A Behavioral Approach to Instructional Design and Media Selection

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This paper proposes a new model for instructional system design and develops a system component called a presentation form. Presentation form is designed to be independent of media and content so that media forms may be paired to educational requirements and theories in a rigorous manner.

A significant feature of the developmental model proposed here is the distinction between medium and presentation form. A presentation design theory leading to the generation of presentation form is discussed in detail, and six dimensions of the presentation form are proposed: stimulus (encoding, duration), response (response demand, response frequency), and management (frequency, purpose). After presentation forms have been specified and media choices are to be made, media limitations are proposed as the basic selection criteria instead of media advantages.

According to Webster, a medium is "a means of effecting or conveying something." Since in education we are obviously very concerned with effecting a change in learning behavior, it fol-

1 This paper is an adaptation of a 90-page monograph prepared for the Westinghouse Learning Corporation.

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allows that educational media research should be important. But
to date research in media effects has not produced practical
results. It could be, as some writers have pointed out, that fault
lies in the nature of the experimentation we conduct in media
research. Or it may be that media effects in themselves are
not significant enough in the teaching-learning process to war-
rant investigation.

This last statement must be considered rationally and not
emotionally. There is already too much emotion centered around
media. Organizations devoted to the spread of new media in-
formation and excitement have appeared. Defense of the tradi-
tional media of lecture, laboratory, and text is also voiced.
However, when the extant literature is examined from the stand-
point of what is actually known about the learning process, in-
eligible data, faulty generalizations from learning theory, and
appeals to the emotions or artistic inclinations are apparent. If
procedures for learning are to be improved at a reasonable pace,
then more solid theory and less of the above must be forth-
coming.

The major fault in instructional design today is the frequent
failure to recognize the distinction between three separate de-
dign elements: the medium, the presentation form, and the
content.

The key to establishing such a distinction lies in taking a
behavioral view. Although such an approach is still questioned
in educational circles, its support in learning research and in-
structional design is such that no alternatives seriously rival it.
The behavioral approach elicits the inevitable conclusion that
the quality of an educational system must be defined primarily
in terms of change in student behaviors. Thus every factor in
the educational system must be evaluated as to its ability to
modify either directly or indirectly the behavior of the student.
In designing a behavioral change system, several classes of
variables must be considered (see Figure 1). Generally, educa-
tional research attempts to control task variables and student
variables and directly relate these to operational variables with-
out controlling those intervening events which we call presenta-
tional variables. However, psychology and learning research has
taken quite a different trend. In learning experiments the presenta-
tional variables are primary. Thus most experiments in human
behavior learning can be classified into those dealing with 1)
stimulus factors, 2) response factors, or 3) consequential or contingent factors. What we have attempted to do in this paper is to sort through these behavioral factors to select those which have the maximum impact in determining the operational system or media mix. Concepts like response-similarity may have no direct media selection implication, while a concept like response-type definitely does. As an example of the effect of the latter, certain media such as films cannot accept a written response, while other media such as workbooks can.

It is important for us to examine all the steps leading to the design of the operational system (which includes considerations of the medium) and also to include shaping of student repertoire as a parallel development. (By shaping student repertoire we mean deliberate instruction in observational sets, learning style, syntax of presentation, etc.) Such a developmental procedure is shown in Figure 2 and summarized as follows:

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 behaviors 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.

Given the inputs of behavioral objectives and environmental information, presentation design theory will be used to prepare one or more presentation forms for those inputs. Then media selection may proceed, considering the medium's limitations in conveying the presentation form intact rather than some unsupported advantages claimed for it.

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

- stimulus
  - 1. encoding form
  - 2. duration

- response
  - 3. demand form
  - 4. demand frequency

- management
  - 5. management form
  - 6. management frequency

Media researchers to date have not chosen to distinguish a presentation form from the media which carry that form. This 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 the structure by which the information is carried by a medium that is called the presentation form. 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.

As an example of the relationship between presentation and media, consider that a picture of an elephant in a book versus a verbal description of an elephant by a teacher differ in both media and presentation form. However, a picture of the elephant on a slide and the one in the book have the same presentation form but are being delivered by two different media. It is also possible for a given medium to be able to deliver several presentation forms. It is doubtful if all presentation forms can be delivered equally well since media have differing limitations. To illustrate presentation form and point out the existing confusion between presentation form and medium, let us examine the technique known as programed instruction (PI).

The term programed instruction is commonly used both for the presentation form and for a particular type of workbook often employed as a medium. The basic PI presentation form is 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.

The four characteristics given above define a format or procedure for teaching that is independent (to a first approximation) of both content and media. 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 that could be used to implement the PI presentation form is the printed frame-by-frame workbook. But other media such as slide-tapes, laboratory-workbooks, TV-problem booklets, peer-tutor scripts, and sound films with Edex-like
feedback devices could be used to implement this same presentation form. Some of these media choices will impose limitations upon the intent of the presentation form or upon other system components. Where medium-based limitations exist, value judgments must be used for final selection. Further research is necessary to give some structure to media choice situations or at least to provide guidelines for value judgments.

In examining current media research we frequently see 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.

A typical 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 forms present in the lecture session and the experimental media session. It is the form of the presentation which influences learning rather than the media employed (to a first approximation). A direct comparison of any two such experimental situations is analogous to an engineer comparing 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. Media studies that confound the presentation form cannot be analytical nor extendable.

Yet researchers seem blissfully unaware of these implications. For example, in a recent experiment by Warner (1968) a mechanical medium, the Language Master, is compared to the human medium, the teacher. In her discussion, Warner admits that the two presentations are not equivalent in her 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.

Several years' experience in developing programmed materials forced us into careful consideration of the stimulus and
response aspects of the presentation, and for the most part any motivational factors were ignored. But as we began to actually use such material in classrooms we were amazed to find that other factors could compensate for poor stimulus control design. This realization forced us to cease thinking of PI as synonymous with the workbook medium, and to abstract the characteristics of PI as a presentation form.

Today, presentational design is used at the Behavior Systems Division (BSD) to generate presentation forms which allow a variety of media to be utilized in operating instructional systems.

Behavioral engineers, using presentational design theory and known techniques for behavior modification, have been able to develop a technology to work around most limitations of particular media. This effort has been so successful that today almost anything can be taught to anyone over the age of six using printed text with illustrations as the sole medium.

Of course, there is a danger in overgeneralizing this success, since it does not mean that such an operating instructional system will be efficient in terms of cost of preparation, student effort, or other criteria.

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 form, 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 multisensory, it is new, it has been successfully used in other settings, or it has received great press reviews. The novice designer may, therefore, incorrectly select Medium B because of its intrinsic advantages which are really superficial to the learning task.

Since few researchers have even recognized that there is a distinction between media and presentation form, it is not yet known just what attributes of media may constitute inherent advantages. However, a reduction to practice of presentational analysis would allow the limitations of media to be easily distinguished. Such media attributes might be structured in behavioral terms, in operational terms, or in terms of inherent syntactical cues.
The assertion that media limitations are the key to proper media selection does not outlaw at least two special cases in which media advantages should be used. Suppose at least two media have almost equivalent limitations for a given presentation form. Then, if one medium has the advantage of greater student experience or preference over the other medium, this should be a consideration in the actual media selection. A second special case also assumes two media more or less equivalent from the standpoint of limitations but the accompanying advantages are weighed 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 form 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. Interestingly, 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. Similarly, many learners and educators are superstitiously conditioned to prefer one medium over another because one "packager" may have added a desirable form of presentation not used by the other.

Engineering of student behavior is considered to be an important part of any instructional system implemented by BSD. Perhaps the basic reason that student engineering has assumed such prominence at BSD derives from the equipment used in early instruction experiments. Typically available equipment was unreliable, was frequently 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 simulation is a difficult task, many ways were found to engineer the student's behavior to compensate for the limitations of the media devices used.

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 that 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 described as simulations of a teacher, a blackboard, and a writing tablet. This is not necessarily bad since the information receptors that students possess are standard equipment and do not 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 that exist in the classroom. Two examples of this carry-over 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 specializing in automated learning and learning aids, over-emphasize the mechanical aspects of their system and ignore all but the most obvious behavioral considerations as a result. Their actions have been not so much to design an integrated instructional system as to simulate the desirable features of an individual tutor.

It is convenient and essential to the theory of presentation design that a classification system be as independent of media device, content, and external constraints as possible. The classification scheme presented here does not necessarily meet the above criteria, but it is sufficiently structured so that experimental verification of the theory of presentation design can begin now.

From a list of almost 100 variables in the area of structuring and producing educational materials, six attributes relating to structuring presentation form from given behavioral objectives were derived. These attributes, called the dimensions of presentation, are summarized as follows and diagramed in Figure 3.

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. **Duration.** Presentation varies on this ordinal dimension from transient to persistent depending upon the duration of the stimu-
Figure 3
The Dimensions of Presentation

<table>
<thead>
<tr>
<th>Encoding</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental structure</td>
<td>Transient</td>
</tr>
<tr>
<td>Pictorial</td>
<td>Length of time</td>
</tr>
<tr>
<td>Symbolic</td>
<td>the presentation remains intact</td>
</tr>
<tr>
<td>Verbal</td>
<td>Persistent</td>
</tr>
</tbody>
</table>

Response Demand

<table>
<thead>
<tr>
<th>Response Demand Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covert</td>
</tr>
<tr>
<td>Selective</td>
</tr>
<tr>
<td>Constructed</td>
</tr>
<tr>
<td>Vocal</td>
</tr>
<tr>
<td>Motor</td>
</tr>
<tr>
<td>Affective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Response Demand Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
</tr>
<tr>
<td>Sparse</td>
</tr>
</tbody>
</table>

Manager Purpose

<table>
<thead>
<tr>
<th>Instructional Management Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need Management</td>
</tr>
<tr>
<td>Attainment Management</td>
</tr>
<tr>
<td>Prescriptive Management</td>
</tr>
<tr>
<td>Enrichment Management</td>
</tr>
<tr>
<td>Motivation Management</td>
</tr>
<tr>
<td>Systems Support</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructional Management Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
</tr>
<tr>
<td>Frequency of decision to change presentation</td>
</tr>
<tr>
<td>Sparse</td>
</tr>
</tbody>
</table>

Response Factor

3. **Response demand characteristics of the presentation.** This is another nominal dimension which includes covert, selective, constructed, verbal, motor, and affective responses.

4. **Response demand frequency.** This is an ordinal dimension concerned with the frequency with which some response is demanded from the student.

Instructional Management

5. **Presentational management frequency.** 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.
6. Management purpose. 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.

Stimulus encoding is probably the most obvious of the presentational dimensions. Man has invented encoding forms for many reasons. These forms enable him 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.

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, or hear it. 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 that the student use more than one sense should depend on the behavioral objectives.

2. Pictorial. Pictorial encoding requires a reproduction of either real or imagined visual aspects of objects. The media used to convey pictorial encoding always distort the various visual dimensions, 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.

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 and 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 objectives.

4. Verbal. Words and verbal syntax 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).

Duration is an ordinal dimension that varies according to the length of time a given presentation remains unchanged. Presentations vary from transient to persistent. 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 six-hour movie of the Empire State Building) can also be conveyed by movies. The primary disadvantage of transient presentations is that the student must store information, since it is not available in the environment for a long period of time. Transient presentations present difficulties when a response is demanded to several stimuli simultaneously. The requirement of storing information places limits on the ability of media employing transient presentation to generate new learning particularly if the tasks involve both discriminations and new information to be processed, or if the student must combine the new information with associations from his existing repertoire.

There are further implications in this limitation. In the portrayal of a dynamic sequence 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.

Although transient media have potential, their presentational design does not usually provide for simultaneous discriminations of stimulus conditions in behavioral sequences. This is probably because the presentation designers who work with the media are unwilling to interrupt the real-time sequence. This suggests that educational film and ITV makers should follow neither the techniques of the lecturers nor the techniques of the entertainment producers, but develop a new form based on a knowledge of learning conditions. Discrimination learning in a more persistent medium prior to exposure to the dynamic medium would shape observing behaviors necessary to elicit the covert response to the transient medium associated with 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 more persistent
INSTRUCTIONAL DESIGN AND MEDIA SELECTION

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 of calculus to analogous situations that are highly familiar. The two main considerations in selecting more transient presentations are the possible closer simulation of the criterion situation and the increased speed at 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 disadvantages of persistent media is to combine persistent and transient presentations. The lecture and blackboard are the most common examples. 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 second disadvantage of most persistent media, their lack of any response-time demand, can be offset by presentational management techniques such as contingency management.
For use in the theory of presentation design, student responses have been classified into the following categories:

1. **Covert**. Those behaviors that are normally not directly observed. Examples are attending (listening, reading, observing), meditation, 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 nonvocal activities which employ the striated 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, if he selects it or rates it over several other alternatives, or if he engages in it enthusiastically.

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

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 equivalence. 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.

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, i.e., they act to modify the form of the response on its emission. External confirmation is one such class of response-produced stimuli.

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 pre-
school children practice in 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.

At this time little can be said about this dimension since in most studies the frequency of response demand is confounded with the frequency of confirmation or frequency of reinforcement (both are management considerations). However, some data in PI research where confirmation has been removed indicates that just calling for the response is equivalent to calling and confirming. There also may be an interaction effect between demand frequency and demand type since some data show that in PI with a high response demand frequency it makes no difference what type of response is called for.

In designing an educational system, one of the most important tasks is the presentational dimension of management. Management refers to the decision to alter the presentation as a function of an assessment of the student or of the environment. Management involves three activities, all of which take place in every instructional system:

1. Appraisal of data,
2. Selection of an assignment as a result of a decision based on the data,
3. Specification of the various actions that may be assigned.

Some of the reasons for presentational management are considered below.

This type of management usually involves bypassing 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 know. On the more complex level, achievement test data can be used to indicate proper placement in an instructional sequence. A summary typical of need management activities in an operational instruction system follows:
It frequently happens that the student responds to the presentation in a manner which does not allow him to reach the objective. There are four strategic subclasses of management activity appropriate for such situations.

1. **Redundancy.** If the student fails to reach the objective, repeat the same or continue through as many similar presentations until he does.

2. **Multiform.** If the student fails to reach the objective with one presentation form, select a parallel but different form.

3. **Multilevel.** If the student fails to reach the objectives with the presentation form, select a lower level (more expanded) form.

4. **Error-Diagnostic.** If an error is made at any point within the presentation, an action designed to correct that specific error is selected. It is necessary when using this error-diagnostic strategy to classify errors as a) **input errors**—due to poor presentational design; b) **processing errors**—due to 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; or c) **output errors**—due to carelessness, poor attention, or chance error (failed to attend to a significant stimulus).

Following is a summary typical of attainment management activities:

<table>
<thead>
<tr>
<th>Appraisal</th>
<th>Selection</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examination of student error</td>
<td>Comparison of student achievement scores with prescriptive flowchart</td>
<td>Student shifts to those instructional tasks appropriate for him</td>
</tr>
<tr>
<td>Medium—diagnostic, pretests</td>
<td>Medium—teacher or teacher aid</td>
<td>Medium—Workbooks and exercise sheets</td>
</tr>
</tbody>
</table>

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

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).

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 motivational management, those data are usually the student's score on some progress check test, and the selection possibilities include activities the student may prefer, e.g., playing games, talking with friends, working on algebra, viewing an entertaining movie, reading a novel, or engaging in a guided group discussion with peers and the teacher.

Once the presentation has been designed, it is necessary to design the operational instructional system to 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 4 and 5 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 or equations on them, texts may display pictorial and verbal presentations, and sound motion pictures usually convey both pictorial and verbal presentations simultaneously.

Also, with enough prior instruction and follow-up, one can demand almost any response to any medium. Figure 5 indicates those responses most frequently demanded in practice.

For a complete analysis of the media selection possibilities of the six presentation design dimensions, a six-dimensional matrix would have to be imagined or constructed, or another tabular technique would have to be developed for selecting media
from a prior choice of intersections along the presentation design axis.

Depending on the particular intersection choices on each dimension, there may be none, one, or several media choices listed at the common intersection point of all dimensions. Where not enough media choices are available, one or more of the dimensional intersections must be expanded to include more of the axis, or media-mix possibilities must be investigated.

Consider the following objective statement. Given a coin minted in England during the period 1200 AD—1400 AD, the student will be able to name and characterize the purpose or origin of each mark on the coin.

Since the marks on the coin must be seen to be identified, some sort of pictorial encoding must be used. The objective does not specify the response form but again, a reasonable choice would be vocal. The duration would be toward the transient end of the duration scale since the amount of detail on the coin is small. A proper choice for the management type and frequency of this objective would be to give feedback or error diagnosis after each response. A tabulation of these choices would appear as follows:

<table>
<thead>
<tr>
<th>Presentation Form</th>
<th>Film</th>
<th>Book</th>
<th>Audiotape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encoding ..........</td>
<td>Pictorial</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Response Demand ..</td>
<td>Vocal</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Duration ..........</td>
<td>Momentary</td>
<td>No</td>
<td>X</td>
</tr>
<tr>
<td>Management ......</td>
<td>Feedback after each response</td>
<td>No</td>
<td>1/2</td>
</tr>
</tbody>
</table>

The choices in the center of the table constitute the presentation form. One technique for continuing from these intersections on the dimensional axis to find media common to all requirements is to extend the above table by listing several plausible media choices to the right, as shown. Then the spaces can be filled in with checks or scaled numbers representing the applicability of the medium choice to the dimensional intersection.

None of the medium choices listed meet all of the requirements. 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 then be based on external considerations such as: 1) cost, including developmental costs, purchase costs of media devices, initial setup costs, and the cost of maintaining the system; 2) availability of various media, e.g., tutors, AV devices; and 3) market or user preference.

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

Let us consider a second exercise in media selection where a media mix can be evaluated. Suppose it is determined from a behavioral analysis that the best presentation form to meet the objectives is as follows: the stimuli are to be presented in a

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**FIGURE 6**

Distortion of the Presentation by the Single Medium of Motion Pictures

- The stimuli are presented in a verbal or illustrated form.
- A demand of a written or selection response is made.
- The presentation can last as long as the student desires it.
- The student must make some response before proceeding.
- The next presentation occurs no matter what the student does.

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**FIGURE 7**

The Presentation by the Single Medium of Tutor

- The stimuli are presented in a verbal form.
- A demand for a vocal response is made.
- The presentation lasts only as long as it takes the tutor to speak words.
- The student may be required to make some response before proceeding to the next item.
verbal and illustrated form: a demand of a written or selection response is to be made; the presentation must last as long as the student desires it; and the student must make some response before proceeding to the next item.

Figure 6 shows the limitation of the medium of motion pictures against these requirements. The presentation is by necessity distorted. A better fit in some areas can occur if a human tutor is used (Figure 7), but still there is much distortion. If a mixed-media system is used (Figure 8), the presentation remains intact.

There are considerations in the selection of media other than presentation form. Such factors as the cost of making a movie or the instructional reliability of a tutor have to be considered. But this new model of presentation design allows us to examine on a systematic basis most of the important trade-offs which are possible.

As can be seen, the process of presentation design is not foolproof. Much more work on the subject must be done. However, the promise of defining a form of presentation—indepen dent of media, content, and learner—and the technology for its use is very exciting. Such research work must be continued.

REFERENCES