject matter is being aired.

Taylor's model is three dimensional with one dimension centered on teaching methods, media, etc. The other two dimensions are student centered.

Specific dimensional attributes are as follows:

Dimension 1. Proceses in student-type of giftedness

Memorizing

Academic

Critical thinking

Productive thinking

Creative thinking

Planning

Decision making (evaluative)

Communications (various types)

Human relations

Leadership

Other types of giftedness

Dimension 2. Content acquired by students

Biology classwork

Biology lab

Biology research

Physics classwork

History

Art

Music

Dimension 3. Teaching methods and aids, teacher, fellow students, and other environmental factors affecting thinking and learning processes.

Another version of Taylor's model reorganizes the first dimension into different kinds of student processes as follows:

1. Processes in student

Intellectual - Cognitive
- Memory
- Divergent
- Convergent
- Evaluative
- Learning Strategies
- Other

Nonintellectual - Intuitive
- Sensitiveness
- Emotion and feelings
- Involvement
- Physical
- Other

Taylor (1966), Guilford (1964), and Office of Education Cooperative Research Project No. 621 discuss these ideas in detail. Taylor is probably right in not wanting to ignore what happens at the student level, but these student processes are only one part of the broader concepts of engineering student behavior and presentation design.

It seems that the procedure specified here involving student engineering and presentation engineering is a comfortable and workable middle approach between the two extremes of microcourse construction and a macrosystem. Microcourse construction refers to the process of examining small bits of course content or taking a particular student learning type and trying to fit some media experience to it. Macrosystems include the present school where the course design edict is "teacher here is a text and a syllabus. That is all you need to teach this course." Student learning pro-

cesses are important, but they are more properly handled as perturbations of a solid presentation design than as separate and unchangeable design parameters.

Going on to another media research topic, the main theme of Taylor (1966) is Instructional Media and Creativity. One of the contributors to this book, Dr. Beck, is concerned with film materials which attempt to pose problems of the unknown or to explore the forefront of knowledge. He cites examples of film footage he has collected and elicits comments on the difficulty of such selection. An immense amount of film footage can be scanned, but the possibilities for the usage of every foot rests on the ability of the person doing the scanning. He must know his subject matter, and he must also be interested in creativity and the teaching of it. The prospect of using some of the vast amount of film footage in the industry repositories is attractive economically until the cost of searching and compiling useful film requests is included. Using a detailed pres .tation design as a basis, specific film requests could probably be used.

Dr. Beck looks at creative film from two points of view: content and process. "Content" means the information conveyed, and "process" refers to the involvement and motivation of the learner, the learning climate which is induced, and the cognitive processes that one calls into play.

The first film clip discussed is titled "On Darwin's Trail," produced in Germany. This film shows the ecology of the Galapagos Islands and the tool-using behavior of the woodpecker finch. Since the whole business of how this species of finch came to use a tool, how this behavior developed, and the role that learning played is

still a scientific mystery, the junior high viewer is brought right to the front of current scientific endeavor.

Very little is known as to whether showing creative actions promotes creative thinking in the viewer. Also the question of whether creative children retain their creative qualities as they grow up is of interest.

Among the many other unsolved and even undefined problems connected with producing creative materials is that the producers don't know the cues that are important to the student for learning. Several researchers have demonstrated that the concept of giving the student guided planned experiences in creative thinking can be translated into instructional materials, but their talent is not yet universal nor the procedure definable.

Robert Mager (Taylor, 1966, p. 32) has devised a capsule where the learner has complete control of environment and information flow. He found that, when a person asks for information, he will want to know something and so it will come in by television. But about the time that the transmitter supplying the information is about to make its point, the person will turn the television off because he has the information or he has the cues that have triggered off some thought.

Mager's point is that creative behavior can only be stirred if the learner has some kind of control over the media, i.e., a high degree of attainment management is possible with one medium, and the student himself makes the presentation decisions. Instructional-media devices, such as a rich sensory input which provides the necessary encoding form of presentation, set the stage for the student to make decisions as to what additional information

he needs or what subsequent acts he may perform. A suitably rich source of input may set the stage for the creative act to follow.

Williams in Taylor (1966) gives a three-dimensional model for viewing the arrangement or manipulation of information transmitted via audio and/or visual stimuli for the purpose of evoking creative behavior. The first dimension takes into account the complexity of research on creativity and is focused primarily on the following six variables:

1. the product created
2. the process of creating
3. the personality of the creator
4. the tasks chosen for attacking or assessing creativity
5. the environment or favorable climate in which creation occurs
6. the training techniques for developing or releasing all of the intellectual and nonintellectural abilities that manifest creativity

A second dimension involves the content which instructional media need to reveal when designed or used for developing creative abilities. This content takes three forms: human forms, other life forms, and universal structure.

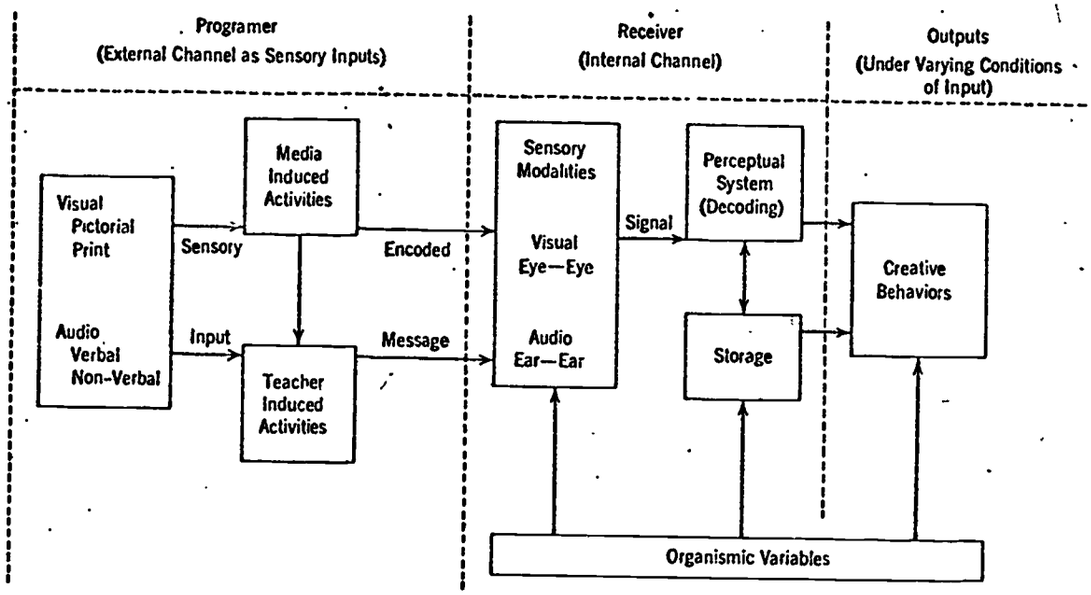
The first form reveals human forms of man creating in the way his body works, his mind functions, or how his society develops. This might involve content on the lives of highly creative people or the output of highly creative societies or groups of people in the processes of creation.

A second type of content for designing media devices is that of revealing other life forms such as plants and animals. This could reveal the birth and growth of species or events relating to creation in nature.

A third form of content deals with how the universe works. Here, instructional media could be designed around laboratory experiments, models, charts, or schematics revealing the physical or chemical operations of universal phenomena.

A third dimension of the model deals with methods for presenting input information as an aid in the creative teaching process. This dimension deals with three methods of programing information for creative attack. One method may be through presenting rich sensory inputs by which the student is given vicarious knowledge and experience consisting of a multitude of events supplemental to the curriculum. Another method may be inputs designed and used merely for enrichment. These could be presented as extra-curricular materials to embellish the life experience of the student. A third method has to do with presenting materials as dramatizing events with which the student can closely identify in the act of creation.

Williams continues by presenting a conceptual model concerning the design of new media or the teacher's use of existing media for evoking creativity. The model's block diagram is shown in Figure 8 on the next page. A fundamental problem in any instructional system is that the programer and receiver must use the same alphabet. By alphabet it is meant the whole range of signs, symbols, and inferences which are present at the student system interface. System design must add new alphabet entries to the student repertoire before they are used in context.



Taylor (1966)

Figure 8 -- Information transmission system for evoking creativity through the design or use of instructional media

Williams also suggests that further research is needed on the subject of redundancy inclusion to minimize the effects of a noisy channel. It is not known, for example, whether redundant cues should be presented simultaneously or whether they should be sequentially spaced so that the receiver need only to attend one at a time in order to decrease a loss resulting from interference.

Williams closes with a list of 112 tenable ideas for use by media producers or teachers and a list of 38 research questions concerning media and creativity.

Another recent project designed to excite creative abilities is Project Fine Arts which is currently being implemented at Taylor Allerdice High School in Pittsburgh, Pennsylvania. This United States Office of Education Project using materials developed at Carnegie Mellon University is given to the top 15 percent of the class. It was determined that this student population required only 4 days a week to learn the required academic material. The schedule was then rearranged to allow one period a day for enrichment activities. In Project Fine Arts, experience is offered in three fine arts areas, visual-tactile, oral, and kinetic. The class leadership was trained to pick up isolated occurrences of artistic behavior and lead them into finished art work. All of the emphasis is on active participation. Judged from the leaders, enthusiasm, and the observable art work produced, this course is a success. A syllabus of the Project Fine Arts Course is available from Carnegie Mellon University.

Alfred Binet (Taylor, 1966, p. 149) has perhaps the last word on the creativity theme. He maintained that almost all children begin school with highly developed skills in learning by experimen-

ting, manipulating objects, arranging them, and combining them in different ways. It was his contention that education should be grafted on these highly learning skills rather than suddenly abandoning learning in these ways for learning in ways strange to the child. Most characteristics thought necessary for genuine creative activity are not especially honored by our society--good guesser, intellectual courage, emotional sensitive individual, the sensitive thinker, the regressive person, visionary, person unwilling to accept things on mere say-so. Activities which have come to be rewarded include courtesy, promptness, obedience, popularity, peer approval, and willingness to accept authoritative judgment, and these cannot be said to favor creativity.

The last topic in media research to be reviewed is applied media experiments.

The Health, Education and Welfare study, Research in Instructional Television and Film (Reid & MacLennan, 1967), contains abstracts of 350 experiments in media usage. The studies are classes in eight categories.

1. comparisons of televised with direct or face-to-face instruction.
2. comparisons of filmed or kinescoped courses with direct instruction
3. studies of other uses of television for instruction
4. studies of other applications of films for instruction
5. studies of attitudes related to instructional television

6. studies of attitudes related to instructional films
7. studies of effects of production variables in instructional television programs
8. studies of effects of production variables in films

About 90 percent of these studies showed no significant difference, and the balance showed no exciting results. Various reasons have been suggested for this lack of positive results. Some are critical of the measuring instruments, others the testing style, and others with the comparisons of complexes of variables some of which may have cancelled each other.

A different kind of hypothesis supposes that a "law of compensatory effort" may be operating in the learning situation. This law asserts that students have certain levels of aspiration and that they strive for a particular grade. If the instruction is improved in a course which is the subject of an experiment, many students will put less effort into that course and will work harder in other courses which are not being taught as well and where more effort is needed to achieve the desired grade.

Guides to fruitful lines of research are suggested including a reference to work by Siegel at Miami University (Greenhill, 1967). His results indicate that multivariate experiments where reinforcing effects among large numbers of variables are allowed have been very productive. No further qualification of these results is given.

Two of these studies picked at random illustrate the difficulty of operating without a presentation design. Abstract 143 (Jacobs, Bollenbacher, & Keiffer, 1961) is titled "Teaching seventh-grade mathematics by television to homogeneously grouped below-average students". The problem as stated is to determine intrinsic

effectiveness of television as a means of instruction. Six classes were taught mathematics by television and six other classes were taught mathematics by face to face instruction. No mention is made of the design of the instructional design or style; therefore, it must be presumed that the authors did not think this to be a significant variable.

Their conclusions are rather definite, however,

> Television instruction is equally effective to face-to-face teaching instruction in teaching computational skills to below-average students. Television instruction tends to be superior to face-to-face instruction for teaching problem solving and concepts to the same group...

This abstract is typical in that a problem is stated, the statistics are quoted, and then a conclusion is invented. It would be more critically satisfying to be able to study a plan of material as presented by the two media forms, but none of the authors think it important enough to mention.

In abstract 282 (Spencer, 1963) the presentation designs for two media channels are mentioned, but they are too different to be statistically compared. The study is entitled "Comparison of televised with teaching machine and televised with instructor presentation of English grammar."

Presentation designs are stated in this manner.

> The grammar classes were supplementary to the basic English course and met

twice a week. Television students responded to each question as it appeared on the screen and were instructed to check their answer with that on the screen. Each frame lasted about 30 seconds. The face-to-face group covered the same topics, but the lecturer was free to teach as he wished.

No significant difference was the conclusion for all groups, although it was noted that students in the face-to-face group had more positive attitudes toward their method of instruction than did students in the television group.

A comparison of two designs to solve a common problem is not without precedent or value. For example, pencils, fountain pens, and ball-point pens solve the problem of making marks on paper. However, in this case, care is taken to judge only that marks are made on the paper and not to judge the literary or artistic quality of those marks. In the educational case, television instruction and face-to-face instruction were both successful in getting students to attend the classes and take the required tests, but no comparison should be made regarding behavioral changes occurring in the students as a result of such media exposure.

Numerous media research efforts are reported in the educational and psychological journals. One such study in The Journal of Educational Research (Warner, 1968) examined the effects of first-grade reading instruction with and without the use of a Language Master machine. The conclusions stated that for first graders in the initial phase of reading instruction,

prompting and reinforcing may be more effective when provided by the teacher than by a mechanical device. The presentation design in this experiment was different for the two media choices, and no mention was made of the use of behavioral engineering techniques. The statistics showed large standard deviations in both the experimental and control groups.

Another study being conducted by the University of California at Los Angeles Center for the Study of Evaluation of Instructional Programs is directed toward discovering what characteristics in selection and organization of the curriculum and the structuring of the teacher behavior have important effects on a child's learning. For a first step in this investigation, they are concerned with the question: How can the educational situation be arranged in such a way that a child organizes his memory so that he remembers the material and recalls what he needs when he needs it. Present work is being done on memory organizing strategies, both for long-term and short-term memory. (Automated Education Letter, 1968)

A very complete study by Schramm (1961), Television in the Lives of Our Children, tries to explain how television is used by children and what television has replaced in children's lives. As to the power of television, Schramm states:

> In the decade of the 1950's, television came to dominate the nonsleep, nonschool time of the North American child. One-sixth of all the child's waking hours, from the age of three on, is now typically given over to the magic picture tube. During the first sixteen years of life, the typical child now spends, in

> total, at least as much time with televison as in school. Television is probably the greatest source of common experience in the lives of children, and, along with the home and the school, it has come to play a major part in socializing the child.
>
> If any of us were now compelled to find two or three hours every day for a new activity, we should probably resent that requirement as an intolerable intrusion on our scheduled lives. It would require us to make profound and far-reaching changes. And this is precisely what television has done. It has come as an interloper into lives which already seemed full. It has taken two or three hours daily from children who previously gave it no time at all.

Schramm details the development of a child's exposure to media beginning with the bedtime story. He says that the pattern by which a child is introduced to the media is one of increasing control over the content. His first real control over the media occurs when he is able to read. The final step is when he masters the process of selection -- knowing where to find what he wants in the available media. The complete process takes about 10 years.

Since a child is introduced to televison almost wholly as fantasy and as an audio-visual experience in his most pliable and impressionable years, it is difficult to think of educational television as a proper use of the medium. And similarly the printed medium assumes an air of propriety for educational use through early

association at school and church school. Various predictors of a child's televison taste are discussed: age, sex, mental ability, and family.

Concerning value judgments about children's use of television, Schramm says:

> Children may learn good manners or bad grammar without ever seeking it from television. They may learn how to decorate a room or how to burglarize a home. What they learn, and the use they make of it, depend on the child as well as on the program.
>
> The point is that children do not typically go to television to learn. They more often go to televison to escape boredom or forget their problems.

The book's scope and statistics are too broad to be discussed further here. Since this work was a study of existing pattern rather than an experiment with the medium, the presentation designs which were responsible for children's current television behavior were evolved as a business matter rather than for educational purposes. That they have succeeded in business may be a result of presentation, novelty of the medium, or just changing times. It will be interesting in the next decade to see if education can make as effective an impact using the television medium.

A paper by Jack Phillips in Education Technology suggests three drawbacks of this age of specialization that can be overcome by modern media techniques: the need to educate large numbers of students, the need for students to progress at their own rate,

and the need to make certain that the instructional staff keep up with the latest findings in their disciplines.

This can only happen if complete, consistent instructional programs which include media selection based on realistic models are sold intact to schools or administered for them. Teachers and individual schools cannot institute dramatic educational change. Hirsch (1967) says that "the classroom teacher is not an independent professional, much inspirational literature to the contrary notwithstanding. He is instead, one member of the staff of a stable institution. His behavior reflects his position."

Several attacks on the corporate development of educational programs have also been published. One of the articles is by Dr. Stiles in The Journal of Educational Research and contains this admonishment of the big business systems approach.

> The business controlled and directed systems approach, while it promises certain improvements, leaves much to be desired. The classroom teacher will still be at the mercy of competitive commercial developments. Instead of waiting for some company to produce a better textbook for a particular kind of learner, the teacher will be hoping for a better system to be marketed... The key-question concerning the systems approach in education is: Whose system will it be?

The key to Dr. Stiles' dilemma and other similar commentaries is perhaps the establishment of a continuing dialogue between industry and educator so that systems are prepared by the educator so that systems are prepared by the educator for their own use instead of being offered over the industrial marketing counter.

However, it is industry which uses 90 percent of the product of the educator's factory, and so it is imperative that the voices of industry be heard.

As a finale to this section on current media research, a slightly psychedelic admonishment from Charney in Psychology Today seems appropriate.

> Sight and sound. The Electric Circus. The mantra of the Maharishi. The message of Marshall McLuhan. The Beatles. The beat. This is the turned-on, tuned-in, audio-visual world of today's youth...
> And we're trying to compete with all this in education by selling the same old textbooks to our students... Education is not where the action is. Advertising movies, TV, magazines - the modern media have responded to the Now. God knows, the content of our education programs, our textbooks, our approach, are all bad enough. But the easiest thing to repair is form. It doesn't take too much creativity to change form.

> The technology is here. The ability. The capacity... Our textbooks are about as innovative as the green blackboard. No glare. No glaring success...
> Content is first and foremost. But repairing that is a real education process - educating the teachers, the publishers, the educators. But form. Why that's easy. That's technology. We're good at that. Except in our schools. Just think, in the past 20 years almost every public school has switched over to the green blackboard.

8. Continuing Media Research

It would be comforting to think that the engineering model proposed in this report would appear immediately in operational educational systems and revive the ed' bizz'.

However, the model proposed here is neither sacred nor sufficient.

An initial look at the dimensions of media produced a chart containing over 100 dimensional candidates organizable into small numbers of generic dimensions only with great latitude in the meaning assigned to generic headings. Many of the dimensions were concerned with general learning theory and threatened to broaden the media selection model beyond hope of a practical solution.

The present five dimensions of presentation design are a good first attempt to structure presentation in terms meaningful to the behavioral engineer. Of course, the underlying philosophy in

these dimensions and the whole model is that behavior engineering is a practical solution to the needs of education. Overt considerations of behavior engineering are foreign to present educational practice, but Homme, and others feel that an acknowledgement of the efficacy of behavioral engineering and its dedicated practice in the schools will solve most of the educators' problems.

Presentation engineering was discussed in terms of five empirical dimensions. A continuation into procedures for selecting presentation form must be made. Any real situation will also be finally judged in the marketplace where cost, equipment, transition, and completeness will be prime variables. Much work is needed to devise and measure alternate systems which will be responsive to the demands of the market. The creation of demand for a fixed product is another strategy which the diversity of educators' interests, goals and experience and their autonimity seems to preclude.

Media limitations is another research area which will ultimately produce media selection criteria together with behavioral change expectancy figures.

If media preferences really exist and if learning rates of individuals are sensitive to media choice, then some measurable student attributes must be defined which will provide media selection guides. It would be optimal to be able to derive curves for expected behavioral change versus media selection on a real-time basis for each student, and so provide material to achieve highest expected gain.

A more practical solution may be to research thoroughly the techniques of behavioral engineering of the student so that a

reasonable (but possibly not optimal) gain is achieved with a practical media multiplicity. Not enough is yet known about media cues which promote media preference to engineer the presentation over several media devices. The domain of presentational and media cues must be explored in depth.

Finally, the complexities of creating and maintaining an operational system must be sorted out. The job of educating will be only half done when a system is on the store shelf. Success will be largely a function of administering a smooth operating system that works in the field, cranking out the required student goals as was predicted on paper.

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