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# COMMUNICATION MEDIA: PROPERTIES AND USES

Rudy Bretz

Rand Corporation
Santa Monica, California

September 1969

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AD 696956

MEMORANDUM
RM-6070-NLM/PR
SEPTEMBER 1969

# COMMUNICATION MEDIA: PROPERTIES AND USES

Rudy Bretz

PREPARED FOR:

NATIONAL LIBRARY OF MEDICINE
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UNITED STATES AIR FORCE PROJECT RAND

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| TELECOMMUNICATION | Sound | Picture | Line Graphic | Print | Motion | RECORDING |
|---|---|---|---|---|---|---|
| **CLASS I: AUDIO-MOTION-VISUAL MEDIA** | | | | | | |
| | X | X | X | X | X | Sound film |
| Television | X | X | X | X | X | Video tape |
| | X | X | X | X | X | Film TV recording |
| Picturephone | X | X | X | X | X | |
| **CLASS II: AUDIO-STILL-VISUAL MEDIA** | | | | | | |
| Slow-scan TV<br>Time-shared TV | X | X | X | X | | Recorded still TV |
| | X | X | X | X | | Sound filmstrip |
| | X | X | X | X | | Sound slide-set |
| | X | X | X | X | | Sound-on-slide |
| | X | X | X | X | | Sound page |
| | X | X | X | X | | Talking book |
| **CLASS III: AUDIO-SEMIVISUAL MEDIA** | | | | | | |
| Telewriting | X | | X | X | X | Recorded telewriting |
| **CLASS IV: MOTION-VISUAL MEDIA** | | | | | | |
| | | X | X | X | X | Silent film |
| **CLASS V: STILL-VISUAL MEDIA** | | | | | | |
| Facsimile | | X | X | X | | Printed page |
| | | X | X | X | | Filmstrip |
| | | X | X | X | | Picture set |
| | | X | X | X | | Microform |
| | | X | X | X | | Video file |
| **CLASS VI: AUDIO MEDIA** | | | | | | |
| Telephone<br>Radio | X | | | | | Audio disc<br>Audio tape |
| **CLASS VII: TYPE MEDIA** | | | | | | |
| Teletype | | | | X | | Punched paper tape |

The Communication Media

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This research is supported by the National Library of Medicine under Contract No. NLM-69-10 and by the United States Air Force under Project RAND--Contract No. F44620-67-C-0045--monitored by the Directorate of Operational Requirements and Development Plans, Deputy Chief of Staff, Research and Develoment, Hq USAF. Views or conclusions contained in this study should not be interpreted as representing the official opinion or policy of the above agencies.

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This study is presented as a competent treatment of the subject, worthy of publication. The Rand Corporation vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the authors.

Published by The RAND Corporation

## PREFACE

This study was undertaken as a contribution to two Rand projects involving instruction and the communication of information. The first, supported by Project Rand, concerns Air Force instructional systems and ways in which they might be improved. The second, undertaken for the Department of Health, Education and Welfare, is intended to assist the Lister Hill Center for Biomedical Communications of the National Library of Medicine in planning programs in support of nationwide needs for biomedical information. Specifically, Rand is considering ways of improving the design of systems for technical training, of improving medical education and medical-information delivery, and extending continuing medical education. All of these objectives involve applications of communication media in instruction and information retrieval.

Although much has been written about techniques of artistic expression in various media and about the social implications of the more pervasive of these, there is little information on communication theory which is useful to those who must make decisions concerning the applications of this new technology. It is to fill the need in this area that the present Memorandum was conceived.

This Memorandum is but the first phase of a much more extensive treatment of the subject. It is limited to defining the media themselves and describing the characteristics of each medium which determine its best uses. Subsequent phases will consider the effectiveness, flexibility, accessibility, and responsiveness of the media, and their adaptivity to the individual needs of the learner. Feasibility considerations will also be examined, such as costs and benefits, standardization, equipment reliability, staff training requirements, demand, and acceptability.

The author of this Memorandum is a consultant to The Rand Corporation.

## SUMMARY

This Memorandum defines and describes communication media; discusses the difference between information and instruction, instructional media and instructional aids; and proposes a set of criteria by means of which communication media may be distinguished from nonmedia, one medium distinguished from another, and discrete media distinguished from multimedia applications.

A two-dimensional classification system for communication media is proposed: In one dimension, seven classes are defined, based on ways of representing information; in the other, communication media are divided into two groups, telemedia and recording media.

This Memorandum is directed more toward media users and professional practitioners than toward scholars or researchers in the field. As much as possible, standard audiovisual terms and phrases have been used. Since there is wide variation in the meaning of even the most common terms in this field (e.g., message and media), each term is defined as it is used, and a glossary is included of all terms and the meanings in which they are used here.

Twenty-eight specific communication media are defined and described. This list includes the major available and soon-to-be-available media. Since the entire communication field is in a state of rapid growth, both in the development of systems and in their applications, it is to be expected that revision of this list would be needed frequently.

## ACKNOWLEDGMENTS

I am indebted to a number of my colleagues at Rand for their patience in listening to my arguments, reading my material, providing constructive criticism, and contributing insights in subsequent extensive discussions. This has resulted in not only a sharpening of the thinking involved, but the addition of important elements to the argument. Most helpful were Matthew Reilly, Leland Attaway, and, particularly, Polly Carpenter, who generously devoted the time to examine each point of the study.

The draft manuscript was carefully read and reviewed by Robert Specht, J. C. Shaw, Ann Summerfield, and George Comstock, also of Rand, for whose comments and contributions I am also grateful; I am similarly indebted to Michael Bretz of the University of Washington, Harold Wigren of the National Education Association, and Ken Winslow of the Ampex Corporation. The contribution of Janet Murphy, a Rand editor, rates a particularly honorable mention. I would like particularly to thank C. Ray Carpenter, of Pennsylvania State University, and William Paisley, of Stanford University, who were kind enough to review and comment extensively on the completed manuscript.

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## GLOSSARY*

Contrary to traditional practice, the glossary of terms required for this Memorandum is placed before the text rather than after. In a definitive study such as this, the specific meanings of terms, as intended by the author, have particular importance.

Page numbers after a term indicate where a use or further discussion of the term may be found.

*Adaptivity*: Capability of an instructional system to adjust to the specific needs of the individual learner.

*Application*: A specific instance of a general use (see *use*).

*Audiovisual (A-V)*: Concerning both hearing and vision.

*Bandwidth*: The difference in frequency between the maximum and minimum boundaries of a telecommunication channel.

*Broadcast*: Transmitted via the public radio or television channels on a broad or nondirectional beam (see *open circuit*) and received on generally available apparatus.

*Cartridge*: A device that contains and protects a film or tape even during playback and obviates the necessity for threading the playback machine. A cartridge generally contains only one program unit (see *magazine*).

*Cathode-ray tube (CRT)*: One of several types of vacuum tube used generally for display purposes (e.g., TV picture tubes, oscilloscope display tubes, computer graphic displays, etc.) (p. 51).

*Closed circuit*: Any transmission method other than face-to-face communication by which reception is not available to the general public. It may be confined to wires, microwave beams, and the like, or it may require special receiving apparatus not generally available.

*Communication*: The sending and receiving of messages between two or more persons (p. 12).

*Computer-assisted instruction*: Applications of computers to many aspects of the instructional process (p. 51).

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*Some of the definitions are based on entries in *Webster's Seventh New Collegiate Dictionary*, G. & C. Merriam Co., Springfield, Mass., 1967; some others have been adapted from English and English, *A Comprehensive Dictionary of Psychological and Psychoanalytical Terms*, Longmans, Green and Co., New York, 1958.

*Cross media*: Multimedia (p. 43).

*Electron Beam Recording (EBR)* (trade name): A method of recording television signals on motion-picture film by scanning the film with an electron beam rather than by focusing an image upon it (p. 64).

*Electronic Video Recording (EVR)* (trade name): A motion-picture system by means of which two tracks of picture and magnetic sound are recorded by electron beam on a film 8.75mm wide (p. 64).

*Extrainstitutional objectives*: The economic, social, vocational, and other objectives in the society at large to which the educational institution contributes.

*Facsimile*: A transmission-recording system in which pictures or print are transformed into electrical signals, in the manner of television, except very much more slowly and requiring a very much narrower bandwidth for transmission. The output of the system is hard copy (p. 85).

*Filmstrip*: A communication medium involving static graphic materials which are recorded on a roll, usually of standard sprocketed motion-picture film, and projected frame-by-frame for group viewing (p. 89; see also p. 75).

*Frame*: (1) A single still picture isolated from a sequence of still pictures, in still-visual or motion-visual media; (2) a discrete increment of information presented to a learner by an instructional program.

*Hard copy*: Printed material of any kind ordinarily read by the unaided eye.

*Hardware*: Equipment as distinguished from materials; machinery, tools, and devices (see *software*).

*Independent access*. A term that applies to a multiuser storage system in which the method and time required for any one user to gain access to a piece of information are apparently independent of the number and actions of all other users (see *random access, sequential access*).

*Individual mode*: One person alone, using materials at will, with control over the materials to a lesser or greater extent and limited interaction with other users.

*Information*: (1) Facts and concepts in transit; (2) a message (p. 4).

*Instruction*: Teaching and learning; the systematic attempt to impart knowledge and skills and to instigate learning (see *self-instruction*) (p. 7).

*Instructional aids*: Devices that assist an instructor in the presentation of information. They are not self-supporting, generally because they do not contain expository narration. Included under this heading are visual aids, audio aids, and sometimes audiovisual aids.

*Training aids* is sometimes used as a synonym but generally covers learner aids as well. *Audiovisual aids* are generally classed under *instructional media*, since they can be self-supporting (see *learner aids*) (p. 20).

*Instructional devices*: Training devices; items of standard on-the-job equipment used in instruction (see *instructional aids, learner aids*).

*Instructional medium*: The entire system of equipment, processes, people, and materials that are necessary for the presentation of information and direction of learner activity. It often includes the software as well as hardware; program planning, production, recording and/or transmitting; and program reception. It may also include response methods and/or devices, and feedback to the learner. Instructional media are self-supporting and self-contained means of presentation, generally because they contain expository narration. Their application does not require the presence of an instructor (p. 18).

*Instructional program*: (1) The information presentation component of a lesson (e.g., an instructional television program); (2) a lesson or other segment of *programmed instruction* which presents information in small increments, elicits learner response, and provides the learner with knowledge of results. It may pace the learner or let the learner set the pace, select from alternative information increments based on the learner's responses, and/or, to a lesser or greater degree, be adaptive to specific needs of the individual learner. Learning objectives are expressed in behavioral terms (pp. 10, 17).

*Instructional television (ITV)*: Any television, recorded television, or film-media system using teletransmission that is used primarily for formal instruction.

*Instructional Television Fixed Service (ITFS)*: A television wireless transmission/reception system utilizing special frequencies which are allocated for instructional point-to-point transmission purposes only, such as between a central transmitter and several school buildings, or from hospital to hospital. ITFS may be used in an educational system for administrative communication, data transmission, studio-transmitter links, and interstation relay.

*Interaction*: Mutual or reciprocal action or influence (e.g., information presentation plus learner response, plus feedback based on learner response) (p. 16).

*Kinescope recording (kinerecording)*: A system for recording television sound and image on photographic film. Basically, it consists of a film camera focused on a kinescope tube (television picture tube). An ordinary motion-picture film results, which can be projected on a screen or transmitted by television in the normal manner (p. 62).

*Knowledge*: The body of understood information possessed by an individual (p. 3).

*Learner aids*: Devices that aid a learner, generally in drill and practice activities, with or without the assistance of an instructor. The learner uses or interacts directly with the device. Includes tools such as pencil and paper, and simulators for individual or team practice (p. 16).

*Light pen*: Input device for a computer system; a stylus whose position when held against the face of a CRT can be determined by the computer (p. 51).

*Live*: In real time; that is, the message originates simultaneously or nearly simultaneously with its display and perception (p. 37).

*Magazine*: An adjunct to a projector or other playback device holding a supply of program materials consisting of many individual units and generally accessed automatically, e.g., a slide magazine (see *cartridge*).

*Mass medium*: A telemedium or recording medium which generally involves a large number of message receivers per sender and generally does not involve simultaneous interaction. It is available to the general public.

*Media system*: Communication medium.

*Medium* (pl. *media*): A means of effecting or conveying something. *Medium* is a general term roughly comparable in many ways with tool, instrument, vehicle, means, etc. (see *instructional medium*) (pp. [illegible], 29).

*Message*: A discrete amount of information which has been formulated by one person with the intent of its immediate or ultimate transmission to other persons or to himself; any recorded or transmitted information of any kind (p. 17).

*Microfiche*: A recording system using transparent chips (cards), usually 4 x 6 inches in size, onto which up to 3200 pages of printed material may be photographically recorded. Can be read with magnifying or projection devices (see *ultramicroform*) (p. 92).

*Microfilm*: A recording system using roll film, on which photographic images of printed materials, usually, are reproduced. Can be read with magnifying or projection devices (p. 91).

*Microform*: Any record or reproduction in which the reduction ratio is at least 12 to 1, usually 20 to 1 or greater (p. 91).

*Mode*: (1) (General). Manner of being, doing, etc.; way; method. (2) Manner of reception of a communication, e.g., individual or group mode. (3) Manner of operation of equipment, e.g., recording or playback mode. (4) Manner of utilizing the possible ways of representing information via a medium, e.g., full or partial modes of use.

*Multimedia*: More than one medium used in a single communication, either sequentially or simultaneously (p. 42).

*Network*: (1) (Telemedia). A series of reception, display, or redistribution points that are interconnected so they may simultaneously share the same programs. (2) (Recording media). A series of points as in (1) above that share programs by transporting recordings between them. (3) Various combinations of (1) and (2).

*Open circuit*: A broadcast transmission method in which the receiving equipment and programs are available to the general public. Open-circuit programs usually can be, with the necessary equipment, received anywhere. ITFS broadcasts, by contrast, are not open circuit.

*Picturephone* (trade name): A system of transmitting video and audio information via relatively narrow bandwidth, involving digital encoding. Intended as a two-way system to enhance telephone intercommunication (p. 57).

*Print*: A way of representing information using symbols such as alphanumeric characters, pictographs, logograms, ideograms, hieroglyphics, and handwriting. Does not include line graphics or pictures (p. 86).

*Production*: Encoding of a message into the form of a program appropriate to the medium being used; the process of creating programs. May include such phases as program planning, preparation, script writing, rehearsal, and recording and/or live transmission. May also include testing, revision, and validation (p. 18).

*Program*: (1) Any prearranged plan or course of proceedings; an organized sequence of events. (2) A unified presentation occupying a discrete period of time and having a beginning, a middle, and an end. *Program* is a general term covering entertainment, fine art, general interest, and instruction. Program as used here refers to the content of a medium and consists generally of a message expressed in the terms and techniques of the medium (see also *instructional program*) (p. 17).

*Radiovision*: An instructional media system presenting static visual materials and sound. The sound portion is transmitted by radio, while visual materials are projected at the point of local reception (p. 97).

*Rand Tablet*: An input device for a computer system consisting of a printed-circuit surface electrostatically coupled to a stylus. The computer senses the position of the stylus and thus makes possible the input of two-dimensional line drawings (p. 51).

*Random access*: Direct access. A method of storage in which any unit of information may be accessed directly regardless of the location of the previous piece of information retrieved. An example would be a slide projector in which any slide could be projected promptly by pressing a corresponding button (see *independent access*, *sequential access*).

*Telecommunication media (telemedia)*: Electronic media capable of transmitting programs across distance in real time (p. 24).

*Telelecture*: An instructional media system involving the use of static visuals and sound. The sound portion is transmitted by telephone while the synchronized visual materials are projected at the point of local reception. Since standard telephone facilities are used, a feedback channel is also available (p. 94).

*Telewritevision*: An instructional media system incorporating telewriting plus static visual materials projected by the telewriting display equipment at the point of viewing (p. 81).

*Telewriting*: An instructional media system which transmits sound and writing as it is being written. The principle is basically that of the TelAutograph: The vertical and horizontal components of movement of the sending stylus are transferred to electrical impulses which are then transmitted on different channels to a receiving stylus which moves in accordance with the signals it receives, and reproduces, simultaneously, the original writing. This may then be projected on a screen for group viewing (p. 80).

*Terminal*: Interface equipment between user and machine in a computer system; input-output equipment, usually in the form of teletype and/or CRT (p. 51).

*Time-shared television*: A proposed transmission system which would utilize one television channel to transmit, for instance, 300 still pictures to 300 different viewers each 10 seconds, instead of the usual 300 successive frames of a single moving picture (p. 72).

*Transmission*: An electrical or electromagnetic process whereby a properly encoded message may cross space to a decoding apparatus in real time (p. 12).

*Ultramicroform*: Any microform in which the reduction ratio is greater than 40 to 1 (p. 91).

*Use*: A general purpose or objective which a medium helps to attain, e.g., a springboard for discussion. *Uses* are general and abstract; *applications* are specific and concrete. *Use* refers generally to an entire media system. *Utilization* refers generally to the receiving end of the system and its integration with other aspects of instruction (see also *application*).

*Utilization*: Use at the receiving end of a media system; *utilization* generally refers to the manner in which the instructional program is integrated into the whole instructional system; that is, how it is coordinated with other instructional activities.

*Video recording file (VRF file)*: An information storage and retrieval system using video tape as the storage medium (p. 93).

*Video tape*: Thin (0.5 to 1.5 mil) acetate or mylar tape of various widths between 1/4 inch and 2 inches, coated with magnetic material, used to record and store video and audio information.

*Video tape recording (VTR)*: A recording system which stores video and audio information by transferring electrical signals directly into a magnetic pattern on the emulsion coating of a thin (usually mylar) tape (p. 66).

# I. INTRODUCTION

The term "medium" has many definitions, from a solution for mixing paints to a person who purports to make contact with the dear departed. In all of its meanings, however, a medium is something in the middle, between other things, and most often it is considered as a vehicle or instrument for making something happen. Communication media or instructional media, however, while they may be broadly considered instruments or vehicles (which need play only a very limited part within a total system), are actually something more: A communication medium can be an entire system for human communication, either informational or instructional in purpose. If instructional, it may constitute almost an entire system for instruction.*

This Memorandum forms certain generalizations about the communication media, discusses the differences between information retrieval and instruction, and then describes each of the major instructional media in respect to the generalizations which have been formulated. This material is intended to be definitive and descriptive, and it is, hopefully, fairly complete. Much has been written about "new media" and "newer media"; there has been much viewing with hope, as well as viewing with alarm. On the part of media users there is a growing tendency to take the technology for granted and to settle on limited uses, failing to exploit some of the most valuable characteristics of the media. To date, there exists no exhaustive list of all these media, both new and old, which compares their characteristics and presents all the various alternatives for the media user to consider.

Perhaps because of this lack of analysis of media and what they can do, many possible uses of the more simple, inexpensive media were not conceived until complex, expensive media such as television and film had been applied to these uses. It will sometimes be pointed out that one application of television, for instance, does not require real-time transmission, and another application does not require pictures

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*Although instruction may include conveying information, it is a multifunctional process designed according to a strategic plan, with the end purpose of modifying or changing behavior.(1)

in motion; therefore, much of what instructional TV is doing could be done as well by less expensive means.

Instructional media have traditionally been administered by school audiovisual people along with various other kinds of learning resources and instructional aids for the classroom teacher. As a result, instructional media have frequently been confused in many people's thinking with instructional aids. An important distinction is made in this Memorandum between instructional aids and instructional media: Basically, an aid merely supports a teacher's presentation, whereas a medium is self-supporting. A medium, within its specific limits, is capable of the entirety of information presentation, and a good share of learner/subject-matter interaction as well. This is not to say, of course, that instructional media could ever totally replace live teachers. But while instructional technology cannot take over all of the functions now performed by a good classroom teacher, it has enormous potential for increasing both the quantity and quality of available education.

## II. INFORMATION AND INSTRUCTION

In any discussion of communication media we must use the terms "information" and "instruction," which refer to the two purposes for which communication media may be used. It is important that these terms be clearly defined and the distinction between them made clear. The word "knowledge" must also be defined, since the interaction between what is meant by knowledge and what we are calling instruction and information is an important determinant of all these meanings. The definitions used here are based partly on dictionary definitions, partly on a feel for frequency and generality of current use, and partly on their usefulness to the kinds of thinking needed in this area.

To begin with, "information," as used in this Memorandum, refers to a thing, which may exist in space or time, but not to an action or a process such as the act of informing. On the other hand, "instruction" refers to an entire process, in the sense of "a series of actions or operations conducing to an end."(2) Instruction as we define it is not a single act but a systematic series of actions, the end of which is the imparting of knowledge and modifying behavior.*

We will think of knowledge as something that is stored or filed in the brain. Specific information, concepts, relationships, and so forth, must be sensed, perceived, comprehended, and then integrated into the learner's existing structure of associations in order to become knowledge. Knowledge, in short, is the content of human memory which is organized for retrieval. This is also sometimes referred to as knowledge structure.

Information systems and instructional systems have one important characteristic in common: they are both concerned with transmission of stimuli to others. Information systems are intended to impart information. In an instructional system information is frequently a major component, but its purpose is to impart knowledge--not only facts and concepts, but also such things as emotional attitudes and

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*The instruction that can be contained in a medium is the "instructional program." This may be as simple as the presentation of a segment of information; it may contain directions to exercise the student; it may even be programmed to include appropriate feedback based on anticipated student responses and/or other data.

cognitive and psychomotor skills. Here, an important distinction must be made between the process of presenting information and the process of instruction. The purpose of instruction is to create, alter, or add to the knowledge of the learner, whereas informing someone does not necessarily affect his file of knowledge.* Although a person may add the information he receives to his knowledge, the mere delivery of information is not designed and directed toward this end, as instruction is. The information user generally has a task at hand which he is interested in resolving; he acquires information, uses it in his task, and may forget it quickly--if he ever retains it at all. Information systems are designed for use and for the convenience of the user. Instructional systems are designed to achieve learning and to affect the knowledge of the learner. The learner, of course, is often an information user as well. For the learner, "information use" suggests an active role, while "instruction" generally implies a more passive relation to the teacher or to an instructional system.

## INFORMATION

Information has far less structure than knowledge; much information, in fact, consists of isolated and unrelated facts. In general, unrelated information can be filed in a human memory only when it has become associated with some prior structure of understanding and has become part of a person's knowledge. (Knowledge is, of course, transitory as well, but it can generally be retained far longer than unassociated information.)

In this study, we are most interested in information outside the individual: the technology of information-handling; the systems of processing, storage, and retrieval; and the means of conveying and imparting information to others. Because information so often consists of isolated data, to be useful it must be filed within various arbitrary classifications, often alphabetical, so that it can be retrieved. Thus we have directories, bibliographies, and statistical tables of many kinds. Considerable predigestion of information is done by librarians,

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*This point is discussed more fully on pp. 10 and 11.

who, for example, prepare annotated bibliographies, which add a dimension of qualitative evaluation to what would otherwise be unevaluated information.*

These efforts of the librarian should not be confused with the work of the instructor. The librarian may serve the instructor by assisting him in the preparation of information for use in the instructional process; the librarian may indeed serve the learner directly, in his capacity as a user. The learner himself then may take the information retrieved and build it into his knowledge. It has been said that there is no teaching, there is only learning; however, well-designed instruction can greatly facilitate this process. It is rare, therefore, that a librarian plays the part of instructor, mainly because the instructional process involves so much more than the mere presentation of information.

Up to this point, we have discussed information as something existing in a more or less static state. Let us now consider the role of information in the dynamic transfer of knowledge from one person to another. Figure 1 presents a model for this process.

The process of communication by speech, for example, can be traced in this model as follows:

1. The message sender selects a thought from his knowledge and formulates it into words, so that it exists separate from his knowledge, ready to be transmitted.
2. When he speaks, he sends forth his information, encoded in spoken words which travel as vibrations in the medium of the air.
3. These sounds are perceived by the recipient, filtered out from the noise that accompanies them, decoded, and comprehended. If the information is considered valuable enough, it may immediately be "filed" as knowledge.

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*Future librarians may go much further. Information needs to be directly available within its sources (books, journals, etc.) or to be extracted from its sources so it can be directly addressable. This might take the form of the information chunk, defined as "the smallest identifiable unit of task-required information which would lose its identification and meaning with respect to the task, if segmented further."(3)

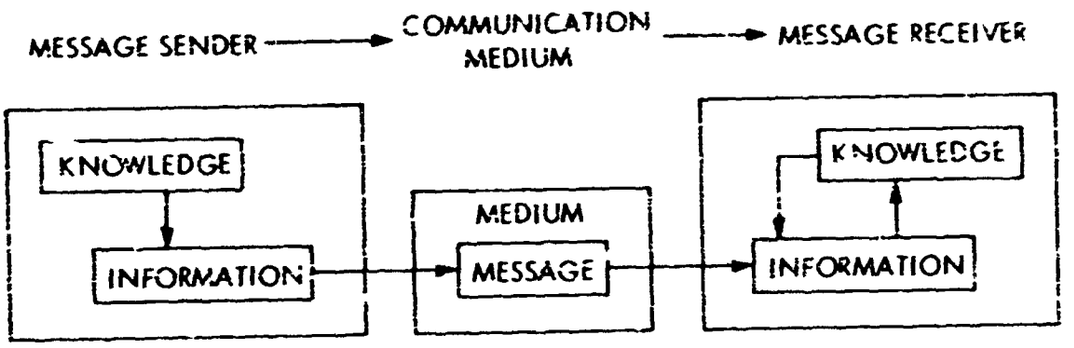


Fig. 1 — Simplified communication model

The message may go through inadvertent changes during any of the phases of the process, especially the first and last phases, when it is emerging from and merging into knowledge. It also may be distorted during transmission or become obscured by noise. In any case, during the entire process of communication, knowledge exists as information both inside and outside the individual. It can be useful for some purposes, therefore, to think of information as knowledge in transit.

The example above (communication through speech) represents a live (real-time) communication. The same model applies to recorded information if the recording is considered to be merely a delay stage in the general process of transmit. If the message sender decided the room was too noisy to allow him to be heard or understood, he might choose to communicate by writing a note and passing it over from hand to hand. This process will take longer, particularly if the message is delayed en route, but the message in storage is nonetheless a message in transit. All messages, transmitted or recorded, are in transit from the time they are first encoded.

INSTRUCTION

The role of information in the instructional process occurs in the lesson-presentation phase, when the learning objectives are mainly cognitive. However, since instruction includes much more than the mere presentation of information, it will contain, or be based on, a strategy for achieving the desired learning. The instructional process may include stimuli designed to elicit thought or overt action or to stimulate discussion among two or more learners; it may, if properly programmed, be so systematized that the learner cannot obtain access to one piece of the contained information until he has demonstrated by some action that he has apprehended the preceding and prerequisite information. Such instruction, of course, can be administered to the learner only through a teacher or through a medium which involves a response and feedback component.

One of the important objectives of good instruction is to give the learner the skills required to seek out information on his own and to devise activities which will help him to use and retain that information. Most important of all, instruction should contain an intrinsic

element of motivation and encouragement to capture, hold, and increase the learner's interest and his desire to know. None of this strategy plays any role at all in simple information retrieval by a user with an immediate task at hand.

## AN INFORMATION-INSTRUCTION MODEL

Figure 2 presents a model of the processes of information retrieval and instruction. The large block labeled "Information" represents the recorded information of the world. The input to this vast data bank is shown at the top, where unknown facts are observed and become known facts--hence data. The librarian, knowing the needs of various kinds of users, works within this area, creating and maintaining order. All recorded information and all of the order it may possess exists ostensibly for one reason only: so that this information may be imparted to others. (It is also recognized that a vast quantity of scientific information comes into existence so that whole documents can be traded as unit commodities; the merit of their detailed contents is a secondary consideration.)

Probably most information is ordered for the convenience of the information user, shown at the upper left. He receives the information, uses it in performing his task, and usually then loses or buries it. The person with a photographic memory is a rare exception.

Some information is retrieved by the instructor, shown at the lower right, whose purpose is to build it into instruction. Most of this information enters his knowledge, where is it combined with existing knowledge acquired from experience or earlier training. Out of this knowledge a selection of information is made, organized, and encoded as an instructional message. Some of the information which the instructor retrieves, however, may not actually go into his knowledge bank at all, but may be used directly in his instructional task. (This is represented by the arrow bypassing the instructor's knowledge.) The importance of this information route will vary inversely with the creativity of the instructor.

That part of the instructional process which contains information--the lesson--is labeled "Instructional Program" in Fig. 2. The reason

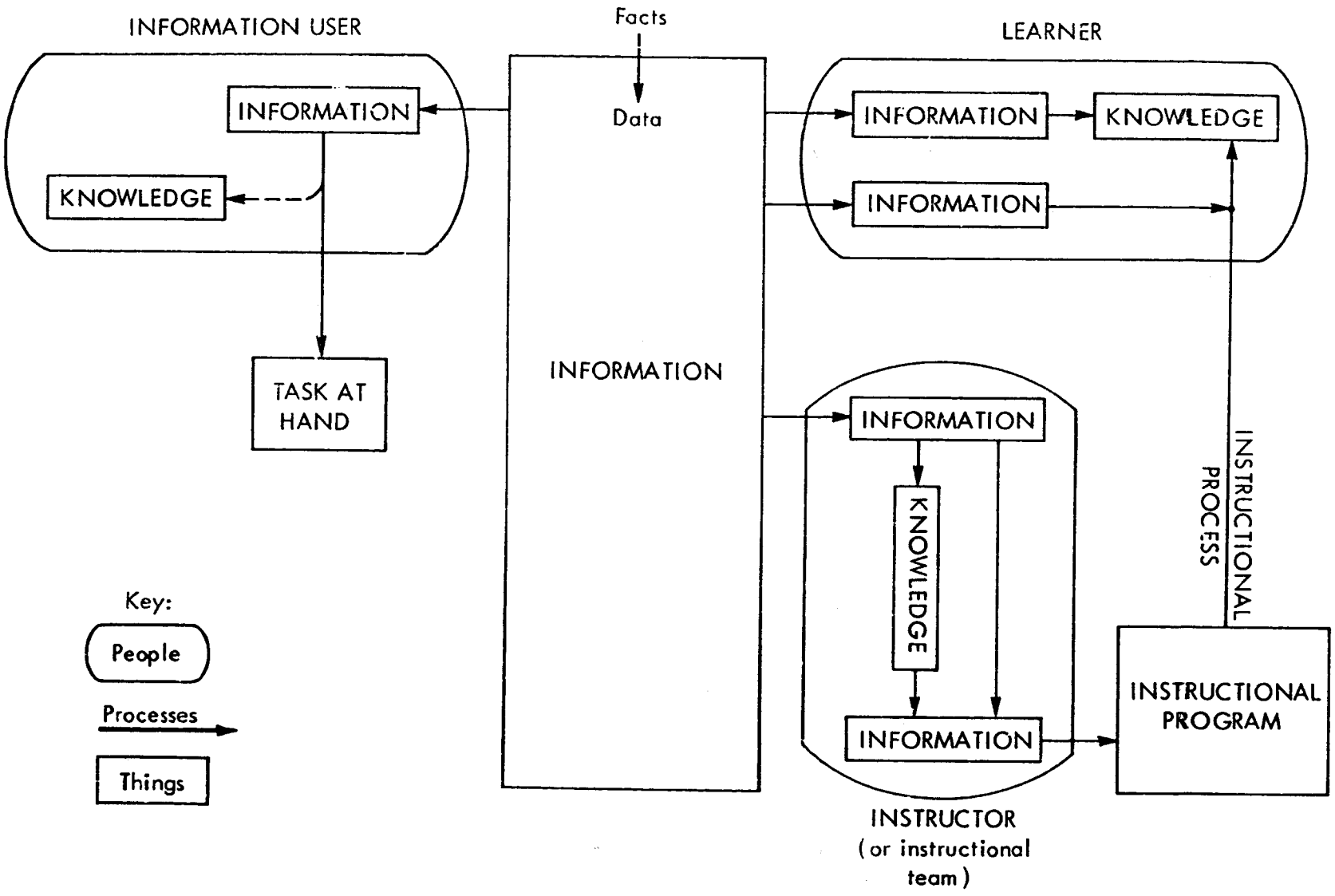


Fig. 2 — Information-instruction model

is this: The term "instructional program," originating in the vocabulary of programmed instruction, implies considerably more than the presentation of information; it also includes the direction of learner activities relevant to the information, the provision of resources, and the application of methods for the practice of responses until the achievement of stated learning objectives can be certified. Thus it may encompass some, much, or all of the instructional process. The program may actually direct the entire process, then, rather than simply initiate it, as the lesson commonly does.

As stated above, one of the most important objectives of instruction, especially in terms of lifelong education, is to train the learner to utilize the information bank directly and to devise his own instructional process. This skill should be called self-instruction, rather than self-study, since with it, the learner directs his own activities. "Self-study" describes any learning activity of any sort which is performed individually, whereas self-instruction, or independent study, incorporates heuristic methods such as inquiry and search and discovery. The lower arrow from the information bank to the learner represents the activities involved in learning self-instructional skills. The upper arrow represents this same process taking place outside the instructional process after transfer of the learned heuristic skills, so to speak, into daily life.

During this process, the learner may be considered in much the same light as the information user, except that his task at hand is not external--it is the acquiring of knowledge. Students, especially college students, may play the part of the mere information user, and this is encouraged by a limited concept on the part of many people, namely, that instruction is merely the process of dishing out information. The task at hand for the student is often a paper or an examination on which he hopes to get a good grade. Cramming for an exam is a kind of information-using; the crammer is frequently not really interested in retention beyond a few hours or days, at the most.

A commonly held view is that learning is achieved when information has been fitted into an individual's store of patterns and structures; that is, when it has become knowledge. Such knowledge then becomes

part of the way the learner views the world, and it helps determine the manner in which he perceives reality. Information that is not so related finds no structure in which to be filed, which may explain why it is not long retained.

## III. WHAT ARE COMMUNICATION MEDIA?

### COMMUNICATION VERSUS TRANSMISSION AND RECORDING

The concept of communication is frequently confused with the much simpler and more limited process of transmission. A communication medium is a relatively large system that includes software as well as hardware, plus all the resources necessary for the planning, production, and proper utilization of this software. Communication plays an important role in instruction, of course, and a communication medium used for this purpose is called an instructional medium. Thus the television instructional medium is something far more extensive than the television transmission medium, which is merely a means of transmitting picture and sound (see (a) of Fig. 3). Many kinds of wired or wireless transmitting circuits are each capable of carrying messages associated with several different communication media, as for example, voice-grade telephone lines carrying teletype or telewriting messages. Not all communication media are also transmitting media, and there are many transmitting media, such as laser beams, wave guides, and the like, that are not at present considered to be communication media. In general, a transmission medium does not include any program software, and in the example of television, again, it need not even include cameras and microphones at one end of the system, or display equipment at the other end.

It is characteristic of the television transmitting system, for instance, that it can theoretically transmit almost anything that can be recorded, whatever combination of sound, picture, or print it may contain. In such a case it is the recording system which should be considered the communication medium, not the transmitting system, because the recording system contains the program software elements. When an instructional film is transmitted by television, for instance, film is the instructional medium; television is only the transmitting medium. It is only when the program materials are specifically made for the television transmission system that the whole may be termed a television communication medium.

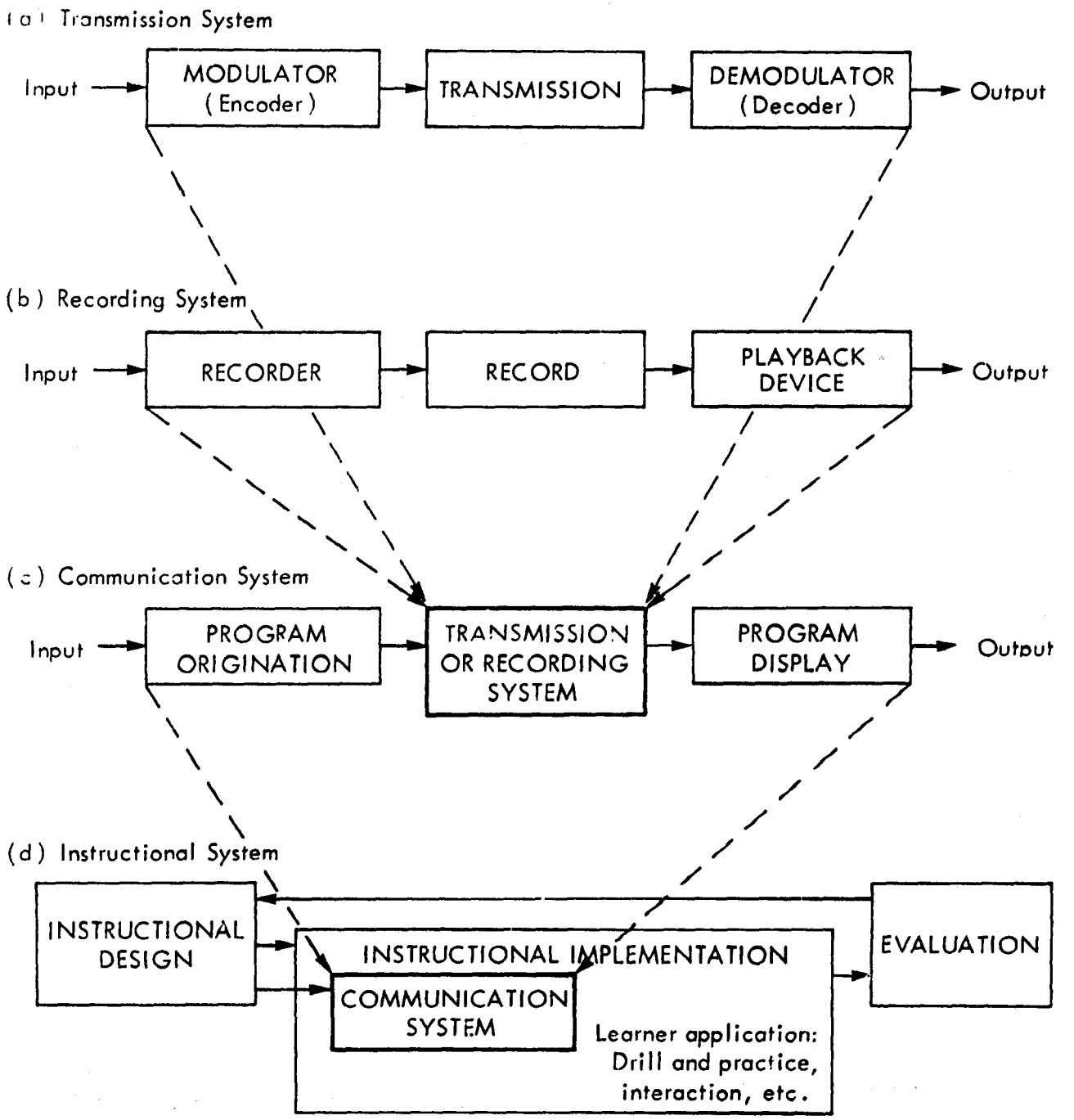


Fig. 3—Systems within systems of communication technology

The same confusion occurs between mere recording systems and the communication media that are based on these recording systems. The magnetic-tape recording system, for instance, is only a recording medium. Magnetic-tape recording systems may be used to record audio, video, telewriting, or slow-scan TV. They contain only recording equipment, recording material (tape), and playback equipment (see (b) of Fig. 3). A video-tape recording system need not include cameras and microphones at one end of the system, or display equipment at the other.

The communication system, as shown in (c) of Fig. 3, will incorporate either a transmitting or recording system (or some combination of the two) and in addition will incorporate components which concern the message itself. Program origination (planning and production) and program display (making the program visible and audible) are part of neither transmitting nor recording processes, yet are vital parts of the communication system.

The telephone, as we commonly comprehend it, is purely a transmitting medium. We do not generally conceive of it as having any software component. However, the telephone can be used as an instructional medium, depending on the kind of program the telephone medium is transmitting.

The universe is sometimes seen as a vast system of "wheels within wheels." The communication medium, in turn, is useful only as part of some larger instructional or informational system ((d) of Fig. 3), which again must take its place in a larger social system.

The purpose of a <u>transmission</u> system is simply to get a message from here to there. A <u>recording</u> system may have the same object, but in addition it bridges time, sending a message from now to then, with a minimum of loss, distortion, or added noise. Although Berkeley, who proposed that the tree which falls on a desert island makes no sound, might disagree, the transmission system may function perfectly whether the message actually reaches anyone or not. Successful or effective transmission is independent of what sort of message is sent, how it may affect the recipient, or whether the result is good or bad.

The objectives of the <u>communication</u> system are more extensive.

It starts and ends with people, and its purpose is to create and transmit a message which will affect the receiver in the manner that the sender intends. The message may simply include data that the recipient will use, or it may be intended to permanently affect his behavior.

Communication, in and of itself, is rather limited in achieving productive results. It may affect people briefly, but other activities are generally needed (such as performance practice) to make such changes permanent. Thus good communication alone, in instruction, for instance, generally is not sufficient to achieve learning. The objective of the instructional system, learning, is a personal, intrinsic process which requires responsive activities by the learner. But it must begin with communication of stimuli, selected and organized to bring about learning. Part (d) of Fig. 3 shows some of the most important functions in the teaching-learning process, including the communication system. Figure 4 is a more complete chart which breaks these activities down into their components, identifies the various functions, and suggests examples of each. The learning environment is shown within the larger social environment. The social objectives (or the job-performance requirements in a training system), at the far right, should be compared with actual social behavior or job performance after graduation for an ultimate evaluation and validation of the instructional system.

Figures 3 and 4 place the communication media in proper perspective, which has not always been done in the past. The failure of much early educational broadcasting, for instance, stemmed from the broadcaster's involvement in communication per se and a lack of sufficient concern with the larger objectives which his medium may have been trying to help achieve. It is not sufficient to design, produce, and transmit an educational program, even if it has been publicized sufficiently that the intended audience is there to receive the broadcast. If the objective is learning, someone has to organize the learners--get them to commit themselves to action, follow up on the activities that the program may direct, provide human interaction and personal interest, and monitor, observe, and measure their growth and achievement along the way. Mere lesson presentation is not the whole of instruction, as Figs. 3 and 4 illustrate.

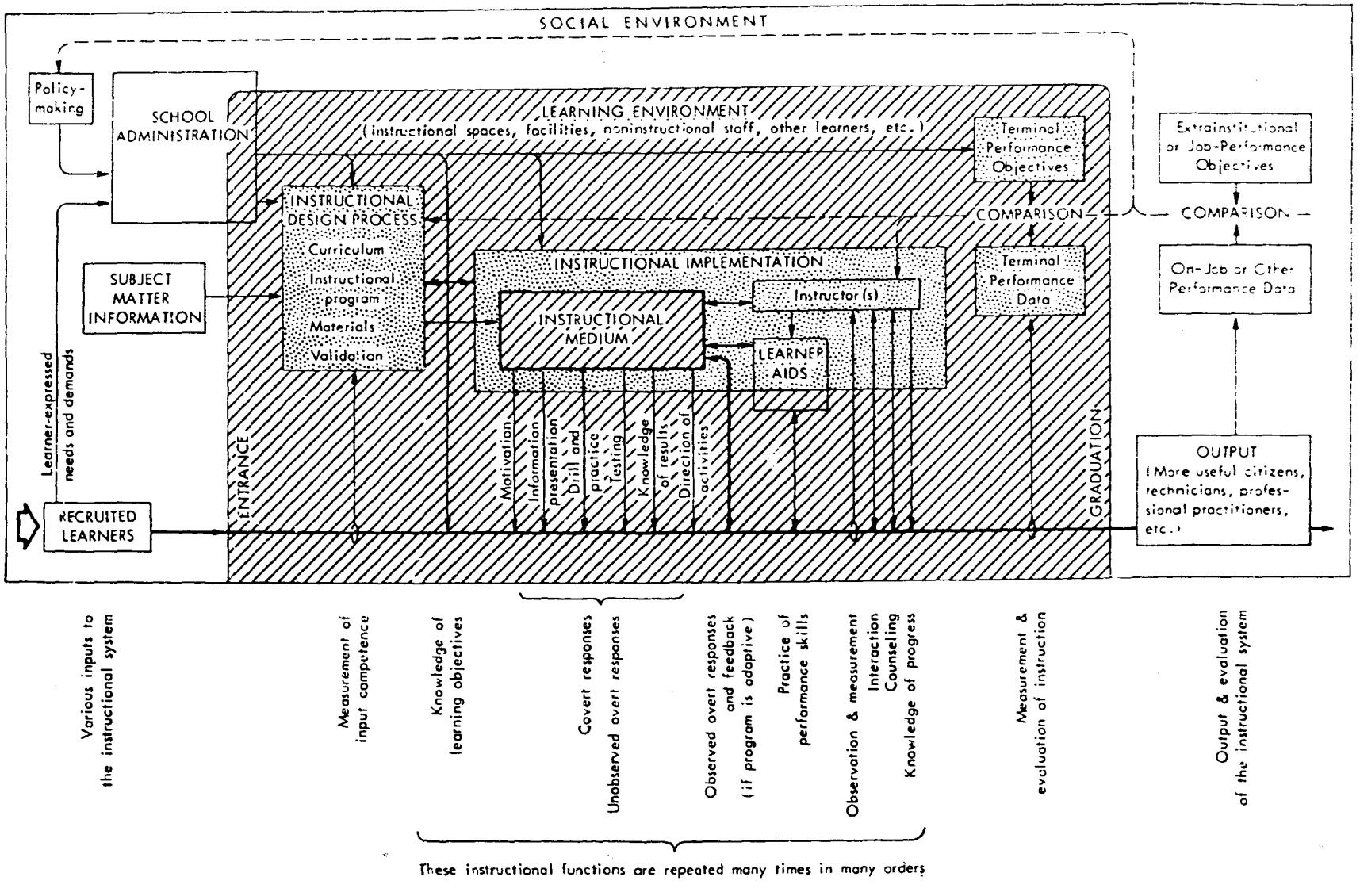


Fig. 4 — An idealized instructional system in its social context

The presence of the message as part of the system, we have said, is the condition which distinguishes the communication system from the transmitting system. The message, of course, is not the medium, any more than the medium is the message. There is nothing to be gained in this discussion by going along with McLuhan's semantic trickery and using message to mean the general social importance or significance of the medium. We shall use message as everyone else does, to mean the information which is communicated, and medium to mean the means whereby communication is accomplished.

The message or content is generally organized into a form called the program. "Program" is a very broad term and has many meanings, at least two of which are applicable here: (1) a unified presentation occupying a discrete period of time and having a beginning, a middle, and an end (e.g., a television program), or (2) an organized activity, such as programmed instruction. A program in this sense is unified and discrete, as is that of definition 1, but it is also designed to clear specifications related to its output objectives. An instructional program, thus, would be based on clearly defined behavioral objectives, would present instruction in small increments, would constantly elicit and evaluate learner response, and would provide knowledge of results. Any instructional medium is capable of this degree of programming, even though it may possess no actual feedback channel.

Programs are rarely involved in the communication of simple information to the information user. The message is merely encoded in words or pictures, then further encoded in the technical transmission or recording code of the medium.

In instructional communication, the content of the medium consists of both the message and the program containing it. The message is what the instructor says and the program is how he says it.* A curriculum of specific information and general concepts as presented in a book would differ from the same curriculum as presented in a film, for example. Each medium requires the message to be encoded into a different

*"Says" is used here in the general sense of expressing or presenting.

format, using a different set of techniques, and resulting in a different kind of program. "The medium shapes the message."* Within each medium, however, there is a wide variation in the kinds of programs that can be devised. There are many kinds of books, for example, and many ways of laying out type and illustrations.

The model shown in Fig. 5 summarizes the points that have just been made. There are nine successive stages in the encoding and decoding of a message for communication via an instructional medium. Step 1 is the conception of the message. A certain amount of information is generated out of the instructor's knowledge, some of which may have also been retrieved from his access to information storage systems (see Fig. 2). Step 2 is the first encoding. The information is expressed in language, which need not necessarily be verbal--it may be the language of pictures, for example, or of gestures, or combinations of these.

Step 3, where the message is further encoded into a program, occurs at the same time or later. (Step 3 is an artistic encoding relying heavily on technique.) In Step 4 the third and final encoding takes place when the program is transferred by technical means into the analog or digital code of the recording or transmitting medium.

Step 5 is the actual transmission of the program (if a telecommunication medium is being used) or the combination of storage and transportation, e.g., with a recording medium, this combination occurs between the stage of recording (Step 4) and the stage of reading, playback, or display (Step 6).

Step 6 is the first stage of decoding, where the program is transferred into a perceptible form. In Step 7 the message receiver--in this case, the learner--views the program (reads the book, listens to the tape, etc.). He selectively decodes and comprehends the message if it has relevance for him and he understands the language in which it is encoded (Step 8). The last stage, Step 9, is learning, which the learner must do for himself; however, the instructor has designed

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*Personal communication from C. R. Carpenter, Pennsylvania State University, July 1969.

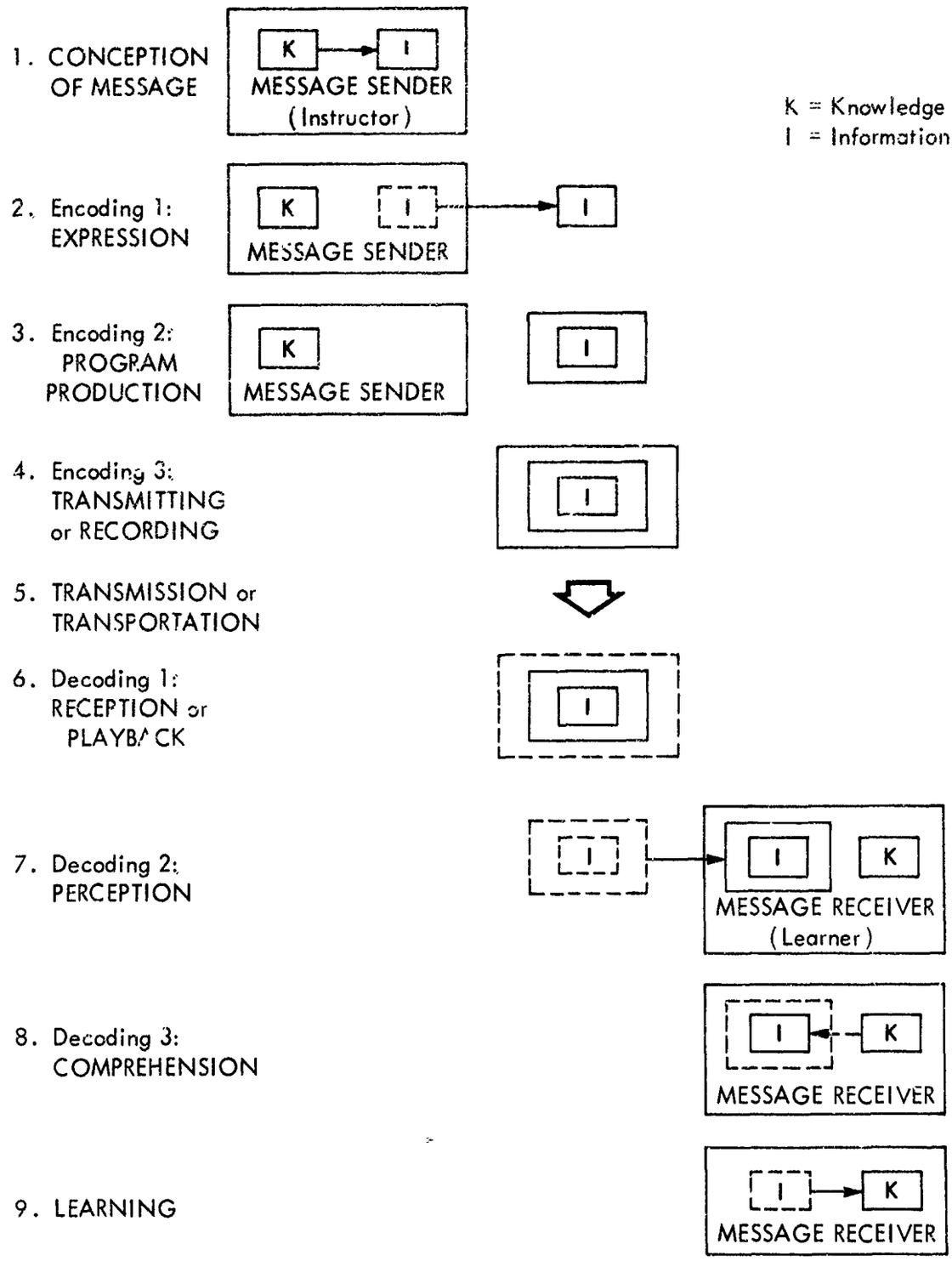


Fig. 5 — Phases in communication via an instructional medium

the message and the program to facilitate this process as much as possible.

If, as frequently is the case, a program is communicated via a combination of media--recorded on video tape, for example, and subsequently broadcast or transmitted by wire--another step must be added to the total process. In Step 4 the program is encoded into the magnetic analog code of the recording medium (video tape) as shown, but before it can be transmitted it must be transferred to the electrical analog code of television. This is not a further encoding; it is a transfer process in which the program is simultaneously decoded from its magnetic form and encoded into electrical impulses. The next decoding takes place nearly simultaneously at the other end of the transmission path, in which case the program may be either decoded immediately and viewed (as shown in Fig. 5) or transferred again to video tape to be decoded and viewed at a later time.

No program is involved in the transmission of simple information, rather than instruction, so the program encoding and decoding stages (Steps 3 and 7 of the process) do not exist, and the entire process consists of only seven steps.

## INSTRUCTIONAL MEDIA VERSUS INSTRUCTIONAL AIDS

An instructional medium makes it unnecessary for an instructor to actually be present when and where his instructional presentation is received. This separation is possible because the instructional program contains all necessary parts of the message: audio or visual stimuli, and exposition of some kind to give them the requisite significance. The exposition is nearly always verbal--either spoken or written. The medium carrying this complete message is being used as an instructional medium. Considerable confusion in thinking has resulted from the practice of applying the general term media to both complete instructional devices such as films and video tapes, and to aids, such as charts and slides, that a lecturer might use to illustrate his remarks. These instructional aids do not carry the entire instructional load but serve only to support a classroom teacher's face-to-face presentation. But even if they are referred to as media, which appears to be common usage, a clear distinction must be made between instructional aids and instructional media.

Communication aids and communication media, among many other subclasses, are subsumed under the general term "media." (McLuhan even lists roads, money, motorcars, and games as types of media.[4]) The term audiovisual media, as presently used, covers both instructional aids and instructional media, and this is the source of the failure of many people to distinguish between them.

As a general rule, the instructional medium contains verbal exposition, whereas the instructional aid does not. A device that does not contain narration, commentary, dialogue, or captions in its software is generally useful only as an aid to instruction; verbal exposition by a live classroom teacher must usually accompany its presentation. On the other hand, if the device does contain its own exposition, it cannot readily be used as an instructional aid; the sound must be turned off or the printed captions edited out, if the words of the program are not to interfere with what the classroom teacher is trying to say. Thus, for most purposes the two categories, instructional aid and instructional medium, are mutually exclusive.

Three situations should be noted which may look like exceptions, but which actually do not affect the rule: (1) A self-contained film, a recorded speech, or a piece of music may be presented, not as instruction but as a subject for study in and of itself. This would constitute neither an instructional aid nor an instructional medium. (2) A short segment of sound film, a filmstrip, or another instructional device may be integrated into a classroom lesson presentation. This is a clear case of the use of an instructional medium, however brief the use may be. When a film is on the screen, for example, the teacher will, in effect, turn the students over to the medium and expect them to give it their full attention. The teacher may assist or supplement it by occasional comments or provocative questions, but the medium is doing the teaching. (3) A classroom teacher may interpose comments during the running of a film, relate it to the recent experience of the class, name individuals to respond to questions put by the film, etc. In this case the teacher is assisting the film, not the other way around.

The main reason for this insistence on a clear distinction between instructional aids and instructional media is the decided difference between them in their importance to education. The difference is between

incompleteness and completeness. The instructional aid generally plays a minor role in a limited-output system, in which an instructor making a lesson presentation reaches no more learners than his classroom can hold. Except for becoming more widely and effectively used, instructional aids in the classroom will probably never play a more important role than they do today. Certainly they are not likely to change the nature of instruction.

Instructional media, on the other hand, can be put at the core of a system, the output of which could be staggering. Recording media and telemedia, able to reach tremendous numbers of learners with a single lesson presentation, are capable of both raising the overall quality of instruction and greatly extending its reach. Even the instructional aids will play a more significant role when they are part of the programming of instructional media. The instructional media have the potential to transform instruction as much as the mass entertainment and information media have transformed society over the last fifty years.

One trend should be mentioned in regard to this impending revolution in learning: the trend toward independent learning and self-instruction. Instructional media may play their most important role in this area. Because no educational system will be capable of imparting to an individual all the knowledge he will need in the future, learners will be increasingly trained in the skills of information retrieval and self-instruction. Individual study carrels, autoinstructional devices, single-concept films, and individual cartridge projectors are examples of technological developments within this trend. Note, however, it is the instructional media with their built-in verbal exposition which will be used in self-instruction, not instructional aids. The instructional aids, limited to functioning as illustrative material for face-to-face teacher presentation, not self-contained and not self-explanatory, will have little if any role to play in self-instruction.

## SOME IMPORTANT CHARACTERISTICS OF COMMUNICATION MEDIA

One of the reasons for the importance of communication media in our rapidly developing society is the fact that senders of messages find it increasingly difficult to deliver them in person. Face-to-face communication is still generally felt to be the most effective technique--in the

performing arts, in persuasion, and in instruction (except for lectures in large halls where the communication is face-to-distant-face). However, our societies have grown far too large for personal contact between all those who have something to say and those who might want to hear (or see) it. But in making it possible for one person to communicate with another at a distance, and/or at another time, the inventors of the media have opened up a vast new dimension. The dimension is measured by the number of people that a single message may reach, and the key characteristic that makes this dimension possible is reproducibility.

REPRODUCIBILITY

Telecommunication media can transmit a single message to countless widely separated viewer/listeners at one time. Recording media can put a single message into permanent form which can be multiplied into many identical copies and delivered countless times for countless reader/viewer/listeners over a long period of time. This is not only convenient but extremely economical.

The reproducibility of communicated messages via the media is one of the major achievements of technological civilization. "Margaret Mead has reported that when she brought several copies of the same book to a Pacific island there was great excitement. The natives had seen books, but only one copy of each, which they had assumed to be unique. Their astonishment at the identical character of several books was a natural response to what is after all the most magical and potent aspect of print and mass production. It involves a principle of extension by homogenization that is the key to understanding Western power."(4)

There are four kinds of reproducibility, three of which can make possible large economies of scale in communication:

1. Point-to-point transmission (one reproduction in one distant place)
2. Point-to-many-point transmission (simultaneous reproductions in many distant places)
3. Recording (many sequential reproductions at different times and places)

4. Printing (many duplications made of one recording, thereby increasing the possible number of sequential reproductions at different times and places)

The first kind of reproducibility is based on simple transmission. The telephone speaker's voice, for example, is reproduced in the listener's ear. If the transmission takes place within normal earshot or other perceptual range, such as within a room, it can be called amplification or magnification. For telecommunication to exist, the sender and receiver must be separated by distance greater than normal sight or hearing range. This kind of reproducibility is on a one-to-one basis--the message is reproduced once and in one place. Individual communication media have only this capability.

The telecommunication media, such as live radio and television, add another dimension of reproducibility. Via these media, a message is simultaneously reproduced for listeners or viewers in many different physical locations. The reception of the message is multiplied by the medium.

The recording media exhibit still other kinds of reproducibility. Once a message is recorded it can be stored, carried from place to place, and reproduced sequentially many times in many places, over a long period of time. This kind of reproducibility may be further extended by duplicating the software containing the message. Films and books can be printed, and other media are dubbed or duplicated. The message itself is multiplied by this use of the recording medium.

When recorded messages are transmitted by telecommunication media, they may have the simultaneous reproducibility of telecommunication while retaining the sequential reproducibility of the recording media. That is to say, a recorded message may, if broadcast, be received simultaneously over a wide geographical area and in addition, via multiple copies, may also reach a large number of viewer/listeners over a period of time. While telemedia released communication from the constraints of place, recording media released it from the constraints of both place and time.

EFFECTIVENESS

A common first reaction to the application of a communication medium is that it must be less effective than face-to-face communication with an individual or group. Depending on the meaning assigned to the word "effective," this can be true; however, there are several factors which can tend to make the reverse true. If these factors are understood and emphasized, many kinds of communication can be considerably more effectively presented via a medium than face-to-face. To exemplify this point, let us consider a specific medium, television, in respect to a specific kind of communication, instruction.

When television is introduced into an instructional system to replace certain traditional elements of that system, it can have qualitative advantages over what has been done before. Television lessons can be better prepared and can bring better teachers into the average classroom, despite the tendency of media presentations to be impersonal. To some people this impersonality seems like a large obstacle to effectiveness. Also, the large-scale or mass aspects of the media bring to mind an unfortunate analogy with mass production and assembly-line manufacture. It is often expected, therefore, that students who receive lesson presentation by instructional media will achieve poorer results than students who have been taught by traditional classroom methods. If this is so, it has not been detected in a very large number of comparative studies.(5) Neither has any evidence been found to show that presentation via an instructional medium, per se, results in any greater scholastic achievement than classroom presentation. A recent study reviewed some 421 comparisons of instructional television with traditional teaching, of which 308, or 73 percent, showed no significant difference in achievement between experimental and control groups. In 15 percent there was a significant difference favoring television, and in only 12 percent was there a significant difference favoring the traditional classroom methods.(6)

These results have, of course, been interpreted in many ways, depending on the prior bias of the interpreter. Opponents of instructional television (ITV), for example, see in such data no indication of any advantage to using the medium, as far as achievement is concerned.

Proponents say that ITV has been shown to be at least as effective as conventional methods, so it may be used where economies are indicated, without fear of lowering standards. Some skeptics say the failure to show any significant difference may be due to the inadequacy of measuring methods, and others suggest that it is due to the paucity of our knowledge about the learning process--in their view, both ITV and conventional methods may be equally inept.

It should be noted that many of these studies have failed to measure some of the most important factors. In order to be scientifically valid, most were designed to control all variables rigidly, except the one being examined--television versus face-to-face instruction. In real life, however, the introduction of a new significant element into a system generally affects all other elements of the system, and it is in these secondary, unmeasured effects that instructional media can often provide advantages. A typical example is the use of television lessons for basic presentation, that is, the initial exposition of a given subject matter. There are many ways in which ITV lessons can be superior, by usual standards, to classroom lessons and, if these standards are valid, can be more effective in producing learning. The same arguments can be used to support the use of various other instructional media.

1. ITV lessons can provide audiovisual enrichment. Audio and visual materials of many kinds may be used in television production. Often these are the same kinds of materials that are used as instructional aids in the classroom. However, the television teacher can spend much more time than the classroom teacher on the selection and/or production of such materials and generally has the assistance of librarians and craftsmen, as well as a wider range of materials from which to select. Thus the televised lesson can be greatly enhanced in audiovisual complexity, compared with the average classroom presentation with generally available instructional aids. Insofar as this is constructive rather than distracting, it can lead to increased effectiveness.

2. More effort can be put into the preparation of ITV lessons. Since television lessons reach many learners in many classrooms, more time and energy can go into them than is available, in the economics of school instruction, for the lesson which is to be given only once

to one group of learners. Assuming that this energy is well directed, the ITV lesson can be better thought out, better organized, and better presented than the usual classroom lesson.

3. ITV lessons can raise the average level of lesson quality in a school system. When television is used in basic presentation, it replaces a large number of good, bad, and mediocre classroom presentations of the same material, with a single televised presentation of the highest available quality. The medium thus offers the opportunity to raise the average level of effectiveness of presentation of the given lesson material throughout the system. This in turn can help assure a higher overall level of student achievement.

4. ITV lesson presentation is public, not private. The television lesson is presented in a more public context than the classroom lesson, because it is transmitted (even though this may be within a closed-circuit system); administrators, colleagues, visitors, etc., are likely to see it, since it is not confined to the relative privacy of the single classroom. This makes it more ego-involving for the performer and participants and motivates greater care and effort in its preparation. It should be noted, however, that if this factor creates nervousness or camera fright, it will often cause the kind of stiffness and formality that is destructive to communication. Under these conditions, it frequently happens that a teacher who is very effective in the classroom is deadly on ITV.

5. ITV lessons can release the classroom teacher for other important functions. Perhaps the most important contribution of the media to the improvement of instruction is an indirect one. Media, especially when programmed, can fulfill many instructional functions traditionally performed by the classroom teacher. Lesson presentation, drill and practice, and review may be done as well via a medium as by a classroom teacher. On the other hand, probably the most important things that happen in a classroom are things that only the teacher can provide: interaction, help, support, understanding, enthusiasm, encouragement. The teacher, as group leader, can greatly help the learner to relate well with his peers and to learn how to become part of a social

unit. At the elementary level, only a teacher can constitute an adult model to emulate; only a teacher can take a sincere personal interest in a child. There is little enough of these priceless ingredients in any classroom. Where the use of a medium can release teacher energies for these essential functions, the entire instructional system cannot fail to benefit.

## V. A PROPOSED TAXONOMY OF COMMUNICATION MEDIA

What are these media which are becoming so important in our expanding world, and what can we do with them? The first step in answering these questions is to classify the media so that some generalizations can be made about them. Since communication media are all the product of man's inventiveness, there is no natural relationship among them to discover; we must choose some arbitrary means of classification. The best means, we may assume, will be the means that is the most useful. Prior to this, however, we must establish a set of criteria with which we can distinguish between (a) a medium and a nonmedium, (b) one medium and another, and (c) a discrete medium and a multimedia application.

### COMMUNICATION-MEDIA CRITERIA

The first criterion for a communication medium is that it be capable of communicating messages that are complete within themselves and do not require face-to-face verbal narration at the point of reception. This criterion distinguishes the communication media from audio or visual aids.

The second criterion is that the system be capable of reproducing a program either by simultaneous reproducibility (point-to-point, or point-to-many-point) or sequential reproducibility (recording or recording and printing). The capability of reproduction may not be exercised in every application; it is possible in any recording medium, for instance, that local production may result in a single copy for a single use. The fact that the system is capable of reproducibility, however, qualifies it under this criterion. These first two criteria, then, distinguish a communication medium from a nonmedium.

The next two criteria are useful in distinguishing one medium from another. They have been used in deciding which systems are independent media and which are varieties or subclasses of other media. Criterion 3, then, states that a system is an independent medium if it utilizes different or additional ways of representing information from those of its near relatives. Thus the sound motion picture is considered to be a different medium from the silent film, even though the equipment configurations

are so similar that many hardware items are interchangeable between the two. Through the addition of audio, the nature of the medium is substantically changed, requiring quite different production techniques and opening up a broad new range of uses.

Criterion 4 states that a medium is distinct if it is based on devices (hardware) that are of a different kind from those of its near relatives--that is, different combinations of electrical, mechanical, photographic and/or optical processes. Thus audio-disc recording (a mechanical record) has been classed as a separate medium from audio-tape recording (a magnetic record), even though the same program could be recorded on either and the listener who heard only the result might not know or care about the difference. Application of this criterion is somewhat arbitrary, however, as demonstrated by the fact that FM and AM radio are not separated. The difference between these, while great enough that messages transmitted by one system cannot be received by the other, is still not sufficient to be considered a difference in kind--at least not for our present purposes.

Criteria 5 and 6 (see p. 32) distinguish discrete communication media from multimedia combinations. Sometimes a program display is combined with additional displays that require their own hardware systems (radio broadcast combined with projected slides, for instance). When the additional elements are not encoded into the primary medium and/or constitute materials that did not come from sender to receiver along with the primary message in a single "package," the whole may be called an instructional communication system, but not a single medium.

It is not uncommon, for example, for an audio tape to be planned in conjunction with a student workbook, with the intent that illustrations in the book are to be viewed while the tape is heard. (The workbook also may provide a medium for overt learner responses.) This is an instructional system which integrates two communication media simultaneously: audio tape and printed page. The two cannot be called a single medium even though they are integrated into a single instructional system.

At least three of the telemedia possess augmented forms in which locally displayed elements are coordinated with the transmitted elements.

These are telelecture, radiovision, and telewritevision. Radiovision is often discussed as an independent medium, whereas telelecture and telewritevision are generally considered to be simply augmented forms of telephone and telewriting. For our purposes, all three of these systems will be considered to be simultaneous multimedia systems in which an audio telemedium is augmented by the simultaneous display of coordinated visual elements.

There are cases that are difficult to distinguish. For example, the sound filmstrip with separate sound might be said to consist of an audio-disc (or audio-tape) system in coordination with a silent-filmstrip system. Because both of these systems are integrated into a single piece of display hardware, however, and because both filmstrip and record are included in the same package, separate-sound filmstrip qualifies as a discrete medium.

The ultimate judgment of classification will probably be based on usage as much as logic. If an audio and printed-materials system became widely popular, such as the currently used audio tape and workbook system for language teaching, both materials would probably be distributed in the same package, and it would come to be described by a single name as a single system. Thus we can foresee the possibility of successful combinations of means, which are considered multimedia applications today, becoming integrated in hardware and packaging and becoming single and discrete new media tomorrow.

In summary, let us briefly review these criteria which a system must meet if it is to be called a communication medium:

1. The system must be capable of conveying a complete message; it must be self-contained and self-supporting.
2. The system must be capable of reproducing the message in the same or another form in one or more of the following ways: simultaneously in a distant place; simultaneously in many distant places; sequentially over a period of time; sequentially and simultaneously in many times and places.
3. The system must involve a distinct combination of ways of representing information.

4. The system must use a special equipment system (for one or all of the various encoding, transmitting, and decoding functions).
5. A discrete system includes only the program elements and materials which reach the receiver from the sender through one transmission or recording system.
6. All elements of the program must be distributed in the same package.

Criteria 1 and 2 distinguish communication media from aids; criteria 3 and 4 distinguish one communication medium from another; and criteria 5 and 6 distinguish discrete communication media from multimedia applications.

The communication media of which the author is aware are listed by class in Table 1. Each of these media, of course, has its varieties (for example, the various gauges of film). There may be other clearly defined media which have been inadvertently omitted from the list; almost certainly, others will evolve in the future.

There are points of correlation between the telecommunication and recording media. Several telecommunication media appear to have recording-media counterparts, which could possibly be used to record messages as they arrive via telecommunication media, or to record messages in advance for later transmission via these media. There is a basic difference between a telemedium and its recording-medium counterpart; they have quite different characteristics and uses and should not be confused.* In Table 1, such media are related to their counterparts by dashed lines.

Telecommunication media are those that can involve instantaneous transmission via wire, broadcast channel, or other such means. In the

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*A somewhat different view is taken by Winslow in Ref. 5. He makes no basic distinction between television and video tape, seeing video tape as a device for storage/retrieval of television--a means of communication delay. Television, in his view, is an audio-motion-visual medium in real time, video tape the same thing in delay time. While this concept serves the case of video recording, and probably applies as well to recorded still television, recorded telewriting, and punched paper tape, it cannot be generalized to other media, especially to those that have no telemedia or recording-media counterparts.

Table 1

THE COMMUNICATION MEDIA

| TELECOMMUNICATION | RECORDING |
|---|---|
| CLASS I: AUDIO-MOTION-VISUAL MEDIA | |
| Television[a] - - -

pure form of these media, origination of message or program is simultaneous with its reception. Setting aside for the moment the transmittal of previously recorded materials such as film on television, audio tapes on radio, etc., what one sees or hears through these media is being picked up by a microphone or scanned by a camera at the very moment of broadcast; the program exists in real time. The viewer or listener has the sense of immediacy, knowing that what he sees or hears is at that very moment happening in a distant place.* The possible advantages or importance of "seeing at a distance," rather than seeing something which was recorded in the past, will be discussed later.

Possibly the heaviest uses of these media, however, do not require or use the real-time characteristic and its attendant sense of immediacy. Any of the telecommunication media can be used simply as transmitting media, to relay recorded materials from one place to one or many other places. Some of the telecommunication media, such as television and still-picture television, can transmit many types of recorded media. It is anticipated that the picturephone, an individual medium not yet in general use, will also offer such possibilities.

By contrast, in the recording media, the content is made permanent and can be reproduced at any time. The earliest recording medium was probably drawing; the first real instructional medium came with the invention of writing, but writing was mainly an individual medium because it could only be reproduced by laborious copying. Printing was the earliest recording medium with broad reproducibility; its history goes back about 500 years, and it is still the most heavily used of all the recording media, by a vast margin.

## RELATIONSHIPS BETWEEN TELEMEDIA AND RECORDING MEDIA

The media in Table 1 are divided into seven classes based on the combinations of audio and visual elements which they utilize. The characteristics of these classes will be discussed in detail in a later section. The relationships between the recording and the transmitting

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*Thus, the word "tele," meaning "far" in the original Greek, has been frequently used in naming these media.

media are diagrammed in Fig. 6. Face-to-face communication is the traditional and most direct method. The sender (the teacher, in the case of instruction) formulates and encodes a message, then by speech, gesture, or other means conveys this message to one or more receivers (e.g., learners) who are within his sight and hearing. The next method involves a recording medium in which the recording is under the sender's control. The recorded message becomes tangible software for the system; it is transported to the receiver, where it is played back and displayed. Audio and video tapes, films, and filmstrips are examples of such media. The printed page is also a medium of this type, but it differs from the others in that the receiver requires no complex piece of playback equipment for display. Instead, the receiver uses a highly developed skill to decode the message, or a second person possessing this skill acts as a decoder.

The third method utilizes electronic transmission instead of transportation to carry the message from sender to receiver. Those media that have direct counterparts in both the telemedia and recording-media groups are capable of three additional methods which combine telecommunication and recording in various ways.

Now let us examine the communication model we have been discussing in somewhat greater detail. If the message is to be contained in a program, the sender will put it through a production process prior to transmission or recording. He may then elect to transmit it directly in real time, or to record it and transmit it later. Delayed transmission is the most widely used method in present-day television broadcasting, for instance; programs are recorded on video tape when convenient to the scheduling of the studios, and later transmitted when convenient to the program schedule. Control over the time of communication may also be exercised by the receiver at the other end of the process. Thus a school may pick up and record ITV programs at the time they are broadcast, playing them back later, often several times, to fit them better into existing school schedules. The various points in the process where time control is possible are shown by the blocks in Fig. 6 marked "storage." At the receiving end, either playback or reception may take place at the point of display (as when a tape is played back in the classroom,

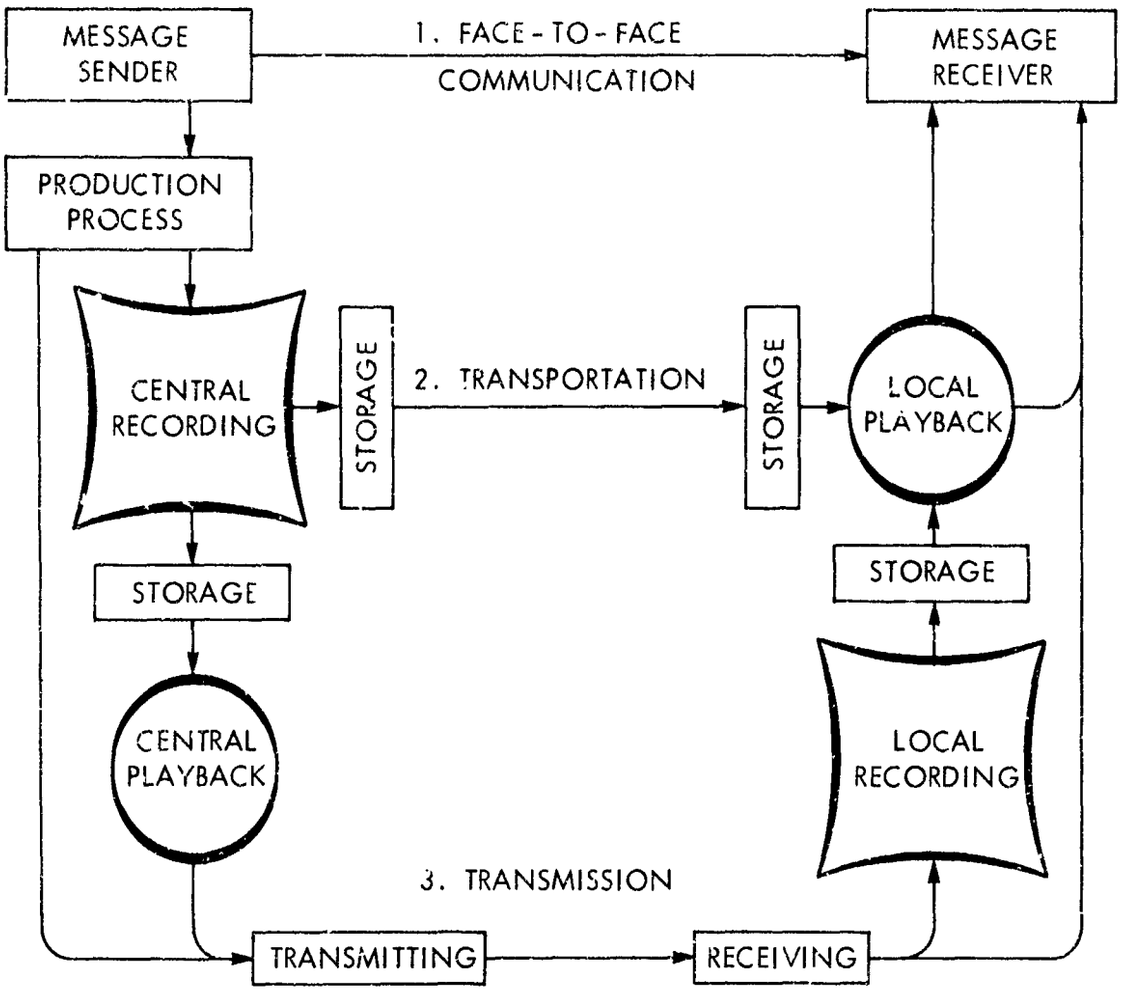


Fig. 6 — Simplified model of telemedia and recording-media integration

or a television receiver is tuned in), or they may take place at a central point such as a local school and be piped to the intended audience via a local transmission system. The extra line from local playback, joining the reception route, indicates the possibility of playback over a local transmission system, rather than at the point of display.

LIVE VERSUS RECORDED BROADCASTING

Both radio and television broadcasting began as nearly exclusively live media, adding the element of central recording (see Fig. 6) only when sufficiently high-fidelity recording systems had been developed that it was not possible for the general audience to distinguish between recorded and live presentation.

There has been considerable difference of opinion since the first days of the broadcast media, concerning the merits or advantages of live telecommunication versus the playback of recordings. Most broadcasters have agreed, for example, that the "newness" of news broadcasts and the "actuality" of special events and sports contests requires the immediacy of live transmission. "This is Ed Murrow in London" carried a significance for real-time broadcasting which it could never have for a recording.

There was even a strong case made, in the days of live television drama, to support the stand that a live television drama was an actual performance, like the living theater, and therefore required the actuality of the live broadcast. Live television drama, it was maintained, conveyed a feeling of audience participation never possible when a film was transmitted. The appearance of video-tape recording, however, made possible the permanent recording of productions where television techniques were used, with such technical quality that the playback was indistinguishable from live display. The argument was then no longer as clear-cut, and the difference in audience response seemed to disappear. This effect may have been more apparent than real, however, because overt audience response had never really been possible. The discussions did not die, however, until the near disappearance of live drama on television.

Similar arguments are also heard pro and con the question of live-production versus recording media in relation to instruction. Again,

there can be no doubt as to the necessity for live telecommunication to provide dialogue via a two-way system. It is even considered essential for some administrative uses, such as announcements of school events and the regular visits of the school superintendent with his staff. The institutions that use live television for lesson presentation, however, justify it on the basis of lack of video-tape-recording (VTR) equipment, lack of funds for the tape inventory required for all recorded presentations, and the advantage of possible revision and improvement when lessons are produced afresh each time they are presented. There is also another viable argument for live transmission: The studio teacher who knows he is recording something for all posterity may be frozen into formality. In general, however, the central recording of a lesson at a time that is convenient for production, and the playback of the lesson later, when it is convenient to the school schedule (that is, delayed transmission), has not been considered less effective than live transmission. There is great doubt that learners distinguish any difference among live transmission, delayed transmission, and the transmission of recordings. There is little evidence, however, to determine just what learners do imagine a given medium to be, and what difference it would make, if any, if they learned that something was really recorded when they thought it was live, or really live when they thought it was recorded.

It seems likely that the learner will tend to respond to a program either as if it were the most commonly experienced mode, or as if it were the more desirable of the two possibilities. In general, since seeing something that is happening at a distance is somewhat more magical than seeing something that happened in the past, school children, at least, would probably react to video tape as though it were a live broadcast. This will probably change as portable video-tape machines become increasingly familiar in the classroom and video tape becomes the more common consciously experienced medium.

## CLASSES OF MEDIA

In the past, communication media have been classified in various ways. Purpose, for example, used as a basis for classification, divides

the field into information, instructional, and entertainment media. Mass media, those media which have so pervaded our society that they are used by very large numbers of people, may be distinguished from media which are limited to group or individual use. Media have also been divided into those that are essentially two-way and are used for intercommunication purposes, like the telephone, and those that are essentially one-way. McLuhan speaks about "hot" and "cool" media. A more valuable approach is to divide those which are personal from those which are impersonal.[7] One trouble with most of these classification systems is that they are based on current and possibly temporary characteristics. On the other hand, division into telemedia and recording media is permanent because it is clearly an intrinsic differentiation. The ways in which a medium represents information define another basic and intrinsic set of characteristics. These ways are, basically, audio and visual, with the added possibility that the visual elements may be given motion.

For this study, we shall treat audio as a single element, although in representing information, audio can be classified in three categories: (1) the human voice, which produces symbolic sound (except for singing); (2) natural or artificial sounds and noises, which are largely concrete rather than symbolic; and (3) music, which is most often not a way of representing information, but an object in its own right.

Picture and print can be considered two ends of a visual continuum, ranging from highly realistic photographs in motion to alphanumeric symbols. Between these extremes are drawings, diagrams, maps, charts, pictographs, ideograms, logograms, and other symbols. The division between picture (icon) and print (symbol) in the above list occurs between the map and the chart. Despite the fact that a map may contain many symbolic elements, as a whole it is a kind of picture, since it represents something by expressing its spatial relationships. The chart, on the other hand, bears no relationship in physical form to the information it represents, except in a symbolic fashion. Hence, pictures are most appropriate for representing people, places, and things; print is appropriate for generalities and for abstract concepts. Unless the latter function is performed by the spoken word, pictures, to be instructional, must almost always be accompanied by printed or written symbols.

For our present purposes we shall divide the print-picture continuum into three parts instead of two, adding an intermediate class, line graphics. Under line graphics we will include all graphic representations that do not attempt to be realistic. Graphics that represent the three dimensions of space in a realistic manner will be considered pictures. All the known means of visual representation may be laid out in a continuum, extending from the most abstract at one end to the most realistic at the other. (See Fig. 7.)

There are still other ways of representing information, such as Braille, which presents data to the tactile sense. A communication system has been developed* for men in combat which utilizes a pressure belt, applying meaningful pressures in various areas and in various patterns of pulses. These means of communication, however, are generally limited to special needs. Because of the relatively limited importance of the minor senses in comparison with sight and hearing, we can expect that tactile and pressure communication will not be extensively used.

The language of gesture and bodily demonstration, dramatization, mime, and dance can also be highly useful in some situations. In the past, sign language has been an important means of communication, used, for example, between American Indian tribes that were linguistically unrelated.

The ways of representing information used by the communication media listed in Table 1 are limited to the audio and the visual. The visual is further subdivided, as discussed above, into picture, line graphics, and print. On this basis, then, seven classes of communication media are defined.

Class I: Audio-Motion-Visual. This is the most encompassing of all the media classes, since it utilizes all audio and visual means of representation. Television and sound film are Class I media. Theoretically, programming for any of the other media may be transmitted or recorded by media of Class I.

Class II: Audio-Still-Visual. This is the second most encompassing media class; it is capable of everything that Class I media can do,

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*By the HUMRRO Corporation, Alexandria, Va.

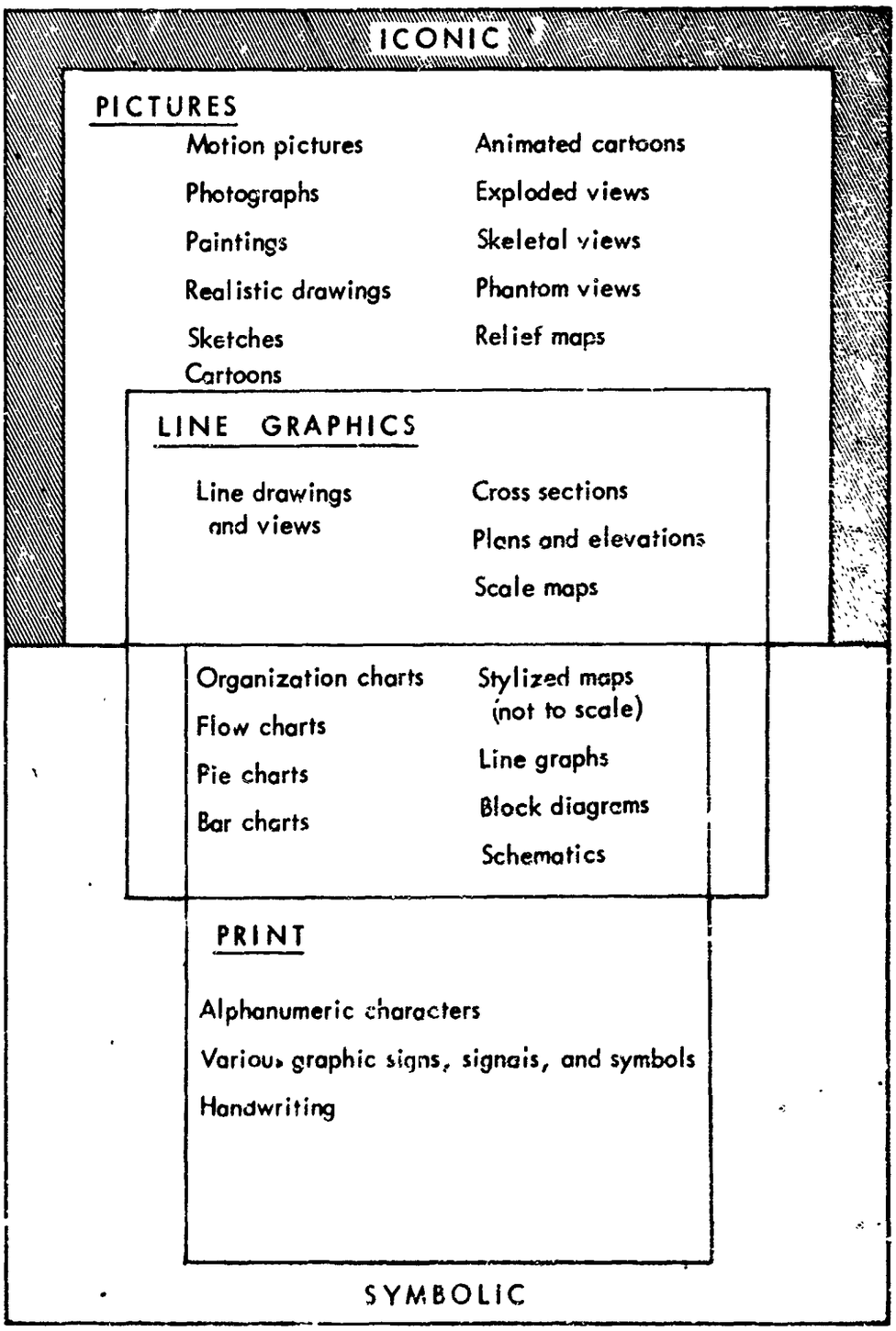


Fig. 7—Visual elements

except the representation of motion. Sound filmstrip is an example of Class II media.

Class III: Audio-Semivisual. Media of this class are called semivisual because they are capable of print and line-graphic representation but do not include the capacity to transmit or record pictorial material. Telewriting is the only currently used medium of this class.

Class IV: Motion-Visual. This class is capable of everything included in Class I except audio. Silent film is the single current example of motion-visual media.

Class V: Still-Visual. Still-visual media represent information with all the visual methods but do not represent motion, except by implication. The printed page and the filmstrip are examples of Class V media, the only class that is not time-based.

Class VI: Audio. Media using sound only, such as tape, disc, and radio, comprise this class.

Class VII: Type. Media of Class VII represent information only through alphanumeric and other symbolic characters. Teletype and punched paper tape are the current examples of telemedia and recording media in this class.

## MULTIMEDIA AND CROSS-MEDIA APPLICATIONS

The terms "multimedia" and "cross-media" can be considered synonymous, so only the former will be used in this discussion. "Multimedia" applies to any situation where more than one medium is employed in a single communication. Multiple media can be used in either the sequential condition or the simultaneous. The most common pattern of multimedia use exists when several media are used sequentially as part of a single presentation. An auditorium program, for example, that begins with a tape recording, follows this with a filmstrip, and ends with a sound film is a multimedia presentation.

As an example of simultaneous multimedia presentation, audio or audiovisual media may be combined with printed materials, such as student workbooks, which are intended to be used while listening to the

sound. It is necessary, of course, that the coordination of two such media be planned (and program materials for both be prepared and produced) together.

Most such simultaneous multimedia combinations include one of the still-visual media, the only class of media which is not time-based. The still-visual component, be it pictures or print, is generally "synchronized" to the progress of the time-based component (usually audio narration) by the viewer himself. This is to say, he turns pages as needed, looks where he is directed to look and keeps up with the presentation.

A similar process takes place in the group mode in the case of radiovision or teleclecture. During the audio presentation by radio or telephone, a projectionist listens for the proper cues and advances slides in synchrony with the program.

It has been suggested that the most useful multimedia combinations may in the future be integrated, resulting in systems that will have to be considered as discrete media. This is probably the route of most fruitful development in the media field. Various combinations of communication means will be tried out in practice, and those systems that prove most successful will be further developed--integrated, unified, simplified in operation and in program packaging--in response to demand. It is probable that the most valuable of these new multimedia systems will be those constituting the communication components of computer-controlled and managed instructional systems (see the discussion on pp. 49 - 53).

There is still another frequently used connotation to the term "multimedia": a presentation in which a lecturer uses several kinds of instructional aids. For example, the lecturer might use a portion of a tape-recorded speech as an object of study, a set of slides to illustrate his presentation, and a silent film over which he supplied a narration. While this would, in common parlance, be called a multimedia presentation, it might more properly be called a multiaid presentation.

In recent years there has been a trend in media presentations toward the simultaneous display of several slides, or films and slides, on multiple screens. The projection function becomes so complex in

these highly impressive presentations that the people who operate the projectors must often be the same people who have been involved in the production process. Several universities have permanently equipped auditoriums for the multiple-screen presentation of elaborately illustrated lectures. The screens are generally of the rear-projection type, forming a wall between the front of the auditorium and a projection room directly behind the screen(s). Several projectors are installed in this room; each is equipped with a short-focal-length lens in order to produce a large picture even though the projector-to-screen distance is very short. In a typical multimedia auditorium a set of slides may be immediately followed by a film and this by a large-screen television image originating in the instructor's television camera, which is mounted over the lectern. The instructor uses this camera to display illustrations from books, to demonstrate small biological specimens, or to draw his own equations and diagrams. While the lecturer may display this series of instructional aids sequentially, the sophistication of the equipment and control system is such that all of the screens may be used simultaneously. A history professor, for example, may use a slide showing a map of the Ottoman Empire and a second slide listing a series of key events and dates, and he may leave these two displayed for constant reference while he runs another set of slides on the main screen.

Equipment is available on the open market with which it is possible to prepare a punched tape or audio tape for control purposes, on which the sequence of projectors and slides can be coded and controlled by push-button from the lectern. The instructor may follow a script and advance the projection system to the next event, however many projectors it may involve, simply by punching a single button whenever he reaches a cue to do so on his script.

Alternatively, he may depart from the preset procedure and control each projector manually if desired. Some installations include one or more random-access slide projectors which make it possible for the instructor to return to any numbered slide for review or discussion, simply by pushing the correspondingly numbered button. It is even possible, in some of these installations, to prerecord the lecture on audio tape, add cue pulses in the proper places, and allow the audio tape to advance

the control tape, which in turn operates the projectors and other instructional aids being used.

This example meets at least one of the criteria given earlier for an instructional medium: It is self-contained. It does not require, in the case of the recorded lecture at least, a live teacher's narration; it contains a complete program.

Even the recorded multimedia lecture, however, does not meet the second criterion--that programs produced in the medium must be capable of being reproduced. If it becomes possible to package punched-paper tape, slide sets, and film clips along with the tape-recorded narration and ship the whole complex off to another location for a repeat of the presentation, we might stretch the point, but that condition would be most unlikely to occur. Most multimedia installations are custom designed, and a presentation, once prepared and released, can generally be reproduced only in the auditorium for which it was designed.

It should be noted that approximately the same number of man-hours are required for the planning, preparation, and rehearsal of such a multimedia presentation as are required to produce a program of the same length and containing the same elements in one of the Class I or Class II media. The costs of production equipment are also roughly similar. When this is recognized, it can be readily understood why some people have questioned the feasibility of the multimedia auditorium.

Of course, the multimedia presentation can be visually and emotionally most effective and a valuable enhancement for an institution. The display of a single audio-motion-visual or audio-still-visual medium currently lacks the possibility of simultaneous multiscreen projection. It can be recorded and distributed, however, and be extensively reproduced nearly anywhere, at many places at once, over a long period of time, at very little cost, and without any further concern on the part of the lecturer and his production assistants. Proponents may argue that the multimedia projection system and the reproducible medium are quite different things, which are appropriate for different purposes and cannot be considered alternatives for one another. This is true--the multimedia system is not an instructional medium but is simply a very sophisticated and dramatic method of using instructional aids.

MEDIA WITHIN MEDIA

A primary advantage of classification by ways of representing information is that it indicates very readily how the program software of one medium may form the content of another, and how one medium may be used as a transmitting or recording medium for another.* The commonest example is the transmission of film via television, or conversely, the recording of a television program on film. Figure 8 shows how program software of simpler media may be included in more complex media. For example, a Class V recording such as a filmstrip (column V) could be transmitted or recorded by media in Classes I, II, or IV (as shown in line V). These relationships are theoretical; practical application would depend on various technical considerations. For example, the level of fidelity of the contained program software and the containing medium must match. If a standard page containing some 2500 characters is to be transmitted via a television system, either the page must be retyped so the lines are 40 characters in length instead of 80, and are transmitted, in effect, as several pages, or a high-definition television system must be used. Also, program software must be compatible. Silent film, recorded at its standard 16-frames-per-second rate, for instance, may be transmitted by television but must be run, generally, on TV-film projection equipment which operates at half again that speed. The result is a speeding up of motion unless either (1) the silent footage is originally shot at 24 frames per second, or (2) a special 16-frames-per-second projector is incorporated into the television system.

MOTION

There are several kinds of motion, some of which are possible in media classes in which no motion component is listed. Motion, in this discussion, is used to mean the representation of full and continuous movement, the way it is perceived in reality. Motion is applicable to all visual elements in a display, singly, separately, or in concert. Camera movement such as panning, tilting, zooming on still pictures is motion. Full animation is motion; semianimation where the position of

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*Marshall McLuhan has pointed out how film incorporated the content and structure of the novel, and television incorporated the content and structure of film.(4)

| Media Class | Containable Software | | | | | | |
|---|---|---|---|---|---|---|---|
| | Class I Media | Class II Media | Class III Media | Class IV Media | Class V Media | Class VI | Class VII |
| I: Audio-Motion Visual | A, Pi, L, Pr; MOTION | | | | | | |
| II: Audio-Still Visual | A, Pi, L, Pr | A, Pi, L, Pr | | | | | |
| III: Audio-Semi-visual | A, L, Pr | A, L, Pr | A, L, Pr | | | | |
| IV: Motion Visual | Pi, L, Pr; MOTION | | | Pi, L, Pr; MOTION | | | |
| V: Still Visual | Pi, L, Pr | Pi, L, Pr | | Pi, L, Pr | Pi, L, Pr | | |
| VI: Audio | A | A | A | | | A | |
| VII: Type | Pr | Pr | Pr | Pr | Pr | | Pr |

KEY

Containing media — Containable software

A = Audio — Pi = Picture

L = Line Graphics — Pr = Print

(Visuals are still unless otherwise noted)

Fig. 8 — Media within media
(showing how media of one class may contain software of other media classes)

objects changes abruptly is not. Full animation can only be accomplished in a Class I or Class IV medium.

Class II media are capable of some types of simple animation of simulated motion, such as rapid picture sequence (from a second or two each ) to several per second). If all elements but one in a sequence of two pictures are identical, and the one element which changes does not change too much, the effect will be perceived or at least interpreted as movement. The motion of a man pumping up a tire, for example, might be continued indefinitely by simply cutting back and forth between two still pictures showing him in the two extreme positions. However, not all Class II hardware is capable of such rapid picture change.

Still-visual media, Class V, have no time dimension (i.e., they do not play or run at a set rate as motion or audio media do). However, they are still capable of implying motion in several ways. Some of these are symbolic, such as "whiz lines" trailing after an object in the direction opposite to its movement. The representing of subjects in dynamic disequilibrium is also frequently used to imply motion.

The adding of new elements to a visual display can also contribute a kind of motion, e.g., (1) pop- n labels, or (2) underlining or circling. Labels can be made to suddenly appear by cutting from one still picture to another in which all elements are identical except the added label. Underlining and circling can also be done by build-up, using the telewriting medium.

Telewriting is capable of another type of motion. A line can be drawn by a moving stylus, and element by element, writing and/or graphic representations take form. This has the same pedagogic advantage as the chalkboard: Items are displayed gradually, as they are needed. For these purposes, however, this process is considered to be build-up, not motion.

There is still another type of motion, which might be called "pointing," of which telewriting is again a good example. Pointing, whether it is done by means of the moving stylus as in telewriting, or electronically by a spot, oblong, or arrow superimposed on the screen, leaves no record and contributes in no permanent way to the display.

A future form of electronic transmission might consist of still-picture television plus an electronic pointer controlled live at the point of origination. Signals to locate and move this pointer would be fairly simple to transmit and should require little additional transmission channel space. A combination of telewriting with slow-scan television, for instance, which would be capable of writing and build-up as well as still visual display, all presented on a television system, would be a logical development.

It has been shown in several research studies that full motion is not needed in the majority of instructional presentations and may even be a distraction in some. In fact, several studies have indicated that significant or germane motion constitutes only a minor part of instructional films.* What motion exists in most such films adds realism to photographed action or adds a dynamic quality to otherwise static material. In other words, so far as cognitive learning is concerned, it is motion largely for its own sake. (This is not to say that there may not be affective values inherent in such motion which have so far escaped measurement.)

In the light of this information, then, it is surprising to see relatively little use being made of audio-still-visual (Class II) media, especially since they are generally very much less expensive media in which to produce materials and to transmit by wire or wireless.

## THE ROLE OF COMPUTERS IN COMMUNICATION

The reader may have wondered why computers have not been listed among the communication media, especially since they are beginning to show such promise in the area of instruction. The reason is that computers are basically control and computation machines; when communication is one of the functions involved in computer-assisted instruction,

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*Keesler, in 1945, studied 24 science films and found that about 45 percent of all film footage contained no motion at all, while the remainder portrayed much movement which was insignificant to the apparent learning objectives. He stated, "Evidence suggests that less than half of the total footage contained in instructional films depicts motion significantly contributing to desired learning." Similar studies by McClusky (1924), O'Conner (1942), and Irwin (1950) produced similar conclusions.[8]

this is performed under the control of the computer by one of the communication media acting as an adjunct system. Similarly, computers are being used increasingly to control information-transmission systems such as teletype or radio and television broadcasting stations.

Some educators who have investigated the growing field of computer-assisted instruction (CAI) propose that the computer is potentially capable of such tremendous flexibility and can be combined with so many instructional media and learner aids that it will be capable of effecting nearly all instructional functions. There is also strong evidence to indicate that the computer will be able to provide some of these functions far better than they have ever been performed by any other means, machine or human. These are strong statements, but these are rapidly changing times. A few years ago we were amazed at the development of a mechanical machine the size of three desks, which could turn out 80 different forms of auto mufflers and tail pipes in any succession. Today many people expect that an electronic machine of about the same size will be capable of simultaneously custom-tailoring instruction for hundreds or even thousands of different learners with different, changing needs. Cost constraints, serious today, may be ameliorated by a continuing decrease in the cost of central processing units and the development of inexpensive terminals and other peripheral equipment.

Instruction by computer is admittedly still in a primitive phase. In this discussion we are looking ahead--extremely far ahead, in the opinion of some. The first communication medium to be widely used by computers for presenting information to the learner was the teletype or the electric typewriter. This is to be expected, since type was all that could be displayed by most of the existing computer terminal equipment. Besides, the print medium can handle both specific and abstract information on practically any subject matter. Experimental projects and laboratory demonstrations, however have shown that at least seven different communication media can be associated with a computer, and in any desired combination.

An increasing number of systems now incorporate a cathode-ray tube (CRT), on which print can be made to appear much faster than the

teletype can produce it. Some of these systems can also display various types of computer-generated graphics. Other systems have an audio component, which uses prerecorded audio tapes; these systems are particularly useful in language teaching. Systems are in use which generate their own audible speech, which has (at the present state of the art) a somewhat artificial quality and is as impersonal as printed words in a book, but which can be created especially by the computer for the individual dialogue at hand. Other systems can display visual materials, slides, microfiche, and the like, which are selected by the computer from a file of recorded materials stored within the individual computer console. Some of these consoles also store motion-picture materials for similar control and display.

An almost equal number of devices now exist that allow the learner to respond to the computer. The teletype, the electric typewriter, Engelbart's five-finger typewriter,* and the touchtone phone are devices by which the learner can respond in print. Cathode-ray-tube display devices make possible the display of graphic material, and several systems allow the learner to respond by pointing to a spot or area in the graphic display (e.g., the light pen, the stylus of Rand Tablet,** and the touch-sensitive screen).

Then there are several possible ways in which a learner, in future computer instruction, may construct his own graphic response. The Rand Tablet, coupled with character recognition, allows the user to at least print, if not to write in script. Using the Rand Tablet stylus, he may make line drawings, which are then recorded according to the coordinate points that the stylus has located. For drawing, the stylus or light pen is superior to devices such as the "joy-stick" and the "tracking ball" which were previously used for two-dimensional pointing and simple lines. An esoteric new device is the Engelbart Mouse,* a box the size of a large mouse trailing a wire tail. When the operator moves the mouse about on the surface of an ordinary table, a pair of wheels on the

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*Developed by Douglas Engelbart, Stanford Research Institute.

**A surface about a foot square on which the user may make writing and drawing movements with a stylus. The results of this action are simultaneously recorded and displayed on a cathode-ray screen.

underside of the creature register the amount of motion in each of the two dimensions, and a moving spot or "bug" is displayed on the cathode-ray tube. Most of these graphic-response techniques were designed for the purpose of generating materials, not for instructing. There is a long step yet to take between the present stage of development and that where a learner will no longer be constrained in the type of response he may make and the computer will be able to understand and evaluate that response sufficiently that it can act intelligently upon it.

In the distant future, beyond a doubt, machines will be able to understand and respond to human speech in some constrained language. An interface device by which one may converse with a computer in ordinary human language, instead of specially designed human-machine-interface languages is considered much farther away, if it can be developed at all. In addition to live-response media, recording techniques such as simple paper-and-pencil methods are also being integrated with computer instruction. For example, in some applications the computer may be used for batch processing--correcting papers overnight, so to speak--and feeding back knowledge of results the next day.

Considering only the presentation and response methods listed here, and assuming a combination of only one method of presentation and one method of response, a total of some 70 or more computer stimulus-response systems are possible. If we assume what is even more likely, that in any one device several methods of display will be combined with several methods of response, the total of possible combinations of the presently known presentation and response systems is well over a thousand.

The most important aspect of the computer's capability for directing learner response is that the computer, when properly programmed, can react to the learner's response in a highly complex fashion--much more so than ordinary teaching machines--in providing knowledge of results and altering both information presentation and direction of activities in accordance with the learner's needs. The computer can make these decisions not only about the correctness of the learner's responses to criterion questions, but also on data such as his rate of improvement and the time it takes him to answer correctly. There is no doubt that computers can be used to administer examinations. In fact, it is generally conceded that examinations test learning achievement best when

they are given via the same media through which the information was first presented.

Interaction--the opportunity to discuss a subject with one's peers or with someone who knows more about it--has traditionally been accomplished through classroom discussion, led or at least controlled by a teacher. It is conceivable, however, that a computer-controlled instructional system could do some rather complex things within this function. Dialogue between learner and program has been demonstrated in a limited number of expensively produced programs. This will develop much further. It is possible for the computer to interconnect, at appropriate points in a program, two or more learners of the same achievement level. If one computer system has 10,000 terminals, as one study has proposed,[9] it might be possible to find two or more learners at or near the same place in the same program. The computer could give them a point to argue, or have them play as opponents in some kind of simulation game. This kind of interaction, in the individual mode, might actually be more effective than classroom discussion, since the computer learner would be participating 100 percent of the time.

There are important functions of the instructional process which a computer cannot now and probably never will be able to perform as well as a human. One of these is the evaluation of unanticipated learner responses, and another is personal attention. Here, humanists believe that the machine can have little effectiveness. There is evidence, however, that even the one-way broadcasting media give people the feeling they have friends and acquaintances coming into the house, and children feel a strong sense of being <u>liked</u> by a beloved television personality. It is possible to conceive of even closer and more intense surrogate relationships developing from a program that is highly individual and personal in its response to the learner. Even today, the feeling of personal attention that a learner derives from a good computer program may well be far in excess of that experienced in the usual impersonal college lecture course.

## V. COMMUNICATION MEDIA: INDIVIDUAL DESCRIPTIONS

In this section each of the currently used media, plus the new or laboratory-stage media which may have application soon, is described and discussed, with emphasis on instructional applications and implications.

### CLASS I: AUDIO-MOTION-VISUAL MEDIA

Class I (audio-motion-visual) is the universal, all-inclusive class of media. There are no ways of representing reality in any of the other media classes of which Class I, which includes sound film, television, and the various means of recording television, is not also capable. Accordingly, no combination of audio and visual elements that can be organized into a program for any of the other media exists which cannot, given the proper interface equipment, be recorded or transmitted by means of one of the audio-motion-visual media. Such procedures might be impractical and wasteful, but they would be possible. Class V media (still-visual) alone have capabilities that Class I media do not possess, because still-visual media are not time-based.

#### Television

Television is the most universal of all the telecommunications media in that it combines more ways of representing information than any other, and it is the most heavily used in education today. A 1967 estimate placed the number of elementary- and secondary-school learners in the United States who receive a small part of their instruction through television at 10 million--about 20 percent of the children enrolled in these grade levels. This is true despite the fact that many uses of television do not require or utilize its full spectrum of possibilities. It has been frequently pointed out that a given program could have been done as well by some less complex or less expensive medium: a music program by radio, a blackboard lecture by telewriting, etc. The most convincing of such observations concerns the as-yet-nonexistent still-TV medium and the extent to which it might replace or

supplement television in education. Several studies have been noted which indicate that instructional films make very little use of relevant motion, and the same is probably also true of instructional television. It is possible that still-TV media will be able to convey over 80 percent of the cognitive stimuli we now convey via full television; some estimates have ranged as high as 95 percent.

Historically, it may have been necessary for television to become well known as an instructional medium before the possibilities of the simpler media could be fully appreciated. This could not have been true of sound-film because the enormously greater cost of traditional film production generally removed it even from consideration by institutions that needed to integrate a full medium, including both program origination and utilization, into their instructional systems. Now that a wide spectrum of media is available which can be totally embraced by a local school district, a medical college, or a local consortium of schools of any type, the possibilities of choice are becoming apparent. It is only when at least one completely justifiable use for television calls on its full potentials--sound, print, picture, motion, and the immediacy of live transmission--that television can be applied successfully as a universal instructional medium. Under such conditions, a television system can be utilized for any telecommunication purposes, in full or partial modes, audio only, still pictures only, or simply as a transmission medium to distribute recorded materials.

Before the development of video tape (approximately 1956), television recording was dependent on kinerecordings, which were, even at best, easily distinguishable from live transmission because of their degraded quality. Entertainment television was primarily a live medium in those days; but since the appearance of video tape, which at its best is difficult to distinguish from live transmission, even after many generations of duplication, the television mass medium has become primarily a means of transmitting films and video-tape recordings. A few instructional television systems have continued to transmit their programs live, however. Both the Anaheim (California) City School District and the Washington County (Maryland) systems are based primarily on live television. The necessity for producing lessons afresh each

time they are transmitted (each year in these cases) has the advantage of encouraging frequent revision and tends to allay television teachers' fears that they might some day be replaced with the products of their own creativity. Until recently, the cost of equipment and the large stock of 2-inch tape required for the storage of all of a televised course made the extensive use of video tape impractical. At Anaheim, for example, some 1440 lessons are produced and transmitted yearly to the third, fourth, and fifth grades. At $100 per hour for the standard broadcast video-tape stock they use (running at half speed), the backlog of tape alone would cost $144,000 and would require some 300 linear feet of shelf space. The development of less expensive, smaller-gauge tape equipment cut these costs nearly in half, and recently they have been halved again, but picture degradation still limits the usefulness of the narrowest, least expensive tape systems. Video tape, however, is used frequently for delayed transmission, erased, and used again the following day. If delayed transmission (1 hour to as much as 48 hours, in some instances) is considered to be the transmission of a recording medium instead of live television, then live television is today a relatively small part of instructional television. And indeed, instructional television must be considered largely a transmitting system, rather than a telecommunication medium (see p. 13).

Broadcast television has been regulated and standardized in all countries, and although there are several different sets of standards in the world, in general all broadcast television in any one country is of one type, and all of any one country's transmitting and receiving equipment is compatible. This holds true even between monochrome and color, i.e., color programs can be received on black and white sets and monochrome programs may be displayed in black and white on color receivers.

Most closed-circuit television in this country follows the established broadcast standards: 525 scanning lines per frame at a rate of 30 frames per second, utilizing a 6-MHz bandwidth for transmission. This makes it possible for many television system components to be used for both broadcast and closed-circuit applications; closed-circuit television can use off-the-shelf equipment at minimum cost. However,

many closed-circuit applications require higher definition quality and broader bandwidths for transmission. Such systems require special components from one end to the other and are incompatible with the standard 525-line equipment. Because of the extra cost of such equipment, and its incompatibility with standard systems, it has not been used widely in instruction. A few installations of high-definition television (1500 scanning lines) are to be found in medical schools, however.

Picturephone

Picturephone, a development of the Bell Telephone Company, may be put into regular service soon, pending the outcome of current product trials. To date, it has been demonstrated for various periods between Disneyland and whatever World's Fair happened to be in operation, as a public-relations exhibit for the telephone company. A regular service has been operating since 1963 between fixed booths in New York, Washington, and Chicago.

The terminal equipment consists of a small combination monitor/camera with a screen about 5 x 7 inches in size, the longer dimension being the vertical, perhaps to keep it from being thought of as a television system. Since the image quality is not equal to that of small-screen television, such comparison is to be discouraged. Picturephone uses a bandwidth about one-sixth that of standard television, so it should be very much less costly to transmit. Even at that, the bandwidth required is about that of some 250 standard 4-KHz telephone channels.

To extend the usefulness of Picturephone, the Model II Picturephone set has been provided with a small mirror in front of the lens to direct the camera's view downward. The user may hinge this mirror into place whenever he wishes to transmit graphic or pictorial material or his own writing or drawing. He may change the field of view over a 2-to-1 range by electronically zooming in or out, and he may change the camera focus to transmit scenes containing two or more people up to 20 feet away.

The Picturephone has been conceived primarily as a means of adding vision to the telephone conversation. (In the 1920s, whenever television was discussed, this is the form people imagined that it would take.)

It is essentially a television system, in that it may transmit sound, print, picture, and motion in real time, but in its present form it has such low definition in comparison with standard video systems that it could not readily be used for the same purposes.

If Picturephone is to be used for instructional purposes, it will be in the individual mode, possibly connected with an on-line computer system with both video and audio coming from some future digital memory device. Picturephone may present advantages over telephone instruction in achieving affective objectives, since the presentation would be more personal, with both the instructor's voice and facial expressions coming into play. Of course, improved transmission techniques may increase the picture definition and a somewhat larger screen may become possible; with these improvements, the medium's usefulness in instruction will be increased accordingly.

If installation of a Picturephone in the home eventually becomes practical and popular, its use as an individual-mode instructional device will probably follow. The convenience of receiving tutorial instructional presentations, of practicing skills, of testing and evaluating one's progress from the home, office, or study carrel, especially if this instruction is computer-managed, may be one of the most important advantages of Picturephone.

## Sound Film

Sound film is to the recording media what television is to the telemedia, a universal medium embracing all three methods of representing information--sound, picture, and print--and capable of investing the visual elements, where appropriate, with motion. Sound film as a mass medium is now some 40 years old and has lived through one crisis where it seemed to many that television might replace it, and another where it seemed that television production techniques and video-tape recording might at least replace the motion-picture camera and associated studio techniques. The latter issue has not been settled, but merely deferred, pending further advancement in the electronic art.

Sound film began as a separate-sound medium; the sound was distributed on a large disc and synchronized in playback with the film.

Sound-on-film was quickly developed, however, and the successful development of sound film into a mass medium was doubtlessly dependent on this feature. Had sound film consisted of Vitaphone discs synchronized with otherwise silent film, it might never have overcome the limitations of dependence on human factors in the transport and projection processes. Damage to film prints could not have been repaired simply by splicing out the bad portions, which is the current practice, without destroying sound-picture synchrony. This point is made because some new separate-sound film techniques are now making an appearance. While inexpensive in comparison with sound-on-film, these methods suffer from the same limitations as the early Vitaphone movies.

Sound-film standards were originally based on the use of 35mm film running at a speed of 24 frames per second. The sound track was optical, consisting of a strip of variable area or variable density which, on passing through a projector, transferred this photographic analog of sound into electrical impulses by modulating the beam of an exciter lamp falling on a photocell. Within five years or so, sound-on-film was also added to 16mm film, again with a film speed of 24 frames per second, although when expressed in inches this only amounted to 7.2 inches per second instead of the 18 inches per second of the larger-frame 35mm film.

In the middle sixties, 8mm film acquired sound, and when Super 8 was developed, it acquired sound as well. This development had been delayed until higher-quality recording techniques were devised and improvements were made in film emulsion. The 8mm sound film contains 80 frames per foot, which runs at 3.6 inches per second; Super 8, at 72 frames per foot, runs at 4 inches per second. In comparison with current audio-tape speeds, this should be sufficient speed to obtain adequate quality, as indeed both 8mm and Super 8 exhibit in practice.

Film may carry optical sound, in which case the sound track is composed of the same photographic emulsion as the picture portion of the film, or the sound track may be magnetic. In the latter case, a magnetic-oxide strip is added to the film, usually after the picture has already been processed. The sound is recorded on this track, using conventional magnetic-recording procedures. Magnetic sound on film became available

soon after the introduction of magnetic-tape recording and essentially replaced optical sound on 35mm film. It has been threatening to do the same in 16mm film, but progress is slow. In 1968 there were 20 magnetic-sound 16mm projector models listed in the AV Equipment Directory,* in comparison with some 36 models with optical sound.

The development of 8mm and Super 8 sound film was accompanied by another significant type of device, the sound-cartridge projector.

At least ten manufacturers have developed continuous-loop sound cartridges and projectors, but as yet there is no prospect of standardization. One maker's cartridge will not work in another's projector. This cuts down drastically on the amount of program material available to any one user and requires the distributor of film materials to mount his releases in many different kinds of cartridges. Nevertheless, the cartridge projector is proving very popular because it eliminates the need for the skill of projector operation, the lack of which in many teachers and in most students has in the past discouraged the use of film in classrooms and made it impractical to consider using films in the individual mode.

Another type of film cartridge and projector has also made its appearance and seems to have several advantages over the loop cartridge. This second type will be referred to here as the "supply-reel cartridge," although its originator, Eastman Kodak, calls it a reel-to-reel cartridge.** In this design the cartridge is really no more than a simple means of covering and protecting the supply reel. In operation, the film feeds into the machine and onto a take-up reel. It never completely leaves the supply reel, however, to which it is permanently anchored at the tail end. At the end of a screening the film rewinds quickly into the cartridge. The supply-reel cartridge design is also used in the EVR system (see p. 64).

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*An annually updated listing of audio-visual equipment including photographs and list prices, published by the National Audio-Visual Association, Inc., Fairfax, Va.

**In this discussion the term "reel-to-reel cartridge" will be reserved for a cartridge that, like the audio cassette, incorporates both supply and take-up reels within the cartridge. Conventional film projectors, like conventional tape recorders, are reel-to-reel systems.

The supply-reel cartridge has important advantages over the continuous-loop type. To begin with, the film can move both forward and backward. It can be very frustrating to the user of a 20-minute loop film to miss one key word and not be able to hear it again unless he reruns the entire film. In addition to the possibility of movement in both directions, some of the projectors for the supply-reel cartridge are incorporating fast-forward and fast-reverse features, thus providing for film a degree of accessibility which has long been characteristic of audio- and video-tape machines. It is the projector design which determines this feature, however, not the cartridge; but since fast film movement through a loop cartridge is impossible, fast forward or reverse is only possible in those designs based on the supply-reel or the reel-to-reel principle.

As with any equipment, added complexity brings added operational problems. During the 1960s, as a transitional stage before the cartridge projector, manufacturers offered many self-threading models, hoping to reduce the difficulty that unskilled people experience in operating projectors. The self-threading projectors, however, often caused even skilled projectionists added headaches. If the film being projected is new, and without splices, these projectors generally work well. The average film, however, is less than ideal, and if a splice should open while the film is in the inaccessible self-threading works of the machine, the machine will sometimes continue running until the works are jammed with crumpled film.

An inexpensive system of sound-film production for the home was offered by Bell and Howell in 1968. This is a separate-sound system--the picture is recorded by a silent Super 8 camera while sound is recorded by a small cassette tape recorder carried by the cameraman on a shoulder strap. Camera and tape recorder are synchronized by pulses generated by the camera and recorded on the tape; during projection, these same pulses control the projector speed and keep sound and picture in synchrony. Another firm offers similar equipment and a service which transfers the separate sound onto a magnetic track on the picture film. The resulting sound-on-film is then projected by means of a standard Super 8 sound projector.

Film Television Recording

The first method to be used for recording television programs involved simply photographing the face of a television receiver with a motion-picture camera. Because the tube in a television receiver is known as a kinescope tube, recording of the visual image it displays is known as kinescope recording. The term is often shortened to "kinerecording," and the resulting film is commonly called a "kinescope" or "kine."

When a kinerecording is made from a video-tape recording rather than a live broadcast, the process is of course the same, but it is then called "tape-to-film transfer."

It is entirely possible to focus any movie camera on any receiver screen, but the asynchrony between the 30 frames per second of television and the 24 frames per second of sound film may cause roll or flicker unless the camera is equipped with a special shutter. The best kinerecorders consist of a camera specially made for the purpose, plus a kinescope tube of special sharpness, color, and luminosity, mounted together on a rigid base.

Kinerecording was first done commercially in 1947, strictly for record-keeping, but it rapidly came to be depended on for rebroadcast purposes, and for program syndication between stations that were not yet interconnected by live means. At one point it was estimated that kinerecording consumed something like six times as much film stock as the entire motion-picture industry. This came to a rather abrupt end, however, with the appearance of video tape.

Since video tape was far superior to kinerecording in picture quality and could be reused up to 100 times, while film stock could be recorded on only once, it was expected that kinerecording would disappear. This did not occur, however; then its demise was again predicted nearly 10 years later, when low-cost portable video-tape machines costing less than many sound-film projectors became available. These predictions were still not realized, however; quite to the contrary, the greatest developments in the art and science of kinescope recording have taken place since the advent of video tape.

There are several reasons for the importance of kinerecording in instruction. To begin with, permanent storage of program material can be less expensive on film than on standard broadcast video tape. Kinescope recordings, which are on standard 16mm film stock, may be projected wherever a 16mm sound projector and screen can be set up. All that is required beyond this equipment is standard 110-volt electrical current, a semi-darkened room or a rear-projection cabinet, and a projector operator. Video tape, on the other hand, requires a television monitor for display and, generally, a system to distribute the television signal from a central point on playback to individual viewing locations. In many schools, especially in the Armed Forces, the use of kinerecordings is the most practical alternative because so many sound-film projectors already exist.

Kinerecording was first done only on 16mm film; later, a higher quality was obtained with 35mm film, which the television networks used for program delay and rebroadcast before the development of video tape. Experiments have been made with 8mm and Super 8 kinescope recording, and at least one model of a Super 8 kinescope recorder is now on the market. This system performs a function that is certain to be used extensively in the future: the transfer of video tapes to Super 8 cartridge form for use in the individual mode.

Kinescope recording is a complex process involving many decoding/encoding transfer stages as the picture proceeds from one medium to another. In live television, pictorial information exists as electrical impulses. The kinescope tube transfers these to visual patterns of light and shade. The kinescope recording camera picks up these variations of light and images them on a film emulsion, where they are transferred to variations in chemical change, which are subsequently made permanent by the development process.

When a kinerecording is subsequently transmitted via a television system, it must go through two more transfer stages, from photochemistry to optics as it is projected into a television camera, and from optics to electronics when the camera tube scans out the picture.

Video tape owes its higher quality on retransmission largely to the fact that it is not necessary to go from electrical signals through

an optical process to photographic recording and back again. In videotape recording, television signals are transferred to patterns of magnetization in the tape emulsion, and these are, on playback, transferred directly back to television signals.

A new approach to television film-recording is exemplified by Revere-Mincom Electron Beam Recording (EBR), which short-cuts the encoding/decoding process of kinescope recording by eliminating the initial optical stage. The video signal, in EBR, is not formed into an image on a cathode ray tube and photographed on motion-picture film. Instead, video is implanted directly onto the film itself without going through the optical stage. The film runs in a vacuum chamber, where a moving electron beam scans the picture onto each successive frame of continuously moving film. From this point on, the process is the same as in other types of television-film recording.

## Electronic Video Recording

Electronic video recording (EVR) is a method of recording images and sound on motion-picture film, using the previously described EBR method of recording. At the time of this writing, EVR is the most highly miniaturized film system, forming images about 4 millimeters in width (Super 8 images are 6 millimeters wide). If proposed cost schedules are maintained when production begins in 1970, and given sufficient quantity, EVR will also be the most inexpensive recording method of all the Class I media.

The EVR recording system can accept input from any of the Class I media. Output display, however, is exclusively by means of a television system. Optical projection equipment has neither been developed nor contemplated. Thus, EVR differs basically from other film television recording systems in that it is a method of making film recordings especially for television use, rather than a method of recording television on film for other uses.

In practice, the producer who wishes to distribute materials in the EVR form will produce his program on film or video tape, then send it to a laboratory for transfer to EVR. The program will be returned in a supply-reel cartridge form. In addition to television receivers,

users must have EVR playback units, which will cost, to begin with, about the same as sound motion-picture projectors (approximately $800); but by mid-1971 a second-generation consumer product is expected to reach the market, which may cost only half this much.

The EVR process involves the use of a very slow and very fine-grain 35mm motion-picture film stock, manufactured in England by the Ilford Company. The producer's original film or video tape is transferred to a 35mm master negative on this stock, in eight parallel strips of tiny images. From this EVR master, release prints can be run off by contact printing at the rate of a half-hour program every 30 seconds--about the time it takes to press an LP record. The films are then slit into four strips, each 8.75 millimeters wide and containing two tracks. Seven hundred and fifty feet of master 35mm film, which ordinarily would run for a little over 8 minutes on a theater screen, holds 4 hours of EVR material.

A 7-inch-diameter EVR cartridge will contain an hour's program on its two tracks. After a half-hour of screening, the film is rewound (1-minute rewind time) and the second track is run. It is possible to move back and forth between the two tracks, sampling each at will, a possible mode of use in some future programmed-instruction application. Sacrificing sound, one may stop on a still frame at any point and move, frame by frame, either forward or backward by means of a manual control.

Magnetic sound tracks accompany each track of images along the outer edge of the film. A series of what look like sprocket holes runs down the center of the film, one at each frame line. They are not perforated, however; control is achieved optically, so loss of synchrony does not mean torn film.

Color EVR is scheduled to appear on the market in mid-1971. It will require twice as much film area as black-and-white; the first track of each pair will carry a black-and-white image, while the second track will carry the color information, also in black-and-white.* Color EVR cartridges will, of course, contain only a half-hour of program rather than an hour.

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*CBS points out that this kind of color is not subject to fading from exposure to heat and light.

The cost savings of EVR over film or video tape are realizable only when prints are released in sufficient quantity (over 200 of each subject) and of sufficient program length (at least 20 minutes).

Current prices for EVR processing are based on the use of the minimum film footage, whatever the program length may be. Thus a 15-minute program, for instance, will be recorded 7-1/2 minutes on track A and 7-1/2 minutes on track B, with a 15-second period required for rewinding between the two parts.

At this time, EVR can be regarded only as a medium for relatively large-scale applications where centrally produced program material over 20 minutes in length is widely distributed. Whether it will become a medium suitable for small-scale or local-production use will doubtless depend on its success in the first area.

Video Tape

When video tape first became available in 1956, it began a revolution in the television industry which was very far-reaching in its effects. Television had been primarily a full telemedium which produced its own software, even though films had always been an important ingredient of television programming and the broadcast of kinerecordings had been increasing. With video tape, there seemed little advantage in doing much live programming anymore. Television changed rapidly from a telecommunication medium to a transmission medium: The chief recording medium transmitted continued to be sound film, but video tape soon became a close second.

In its improved picture quality, video tape provided a recording method which, at least to the average public, was entirely indistinguishable from live and was hence, in that respect at least, the ideal recording medium. Moreover, video tape could be erased and reused up to 100 times. Thus for purposes of delayed broadcast and short-term storage, video tape was more effective and far less expensive than film television recording, and it quickly replaced most applications of this earlier medium.

Video tape also allowed television-studio schedules to be divorced from transmission schedules. No longer was it necessary, for example,

for the cast and crew of a live television drama scheduled for a 12:00 noon broadcast to assemble for rehearsal at 2:00 a.m. Production could be done at any time, as far ahead of the broadcast date as desirable; and it could be done in segments. When a program segment had been recorded, played back, and accepted, the sets could be struck and studio areas freed; cast members who had no further appearances could be released; and the length of the role which any crew member had to learn at any one time was greatly reduced.

Live television productions had always been rehearsed and broadcast in very much shorter times than the shooting and editing of sound films. (The difference was about 5 or 10 to 1.) This led some producers to experiment with video tape as a means of producing films, for television distribution at least, and later for theaters.*

One discouraging result of the attempts to short-cut the time and cost of film-making by using television-studio techniques was that without the pressure of imminent air time, both cast and crew worked more slowly. Since errors in the final performance were no longer irretrievable and scenes could be reshot, there were many more errors and much reshooting was needed. Creative directors and producers, never really satisfied with the results of slap-dash television production, were suddenly able to reshoot scenes which they considered unsatisfactory and therefore did so. The rate of retaking and overshooting began to approach that in standard film production (between 3 and 10 retakes per scene).

As a result of producing in takes and in short sequences instead of all in a piece, the editing process became more and more complex. Editing had been totally lacking from the production schedule in live television because all editing was perforce done at the time of shooting. In video-tape production, the time and cost of editing too began to approach those in film production. These costs did not ever become as great, however, and many regular television programs are produced today on tape rather than film, primarily for economic reasons.

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*In 1964, Warner Brothers released a motion-picture version of "Hamlet," and in 1965 Magna produced "Harlow," both of which were theatrical releases produced originally on video tape.

In instructional television, where the technical costs of equipment and recording stock are proportionately larger budget items than they are in entertainment production, video tape provides a more feasible medium than film for many purposes. This has been increasingly true with the development of inexpensive, portable video-tape recorders. At the present writing, there are about 40 manufacturers of portable video-tape equipment. From the 1956 cost of $75,000 for the first VTR machines that appeared on the market, the cost of equipment providing comparable picture quality dropped to around $25,000, and equipment designed to somewhat lower quality standards went down to $12,000, then $8,000, then $3,000. In the middle sixties, VTR machines costing under $1,000 appeared in department stores for sale to the home market. The outlook is that the cost of such machines may eventually be reduced to $500. Standard broadcast machines use 2-inch tape; the less expensive models generally use 1-inch or 1/2-inch tape. Since video recorders are little more complicated to operate than audio recorders, and the tape is similarly reusable, video tape now ranks with audio tape as a leading home- or local-production medium.

The most common use of portable video-tape equipment is as a learner aid; that is, a device which a learner uses in practicing the performance of a skill, with or without the presence of a teacher. The learner interacts, essentially, with the device. Thus, portable video tape is frequently used for individual or group self-confrontation or self-observation. A diver performs and then observes his performance critically; group members interact in a discussion situation, then view themselves and objectively discuss their techniques of interaction. In teacher-training, the procedure of teaching a short segment and then observing oneself is being called "micro-teaching." But these are not examples of video tape used as a communication medium. It is probably safe to say that the main application of portable VTR in communication today is in the recording of lectures, conferences, interviews, and the like, for reference or for later playback to persons who were not able to be present at the actual events. There is increasing use of these machines, however, in the production of instructional materials.

The only standards today in the field of video tape are those that apply to broadcast equipment, where all makes and models of machines will play any tape made on any other machine that adheres to the same broadcast standard.* Broadcast standard equipment is expensive ($25,000 to $100,000 per unit), and 2-inch tape stock costs about $200 an hour. Few closed-circuit users can afford it.

A few closed-circuit VTR models are capable of playing back video tapes with the EIA standard synchronizing pulses** which are legally required if the tapes are to be broadcast. All manufacturers claim interchangeability of tapes between individual machines of the same model, although this is not always fully satisfactory. Few manufacturers can exchange tapes between different models within their own line; none can exchange tapes with any of the other manufacturers' models. (Each make and model uses a different combination of tape size, speed, number of heads, and various other factors.) If one or two manufacturers' models capture the greater part of the market, other firms will begin to introduce machines that can interchange tapes with this majority, and standards will thus be set. Until this takes place, however, the central distribution of tapes to users with many kinds of machines will be done by rerecording from one type of tape to another. Rerecording of prints from a master must be done in any case for large-scale distribution, but the necessity for a recording service to have so many types of recorders on hand makes the service more expensive and less satisfactory than it will be after standardization.

## CLASS II: AUDIO-STILL-VISUAL MEDIA

Audio-still-visual media are capable of all the representations of information that Class I media can provide, except that they cannot represent visual images in motion. However, they have the advantages

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*All broadcast standard recorders use 2-inch tape and contain four video heads which scan transversely. Some run at 7-1/2 inches per second, however, and some at 15; some record only color, some only black-and-white; some are "high-band," and some "low-band."

**A standard established by the Electronic Industries Association to assure compatibility.

of being very much less expensive and of having simpler hardware, simpler production procedures, and simpler transmission problems. A single television channel, for example, may transmit, by a process known as time sharing, a different set of still pictures at the rate of one picture every ten seconds to each of at least 300 separate viewers. Ten seconds of sound film, to give another example, can contain 240 separate still images; thus, used for still images, the same film-stock material can hold up to 240 times as much information.

Still-Picture Television

Still-picture television is the most promising unexplored telecommunication medium. It appears to approach both television's universality of use and radio's inexpensiveness. Still pictures and sound may be broadcast in two ways, which are sufficiently different to justify classing the two as distinct media: slow-scan and time-shared television. Because neither of these is in actual use today, except experimentally, they can be discussed only in terms of their inherent characteristics. How they could be applied is only speculation, but the indications are strong that they can be used for many instructional purposes. It is easy to see how still-TV by wire might be an improvement over the more cumbersome telelecture system, or broadcast-still-TV could do more easily what radiovision is doing now albeit at a higher cost. In a world where the usable electromagnetic spectrum is less and less able to accommodate all of the broadcasting demands on it, a system that can fit up to 300 still-TV channels into the space of one standard television channel may be very practical indeed, even if the lack of motion somewhat lowers its effectiveness. Some of the digital methods of encoding and transmitting still pictures developed for the space program may soon be applied, which could make this medium even more efficient in its use of the broadcast spectrum.

Slow-Scan TV. If a picture is scanned at a slow enough rate, it can be transmitted over a standard telephone line or broadcast on a radio channel. Facsimile does this also, but over a period of minutes instead of seconds; facsimile produces a hard-copy printout, while

slow-scan TV is generally conceived as a system which merely displays a still picture on a CRT screen. The more time devoted to its transmission, the higher the definition of the picture can be. The drawback of this system, however, making it unsuitable for instruction in its present form, is that the viewer must spend the 10- to 40-second period prior to each display watching as the picture slowly builds up, line by line, on an initially dark screen.

A second display technique removes the first picture line by line as the second is laid down, thus creating the effect of a wipe moving from left to right across the screen. This is no more suitable for instructional purposes, however, than the first method; both risk distracting the student by the action of image build-up, which, if pictures are to change every 10 seconds, would be a constant process. A means must be devised for storing a picture at the receiving end until it is complete, then displaying it with an instantaneous cut from the preceding picture. Also if standard television systems are to be used for the display, which is the most practical because such equipment is almost ubiquitous, there must be a means of "replenishing" the television picture every 1/30 second. This is the problem of scan conversion (converting from slow-scan to standard scan rates).

One laboratory solution to this problem has been to incorporate "storage tubes" in the still-TV receiver, on which each successive visual may be built up and held while the preceding visual is being displayed.

Another alternative for short-term storage at the receiving end is the video disc, a system which is already appreciably cheaper than the storage tube and is expected to become substantially less expensive. A video disc also has the capability of recording hundreds of pictures and, with multiple pick-up heads, can reproduce as many as 64 separate images simultaneously. Currently available storage tubes are capable of storing only one image at a time.

The production problem in sending live programs by slow-scan TV is that while the audio is transmitted and displayed in real time, the video requires a finite period to be transmitted, and a picture cannot appear in its entirety on receiver screens until some seconds after the decision has been made to transmit it. In other words, for proper synchrony, pictures must be sent in advance of the moment they are needed.

The slow-scan-TV director will thus operate a little differently from the conventional television director. Using several cameras, he will anticipate what should be shown next, as all television directors do, and if there are several possibilities he may send them all, to be received and stored at all receiving locations. When the moment comes in the program to display a given image, he will punch the appropriate button on his switching system. This action will then send a control pulse (possibly superimposed on the audio program as an inaudible tone) to all receivers, directing them to display the appropriate picture.

Video-disc equipment has been developed by Glen Southworth of Colorado Video and is being marketed at present through Visual Electronics Corp. The University of Wisconsin Extension Department, in association with the Westinghouse Corporation, is presently developing a slow-scan system to interconnect the University of Wisconsin Medical School with several nearby hospitals in the state. Available information on this system indicates that more than one still picture will be transmitted in advance of use and stored at receiving locations. Wisconsin Telephone will provide them with a special telephone channel for the slow-scan transmission, a "schedule 4 data channel with D-2 conditioning." There is a possibility that in the future they may use FM radio for the picture transmission.

Time-Shared Television. A proposed alternative to slow scan as a method of transmitting still-picture television involves a television transmitter and channel used jointly among a very large number of users. It is estimated that "...if the normal TV frame rate were reduced from 30 frames per second to one frame every ten seconds on the average, 300 television sets could receive different individual stationary frames at the 'same' time. If digital data processing procedures replace video techniques, a significant amplification of the 300 factor might be achieved."[9] In other words, since a television transmitter normally sends out 300 individual frames every 10 seconds, each could be different and be selected automatically by a different user. A given program would thus consist of, say, frame 1, frame 301, frame 601, etc., another program of frames 2, 302, 602, and so forth.

Time-shared television would not reach its most economical level, of course, until a channel was fully saturated with 300 users. It is possible, however, that experimentation might start with the use of an existing television channel only at certain hours that would not interfere with its regular operation.

Time-shared television is not even in the laboratory stage; it exists only as a proposed method, the details of which have been sketched out in the TICCET* study by the Mitre Corporation.(9) In theory, each individual user would receive a new picture every 10 seconds, which, according to the TICCET system, would have been selected by a central computer from its tape, disc, and core memories. A terminal memory (storage tube or disc) is also required, to store the frame after it has been transmitted and reconstitute it every 1/30 second so it can be displayed on a standard television monitor. However, TICCET as presently conceived is severely limited in respect to the presentation of graphic materials with gray scale (pictorial material in shades of gray), and before such a system can be made operational, considerable development work will have to be done.

Recorded Still-TV. Still-picture television may be recorded by several media, magnetic tape and disc being the most successful; phonograph records have been used, and, theoretically, such recording media as sound slide and sound filmstrip are applicable if the necessary interface hardware is developed. A single video disc 14 inches in diameter can hold 900 concentric tracks, each of which may contain a still picture of equal quality with pictures from television studio cameras or televised slides. Recording on both sides of a disc gives a total capacity of 1800 still pictures. Video disc, however, is not being considered at present as program-carrying software, since discs cost, today, at least $250 apiece. Future 6-inch discs, in quantity, will cost much less, as will also be the hardware required to record and play back. Audio is not now recorded on video discs, but if the material costs come down with time, and certain other problems are solved, audio-visual discs may someday become a medium for program distribution. There has

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*An acronym for Time-shared Interactive Computer-Controlled Educational Television.

been some experimentation by a Japanese company with a lightweight, thin, flexible video-recording material called "video sheet," which could possibly be reproduced quite inexpensively in large quantity.

Because phonograph records can be pressed and distributed cheaply in large quantities, at least one firm has developed an audio-visual system using this medium. Under the name Phonovid, this system was demonstrated publicly a few years ago, then disappeared. The playback system required a 16-inch phonograph record with a standard high-quality audio-pickup device. The record turned at a speed sufficient to play a side in 20 minutes. Pictures were scanned off line by line at the rate of one every 6 seconds, for a total of 200 pictures per side. Each picture was fed to one of two storage tubes where it was slowly written on the target of the tube. It was then immediately scanned back into a television display system at the standard rate of once every 1/30 second for six seconds, while the next slow-scan picture was being written onto the target of the other storage tube. The costs of this storage-tube scan-conversion method made Phonovid economically impractical; it has been estimated that Westinghouse would have had to charge $10,000 apiece for sets of playback equipment. It now appears that video-disc scan-conversion equipment will help solve this problem. The possibility of video and audio recording on phonograph disc is by no means eliminated, therefore, and may still be resurrected in some future system.

A more immediately practicable method appears to be the use of standard audio tape as the recording medium. With sound and picture on the two tracks of a stereo tape, either in loop cartridge or on reel-to-reel tape, a system similar to Phonovid but using disc equipment for scan conversion could be developed.* Standard video tape may also be used for storing still-picture images, as is done in Videofile. On one reel of video tape normally capable of recording an hour of television, 108,000 still pictures may be recorded. A still may then be transferred to a video-disc buffer (in 1/30 second), from which it may be played over and over as long as needed for a television display.

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*To the author's knowledge, only Colorado Video is presently working on such a development.

Pima College, soon to be built in Tucson, Arizona, has a video-disc still-picture and sound system planned. At the start of a study period, for instance, 900 still pictures will be dubbed off a video tape onto a master disc. When a user needs a picture, it will be dubbed off the master onto a buffer disc in 1/30 second, thus immediately freeing the master for other users. The picture will then be picked up off the buffer disc every 1/30 second and fed to a standard television display system for as long as it may be required. Buffer discs are two-sided and accommodate up to 8 pickup heads per side. Since each user must have his own pickup head, 16 learners may use one buffer disc simultaneously. Pima College plans to have one master and three buffer discs, thus accommodating 48 learner positions with still-picture television display.

A system designed by Earl Morrison at the University of Texas Dental School in Houston will use video disc to make still television available on an individual-access basis from some 100 student positions. This will be the first serious use of three-dimensional images in any instructional medium; some hundreds of stereo pairs will be available to the dental students in their laboratories, as well as some stereo motion video, plus live stereo television from a television instructor, for students who need individual help.

## Sound Filmstrip (Slide Film)

The sound filmstrip, since it presents sound as well as picture, is a more effective medium than filmstrip, especially for persuasion, in which the human voice can be very valuable. Sound-filmstrip playback equipment tends to be about twice the cost of silent-system equipment, averaging around $230 per unit instead of $120. Its major use to date has been in sales, where it provides the visiting salesman with a presentation that is considerably cheaper and more portable than a sound motion picture and its equipment, and that lacks only the element of motion. About half of the 53 models listed in the 1968 AV Equipment directory were equipped with small built-in rear or front projection screens which are part of the case or which fold out from it. These units are not designed for group viewing, and those with built-in screens

could not be so used, since the screens are rarely larger than about 8 x 10 inches.

The sound portion of this medium is, with only one manufacturer's system excepted, recorded on a separate disc or tape which is synchronized with the filmstrip. It would be more correct to say that the filmstrip is synchronized with the sound, since the sound runs continuously and sets the pace, and the pictures must follow. About half the units on the market require an operator to advance the filmstrip manually, either at the projector or remotely, in response to a "beep" in the sound. The other half, however, have some automatic means whereby a subsonic pulse or a light-reflecting spot triggers the mechanism and advances the filmstrip.

A new type of sound-filmstrip device recently released by CBS laboratories, combines sound and picture into one piece of software—not by putting the sound on the film, but by putting the pictures on the record. Actually, the pictures are photographed onto a flat ring of film which surrounds a small LP record, then the whole is enclosed in a transparent plastic cartridge, leaving only the playing side of the record exposed. In operation, the record spins within the ring of pictures which are advanced by an inaudible tone in the recording. The cartridge is 5 inches in diameter and 1/4 inch thick and will probably sell for about $3 or $4. The record holds 18 minutes of sound, and there is room for 52 pictures around the edge. A small and highly portable projection device is provided, with a built-in front projection screen on the inside of the cover, which is set in position when the cover is raised. The device is also equipped with four response buttons, so it can be used as a simple teaching machine. It is designed for use only in the individual mode, since the screen is only about 8 x 5-1/2 inches.

This device is not amenable to the local production of software, at least not directly. A service will probably be established that will take a set of slides produced by the client, plus an audio tape to which the slides are to be synchronized, duplicate the images in the ring shape, and rerecord the sound onto the record; the whole will then be sealed into its cartridge and returned to the client.

Sound Slide-Set

The sound slide-set consists of a set of slides contained generally within the magazine of an automatic projector, the advance of which is controlled by an audio tape which plays on a separate tape-playback device. The sound slide-set was made possible only within the last few years by two developments: (1) the automatic 2 x 2 slide projector,* and (2) audio-tape control devices.

Automatic slide projectors are intended, usually, to be used in situations requiring remote control. The lecturer carries a pushbutton device in his hand, or one is attached to his podium; he then advances his own slides at will. The electrical system for activating slide advance, however, may take its impulses from any source, and cues on an audio tape can be as effective as a manual pushbutton. Generally, the tape-playback device is equipped with a sensor consisting of two contacts which ride against the tape. The space between these two terminations is the only open segment of a circuit which, when energized, can activate the slide-advance mechanism. A small pressure-sensitive segment of metal tape is attached to the audio tape; when this reaches the two contacts it completes the circuit momentarily and advances the slide.

Other systems use a two-track tape-playback device, one track being used to carry the program sound, the other to carry audio pulses which advance the projector.

Sound slide-set is not a medium that lends itself to mass distribution. Slides would have to be distributed in relatively bulky and expensive magazines; and there would always be the hazard of people opening the magazines to use single slides, and damaging slides or mixing up the sequence. Furthermore, there is no standardization of tape-playback cueing systems; few individuals or institutions have any such equipment at all. Consequently, this medium is, at least at present, appropriate only for local production and use. An instructor or a department, for instance, might provide recorded presentations which could be administered either in the group or the individual mode.

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*The 1968 AV Equipment Directory lists 15 models of automatic-magazine 2 x 2 slide projectors. Some of these hold 80 to 100 slides per magazine.

Sound slide-set is one of six instructional media in which all or some of the variations involve separate sound. Three of these are telemedia (telelecture, telewritevision, and radiovision), and three are recording media (sound filmstrip, sound slide-set, and separate-sound film).* The sound portion of the three telemedia is a live, simultaneous, real-time transmission, while the visual portions are distributed by mail ahead of time. Visuals are changed manually in response to audible cues in the sound program. In the recording media, the sound and picture portions, although separate, are always kept together; they are often filed in the same box. Slide advance, in these media, can be automated. Thus, they are not as dependent on the human factor as the separate-sound telemedia are for (1) matching the correct sound to the correct set of visuals, and (2) proper manual slide advancement. In addition, they do not depend on the reliability of transportation, which in some localities today is highly questionable. If transport of a recording medium is delayed, the whole lesson is merely delayed; but if the visual portion of a radiovision lesson is delayed, the lesson is lost, since the broadcast sound portion must proceed on schedule.

Sound-on-Slide

Sound-on-slide systems enclose 2 x 2-inch slides in larger holders or cartridges that carry an area of magnetic material for recording. In the 3-M model this is a circular area surrounding the slide. While the slide is projected, an audio head rotates around it following a spiral track. It can either record or play back up to 35 seconds of sound. A magazine holds 36 slides. Kalart provides a combination cartridge which holds, in addition to the slide, 60 seconds of tape in a small cassette.

A circular magazine holding 40 cartridges is placed on a carousel slide projector in place of the usual slide tray. Sound-on-slide is a highly flexible medium. Slides may be rearranged within the magazine; sound for a given slide may be changed while the slide is kept, or the slide changed without touching the sound. Narration may be recorded

*Separate-sound film is discussed under Sound Films, pp. 58 - 61.

and rerecorded until it is satisfactory. Once on the slide, the sound is locked in and must remain in synchrony until the slide is removed from the holder.

The present cost of this system is of course much greater than that of sound filmstrip, and therefore it cannot compete with other systems in large-market distribution of multiple-print software.

## Sound Page

There is a machine on the market today, called Studymaster, which is essentially a printed page with magnetic sound. Sound is recorded in a spiral track on the back side of a printed sheet, 8-1/2 by 11-3/4 inches in size. This medium is usable only in the individual mode but is capable of carrying sound, picture, and print, and the visual elements may, of course, be reproduced in color if desired.

The learner uses a small table-top playback device, about the same dimensions as the printed sheet and 3 or 4 inches thick. He places the sound page on the machine, dons earphones, and starts the playback. The sheet does not revolve, but stays readable while the playback head revolves beneath it, moving toward the center of the circle as it goes. This is not to be confused with the plastic phonograph record; the face of such a record may contain visual elements, but these cannot be seen <u>while</u> the audio is playing, since the disc must revolve.

## Talking Book

In this audio-still-visual medium an ordinary bound and printed book is used, on the pages of which horizontal strips of magnetic oxide are printed. Speech is recorded on these strips to correspond to the adjacent print or picture which the page contains. When used in the learning of reading, for example, or a foreign language, a small reader is placed on the strip; it runs across the page picking up the audio and feeding it into a set of headphones, while the learner simultaneously reads the words or follows the pictures.

## CLASS III: AUDIO-SEMIVISUAL MEDIA

### Telewriting

The telewriting medium transmits two components: the voice of an instructor and his handwriting. Handwriting can, of course, include printing and drawing. Telewriting involves a type of motion or animation: the build-up of written characters or the gradual appearance of parts of a diagram as it is drawn. This feature can be of value when gradual appearance is desired--the instructor may use the device much as he would use a chalkboard. As with the chalkboard, however, there is a basic limitation which prevents an entire visual from being presented at once (unless a chalkboard is used like a more permanent display).

The method of transmitting writing by wire was invented almost as long ago as the telephone. It was originally called the Telautograph (now used as the company name of one firm which manufactures telewriting equipment). Although both horizontal and vertical components of the writing movement must be transmitted, transmission requires about 1/4 the bandwidth of a standard telephone channel. The total cost for both sound and writing is generally about that of two telephone lines. For many years telewriting existed as a means of individual communication, employed generally in industry, where it was desirable to communicate written orders quickly. Telewriting assured that the message went immediately and that it remained in a permanent form. The message appeared on a roll of paper in its original size, so this was essentially an individual communication medium.

In recent years equipment has been devised which projects the telewritten image onto a screen, and telewriting has become a group instructional medium. Some telewriting display devices use the opaque-projection principle, reflecting light from the surface of the paper, then projecting this with an overhead lens and mirror in the fashion of a standard overhead transparency projector. Other devices replace the opaque paper with a roll of clear acetate and shine the light through it, putting considerably more lumens on the screen. Devices of this type are suitable for auditorium projection.

Telewriting has been used as a substitute for instructional television and appears to be most satisfactory in teaching courses where the visual element generally consists mainly of chalkboard writing, such as mathematics and engineering. When distances are great between schools, telewriting can be economically feasible where television is not. It is therefore being used in many areas countywide to share the instructor resources of a number of high schools in the presentation of subjects such as physics, for which good teachers are rare. One current project of this type ties together schools throughout the state of Wyoming, and parts of northern Colorado.

## Telewritevision

Telewritevision is a name the author has given to a multimedia variation of the telewriting medium in which local visual materials are involved, making it possible to include still pictures and nearly all other types of graphic materials, in color if desired, along with the transmitted elements of sound and writing and/or drawing. Telewritevision provides more ways of representing information than are possible with telewriting, and thus stands in relation to telewriting as radiovision stands in relation to radio.

Telewritevision is most successful when the transparency projection method of display is used, and both the transmitted telewriting and the local visual materials are displayed by the same projector. A special frame is provided in some telewriting projectors into which transparent visuals may be placed and then changed by sliding them in and out. It is possible to slide a map, for example, into both the lecturer's transmitting device and the receiver device, so the lecturer may actually draw, write on, or point to the surface of the map, locating points and areas. When a drawing is completed, the lecturer touches a particular area with his stylus, and the rolls of acetate on his and on all receiving devices advance to another clear area without affecting the visual over which the acetate is superimposed.

Recorded Telewriting

While it is possible to record and play back telewriting using the audio-tape medium, recorded telewriting is not regularly used for instruction. Live telewriting is preferred, to take advantage of immediacy, for whatever it might be worth, and to allow for audio feedback. Audio feedback is generally used with telewriting, since it is transmitted free, so to speak; long-distance phone rates are based on two-way lines, and the feedback line may as well be used as long as it is there anyway.

In the recording of telewriting a dual-track stereo audio recorder is used; the audio is recorded on one track, and the coordinates of stylus motion are recorded on the other. Recorded telewriting is done for one of two purposes: (1) to make a record of what was communicated, in which case it will be consulted by someone who wants to know what the message was, not someone who wants to learn the information contained; or (2) to make a presentation of instruction, to an individual or a group, at a later time and/or another place. In either of these cases, the communication medium is recorded telewriting, and the recording medium is audio tape.

CLASS IV: MOTION-VISUAL MEDIA

Silent Film

Before the invention of the sound film in the late 1920s, the silent film had known 30 years as a mass medium of tremendous popularity. Narration and dialogue were supplied by titles separate from the action and spliced in. A few creative filmmakers managed to devise film action that was self-explanatory and could do without titles; generally, titles were considered a necessary evil and were kept as short as possible. After the sound film had taken over the theaters in a communications revolution, silent film remained for another 15 years or so a medium for nontheatrical films, educational films, and, predominantly in the 8mm size, home movies. After World War II, sound film became the preferred medium in the nontheatrical field but did not effectively reach the home market until the development of 8mm sound in the late 1960s.

At present, silent film is still the predominant medium for home movies and, with audio tape, is used more than any other medium for local or home recording. While there is some central distribution of silent films for screening on home projectors, almost all the silent film used in the home is homemade. It should be remembered, however, that in this application film is more a communication aid than a medium, since amateur moviemakers generally project their own films and contribute the necessary verbal narration at the time.

In the mid-1960s a movement began among educational innovators to develop and encourage the use of 8mm film in instruction. Equipment became available which, for the first time, would project films enclosed in a plastic cartridge. This is a relatively small cartridge, about 5 inches in diameter, holding a maximum of only 4-1/2 minutes of film. Since the film is in an endless loop, the end spliced to the beginning, there is no rewinding; the film supply must be run through to completion before it can be started again. Because of these advantages and limitations, a new variety of instructional film has appeared--the single-concept film, used to present only one idea, develop it, and end It is used as a resource for lesson presentation in the group mode, or more often, for review and study in the individual mode. A recent directory lists some 6,000 single-concept silent-film loops in 4-minute cartridges. It is possible to film "home movies" and have them returned in a cartridge if desired. The medium does not lend itself to editing and splicing of individual shots, however, since a loop cartridge will not run very well when the film contains many splices. Loading of the cartridges is too complex for the amateur and is generally provided as a laboratory service.

Standards for silent film have varied considerably over the nearly 70 years of its history, the difference between one standard and another being based mainly on film width. Throughout its history, silent film has run at a standard speed of 16 frames per second, which is two-thirds the speed of sound film. (Sound film has to run faster because of the need of a higher speed for quality sound.) The first standard was 35mm, which is still used in theaters without wide screens. The 16mm standard was established in the 1920s, and in 1935 standard 8mm film was established. Experiments were made with 4mm film, but they were abandoned

because the image quality was unsatisfactory. Now that finer-grained film stock is available, 4mm film is being discussed again. A European standard was also set in the mid-1930s: 9-1/2mm, with the sprocket holes in the center of the film between frames.

In the midst of the development of 8mm film cartridges and the sudden increase in the use of 8mm film in instruction, including the emergence of the single-concept film, 8mm film itself went through a major revolution. A new film standard, Super 8, made its appearance. Although the film is the same width as standard 8mm, the image size is about 50 percent greater, due to the use of smaller sprocket holes and slightly fewer frames per foot. Picture quality is so clearly improved that there is little doubt that Super 8 will rapidly replace standard 8mm film in both instruction and home movies. Many single-concept films are now available in both sizes; others are available only in standard 8mm, and some of the newer productions are being released only in Super 8.

## CLASS V: STILL-VISUAL MEDIA

Class V contains the media that represent information in pictorial or symbolic form without motion. This class includes the medium of print, the most widely useful of all communication media. Its success is due mainly to the fact that it is a most practical form of reproduction of materials for use in the individual mode. Another still-visual medium, the silent filmstrip, is also widely used. A third medium of this class, termed "picture set," includes all kinds of picture sets (with captions, labels, etc.) which are not contained in a fixed order on a strip of film. Finally, there are microform and video file, which are basically information media used at present primarily for storage and retrieval purposes.

An interesting and important characteristic of still-visual media is that their programs are not locked into the dimension of time. In that respect, therefore, they do not seem like programs in the usual sense--they do not "run." Program presentations in any of the other media classes generally proceed forward from start to finish once they are begun, especially if they are being presented in the group mode. Only with media that can be presented in the individual mode is the receiver

free of this constraint, and then only if he has playback apparatus which gives him interior random access. Audio and video-tape media, with their fast-forward and fast-reverse modes, are beginning to have the capability of random access within a program (as opposed to exterior random access, which applies to the selection of programs). Audio-disc and video-disc devices give the user a faster interior random access than any other means. The nonlinear presentation of still pictures and print, tied neither to the one-word-after-another stream of audio narration nor to the filmic stream of the motion picture, allows the user to set his own pace, skip, review, or even start at the end and work forward if that is what he likes to do.

Many of the devices in the filmstrip medium do not actually allow random access within the program (to reach frame ten from frame five, the user must momentarily display the intermediate frames). However, other filmstrip and slide projection devices do allow one to go directly from five to ten without displaying the frames between, and all filmstrip devices will of course allow the user to proceed at his or his group's own pace.

## Facsimile

Facsimile is the only telemedium in the still-visual class. Since still-visual media are not time-based, telecommunication has a different value here than it does for any of the other media classes. Facsimile is a means of transmitting still-visual materials, in which the message is not perceived by the user in real time. In other words, no one expects to sit in front of a facsimile receiver and absorb the program as it comes in. Facsimile would be a poor medium for two-way interaction between sender and receiver.

Facsimile is essentially a transmission system, rather than a communication medium, at least as it is presently employed. Nothing except recorded materials can enter a facsimile system; nothing except recorded materials can be put out. Facsimile is also a relatively slow means of transmission relative to other telemedia. A page of information requires from approximately 6 seconds to 6 minutes to transmit.

Currently, facsimile finds its greatest usefulness in the transmission of pictorial and line-graphic materials. Data in alphanumeric form can be more quickly and inexpensively transmitted by teletype. Facsimile is used to transmit engineering drawings, weather maps, and similar materials under conditions where mail transportation would be too slow. Local television stations receive news photos by facsimile from central news agencies. Input equipment for facsimile systems is available to take still-visual materials in any of the recording-media forms, in nearly any size, length, or thickness--even microfilm. Transmission at slow rates may take place over standard direct-dial telephone lines, in conjunction with Dataphone or an acoustic coupler. For faster rates of transmission, special, somewhat broader-band telephone lines are required.

Facsimile signals may be recorded on audio tape running at about 5 inches per second, which allows for about an hour and twenty minutes of recording on a 7-inch reel (up to 80 pages). Obviously, recorded facsimile is not an efficient means of information storage, in comparison with microfilm, for example. Its value is as a means of delayed transmission of a message and/or delayed printout at the receiving end.

Facsimile is strictly an information transmission system in its present form. It is possible that with the development of less-expensive equipment, however, facsimile may be integrated with other communication media in multimedia instructional systems to transmit supporting printed materials or operating in the other direction, to collect student responses, papers, or exams.

## The Printed Page

Since the nature of the print medium in all its subclasses is well known, it will not be necessary to go into any detailed description here. Recent developments, such as the techniques of photocomposition, promise to bring the costs of high-quality printing and high-definition pictorial reproduction down into the current cost range of second-class methods. These improvements may stimulate increased use of print media, as did the earlier development of the inexpensive paperback book.

The printed page is the most useful communication medium today; it is by far the most heavily used; and it has such great inherent advantages that it will probably remain the most useful medium for some time to come. Nevertheless, it remains a communication medium, and has many of the same advantages and disadvantages as other media, when compared with conventional face-to-face communication. Print is impersonal, canned, and standardized--all receivers read exactly the same words in their separate copies of the same book. If a reader does not understand, he cannot ask the author a question. Champions of the traditional in education frequently point out these factors in regard to the newer instructional media, forgetting that they apply equally to the medium of print.

Print, like other media, also has great advantages over face-to-face instruction. Through print, a learner anywhere may study under the finest instructors of the age, or of any age. Conversely, the printed knowledge and wisdom of the greatest teachers may be reproduced in countless duplications and made available to all who wish to know. A man's words thus recorded may be read over and over again, studied, consulted, quoted in still other publications.

But there are now almost a dozen other, newer recording media that can do most of these same things. What advantages has print that will prevent its being superseded by these newer devices? And what disadvantages does it have in relation to the others?

The greatest disadvantage of the print medium is that it requires literacy. In the last 200 years or so, print has become so essential to the conduct of industrial civilization that all of the developed countries have made literacy almost a mandatory qualification for citizenship. This is not true of the undeveloped countries, of course, which include the great majority of the world's people. More than half of the people in the world cannot use the printed page, except in purely pictorial form, some because they are not old enough, the rest because they have not had the educational opportunity of learning to read.

The print medium, of course, presents pictorial representations as well as symbols, so published materials can be of some use to the illiterate. However, this use tends to be in the nature of an instructional

aid for a face-to-face verbal explanation, rather than as a self-contained instructional medium. In addition to raising the literacy level, the developing countries will also have to stimulate a steady flow of informational and entertainment materials, newspapers, books in the native language, and the like, lest, as has already happened in some African countries, literacy once attained disappears through disuse. In the meantime, the media that depend on the spoken word for verbal exposition will have a big advantage over print in the undeveloped nations of the world.

The print medium has several advantages over other media. To begin with, print requires no elaborate playback or receiving apparatus for program display. All the expensive equipment of the medium is located in the central point of production and distribution, where the expense is justified by great economies of scale. The extension of the reading public requires no fixed per-reader expenditure except as advertising and promotion may be necessary to motivate new readers, and additional software distribution costs are incurred.

Print is almost the only medium in which the software costs are low enough that individuals may maintain extensive libraries of materials. The closest other media are audio disc and audio tape. A single college student may own more hours of instruction in the print medium than his entire university has stocked in materials for the sound-film medium, or video tape, for example.

Print gives the learner the maximum freedom of any medium in choosing his modes of access; he can skip, reread, glance ahead, check back. Because of this factor, print is generally the preferred medium for the presentation of material that is difficult for the learner to grasp readily and requires study, thinking, and rereading. But whether the material is difficult or easy, print is still the medium with the highest random accessibility <u>within</u> the program.

Assuming the existence of a practical index, the system of numbering pages makes finding what you want within a book a fairly easy task. The exterior problem--finding the book you need by consulting card catalogs or bibliographical files, for instance--may be a great deal more difficult. However, this problem can exist with any medium--we have

simply not had to face it in any but the print medium. The information explosion of today is reflected in a print and paper explosion. No one yet seems to be inundated with piles of films or tapes which he has to find time to play. Libraries are still almost exclusively concerned with the print medium, although the trend may be to other media. (As an indication of this trend, in a recent issue of the *Library Journal*, 40 percent of the advertisements concerned materials or equipment for media other than print.)

Filmstrip

The filmstrip medium consists generally of a recording of still pictures and print on 35mm sprocketed film. Filmstrip systems have also used 16mm film. The recording apparatus is usually standard photographic equipment--often a motion-picture camera adapted to photograph single frames. Filmstrips are played back by a small projector into which the roll of film, generally about 3 feet long, may be threaded. Frame advance is usually done manually by an operator at the projector or by pushbutton remote control. Some systems encase the filmstrip in a supply-reel cartridge, from which it unwinds and into which it is again rewound after projection. Other systems include a take-up chamber in the cartridge so the filmstrip never leaves the cartridge at all. This is analogous to reel-to-reel tape cassettes, except that reels are not required for filmstrip--the film simply rolls up in a chamber. Most filmstrips are produced and projected in color. The most common type, single-frame, carries one picture below the other, like motion-picture film. A less common type, double-frame, exposes the film horizontally, in the manner of minicameras, so that each frame lies to the side of the next. Because one double frame utilizes about twice the film area of a single frame, the definition is very much better. Almost 90 percent of the units listed in the AV Equipment Directory could project single-frame filmstrips; only about 20 percent could handle the double-frame type.

There are four main subclasses of the filmstrip medium, with different software characteristics, each requiring different viewing equipment: 35mm single frame, 35mm double frame, 16mm single frame, and 16mm double frame.

Filmstrip has traditionally been a group-presentation medium, for use in schools and other nontheatrical situations, as an inexpensive substitute for motion-picture film. It has rarely been preferred over film except for reasons of cost. Like the film medium, it is primarily based on central production and widespread distribution; filmstrips are rarely produced by an individual teacher for his own use.

Combination slide/filmstrip projectors were, in 1961, the most common schoolroom projectors of any type, motion picture or still. At that time it was estimated that there was an average of one filmstrip or slide/filmstrip projector for every eight public-school classrooms nationwide.[10] The same study estimated that the schools were storing an average of 40 different filmstrips per projector for local use. There were about 14 times as many school-owned filmstrips as school-owned sound films. Except for print, no other medium even approached the filmstrip in number of recordings stored in schools; disc recordings came the closest, with less than half the total number of units. It should be noted that the study did not make a distinction between the silent and sound filmstrip; the sound filmstrips with their associated disc recordings probably accounted for less than 10 percent of the total.

## Picture Set

A set of pictures may contain both picture and print and therefore may carry a message that is complete and self-contained. However, its material is not recorded on a single piece of software such as a strip of film. The slide set, for example, may reach the user safely encased in a magazine for an automatic projector, or as a loose set of slides held together with a rubber band.

Another example is the set of large-size flat pictures reproduced in quantity by photographic enlargement or some graphic process, such as silk-screening or lithography. Such picture sets are distinguished from printed pictures in that they are not screened and produced on a printing press, and hence they are not reproduced in as great a quantity; also, they are generally intended for group use, while pictures on the printed page are usually intended for use in the individual mode.

In some rare instances in information communication, more commonly in artistic expression, pictures will be used to convey a message without the help of words. When, more commonly, picture sets are accompanied by captions, it is generally for use in the individual mode. Pictures without captions are almost always intended to be used in the group mode as instructional aids.

Microform

The microform medium is a system of information storage and retrieval designed as a more practical alternative to printed, written, or pictorial materials that exist primarily on paper. Transparent film is generally used for microforms, the two most common types of which are microfilm and microfiche. Microfilm is generally a strip of film 35mm or 16mm wide onto which a large number of individual documents have been photographed. The strip of microfilm is usually contained on a reel or in a cartridge. Unlike filmstrip images in which the height of the frame is 3/4 or less the width, microform images generally reflect the shape of a typical 8-1/2 x 11-inch page, in which the horizontal dimension is the smaller, being only about 3/4 the vertical.

Microfiche is a method of recording in which the images of individual pages are photographed in rows and columns on a piece of film called a film card or a chip. There are at least six standards that use a microfilm card 4 x 6 inches in size, and at least five formats that use cards of the Electronic Data Processing (EDP) standard size (3-1/4 x 7-3/8 inches). In the 105mm film standard, one very large engineering drawing will occupy the entire area of an EDP card; in the case of HR (High Resolution) Fiche, each card can hold 3200 pages; 4 x 6-inch fiche can carry up to 5600 pages. Maximum reduction ratios for these extremes vary from 12:1 to 150:1. Any reduction ratio higher than 40:1 has come to be called ultramicroform.

A familiar microfiche standard in the EDP card size is the aperture card. In this form, an actual punched card is used, for purposes of machine sorting, which has a window near one end into which an image on 35mm film is inserted. The usual aperture card places only one image in this area, generally an engineering drawing reduced 30:1. The

"packed aperture card" puts eight images (8-1/2 x 11-inch documents reduced 24:1) into this space.

Microforms may be read with various types of direct magnifying systems called viewers, but they are most commonly projected on individual-viewing projection-screen readers which are manually operated.

The primary advantage of microfilming is the saving it affords in storage space and filing equipment. One system, for example, condenses the information that would normally require 100 four-drawer filing cabinets into the space of a single desk top. The ratio of space reduction is sometimes considered to be as high as 500:1. The Encyclopedia Britannica has recently announced a program to develop a series of "Resource and Research Libraries" in ultramicrofiche, intended for new institutions and small colleges. An ultramicroform library of 20,000 volumes will fit on the top of a card table.

The second most important advantage of microform is that access time is greatly reduced. Microfiche, especially, may be filed and accessed very quickly by machine. Finally, mailing facilities and costs are greatly reduced through the use of microforms.

Where large numbers of documents are handled constantly, microform readers can be conveniently located and personnel can be habituated to their use. Since machine indexing and retrieval systems cannot be located in individual offices, many information users find printed materials in their own personal libraries more convenient, more flexible, and easier to access. Some types of work, for example, require that a number of documents be spread out on a desk and consulted in association with each other. A single microform reader could not fill this need.

In recognition of this problem, many manufacturers of microform readers have incorporated hard-copy printout devices into their equipment. This type of hardware is still too expensive for individual office use, however; its most practical application is in libraries and other central information repositories.*

At least one company has incorporated microfiche into a teaching machine, instead of using filmstrip materials. The possibilities of

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*A recent model, 3M's reader-printer, now sells for around $300. As competitors follow suit and the trend continues, we may well see the office reader-printer become ubiquitous.

storing a large amount of visual information locally, within the actual display unit, have led to some experimentation with systems that select and control the display of this material by telecommunication from a distant computer. Further development can be expected along this line.

Video File

The current trend, evident in all the visual media, is toward electronic means of recording, storing, reproducing, and/or transmitting information. The electronic approach to information storage and retrieval offers techniques of computer technology to provide shorter indexing and access time, even though the degree of compression of document information may not be as great as ultramicrofiche can make possible.

The Ampex Videofile system, developed in 1964, uses 2-inch video tape as a recording medium; each 8-1/2 x 11-inch document requires about 1/3 inch of tape. A standard 1-hour roll of video tape will thus record some 108,000 images. A display system with four times more detail than a standard home screen is employed, making possible the recording and legible display of 8-1/2 x 11-inch documents containing characters smaller than elite type.

Documents stored on video tape are rerecorded from the master tape onto a buffer disc when requested, then continuously picked off the disc and displayed on high-quality television monitors for reading. Hard copy may be obtained if needed via an integral electrostatic printer.

CLASS VI: AUDIO MEDIA

Telephone

The telephone has been considered, since its inception, as a private or semiprivate means for conversation at a distance. It can be used, however, as a group instructional medium to bring a lecturer to a distant audience whom he could not normally visit in person. The telephone is a more valuable medium than audio recording in such cases, because of the added interest generated by the fact that the presentation is live, and because it is a two-way medium and members of the

audience may engage a speaker in dialogue following his presentation. Instructional uses of the telephone have generally been limited to single groups, although the simultaneous presentation of a verbal lecture to many groups in different locations is readily possible. Two-way dialogue becomes progressively more unwieldy and impractical, however, as the groups become larger.

There have been some interesting applications of the telephone in the individual instructional mode, particularly in the medical field. The medium in these applications is actually audio tape, but the telephone is used as a means of distribution and individual access to a central, possibly distant library of materials. The University of Wisconsin, for example, provides a service of continuing medical education for physicians, using an INWATS* line which a physician can dial into from anywhere in the state toll-free. (The service can be used by anyone in the world if he pays his own toll fee.) The caller receives a short lecture on audio tape, which is played manually by an attendant in response to his verbal request. University of Wisconsin Extension has used two-way telephone in many subject-matter areas, for discussion sessions following lecture presentation. Up to 15 responding groups can be accommodated in one such hookup; a number greater than this becomes unwieldy.

## Telelecture

The telelecture is a multimedia system in which the telephone is augmented by the addition of visual elements from locally projected materials. In its simplest form the visual component may consist of a single projected slide of the face of the lecturer. More commonly, the visual element will consist of a set of slides that have been produced at the institution originating the lecture and sent out in advance to each location where the program will be presented. The sound portion of the program carries cues for the changing of slides, sometimes in the form of beeps, sometimes in the straightforward "next slide, please" style, or, preferably, in requests for slides by number, to assure that they do not become mixed up.

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*INWATS (Inward Wide Area Telephone Service).

Radio

Radio, the first of the telecommunication media to make its appearance and still the cheapest to operate in its commonest form, is primarily used as a mass medium. However, it is an individual communication medium in many applications, and it has been heavily used in schools as a medium of group instruction. It is not generally used for instruction in the individual mode, except in central Australia, where elementary- and secondary-school "classes" are assembled by radio, each pupil sitting alone in his isolated sheep-station homestead listening to the teacher and contributing to class discussion via transceiver radio. The effectiveness of this live interconnection is evident in the production of class plays, where pupils in widely separated areas interact dramatically, with perfect timing. So real is this live interconnection that the children often play the productions in actual costume, each player describing his costume to the listening audience before the start of the play.

The usual application of radio to instruction involves the transmission of an audio program which has been previously recorded on tape or disc. Most foreign broadcasting systems devote some of their energies and some of their daytime broadcasting hours to school programs. A 1961 survey[10] revealed that radio sets are part of the audiovisual equipment of two-thirds of the school districts in the United States but are not as widely available as the equipment for the three most used recording media--audio disc, filmstrip, and sound film. Although there are now some 3,000 radio stations in this country, instructional broadcasting is largely left to the 450 educational (noncommercial) radio stations. According to a 1966 survey,[11] 85 percent of these educational stations broadcast primarily to the general public, and only about 15 percent program for in-school audiences. The fact that there are four record players or tape machines in the nation's schools for each classroom radio receiver reflects the advantages of convenience in the use of recorded materials, especially when these are so inexpensive that classroom libraries may be maintained. A 1961 survey[10] indicated that the number of radio sets per thousand students had actually declined by 17 percent in the previous six years, indicating a trend away from the use of instructional radio at that time.

Ninety-four percent of the 450 educational radio stations are FM stations; 86 percent are operated by institutions of higher learning. However, most of these licensees participate very little in equipment or programming decisions; they often participate only in budget policy decisions.[12] That educational radio is considered both an inexpensive and an unimportant medium by the organizations that operate stations is shown by the low level of financial support provided. Almost half of all educational radio stations operate on annual budgets of less than $20,000.

An important new development in radio broadcasting, called "SCA"* or "Multiplexing," allows an FM station to carry up to four subcarrier AM channels piggy-back, so to speak, on the main FM carrier, without affecting the regular transmission. Many commercial stations use these extra channels to distribute Muzak-type background music services; some use the extra channels for stereo transmission. To date only about 15 of the educational stations hold authorizations to use multiplexing, but others are making plans to use it. The SCA channels are capable of carrying facsimile, slow-scan television, teletype, or telewriting, and some of these media are being considered today by broadcasters of instructional radio programs.

The SCA channels can be received only by a special multiplex receiver or adapter, which is at present as expensive as a good radio. This need for special receiving equipment puts SCA into a different programming category--it cannot be considered an open-circuit medium. Those broadcasters who service a community with multiplexed background music provide receivers as part of their service and treat SCA as though it were a closed-circuit system

Even if an inexpensive SCA receiver or adapter is produced for the mass market, it is doubtful whether SCA would rapidly become a mass medium. This, however, may be a blessing: The SCA channels may truly become minority audience services. Even the educational television and radio stations have hesitated to limit their audiences by such programming, and the policy of the Federal Communications Commission has always

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*SCA (Subsidiary Communications Authorization).

favored granting of licenses to use the public airwaves to those who proposed to serve the greatest number of the public. Thus, SCA may be of value in professional communications, such as continuing education for doctors, nurses, and others in the medical community, and will involve group listening. Special program services for the blind are proposed, along with adult education in many subjects such as agriculture, law, and engineering.

Radiovision

Radiovision is a multimedia system in which the radio medium is augmented through the addition of visual elements at the receiving end. As with the closed-circuit telelecture, these elements are mailed out in advance to the viewing groups. The visual elements consist of slide sets or filmstrips which may be retained by the schools to which they are sent. This adds an element of permanence to the radio; the visual materials may be used for further study or review.

Radiovision is an important part of the regular broadcast radio service to the French schools. It is also being used in several African countries. It has one great advantage over any other means of audio-visual presentation: It utilizes the very simplest of equipment on the receiving end. A teacher in an African village, for instance, needs only a transistor radio and a kerosene filmstrip projector to have the advantages of the best lesson presentations his country can produce. That is not all of the system, of course. There must be facilities for the production and dissemination of the necessary visual materials, a reliable postal-transportation system, an adequate broadcast signal at the receiving location, a shaded hut for daytime projection, and the teacher must have an accurate watch in order to have his students ready when the program goes on.

Radiovision, like telelecture, requires that the originator of programs make direct correspondence contact with all users. It does not allow for uncontrolled, unknown, hit-or-miss viewership. In this regard it differs from school radio and television, which is all too often simply pumped out in the hope that a maximum number of classrooms will decide to make use of it. This scattershot approach encourages

generalism in the design of programs to make them usable in as many different situations as possible. In a system where each receiving group is known, a much higher degree of specificity is possible.

Several telecommunication media are like radiovision in that they require a direct contact between program originators and viewers or viewing groups--ensuring that the program originators know exactly who their recipients are. These are telelecture, telewriting, telewritevision, telephone, and Picturephone. The mass broadcasting media--radio, television, and the future still-TV media--may share these characteristics under some conditions, but they are not built in, so they are rarely emphasized.

Recording media do not share this direct-contact characteristic generally; although specificity is possible, it is not built in. Materials may be designed and recorded for any degree of specificity, but they may also be designed more generally, and this is usually a necessity if the system is to achieve economies of scale.

Slide advance in radiovision is cued by slide number, or by short transition segments of music. Systems have also been used where pulses carried on a subcarrier of the main FM radio channel advanced slide projectors automatically. Under such a system, of course, all projection equipment at all receiving locations has to be identical. Since it is much more common that each location has its own type of projector, the manual methods are most often used.

## Audio Disc

When radio experienced its fastest growth as a mass medium, it was predicted that home phonographs and record players would be superseded. However, the convenience of having one's own library of recorded materials at home, with consequent freedom of access at any time, encouraged an even greater growth of the record industry. In 1967 the sales of phonographs were about twice those of radio receivers in dollar volume.[13] Nor has the sale of records been affected greatly by competition from audio tape. It is reported that records currently outsell prerecorded audio tapes four to one. To some extent this reflects the higher cost of tape over phonograph equipment; it may also reflect the greater

convenience and accessibility of recordings when one need only set a needle to a specific cut on a disc, rather than run through a long tape to find the start of a desired number.

In 1961, record players were the most frequently found of all audio-visual equipment in the schools, although this is not saying very much. At that time there was, on the average, only one record player for every 100 U.S. public-school pupils. This was about one for every four teachers. By comparison, there was only one audio tape recorder for every 16 teachers, one radio receiver for every 18, and one 16mm projector for every 12.[10] An average of only 8 disc recordings per record player were owned by the schools.

Audio Tape

Recording of sound on magnetic tape was developed during World War II in Germany; after the war, this technique came to form the basis of one of the most ubiquitous of American mass media. The first professional use of audio tape, significantly, was as a replacement for live radio production. The star of one of the most popular radio shows, Bing Crosby, found that adjusting his schedule to that of the radio audience was highly inconvenient. He contacted a small firm, Ampex, which was operating out of an old garage and experimenting with the new German method. He found a method which turned out recordings that were all but indistinguishable from live radio. As a result, the Bing Crosby Show was the first to prerecord on tape, and the Ampex Corporation took a lead in the recording field which it has never entirely relinquished.

Given the necessary equipment, audio tape is the medium in which home recording is easiest for the average person. It is as much an individual recording medium as a mass playback medium. This is in contrast to audio disc, which was always a difficult medium in which to do home recording; even though equipment is available for this purpose, audio disc remains almost entirely a playback medium, with the recording done centrally for national distribution. Audio tape also has a very large sale as a playback medium, but practically all tape-playback equipment is also capable of recording. People with high-quality radio receivers find it convenient to record their own tapes from broadcasts.

The audio-tape medium is based largely on the use of 1/4-inch tape, although other widths are also used for special multitrack purposes. There are several standard speeds, just as there are for audio disc; a higher speed improves quality while using more recording material, a slower speed saves tape but reduces quality. When the magnetic tape was first used in broadcasting, the tape ran at 30 inches per second for best quality, 15 inches per second for ordinary recording. In the 20 years since then, improvements in tape and recording heads first cut these speeds in half, then a few years later in half again. Seven inches per second is now the running speed that is generally used in broadcasting, and 3-3/4 is used for applications in which high quality is not so critical. A speed of 1-7/8 (half of 3-3/4) is also provided in the new portable recorders which use the reel-to-reel cassette. There is even a speed of 15/16 inches per second which allows a miniature recorder with 3-inch reels to record for 4 hours without changing reels. A new kind of tape which is still in the laboratory stage, Crolyn tape (chromium dioxide is the magnetic medium) is expected to cut tape speeds in half once more.

## CLASS VII: TYPE MEDIA

Class VII media are capable of representing information only in alphanumeric characters and other symbols. Furthermore, they can present this program material in no other way than one character at a time. Thus they are time-based; the presentation of information was for years limited to the rate at which such devices as mechanical teletype machines or electric typewriters could operate. Teletype printers operate at up to 100 words per minute, a slow reading speed, but sufficient if not too much is transmitted at a time. Teletype is thus frequently used in computer-controlled instructional systems, where the learner reads material as it is typed out and responds immediately by typing back his answers.

The major uses of teletype in information transmission, however, involve the procedure of recording the information to be transmitted in advance on punched paper tape. It is then passed through a paper-tape reader, transmitted electronically, and recorded by a paper-tape punch

at the receiving end. Paper tape can be read and punched at very much faster rates than typewriters can type; some of the tape-to-tape systems now on the market are capable of 750 words per minute, and some are capable of over 1000. This is about 16 times as fast as the average speaker talks. Once recorded on paper tape at the receiving end of the transmission system, the information may later be decoded by a paper-tape reader and typed off by an electric typewriter at 100 words per minute.

The advantage of all this is that the transmission system for the teletype requires a very narrow bandwidth--the same type of line, actually, that is used for ordinary telephone calls. Thus the costs of long-distance data transmission are the same as the cost of long-distance phone calls, and up to 16 times as much information can be transmitted.

## VI. PROPOSED FUTURE STUDIES OF MEDIA

As presently planned, future writings in this series will discuss the uses to which instructional media are being put and the criteria which determine their appropriateness to the various uses. Such discussion will include accessibility to the user of various media and/or forms of media, the responsiveness of various media to changing needs, and the adaptivity of media to the individual needs of the learner.

Another equally important set of questions will concern the feasibility of different media under various conditions. This will involve discussions of cost and value, equipment standardization and reliability, demand for the medium, and its acceptability to users.

As a practical help to media users in determining the relative feasibility of various alternative procedures in the production of program software, general cost models are being prepared for each media class. Future studies also involve media techniques, including techniques of integrating the use of a medium into a total learning environment; techniques of expression in different classes of media, and techniques of melding sound and picture into a unified whole will be explored. These matters will be discussed as much as possible in a universal way, drawing on many media, as appropriate, for illustration and example. Considerable discussion will be devoted to the techniques of eliciting learner response via the media and means of providing feedback to that response so that more rapid and more lasting learning may become possible.

Appendix

## LOCAL VERSUS CENTRAL PRODUCTION OF PROGRAM SOFTWARE IN INSTRUCTIONAL MEDIA SYSTEMS

The amenability of various media to local or home production of program software (films, tapes, etc.) has been discussed in Section V, where the communication media are compared. Whether program materials should be exclusively professionally produced, or should also be created at the point of use by people who are essentially nonprofessional, is a standing issue among many media people, particularly in sound film, television, and to a lesser extent, filmstrip. Users of the printed page resolved this question decades ago with the acceptance of mimeograph, ditto, and later, the various photocopy devices. A large part of the printed materials used today consists of the relatively inexpensive, nonprofessionally produced forms. Although still regarded by book publishers as a threat, such materials appear to bear primarily a complementary rather than a replacement relationship to professionally produced books and pamphlets. These forms of the print medium have developed because the professional publishing industry could not satisfy the large variety of purely local, small-scale needs with anything near the inexpensiveness, the quick responsiveness to need, and the specificity of local production.

In using the word "local" in regard to the production of program software for the communication media, more is expressed than pertinence to a limited place or area. Local production of media materials implies production by persons with other primary responsibilities, who are generally considered nonprofessionals in the production field. "Central" production, on the other hand, connotes production by a staff of professional craftsmen: experts in camera, lighting, laboratory techniques, and all the other crafts that are required for professionalism in media program production. Generally, such production is centrally located in an educational system because it is expensive and must be spread over a wide base of use to find economic justification.

The terms "local" and "central" are of course relative. For example, a school district of a hundred schools may use some materials, such as

textbooks, which are produced in New York and distributed nationally; it may use certain state-produced textbooks; it may install television studios to produce and distribute instructional television (ITV) lessons throughout the hundred schools; it may, as in Chicago, cluster six or twelve schools with similar peculiar needs and use television to share the resources of the cluster; it may localize to the level of the school, or as in traditional self-contained classroom instruction, localize to the single teacher and classroom. There is production of media materials on all these levels, each being local in relation to the one above, each central to the one below.

Perhaps the most important point is that local production is not, generally, intended for reproduction and distribution but will exist in only one copy if intended for group use and in only a few copies at most if intended for use in the individual mode.

This limited use of one of the most valuable characteristics of a communication medium, its broad reproducibility, means that there are no great economies of scale which, when costs of production can be divided over a large base of users, bring the cost per user down. The limited use base in local areas limits the funds that are available for program production and hence the possibility of maintaining professional personnel and facilities.

Local production is not necessarily limited to places which do not have professional production facilities. Again, the distinction is not alone in locale but in personnel who do the production. On the same airbase, for example, which houses a professional central production unit, there may also be local production going on. There may be a particular instructor or curriculum development group who have obtained access to a portable substandard-gauge video tape recorder and camera and are using television in their own small and limited way to improve their own teaching.

This trend toward production of program materials by the unprofessional is being felt today in all levels and types of education. High-school and even elementary-school children are making their own animated films.

Both film and TV came into communication use out of a background of several decades of existence almost exclusively as entertainment arts. This is not true of the minor media. This background strongly affects our approach toward program production in film and television and to a large extent in the still-picture and sound media as well, where the attempt is often made to emulate the artistic effectiveness of the major media.

When film, and later television, was expensive and steeped in the tradition of the entertainment arts, central production of high-quality program software seemed to be the only possible approach. Production techniques were inevitably compared with those of the familiar commercial products, and any local attempts at film or television production were almost invariably found wanting. We are now emerging from that period. Today the appearance of inexpensive video-tape systems and the resurgence of 8mm film in the Super-8 form have begun to encourage production at the other end of the scale.

There is a continuum of costs, of complexity, and of certain kinds of effectiveness extending from the most elaborate to the very simplest production. It seems that the two ends of this continuum are receiving almost all the attention, however, while the middle, where the great future probably lies, is being largely neglected.

The production of materials for instructional media is thus usually undertaken under one of two conditions: great wealth or great poverty. The production of films, for example, when done centrally, with the whole nation (or the whole of a military service) as a base for distribution, can command traditional professional film budgets of $1000 to $1500 per program minute. At the other end of the scale, films are sometimes made by one instructor (or instructional team) for use in one course in one school on traditional amateur home-movie budgets where the cost of the film stock itself, a few dollars a minute, is considered the major item.

Since the present issue revolves about the usefulness of central versus local production, the two extreme ends of this scale, we will discuss some of the more obvious advantages and disadvantages of each. It is possible that intermediate methods could be found which could provide some of the advantages of both central and local production.

At the local level, there are needs which are specific to a given school or a given course (possibly even to a given instructor in some cases) and there are needs which are more general, common with other schools or other similar courses. The questions addressed here are, (1) Should local specific needs be met by local production or by central production? and (2) Should local common needs be met by local production or by central production? Under what conditions is local and under what conditions is central production best, and what criteria should be applied in making such judgments? These questions have been raised and are being debated in almost all areas where instructional media are used. Some of the advantages and disadvantages involved are enumerated below

Local production has the following advantages over central production:

1. Local production can respond quickly to local need. This is important, since needs often appear suddenly. The small number of manhours that go into local production make this response possible; and long periods of waiting for official approval at various stages in the process are not necessary. The production cycle for instructional films in some of the military services, for example, runs regularly as long as two years between local request and completion of central production. Local production of portable video tape, on the other hand, can be completed in a matter of days, or weeks at the very most.

2. Local production can be highly specific; production can be tailored directly to instructional needs. This is due to the intimate knowledge of these needs by the film producers (since they themselves are the requesters and the future users of the materials). It is also due to the rather limited range of these needs. A film produced centrally for national distribution, by way of contrast, must try to satisfy a much wider range of needs in order to interest a larger market.

3. Local production can be rapidly evaluated in practice and rapidly revised. A production may be put into immediate use, and after observation of its instructional faults and shortcomings revision can be made quickly. In the case of central production this procedure must often be done by several different groups of people at different places,

accompanied by such hazards as the vagaries of verbal communication and the inevitable delays.

4. Local production is more democratic. The tradition which upholds the right of every small town to its own school system, curriculum, and locally designed teaching materials is part of our democratic heritage. The same principle would be applied to the content of the instructional media if an even stronger principle, financial economy, did not conflict. Economic factor are primarily responsible for the national centralization of textbook publishing. So highly centralized has this instructional medium been that a few private publishers concentrated in an area of only a few square block in midtown Manhattan for many years designed and produced the printed learning materials for the majority of the nation's schools. The trend is now toward decentralization. The development of centralized production in the other media may be resisted. Local production of instructional television lessons, for instance, with closed-circuit distribution within a local school district, appears to be the preferred school approach to the ITV medium, given favorable conditions of adequate funds and local acceptance.

5. Locally produced materials tend to be better used. An instructor who has had a hand in planning and producing or has actually appeared in a local media production not only begins its use with a clear idea of how he is going to integrate it with other instruction but generally believes solidly in its value. He has an interest in its success and unconsciously does all he can to maximize its effectiveness.

The main disadvantages of local production are the following:

1. Local production is generally characterized by a low level of production quality. Since on-line instructional people are not generally skilled in the arts and crafts of media production, techniques are nonprofessional. Basic rules of film production may, out of ignorance, be breached. Lack of artistic skill or sensitivity may lead to very pedantic, very pedestrian results. On the other hand, this ignorance of traditional techniques can result in a naive freshness of approach that to the sophisticate, at least, may be appealing. To others it may just seem amateurish. However, it is a well-known principle of amateur production that the faults and shortcomings of a film are not

obvious to its maker. In the case at hand, it must be remembered, the film maker is also the user: He is his own sponsor and he will be the one to evaluate the product. This local pride often seems to rub off on the local learners whose instructor or instructional team have produced the material. It has been a frequent experience at institutions producing ITV lessons that tapes that have been considered highly effective in the local situation are declared unimpressive by instructors and learners elsewhere when they are offered for general distribution.

2. The costs of long-range-effectiveness evaluation, such as measurement of job-performance proficiency, cannot be justified for limited local uses. Following up on graduates for months after graduation cannot be done by the local instructional team. As a result, only terminal performance at the end of a course is used to evaluate instruction and the effective use of the medium chosen.

3. Local production, specific to local need, generally has low commonality. This is the obverse of high specificity, discussed above as one of the advantages of local production. Low commonality/high specificity is also a disadvantage as well. If it is ever desired to make locally produced materials available to other instructional centers, it may be found that their specificity to local needs lowers their commonality and makes them less useful over a range of situations.

There is a possibility that the first of these disadvantages, nonprofessional production technique, is not as serious as it may seem. It may sometimes be found that the nonprofessional techniques which characterize local, low-cost production will actually add a plus value to their use elsewhere. It might also be found that these local crudities make no particular difference in instructional effectiveness, if "effectiveness" is defined as the degree to which measurable cognitive learning changes can be effected.

There is also a possibility that the third disadvantage, lack of generality, may not be as serious as it would seem. When local needs are met by local production, and well met because of a quick evaluation-feedback-revision cycle, these same needs will probably be well met wherever in instruction they may occur. Thus if another training center has

some of the same needs in common, materials produced at the first center may satisfy very well that set of common needs and be useful and acceptable to the other center.

The local versus central production controversy is not an either/or question, however. It may be possible to do both local and central production and achieve the advantages of both. It is suggested that low-cost local production of instructional aids and instructional media be encouraged as much as possible. The resultant materials will stand the maximum chance, thereby, of being developed and validated quickly and have maximum value in meeting the specific local instructional needs. Materials so developed, if successful in local use, should then be examined for general applicability. If they are found to have usefulness elsewhere, the materials could be remade, following the validated and successful pattern but utilizing professional techniques, quality graphics, etc. thus making them acceptable and useful to other schools.

Perhaps the question of effectiveness of production techniques may be resolved by the argument presented below. Bloom lists three kinds of learning objectives--cognitive, psychomotor, and affective.[14] When the instructional media are used for cognitive objectives only, which is most of the time, it is necessary that the information which is to be conveyed be well organized, the subject developed in small enough steps so as to be understandable to the intended learner but developed rapidly enough for each learner so it is not boring. Beyond this it is only necessary that what is to be seen is recognizable, what is to be heard is audible, what is to be read is legible, and that there are not too many extraneous stimuli to distract the learner from attending to the message.

Objectives requiring the development of psychomotor skills outside of the normal repertoire can only be fully attained through practice, and the presentational media can contribute very little in this regard. It is mainly in the introductory aspects of skills instruction that media are useful, and that is because the objectives at that point are actually cognitive. One has to know what it is that he is learning to do, and why; he has to observe the kinds of responses he is intended to learn before he can begin to practice and learn them.

It is in changing people's attitudes that the media are again useful, and it is in the achievement of these objectives that artistic techniques can play their most important role. Only to the extent that affective objectives are involved in cognitive instruction does production technique contribute to the effectiveness of knowledge lesson presentations.

So those who argue that the broadcaster's art can make an important contribution to instructional television are really arguing (1) that there are some hidden affective objectives mixed up with the obvious cognitive ones, or (2) that even though there may be no stated affective objectives connected with the instruction, if artistic techniques are used, the learners will be in some way affected and that instruction will be enriched by the achievement of these unstated and unexpected affective behaviors.

The producer/artists, working in the broadcasting tradition, are experts in the art of moving peoples' emotions. They are skilled in techniques which create drama, involve the viewers, and hold them in suspense until the situation is resolved. They know how to create visual pleasure through pattern design, arrangement of light and shadow, and use of line; they are aware of the subtle connotations of style in lettering, graphic layout, set design, and other visual elements. They believe that the emotional attitude toward a subject that such artistry can evoke will remain with a person long after the program has been forgotten.

Not all educational television or film producers, of course, are such artists. Many simply follow rules of technique that they have been taught and succeed only in coating the program with a veneer of artistry without penetrating its content. It is not that the surface is unimportant, but simply that surface technique alone is meaningless. It is not how the performer looks, but what he does and says that is important. Nevertheless, how he looks doing or saying it can significantly enhance its effect.

Most producers feel they know more about how to achieve attitudinal changes in people than educators or instructors do, or at least they feel they are unique in being dedicated to that end. Thus, they view

their role in the creation of instructional materials as an obligation to add affective objectives to the goals of the communication, even though such objectives have not been specified or planned prior to the production of the program. By so doing they believe they can create better instructional materials which will indirectly increase cognitive learning by increasing its motivation.

There is probably much truth in these opinions. Unfortunately, since the effects they claim lie in the realms of art, aesthetics, and the affective domain, they are not always amenable to empirical study and validation. The researcher will say "Yes, very possibly, but can that be demonstrated?" Uncomfortably, attempts by researchers to find evidence to support the case for artistry have not been successful. Therefore, the instructional designer is in a position to choose either approach. If he dislikes or can't afford production values, he can point to the paucity of research findings which link artistic values to measured learning. If he is committed to the artistic approach, he can point to the same lack of evidence and to the frequently conflicting indications of the evidence available and conclude that his artistic intuition, having been successful in the past, will be his best guide in his present endeavor as well.

Local versus central production is a big issue in the production of films and television programs; in all likelihood, it will make itself felt in the program production process of other instructional media as well. This issue is most likely to arise, however, in the media which are already mass media in their entertainment function: television, radio, audio disc and tape, and to some extent the printed page. It will be the least likely to arise in the purely information media, such as the microform file systems, and the individual transmission media, teletype and facsimile. Where there is the minimum possibility of designing and arranging space and time, or eliciting empathic responses with other humans, in media where no one has yet seen artistic techniques being used, no one will miss artistic qualities. In the other media, however, it is possible that local production, however effective it may be in achieving instructional objectives, will continue to be a lively issue.

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