Preliminary Guidelines for Employing Graphics in Instruction

Paul F. Merrill
Associate Professor
Department of Instructional Science
W-160 STAD
Brigham Young University
Provo, UT 84602

C. Victor Bunderson
President, WICAT, Inc.
1160 S. State
Orem, UT 84057

Abstract. The purpose of this article is to propose some guidelines, based on instructional design theory and empirical findings, for employing various types of graphics under specified conditions. The guidelines are directly related to Gagné's types of learned capabilities: concepts, discriminations, rules, problem solving, verbal information, motor skills, and attitudes. A categorization scheme is proposed for different types of visual displays. The role of these different kinds of graphic visual displays within each of Gagné's types of learned capabilities is discussed.

Educators and media specialists have extolled the virtues of visual aids and graphics for many years. Acceptance of the adage, "A picture is worth a thousand words," has led to the use of numerous forms of visual or graphic material in instruction: pictures, line drawings, schematics, graphs, charts, slides, filmstrips, motion pictures, television, etc. In a recent report Moore and Nawrocki (Note 2) described the historical arguments for using graphics and reviewed the research literature on the effects of instructional graphics. Their overall conclusion based on this review was that the assumptions about the inherent value of graphics for instruction are unsubstantiated by empirical research findings. However, they cite several studies that show that graphics can and do have a positive effect in some specific instances.

The variable results obtained in the research studies reviewed by Moore and Nawrocki lead to the obvious conclusion that the appropriate question is not, "Do graphics improve the effectiveness of instruction?" but, rather, "What types of graphics, if any, will improve the effectiveness of instruction under different conditions?" The purpose of this paper is to propose some guidelines, based on instructional design theory and empirical findings, for employing various types of graphics under specified conditions. Because of the current state-of-the-art, some of the guidelines given are necessarily only hypotheses and will require verification in future research studies.

Types of Visual Displays

In order to address the question, "What types of graphics should be used under various conditions?" it is necessary to identify and define different types of visual displays. The categorization scheme proposed here is based on the previous work of Merrill, Towle, and Merrill (1975), Tosti and Ball (1969), and Moore and Nawrocki (Note 2):

A. Alphanumerics: 1. textual, 2. tabular.
B. Graphics: 1. figural, 2. symbolic, 3. schematic, 4. pictorial.
C. Objects or Events: 1. real objects or events, 2. models, mock-ups, or simulators.

Alphanumerics

This category basically includes the set of characters available on a standard typewriter keyboard. The category is subdivided to distinguish between textual displays and tabular displays. Although both can be generated on a standard typewriter, tabular displays are considerably more difficult to design and construct and are, therefore, generally more expensive to produce. Reading and understanding tabular displays also may require different abilities on the part of the learner than are required by reading and understanding textual information.

Graphics

This category basically includes all nonalphanumeric, two-dimensional displays and has been divided into four subcategories: figural, symbolic, schematic, and pictorial. This distinction between alphanumeric and graphics displays may seem similar to the categories "digital" or "symbolic" (words and numbers) and "iconic" (pictures and diagrams) (Knowlton, 1966; Morris, 1938). However, the authors agree with McDonald-Ross' (1977a) assertion that

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too much generally is included under the iconic category. Thus, in the categorization scheme presented here, the pictorial and schematic subcategories might be considered iconic, although the symbolic and figural subcategories would not be considered as either iconic or digital. The authors feel that these categories represent a better solution to the digital versus iconic problem than McDonald-Ross' (1977a) classification according to purpose.

The pictorial and schematic subcategories include all two-dimensional representations of objects or events where the representation has some degree of resemblance or fidelity to the physical characteristics of the real object or event. The distinction between pictorial and schematic basically is one of degree of fidelity. Pictorial displays, which include photographs, paintings, drawings, etc., have greater fidelity than schematics, which include circuit diagrams, maps, blueprints, etc. Knowlton (1966) has suggested that the fidelity of a representation of an object or event can be thought of as having three "parts": the elements, their pattern of arrangement, and their order of connection. A graphic must have some fidelity in the elements in order to be classified as pictorial. On the other hand, a schematic graphic would have the elements arbitrarily portrayed, while the pattern and/or order of connection would be isomorphic with the actual object or event. A highway road map would be classified as schematic since the elements (towns and cities) generally are represented by arbitrary geometric forms (circles and stars) although the pattern and order of connection of the cities and roads is isomorphic to the actual state of affairs.

The symbolic category refers to those graphic displays that have no resemblance or fidelity to actual objects but serve as arbitrary nonalphanumeric signs of the objects or events. Examples of symbolic graphics are a red cross, a trademark, and an officer's insignia.

The figural category includes graphic displays that are used to show relationships between abstract ideas and generally do not serve as signs for actual objects or events. Line graphs, flowcharts, and histograms are examples of figural graphics.

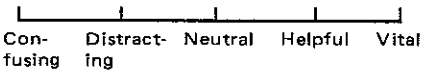
The graphics displays described above also could be categorized along several other dimensions such as still or motion (including animation); color, halftone, or black and white; degree of aesthetic value; degree of complexity or realism; and/or analogical reference (see the section on concepts). The various subcategories of these dimensions could be thought of as sub-subcategories under each of the four principal subcategories of figural, symbolic, schematic, and pictorial. The relevance of these other dimensions will be addressed in appropriate sections throughout the remainder of this paper.

Objects or Events

This category includes real-world objects and various three-dimensional representations of objects such as models, mock-ups, or simulators. Real objects might include a flower, truck, or building. Events could include a session of the state legislature, a rock concert, or a walk on the moon. Models, mock-ups, and simulators could include a plaster of paris skeleton or a scale model of a lunar exploration vehicle.

Guidelines for Employing Graphics

The employment of graphics does not automatically increase the effectiveness of instructional materials. The instructional usefulness of a specific graphic may lie somewhere on the following continuum:



Under certain conditions a given graphic might be confusing and have a negative effect on student achievement. Under other conditions a graphic might be vital for learning to occur. Under still other conditions the use of graphics may have neither positive nor negative effects on student performance.

The purpose of this paper is to propose some guidelines for employing various types of graphics under different conditions. These guidelines will be categorized according to Gagné's (1977) taxonomy of learned capabilities. Gagné has proposed five major domains of learned capabilities: intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes. The intellectual skills domain has been divided further into subcategories such as concepts, discriminations, and rules.

Concepts

Concept learning enables a student to classify correctly unencountered objects, events, or symbols (or a representation or description of such objects, events, or symbols) as a member of a specific class. Classifying behavior is required in a great number of tasks and is often prerequisite to the learning of other behaviors such as rule using and problem solving. For example, students may be required to classify examples of insects, adjectives, assets, or vectors.

Several studies (Merrill & Tennyson, 1977; Tennyson, 1973; Tennyson, Woolley, & Merrill, 1972) have shown that concept learning is greatly facilitated by showing trainees several divergent examples and matched nonexamples and then allowing them to practice classifying unencountered examples and nonexamples. Pictorial graphic representations should be used as examples in the initial learning of concepts that have concrete referents (Levie & Dickie, 1973). In general, the pictorial graphics used as examples should be simplified so that the number of irrelevant cues is reduced and the redundancy of relevant cues is increased (Dwyer, 1978; Levie & Dickie, 1973; Black, Note 3; Travers, Note 4). If the example is too complex or realistic, it may be difficult to perceive and distinguish the attributes of the example that are critical to appropriate classification. This is especially the case in fixed-pace presentations where the trainee cannot control the rate of exposure. However, as training progresses, more difficult and complex examples should be used that approximate the real-world environment or task. Actual objects or realistic pictorial graphics could be used at the beginning of training to add interest, to motivate the student, and to provide an orientation to the real world. Simplified pictorial graphics could then be used to isolate and highlight the critical attributes, followed by more realistic pictorial graphics or actual objects to facilitate transfer. Critical attributes could be highlighted through the use of other graphic elements such as arrows, texture, shading, or color (May, Note 5).

Many of the research studies on instructional graphics have found no significant differences in student achievement when instructional treatments that use graphics are compared with those that do not. There are probably many reasons for these nonsignificant differences. However, we would like to

suggest that one of the major reasons graphics have a neutral effect is because they are used as signs (Knowlton, 1966) for concepts with which the individual has had considerable previous experience. This previous experience can be recalled by the individual and used to create a mental visual image. Such a visual image can be triggered by symbols that, though arbitrary, have been learned previously as labels for the object or event. Under such conditions, the added external visual or graphic is redundant with the individual's mental visual image and thus does not improve learning.

Once a concrete concept is learned, the concept label can trigger the generation of images from the entire set of instances of the concept. Under such conditions a concept label or word "may be worth a thousand pictures." Once a concept has been learned, it would not be necessary or efficient to continue using pictorial graphics when referring to the concept. (However, if the picture is a divergent unencountered example, it may serve to further refine the learner's "understanding" of the concept.) In fact, one picture does not adequately represent a concept or class of objects. This is especially true for general or superordinate concepts. For example, a picture of Lassie represents the concept *collie* fairly well, but is a less adequate representation of the superordinate concepts of dog, mammal, and animal as the degree of generality increases. Thus, although several divergent pictorial graphic examples may facilitate the learning of a concept, once the concept is learned, the symbolic name or label is a more effective and efficient representation for communication.

In considering the employment of graphics, we should not overlook the significant power of word pictures. Great story tellers and novelists are able to capture the attention and imagination of their audience by triggering mental images through the use of word descriptions. These word pictures may be more effective than actual pictures in directing attention to specific relevant details that would go unnoticed in a casual viewing of an actual picture.

Pictorial graphics become helpful and vital when learners are exposed to new concepts, objects, or events for which they have no labels and/or corresponding visual images. However, even when learners have had no previous experience with an object, they often can be taught various aspects of a new object through the use of verbal analogies where the new object is compared with or likened to a known object for which visual images are available in memory. Novelists and poets use analogies effectively to increase the power of their word pictures in generating mental images.

Pictorial graphics generally are not useful for teaching intangible or abstract concepts such as democracy, freedom, or guilt that do not have concrete referents (Levie & Dickie, 1973). Verbal definitions usually are necessary to present the critical attributes of such concepts. These concepts may be best exemplified through the use of verbal descriptions, stories, and analogies.

In general, color has little effect on performance (Levie & Dickie, 1973; Kanner, Note 6; Travers, Note 4). However, color may enhance learning when used to emphasize relevant cues and to aid in making appropriate discriminations. Using color in this way is illustrated by instructional materials developed for the TICCIT Project (Bunderson, Note 7; Mitre Corp., Note 8).

Discriminations

Learning discriminations enable students to distinguish one object, event, or symbol from others. The most common observable behavior that serves as an indicator of discrimination is stating names for the objects to be discriminated. However, the behavior could take other forms such as pressing a button on a machine or playing a specific tone on a musical instrument. Discrimination behavior is involved in identifying specific letters of the alphabet, identifying a particular individual, or identifying symbols on a topographical map.

Although it may be possible to describe certain objects, events, or symbols verbally, learning will be much more efficient if actual objects, pictorial graphics, or symbolic graphics are used. Only five to nine items should be taught simultaneously. Once these are learned, new items may be added with regular review of those previously learned. Multiple discrimination is basically a paired-associate task and requires considerable drill and practice where the student is repeatedly shown the objects or symbols to be learned in random order and is asked to respond with the appropriate label that corresponds to each object or symbol. When an error is made, corrective feedback should be given.

If identification of an object or symbol requires color discrimination, then color should be used (Travers, Note 4). Motion is necessary only if movement is a critical attribute required for proper discrimination. If the movement involved is fairly simple, as with hand signals, it could be indicated adequately through the use of arrows on still pictorial graphics. However, some practice and the criterion test should require the trainee to identify the objects or symbols in actual motion, if the objective requires such skill.

Rules

Rule-using behavior occurs when a trainee is able to respond to a class of stimulus situations with a class of performances, the latter being predictably related to the former by a class of relations (Gagné, 1977). Rule-using behavior is involved in such tasks as spelling words, using proper grammar, and performing mathematical operations.

Usually the most effective instructional strategy for teaching rules involves: (a) the presentation of a verbal statement of the rule, (b) a demonstration of the application of the rule to several example problem situations, (c) the provision of several unencountered problem situations where the trainee is asked to practice applying the rule, and (d) the provision of corrective feedback.

The role of graphics in teaching rules depends upon the nature of the class of stimulus situations corresponding to the rule and the nature of the demonstration required to show the application of the rule. If the stimulus and demonstration involves only symbols and their manipulation as in spelling, grammar, and mathematical rules, then pictorial graphics generally are not necessary for effective instruction.

On the other hand, if the stimulus and/or demonstration involves actual objects and their manipulation, then the actual objects or a pictorial graphic representation or simulation may be required. However, if the class of stimulus situations consists of real objects, and the class previously has been learned as a concept, then pictorial representations of the stimuli would not be necessary. For example, instruction on the "selection of proper fire extinguishers for different types of fires" would require only

pictorial graphics if the types of fire extinguishers and fires had not been previously learned or could not be recalled (see the section above on concepts).

Complex rules often involve a series of operations and conditional decision points. Such rules are actually procedures. The steps and the order of the steps that make up the procedure may be represented in several ways. If the procedure is fairly simple, the steps may be presented as textual prose. However, more extensive linear procedures are easier to understand if the individual steps are separated and presented in a list format. If the procedure involves several decision points and loops (the same steps are repeated several times), then a figural graphic such as a flowchart, decision table, or decision tree will facilitate learning. For example, Lewis, Horabin, and Gane (1967) found that calculating the amount of tax owed was greatly facilitated through the use of a flowchart diagram. Wilcox (Note 9) found that the classifying of various types of sailboats was significantly improved through the use of a decision tree. A more extensive treatment of alternative representations of procedures may be found in Merrill (1980).

Many procedures are so complex and/or the consequences of error are so great that it is impractical to require students to memorize the sequence of steps. In such cases, a job aid that lists the steps or presents a flowchart of the steps should be used.

If the procedure involves extensive motor skills, the steps of the procedure and the motor skills could be taught simultaneously by live demonstration, motion pictures (with slow motion if real time is too fast), or with a series of still pictures (see the section below on motor skills). If film or still pictures are used to demonstrate the steps of the procedure, the performance should be photographed so that the representation shown has the same view or angle that the trainees would see if they were doing the procedure themselves (Hoban & Van Ormen, Note 10).

If the procedure involves the assembly of a piece of equipment with many parts and the motor skills required already exist in the repertoire of the learner, graphics would not be necessary to show the actual motor skills required. However, pictorial or schematic graphics would be necessary to show the various parts of the equipment and their relationship to each other. The graphics would need to be supplemented with verbal or textual instructions that list the order in which the various parts should be assembled.

Cognitive Strategies (Problem Solving)

Problem solving behavior involves the discovery of a higher order rule (often a combination of previously learned rules) that enables the student to generate a solution for a novel problem. Problem solving entails more than applying a previously learned rule to solve a specific problem that belongs to a class of problems known by the individual to be solvable using the given rule. Problem solving refers to the identification and generation of solutions to novel problems. Problem solving is required in such tasks as generating a new poem, composing a new musical score, or inventing a new labor-saving device.

The most effective strategy for teaching problem solving skills is to provide the trainee with a wide variety of appropriate problem solving situations. These situations should be novel or unencountered and correspond to the student's capabilities. In early stages of learning it is often necessary to provide some guidance to the students to channel their thinking in fruitful directions. However, this guidance should not present the actual solution to the problem.

The role of graphics in problem solving instruction is highly dependent on the nature of the problem solving situations presented to the student. If the information or data relevant to the problem are verbal or numerical in nature, then graphics may not be necessary or useful. However, relationships among numerical data sets may be understood best when represented by a line graph (figural graphic) that shows trend directions. On the other hand, if the problem situation requires the use of data that involve the perception of characteristics of objects or events, then the use of pictorial or schematic graphics might be required. However, if the trainees have had considerable experience with the relevant objects or events and can visualize the characteristics in their mind from a verbal description, then graphics may not be necessary.

Computer graphic terminals rapidly are becoming more sophisticated and prevalent. These terminals and corresponding software make it possible for students to dynamically manipulate pictorial or schematic graphic representations of complex objects or phenomena (Kay, 1977). Three-dimensional line drawings of automobiles, city streets, or aircraft carrier decks can be created, displayed, and manipulated (Sutherland, 1971). These drawings can be rotated and viewed from several perspectives. Such computer graphic simulations have great potential for increasing the efficiency and effectiveness of problem solving activities.

Verbal Information

A student who can use verbal information is able to tell, state, or verbalize a fact or idea in the form of a proposition. Generally, it is not necessary that the proposition be restated exactly word for word. (Notable exceptions include recitation of a poem or famous speech or relating a coded message.) However, it is necessary that the restatement of the proposition in the trainee's own words convey the same meaning as the original fact or idea. Verbal information may be classified into three subcategories: names or labels, facts, and collections of facts organized as connected discourse (Gagné, 1977). Recalling verbal information is involved in such tasks as stating the name of a particular building or mountain, listing the first six presidents of the United States, or describing the major campaigns in World War II.

Learning the name or label for a single object is quite an easy task. However, the task becomes more difficult if several different names must be learned for several different objects at the same time. Confusions occur because of the process of interference. This interference can be overcome by making the association between the label and object more distinctive or meaningful.

Verbal information is learned and recalled more easily when it is "meaningful." Real words are easier to remember than nonsense syllables, and words that form sentences are easier to learn and recall than random word lists of the same length. Labels are easier to learn if they can be meaningfully connected to the corresponding object through the use of mediating verbal links or images. These mediating links may include various mnemonic devices. The learning of facts is facilitated if they can be related or subsumed (Ausubel, 1968) into an already existing cognitive structure.

The learning of verbal information often is aided by the use of some organizational device. Facts organized by

topic sentence may be learned more efficiently than those presented without a topic sentence (Gagné, 1968). A figural graphic representation of the relationships between facts can provide organization and meaning to facilitate the storage and retrieval of verbal information (Holliday, 1976). When a large amount of numerically related information is being presented, the use of tables, charts, or figural graphs may make the presentation more efficient, provide organization, and show relationships. Maps (schematic graphics) can be efficient and vital representations of many different types of spatial information, and tables and charts are vital representations of complex time schedule information. However, explanatory information and examples should be provided to assist trainees in reading any tables, charts, maps, or graphs used. Further prescriptions on the use and construction of tables and figural graphics can be found in McDonald-Ross' (1977a, 1977b) recent reviews.

Pictorial graphics such as photographs or line drawings often are inserted in textual verbal information material for illustrative purposes. Although these illustrations may increase interest and enjoyment, they may not increase understanding or learning. This is often the case because the illustration shows an example of a concept that previously has been learned by the trainee or could have been visualized easily in the mind of the trainee from the verbal description provided in the text. Some illustrations that are added to spruce up the text actually may be confusing or distracting.

However, Levin and Lesgold (1978) recently reviewed 12 studies that showed that pictures (pictorial graphics) facilitated prose learning of *unfamiliar* fictional narratives presented orally to elementary school children. The pictures were consistent with and redundant to the story content. Cued factual recall questions were used in the achievement instruments. In these studies the pictures may have helped illustrate unfamiliar concepts.

In our search for efficiency and effectiveness, we should not overlook the role of aesthetics in life or in learning. Attraction, attention, interest, and motivation are all important aspects of learning. Students cannot learn unless they attend to the instructional materials. If attention is not maintained, then students will not learn what they could and may drop out altogether.

Neither color nor motion has been shown to facilitate the learning of verbal information. However, research (Levie & Dickie, 1973) has shown that pictures, color, realism, and motion increase the attraction and interest value of materials and are preferred by learners of all ages. Moore and Nawrocki report a study by Wali (Note 11) that showed that preference does significantly reduce attrition.

Special effects, optical effects, and music have not increased learning (Hoban & Van Ormen, Note 10). Dramatic sequences, comedy, singing, and realistic settings have not increased learning of factual verbal information (Hoban & Van Ormen, Note 10; Travers, Note 4). However, we hypothesize that realistic dramatic sequences may have considerable value in increasing interest, motivation, emotional impact, and in changing attitudes (Scanlon, 1970; Fleming, Note 12).

Motor Skills

Motor behavior occurs when a trainee is able to execute a physical movement with precision and appropriate timing. Motor skills are involved in such tasks as swimming, typing a report, or adjusting a microscope. Motor behavior often involves the execution of a series of several coordinated movements. The order in which these individual movements are performed may be governed by an executive routine or procedure (Gagné, 1977). The cognitive aspects of the procedure may be taught simultaneously with or independently from the actual movements. For example, the order in which the parts of a piece of equipment are assembled may be taught independently from the motor skills required to put the parts together. The role of graphics in teaching procedures is described in the above section on rules.

It is difficult to imagine a student being able to learn a complex motor skill solely from verbal or textual information. The movements must be demonstrated to the student either by an instructor or through the use of some pictorial graphic representation. In some situations, a live demonstration may not be ideal if the model is unable to perform the movement slowly enough for the trainee to see the critical aspects of the movement. The serving of a tennis ball is difficult to demonstrate for this reason. A series of still pictorial graphics that shows various positions or aspects of the movement across time may be more instructive. However, the critical continuity of the movement may be lost. Motion pictures have been shown to be effective in teaching skills involving motion (Levie & Dickie, 1973; Allen & Weintraub, Note 13; Silverman, Note 14). However, motion pictures have some of the same advantages and disadvantages of a live demonstration. If the movement is shown in real time, it may be too fast. Slow motion demonstrates the continuity of the movement while slowing it down so that the critical aspects can be perceived.

Repetitions of the demonstration or motion picture can improve the learning of motor skills (Hoban & Van Ormen, Note 10). Learning also may be facilitated if the trainee can stop the motion picture film and practice the motor skill rather than attempt to practice the skill while the film is in progress. Even mental practice, where the learner thinks through the various motions, may be effective (Bandura, 1977; Travers, Note 4). The new videodisc technology may make a significant contribution in this area (Merrill & Bennion, 1979). The videodisc will enable the students to adjust the speed of the motion sequence, stop on a single frame and look at the "frozen motion" for as long as they wish, step through a series of frames one at a time, reverse the play and repeat the sequence (at any speed), stop a sequence to practice the movement, and then repeat the motion sequence for comparison with their own performance.

Practice is crucial in the learning of a motor skill. However, practice is beneficial only if the learner receives some feedback. This feedback may be intrinsic to the task as when the correct letter is typed on a piece of paper, or may require the judgment of an instructor. Many complex motor skills are difficult to learn because trainees cannot observe their own responses and thus are unable to compare their responses with the correct form (Bandura, 1977). This problem could be alleviated by videotaping the trainees' performance and using the videotape for feedback.

Attitude Learning

An attitude is an internal state that influences an individual's choices of actions towards a class of persons, objects, or events. An attitude is a response tendency (Gagné, 1977). Posses-

TABLE 1. Summary of guidelines for using graphics in instruction.

Subcategory	Guideline
Concepts	Pictorial graphics should be used as examples of concepts that have concrete referents. In the initial stages of training, simplified pictorial graphics should be used in order to isolate and highlight critical attributes. Later stages of training could employ more realistic graphics in order to facilitate transfer to the real-world environment or task. Pictorial graphics are not necessary and may be distracting if they are used as signs for concepts, objects, or events with which the learner has had considerable previous experience. Under such conditions, the added external visual or graphic is redundant with the learner's mental visual image and, thus, may not facilitate performance. Pictorial graphics become helpful and vital when learners are exposed to new concepts, objects, or events for which they have no labels and/or corresponding visual images.
Discriminations	Considerable drill and practice with corrective feedback using graphics of actual objects or symbols may be required in order to learn discriminations adequately. Color may enhance learning when used to emphasize relevant cues and when actual color discrimination is required.
Rules	The learning of complex procedural rules can be facilitated through the use of figural graphics such as flowcharts. These graphics can portray the order of the operations of the procedure and alternate paths that could be taken at various decision points.
Problem Solving	Training in problem solving should involve instruction in the use and interpretation of various numerical relationships represented in tabular displays and figural graphics. Computer graphic simulations may increase the efficiency of problem solving activities.
Verbal Information	A figural graphical representation of the relationships between various facts and ideas can provide organization and meaning to facilitate the storage and retrieval of verbal information. Pictorial graphics that are inserted in textual verbal information often have a neutral effect on performance since they only illustrate concepts that could have been visualized easily in the mind of the reader from the verbal description provided in the text. However, pictures, color realism, and motion increase the attraction and interest value of materials. These characteristics are preferred by learners of all ages and may significantly reduce attrition.
Motor Skills	The demonstration of a complex motor skill in real time may be too fast. However, slow motion pictorial graphics can demonstrate the continuity of the movement while slowing it down so that the critical aspects can be perceived. A videotape of a trainee's performance of a motor skill may be a valuable feedback device.
Attitudes	Human modeling seems to be the most applicable, and probably the most effective, approach for attitude learning. Attitude learning involves the imitation of a credible and respected human model's choices of action. A human model may be presented in several ways: The model may appear in person, in still pictures, in movies or TV, or merely be described in a novel, history text, or biography.

sion of a high level of knowledge or skill does not ensure that an individual will always perform in accordance with that knowledge or skill. The purpose of instruction in attitudes is to strengthen an individual's internal state, thereby influencing his or her tendency to respond with the appropriate actions at the appropriate time and place.

Attitude learning is associated with almost every other type of learning. Attitudes are involved in choices of action such as complying with safety procedures, conforming to dress, grooming, and cleanliness standards, and obeying commands and instructions of officers.

As mentioned above, communication of information and skill alone has little effect on attitude learning. Those learning situations that have had significant effects on attitude change include classical conditioning, reinforcement or experience of success, and human modeling (Gagné, 1977). Of these three, human modeling seems to be the most applicable and probably the most effective approach for attitude learning. Attitude learning results in an imitation of the human model's choices of action. This imitation occurs only if the model has credibility and is admired and respected by the trainee. Attitude change is increased if the model is rewarded or punished for appropriate or inappropriate behavior or choices, respectively (Bandura, 1969, 1977; Goldstein & Sorcher, 1974).

The credible human model may be presented in several ways. The model may appear in person, in pictures, in movies or TV, or merely be described in a novel, history text, or biography. It is not necessary for the human model to actually demonstrate the appropriate choice of behavior; the model may need only to describe the situation in which he or she engaged in the desired choice behavior and indicate the reinforcing events that resulted from that choice (Bandura, 1977).

The principal aspects of human modeling can be demonstrated effectively in motion pictures or television dramatic presentations. Realistic motion pictures are preferred by most individuals; they can reach a large audience and can portray the consequence of certain choices or behaviors that would be too costly or unethical to demonstrate "live."

It is also important that the students be reinforced or experience success when they actually engage in the desired

choice behavior that previously has been modeled (Goldstein & Sorcher, 1974). Such reinforcement will strengthen their attitudes. Individuals enjoy and have positive attitudes toward activities at which they succeed. Repeated failure will produce negative attitudes.

Most television commercials are excellent examples of the use of all three approaches to attitude change. The products are paired with positive situations, they are used or chosen by credible human models, and the models are reinforced for their choice of the product.

Graphic signs such as, "Keep off the grass" or "If you drink, don't drive," will have little effect in changing attitude. However, they may serve as a reminder or reinforcer for those who already have some response tendency in the desired direction. If the verbal message on the sign is accompanied by a pictorial graphic of a respected human model, then some attitude change might occur.

Summary

The purpose of this paper was to propose some guidelines, based on instructional design theory and empirical findings, for the use of various kinds of graphics under specified conditions. In order to address the question, "What types of graphics should be used in various conditions?" it was necessary to identify and define different types of visual displays. The following categorization scheme was proposed:

A. Alphanumerics: 1. textual, 2. tabular.
B. Graphics: 1. figural, 2. symbolic, 3. schematic, 4. pictorial.
C. Objects or Events: 1. real objects or events, 2. models, mock-ups, or simulators.

Several guidelines for employing various types of graphics under different conditions were presented. The guidelines were directly related to Gagné's (1977) types of learned capabilities. The guidelines presented in the body of the report are summarized in Table 1.

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