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ABSTRACT

This collection of five articles presents the viewpoints of experts on various aspects of the field of instructional technology (IT). Wesley C. Meierhenry traces the history of IT from its original emphasis on audiovisual media to its current concern with instructional design and the use of systems and systematic approaches. Henry T. Ingle presents a menu of new information technology developments and suggests some implications for IT professionals. The history of IT research is reviewed by Vernon S. Gerlach, who questions the validity of research focusing on the superiority of individual nonprint media over books and other types of media, as well as the utility of computers for instruction. He calls for disciplined research and increased attention to the behavior of instructional developers. Robert K. Branson cites and reviews the significance of several cases involving applications of instructional systems technology to training problems associated with business/industry and government/military institutions. Barry Bratton and Kenneth H. Silber note some recent changes in the field and efforts to discipline and upgrade IT professionals through certification and accreditation. They conclude by relating their observations to recent national critiques of education and indicating changes in IT performance and career goals that may result. (BBM)

TRENDS IN INSTRUCTIONAL TECHNOLOGY

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TRENDS IN INSTRUCTIONAL TECHNOLOGY

James W. Brown
Editor

ERIC Clearinghouse on Information Resources, Syracuse University

1984

The five articles that appear in this ERIC Information Analysis Product (IAP) also appear as Part I, "Trends in Instructional Technology," in the *Educational Media Yearbook 1984*. This IAP is being published under a special arrangement with Libraries Unlimited, Inc., Littleton, Colorado.

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FOREWORD

One of the most frequently asked questions at the ERIC Clearinghouse on Information Resources is, "Where is the field of educational technology going?" It is an appropriate question and the right place to ask it. For a response to be useful it is usually necessary to ask, "In regard to what?" Many people want to know about cutting edge technologies and others are concerned about professional directions. Some are trying to spot the significant breakthroughs that have a potential for revolutionizing education and some are searching for new ways to perform traditional tasks.

The response to the trends question is different for different people with varying interests. Rarely have collective insights been brought together to give a sense of direction for the entire field. When we at ERIC/IR saw this need and the special role we have in fulfilling it, a logical step was to seek out the best people we could find and ask them to give us the benefit of their insights. Trend means "to extend in a general direction; to veer in a new direction." It is that direction that we attempted to find by commissioning this monograph.

We asked one of the best known and widely respected educational technology authors to put together a team of specialists who would responsibly communicate their sense of trends in areas in which they possessed some expertise. Dr James W. Brown has been the coordinator and senior author of the publication. He has drawn on people who complement each other as they give us a sense of where the field is going: the historical overview—Dr. Wesley Meierhenry; research—Dr. Vernon Gerlach; business/industry/military settings—Dr. Robert Branson; telecommunications—Dr. Henry Ingle; and the likely future of the field, Dr. Barry Bratton and Dr. Kenneth Silber.

This group of educational technology professionals has provided sufficient wisdom to answer most of the questions but they also raise new questions which will need to be addressed by others in the field. Educational technology is a dynamic field—always moving and changing. In this monograph we have stopped the motion with a "photograph" of the present and a hint of the future. Read it to see where you fit into the picture.

Donald P. Ely
Director, ERIC/IR
June 1984

INTRODUCTION

James W. Brown
Editor, Educational Media Yearbook

If we are to believe only some of what we read, we must conclude that ours is truly the Age of Information.

We have already come to regard this condition with only a modicum of awe, almost with equanimity. We are impressed with our ability to produce, manipulate, control, and use the informational data provided by the nothing-short-of-miraculous tools and resources that accompany the Age. New industries and new curricula have sprung up to help design, produce, sell, operate and service them.

Newspapers are filled with information about these latter-day "miracles"—the computers of various persuasions from the fairly simple to the incredibly complex, holography, filmless cameras, videodisc players, videotape recorders and players, data banks and information networks, two-way satellite broadcasting, and more. The list seems interminable; it grows daily in length and complexity. Our children and young people, who are usually unappreciative of what life was like in "the good old days," take these marvels in stride. It is those of us who are somewhat older who find them a bit threatening, at times, to a style of living and working to which we have become accustomed and attached.

The rationale for this Information Analysis Product (IAP) began in a statement that relates to these concerns:*

> Educators want to know: what is the status of educational technology? They hear about the latest innovative and future prospects and wonder how they will fit into the scene. This monograph will pick up those 'threads' of new hardware and software as well as the 'movements' and 'indicators' which seem to be currently prevalent. Emphasis will be focused on the trends which are emerging from past efforts, e.g., instructional television, instructional design and development, the "small media," and the manifestation of programmed instruction in the current computer movement. The changing role of the media specialist/instructional technologist will be considered.

The five articles that follow in this IAP attempt to treat these concerns:

- **Meierhenry** traces briefly the history of instructional technology from its earlier origins as an effort to bring realism to teaching and learning--and thus avoid the pitfalls of "verbalisms"--to the present day, with its emphasis upon instructional design and the use of systems and systematic approaches.

- **Ingle**, who comes from Project BEST in Washington, D.C., has had recent, up-to-date, first-hand experience with the "cutting edge" developments he talks about in his article. He presents a menu of new information technology developments and suggests their professional implications. Change seems inevitable; instructional technology professionals must also change and give more consideration to "what is, what [illegible]ld be, and what will be" in our field.

- **Gerlach** reviews the history of research in instructional technology. He casts doubts on the validity of earlier efforts that concentrated heavily upon attempting to prove

*As presented in a publication proposal by Dr. Donald P. Ely, Director, ERIC Clearinghouse on Information Resources, Syracuse University.

the superiorities of individual nonprint media over books and strictly verbal messages and over each other as well. He questions the utility of computers for instruction, but ends on a note of optimism that calls for disciplined research and for increased attention to the behavior of instructional developers themselves.

- **Branson** cites and reviews the significance of several real-life cases involving applications of *instructional systems technology* (IST) to training problems associated with business/industry and government/military institutions. He analyzes, especially, the economic aspects of such training as compared with less disciplined approaches of the past. Finally, he wonders why IST techniques and principles have not been used more in education than they have been in the past, and predicts that they will be.
- **Bratton** and **Silber** note some of the many changes that have occurred recently in the field of instructional technology, and efforts of the field to discipline and upgrade its members through certification and accreditation. They relate their observations to the several significant recent national critiques of education, and point also to ways in which performance and career goals of instructional technology professionals may be changed as a result. They note, especially, the increasing interest of the business/industry and government/military sectors in using the services of those professionals.

A Brief History of Educational Technology

Wesley C. Meierhenry
Professor of Education
Teachers College, The University of Nebraska—Lincoln

Review of seminal works dealing with the history and development of educational/instructional technology or educational communications yields a number of new insights and understandings of what has occurred and what continues to occur in the field—and why.*

One problem in dealing with historical developments in the field of educational/instructional technology is to separate research activities from other movements. Although historical trends and research are intertwined, aspects of the latter are left, here, to their more complete discussion in Gerlach's paper, which follows.

Definition of the Field

So far, the reader will note that the writer has referred variously to "the field," "instructional technology," and "educational communications." Whether it is an advantage or a disadvantage to label a field or discipline in these multiple ways is open to question. A more precise title would enable individuals to determine more easily the nature and parameters of the field and to make judgments regarding who or what ought to be within it or outside of it. But a disadvantage of such precision could be that the explicitness itself might limit and make more difficult accommodation of new developments occurring within the field.

It should be recognized that transition in the use of terms applicable to a professional field sometimes provides help in examining its historical development. This observation seems to apply especially to the field which is the province of this article (Ely, 1983, p. 2-4). As intimated, there have been many differences of opinion as well as much confusion as to what it should be called. In a 1963 publication (Ely, 1963, pp. 18-19, 36) dealing with definitions, the term "audiovisual communications" was used and defined, although in the rationale for supporting that definition it was indicated that the *process* concept should be used rather than the *product*. In the 1963 publication, reference was also made to Hoban, who suggested that a broader concept was needed to define the field; he preferred *educational technology* or *technology in education* (Ely, 1963, p. 13). In the *Definition and Glossary of Terms* (Ely, 1977) educational technology was chosen as the broad and inclusive term and instructional technology was defined as a subset of educational technology. Educational technology was defined as:

> A complex, integrated process involving people, procedures, ideas, devices, and organization, for analyzing problems and devising, implementing, evaluating, and managing solutions to those problems involved in all aspects of human learning.

Instructional technology was defined as:

> A sub-set of educational technology, based on the concept that instruction is a sub-set of education. Instructional technology is a complex, integrated process involving peo-

*Three publications, especially, provide helpful information about the field discussed here: Saettler's *A History of Instructional Technology*; the AECT Task Force on Definition and Terminology publication: *Educational Technology: Definition and Glossary of Terms, Vol. I*; and Gerald Torkelson's "AVCR: One Quarter of a Century."

> ple, procedures, ideas, devices, and organization, for analyzing problems, and devising, implementing, evaluating and managing solutions to those problems, in situations in which *learning is purposive and controlled.*

There were 16 additional parts of the definition of educational technology which the authors said must be taken as a whole since no one of the 16 parts alone was adequate. Nevertheless, the definition of educational technology emphasized the *process* of producing human learning while instructional technology gave greater attention to the *product* necessary to produce purposive learning.

As Ely (1983, pp. 1, 3) recently pointed out, the definition established by the Presidential Commission on Instructional Technology (note "instructional technology," not "educational technology") has been perhaps more widely used because of its brevity and succinctness. It is as follows:

> [Instructional technology] is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication and employing a combination of human and nonhuman resources to bring about more effective instruction. (Commission on Instructional Technology, 1970, p. 21)

One would assume, therefore, that by 1983 the issue of the definition of the field would be settled and no longer an issue. However, as recently as 1977, Torkelson wrote the following:

> You have probably noted that references have been made to "the field" instead of to some neat encompassing name. Certainly "audiovisual" is not an appropriate term for the field. It is currently passe and does have limitations. But to say categorically that the field is instructional technology or educational communications is a dilemma which I don't think the "field" has completely resolved. References are often made in AVCR to professionals being instructional technologists. Yet, the new format of AVCR will be titled *Educational Communication and Technology*, a recognition of two principal conceptual frames for the "field." It seems to me that there ought to be a resolution of the hierarchical relationships among these and other terms that are used to describe the field. (1977, p. 318)

Perhaps Ely aptly describes the current situation:

> There appears to be no hue and cry for a new or revised definition of educational technology. It could be that the silence connotes satisfaction with the definitions which now exist. It could be that there are more important matters before the community. It could be that those who were so vitally concerned with definitions are tired and have moved on to other projects. There is a Definition and Terminology Committee of AECT, but there do not seem to be any major issues on the agenda. (1983, p. 3)

In turning now to certain historical developments of the field of educational technology, it should be said that although an historical flow may usually be expected to be continuous, a more episodic approach is used here. For purposes of ease of presentation and discussion, the various developments noted have been divided into time frames of roughly 1932-1959, 1960-1969, and 1970-1983, as explained later.

Period from 1932-1959

Saettler developed the theme that instructional technology has two quite different philosophical and theoretical bases: one is the *physical science* concept (media), the other is *behavioral science* which followed several decades later. He discusses the physical science concept of instructional technology as follows:

> The physical science concept of instructional technology usually means the application of physical science and engineering technology, such as motion picture projectors, tape recorders, television, teaching machines, for group presentation of instructional materials. Characteristically, this concept views the various media as aids to instruction and tends to be preoccupied with the effects of devices and procedures, rather than with the differences of individual learners or with the selection of instructional content.
>
> * * * * * * * * * * *
>
> The most influential theoretical notion embodied within the physical science concept of instructional technology is that which casts materials (audiovisuals) and machines (still and motion picture projectors, etc.) in nonverbal roles and some of the more traditional media (lectures, books) in verbal roles. The assumption underlying this view is that nonverbal media are more concrete and effective, and that the perennial villain in the teaching-learning process is "verbalism."
>
> This rationale has led to an abstract-concrete dichotomy which is, in fact, no dichotomy at all, since both verbal and nonverbal media and/or signs vary along an abstract-concrete continuum. It is not true, for example, that the pictorial is inevitably "real" or "concrete." It can be highly abstruse and abstract. What is more, whether we speak with words or pictures, we must abstract if we are to generalize or develop concepts about the world in which we live.
>
> * * * * * * * * * * *
>
> The physical science concept of instructional technology has been accepted quite generally by practitioners in the audiovisual movement and by the electronic communications industry. Since the early 1900s, such terms as visual aids, teaching aids, audiovisual aids, visual instruction, audiovisual instruction, audiovisual materials, audiovisual communication, audiovisual technology, and many more have been used to designate a group of machines and materials. (Saettler, 1968, pp. 2-3)

Because of the dominance of the physical science theory base—at least up to the early 1960s—the history of the field has been linked to "things," "products," and media. It also accounts for many of the earlier texts and other publications justifying the use of audiovisual materials or media by presenting models of the abstract-concrete continuum. There also was inherent in the movement an emphasis on "verbalism" and on how the lack of understanding of word meanings could be overcome by the use of audiovisual materials. (Wittich & Schuller, 1953, pp. 43, 70) A clear embodiment of this thesis could be found in Dale's "Cone of Experience" (Dale, 1954, p. 42; see Figure 1).

It was to Dale's credit that he did not attempt to establish a dichotomy between concrete and verbal symbols. Rather, he regarded them as parts of a continuum. But the "Cone of Experience," which was presented to hundreds of thousands of educators over a period of more than a decade, may have served to retard acceptance of a somewhat newer theory base for later use of media. A particular weakness of the cone, from the point of view of moving the field forward, was its emphasis upon separate kinds of media or technologies rather than upon a more nearly total instructional planning process.

Two other developments may be seen to have contributed to the fixation of the field upon media. One was described by McClusky as follows:

> One factor which characterized general overall thinking about the use of the new media in education, at top policy-making levels, was specialization in the production and ad-

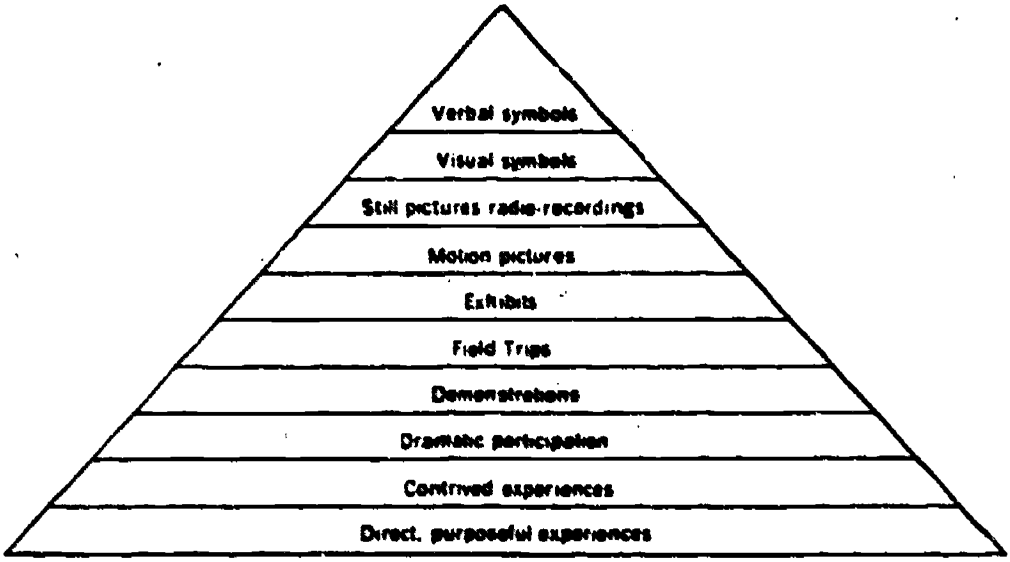

Figure 1. Dale's "Cone of Experience."

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> ministration of instructional media. At the outset, following the turn of the century, commercial interests producing media for school purposes centered on one or two media. Many companies still do. Certain companies made blackboards, others produced slides, some produced motion pictures, others concentrated on maps and models, one centered on sets of slides and stereographs, others produced slide-films, and some specialized in recordings.
>
> Parallel with specialization by producers of media there was specialization in the administration of instructional media. For example, New York State's Division of Visual Education collected and distributed lantern slides only. The St. Louis Educational Museum concentrated on exhibits. The University of California's Department of Visual Education in University Extension distributed motion pictures only. In a number of universities, the department of visual instruction was in charge of the distribution of motion pictures and another department was charged with education by radio. During the 1930s, there was at one time a national association of visual educationists, a national association of educators specializing in school excursions, and a national association of those in charge of education by radio. As time went on, there were those who administered audiovisual materials under one central unit and who tried to develop a rationale for the value and place of each device in instruction.
>
> The commercial interests competed with each other for the school's dollar and in so doing sold their wares under the overall label "visual education." All this fragmentation was confusing to teachers and administrators. To some, visual education meant the motion picture, and to others, visual education centered in the museum. The competition was between things rather than ideas. As a result, the advancement of instructional technology on the whole suffered. (Saettler, 1968, pp. 79-80)

A second phenomenon which contributed to a focus on the medium itself was and is the geographic location of professional preparation programs. There was not (and still is not today) a single place in the United States where one could become proficient in all types of instructional technologies and/or combinations of them. For example, motion picture production has roots in cinematography, slides in art, field trips and exhibits in museums, and radio in speech and communications. Today's situation is even more dispersed: videodisc is located in television, microcomputers in mathematics, and computer science and television in communications.

Saettler, in *A History of Instructional Technology*, published in 1968, foresaw the behavioral science approach to instructional technology:

> Today there is an emerging *Zeitgeist* that an applied behavioral science approach to the problems of learning and instruction is fundamental to instructional technology. Thus the basic view of the behavioral science concept of instructional technology is that educational practice should be more dependent on the methods of science as developed by behavioral scientists in the broad areas of learning, group processes, language and linguistics, communications, administration, cybernetics, perception, and psychometrics. Moreover, this concept includes the application of engineering research and development (including human factors engineering) and branches of economics and logistics related to the effective utilization of instructional personnel, buildings (learning spaces), and such new computerized machine systems as data processing and information retrieval. (1968, pp. 5-6)

Thus, an era was ending in theory (if not in practice)—one that held that the important aspect of instructional technology was the *medium* or the *product*. In contrast, the new era just beginning placed emphasis on *process*, with particular attention to how learner behavior or performance is changed or modified.

Period from 1960-1969

Several phenomena contributed to the massive theoretical shift with regard to instructional technology in the late 1950s and early 1960s. Perhaps of greatest significance was the 1957 launching of Sputnik. This event refocused the attention of all the world, particularly that of the United States, on how critical the development of technology was to survival. Schools came under criticism (as they have again in the mid-1980s) for failure to teach sufficient amounts of science and mathematics and for being too easy on students.

Thus, the stage was set for emphasis on technologically oriented instructional systems which would produce more competent and proficient learners. As a consequence, at least two theoretical constructs came together to affect the field of instructional technology. One was the strong influence of behaviorism on all learning approaches; a second was "system approaches," which came from engineering and technology and which were involved in such technological feats as launching satellites.

The technological development which came from these two diverse but nevertheless complementary theoretical constructs was programmed instruction (PI). The behaviorist movement brought with it the development of behavioral objectives, since, in using PI, it was necessary to specify what behaviors were desired and to develop a system of reinforcements to produce them. This movement changed the emphasis from the medium to the learner and to the learner's behavior. Pure behaviorists did not believe it was necessary to use any medium outside of print materials since they reckoned that a verbal response was tantamount to one's being able to perform. Skinner, in response to a question from the writer, for example, indicated his perception that audiovisual materials or media are not necessary for changing behavior and that they may in fact interfere with learning.*

Along with this emphasis upon producing learner behavior came the holistic view of the "learning cycle," which began with specification of learner behaviors and concluded with evaluation and recycling (repeating the procedures and experiences) as needed to meet

*Personal interview, B. F. Skinner and W. C. Meierhenry.

minimum specified criterion measures of success. Early programmed instruction proponents held that some type of teaching machine was necessary to make this cyclical process operable. Though some educators regarded teaching machines more as glorified "page-turners" than anything else, widespread belief in their efficacy continued. It was not until the mid- and late 1960s that Susan Markle began to present the view that programming was a process and not a product. It is this latter view that comes close to being defined as "instructional technology."

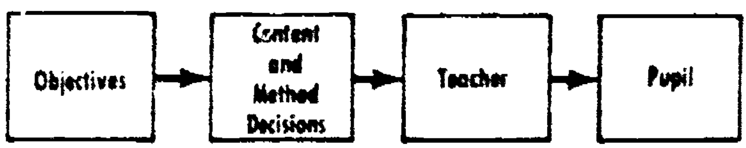
One major problem of the programmed instruction movement was that it failed to give attention to all applicable disciplines in the behavioral sciences—to sociology and anthropology, for example. Rather, its approach was almost exclusively from psychology. Had other disciplines been involved with the development of the movement, perhaps it would not have faded out almost as soon as it started and more attention would have been given to such elements as useful social interaction.

But the programmed instruction movement exercised then, and still does today, a profound influence upon the field of instructional technology. As a matter of fact, the definition of instructional technology developed by AECT in 1977 included the phrase "in situations in which learning is *purposeful and controlled*" (italics in original text) (Ely, p. 3). Thus, even this definition, produced almost fifteen years after programmed instruction peaked, still included the concept of "control" of the learner's behavior.

The PI movement has gradually merged into a conceptual framework called "instructional systems." The original PI model examined the instructional process as a whole but unfortunately, as pointed out earlier, it focused on the program and the teaching machine. Instructional systems was much more process-oriented with a focus on a systematic approach to instructional design and development. Thus, the process by which one solved the learning problem was primary; design and development were secondary. The instructional systems approach is still very evident in the packaging concept and in such approaches as Postlethwait's audio-tutorial systems (Postlethwait et al., pp. 1-114) and in the Keller Plan known as the Personalized System of Instruction (PSI).

Before leaving the 1960-1969 era, attention should be called to an early position paper edited by Barry Morris (1963), which was prepared in 1962 by a DAVI task force. Perhaps because of the overriding influence of the PI movement at the time, the significance of this paper seems largely to have been overlooked. The Morris group conceptualized four types of instruction: Traditional Instruction; Media Function No. 1; Media Function No. 2; Media Function No. 3; and Instructional Systems—as follows:

Traditional Instruction. The direct teacher-pupil relationship as a means of organized instruction may be thought of in terms of this diagram:



This is the traditional arrangement, and although printed materials, chalk, and a few other devices come into play, there is no real technology involved.

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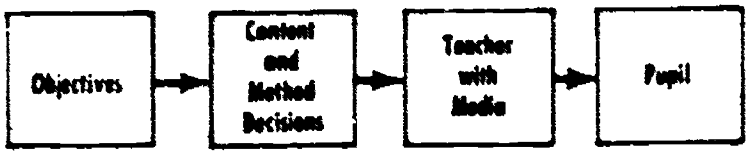
Media Function No. 1. The first function of technological media is to supplement the teacher through enhancing his effectiveness in the classroom.



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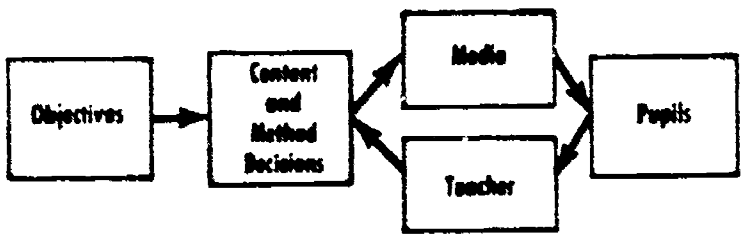
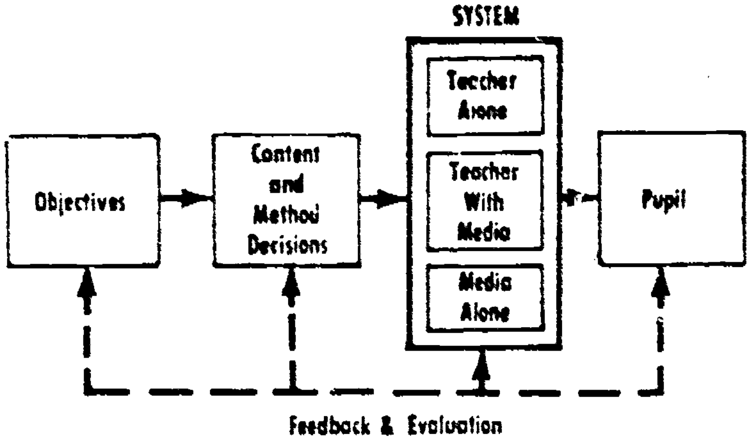
Educational media are both tools for teaching and avenues for learning, and their function is to serve these two processes by enhancing clarity in communication, diversity in method, and forcefulness in appeal. Except for the teacher, these media will determine more than anything else the quality of our educational effort.

Media Function No. 2. Some teachers have begun to utilize another channel for learning in which the media alone may present and, in a sense, teach certain content to pupils.

Here, the teacher determines objectives, selects methods and content, and evaluates the final learning outcomes. The presentation of information, and even the direction of routine pupil activities, may be turned over to such new media as programmed learning materials, television, or motion pictures.



Instructional Systems. The newer media have led us to a new approach to instruction. This is a scientifically developed combination of instructors, materials, and technological media for providing optimum learning with a minimum of routine personal involvement by the teacher. The result is a carefully planned "system" consisting of subject matter, procedures, a media coordinat d in a program-unit design which is directed toward specific behavioral objectives. A variet f learning channels are combined in such a system. Decisions as to where and how to use teacher presentation, discussion, media presentation, programmed learning sequences, or other channels will be made in terms of what and who is to be taught.



It was unfortunate for the instructional systems movement that the impact of this position paper was lost because of other events and movements. Although the instructional systems approach dealt with such elements as behavioral objectives, it was much more of a cognitive and conceptual model that might have served the instructional technology movement better than the strictly behaviorist approach.

Period from 1970-1983

The period from the late sixties to the early seventies was one of upheaval in our society as well as in other parts of the world. It was characterized by student revolts in educational institutions and by rejection of many traditional values. So far as the impact of events during this period upon instructional technology is concerned, there was a rejection by youth of all forms of technology; much more emphasis was placed on personal and humanistic matters. Also, there was insistence that goals and objectives should not be determined externally but rather internally. As a result, the use of behavioral objectives often met strong learner resistance.

Although the 1977 AECT definition of instructional technology included the concept of a system controlling learning, the field was less and less committed to such a theoretical construct. Even the 1972 definition proposed by the Presidential Commission on Instructional Technology, cited earlier, was much less behavioristic in nature and emphasized only the systematic manner of designing, carrying out, and evaluating the total process of learning and teaching.

Toward the end of the seventies there was a reemergence of the cognitive approach in instruction. Many psychologists were proposing the cognitive approach, including Wittrock, whose views—first articulated in 1978—are indicated, in part, below:

> A cognitive approach implies that learning from instruction is scientifically more productively studied as an internally, cognitively mediated process than as a direct product of the environment, people, or factors external to the learner. The approach involves understanding relations or interactions between the learners' cognitive processes and aptitudes, such as attribution, motivation, encoding, memory, cognitive styles and cognitive structures, and the characteristics of instructional treatments. The cognitive movement thus brings a unity of interest to people who study individual differences, learning, and instruction, and a unifying synthesis to many recent research findings. It also encourages research on comprehension, understanding, and transfer, several areas of fundamental importance to education.

* * * * * *

> From this point of view, the art of instruction begins with an understanding and a diagnosis of the cognitive and affective processes and aptitudes of the learners. From these one designs different treatments for different students in different situations to actively induce mental elaborations that relate previous learning and schemata to stimuli. In this conception the learners are active, responsible, and accountable for their role in generative learning. (Wittrock, 1979, p. 5)

It is evident that such an approach to learning places more emphasis upon the internal structuring of experience than upon the external determination of objectives and the shaping of behavior to meet those objectives.

Current Situation, 1983

The current situation is somewhat confused as to the theoretical underpinnings of instructional technology and especially the place of media in it. Some of the more recent writings would be in complete opposition to the posture taken by pioneers in the audiovisual field. For example, Salomon has published two books (1979, 1981) in which he explores media as symbol systems which interact with the cognitive, social, and psychological aspects of learners. Such a theoretical approach supports the idea that media must be viewed more as agents for presenting information than as direct stimuli for given responses. Clark is even more explicit about the lack of media attributes:

> We cannot validly claim any advantage of one medium over another when student achievement is the issue. Media do not contribute to learning any more than the vehicles that deliver experts to a problem-solving conference contribute to the expert's understanding of the problem or to the eventual solution of the same. The choice between instructional mediums is based simply and finally on their capacity to carry the intended message and our resources. (1982, p. 60)

Torkelson adds to this perspective when he says:

> If we accept current conceptualizations of learning as information processing and the idiosyncracies of learners as crucial factors in receiving, processing, storing, and retrieving of information—then what logically become the functions of media?
>
> First, we must dispel the notion, as Clark has indicated, that media are the primary agents that promote learning in and of themselves. Media, in fact, act primarily as agents for providing information.
>
> * * * * * *
>
> Considering that teaching may be likened to information presentation and learning likened to information processing, terminology to express these conceptualizations ought to reflect this broader orientation. Given this need to name generic conditions, for the past decade or so I have been urging the use of the terms *message, message forms* and *message carriers* as designators for the broad spectrum of information and information transmission systems. *Messages* encompass any and every kind of information that one person may wish to transmit to any other person. *Message forms* also include a subcategory of codes or signs that combine to give the message substance or to which the learner must attend as sources of information. Codes are such things as lines, edges, color, texture, shape and so on, which learners use to differentiate forms and kinds of information. (1983, p. 6)

These discussions of the place of media in instruction are a far cry from the idea in the earlier audiovisual era that the medium was paramount. They also represent a point-of-view very different from McLuhan's view that the medium is the message (1964, pp. 23-35).

Conclusion

It remains difficult to assess the future theoretical and applied directions of instructional technology. Will cognitive psychology dominate—with emphasis upon learner experiences and individual learner characteristics? Will the individual learner have considerably more responsibility than now for structuring experiences in meaningful and productive ways? Will it be widely believed that instructional media are really no more than message carriers and that their form, delivery mode, or tendencies toward abstractness or realism are unimportant in producing learning?

It may have been quite unfortunate that the field of instructional technology did not examine and apply more extensively than it did the earlier communications model for the field. Torkelson (1977, pp. 323-327), for example, points out the great emphasis on the encompassing nature of communication in early issues of the *AV Communication Review*. Such individuals as Finn, Gerbner, Ely, Mielke, Lasswell and others urged its use. But it was rarely applied in practice. If more attention had been given to such a communications base in the fifties, the powerful impact of behaviorism might not have dominated the field as it did and a more productive, holistic view of the instructional/learning process might have developed.

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Cutting Edge Developments in Educational Technology: Prospects for the Immediate Future

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In the Indian culture of Central America, young children who experience difficulty in falling asleep because of the day's worries or anxieties about tomorrow are often given a small, colorfully painted wooden box containing tiny wooden doll figurines. According to the folklore and legend, Guatemalan children are taught that if they take out such a doll each night and tell it their particular worries or troubles, the worry or problem will disappear by dawn. There are two cautions, however: a child may only have as many worries as there are dolls in the wooden container, and only one worry or problem may be addressed each night.

This piece of Guatemalan folklore, and the analogy of the wooden dolls, holds implications for the field of educational technology because here too, there are new developments, all problematic in nature, which must be addressed one by one. These include the:

1. ·ecreased use of *mass* media (radio, television, and print) in favor of *personal* media .g., the video cassette recorder, the microcomputer, and related interactive :hnologies) in the instructional process, and a growing importance of the value and utility of information as a commodity which an individual, on his own, can assess, create, or exchange electronically via the new information media;
2. Increased use of the new information media in various management and administrative functions of education (e.g., the electronic grade book, budget spread sheets, attendance, and equipment, class and bus scheduling, or inventories), and for professional information exchange and networking (electronic mail) in addition to direct classroom instruction;
3. Gradual blurring of distinctions between and among communications media, as new technologies integrate various attributes of old media to form new types of information products and services that are accessed via existing media (the telephone, television) readily available in the home, the school, and at work;
4. Greater simplicity in the design of technology and media products so that their use, availability, and affordability make more logical sense for educational practitioners;
5. Growing trend toward the development of more locally, tailor-made, and custom-designed media products targeted for needs of specialized key audiences and teaching-learning requirements (e.g., bilingual education, the handicapped, women, the elderly, vocational instruction, or computer literacy);
6. Concerted push for information media competence and technological literacy as a critical basic education skill for students, teachers, and administrators; and
7. Moving of educational technology out of the media center into classrooms and homes, and into the hands of teachers and students, as opposed to only the AV or media specialist (e.g., "grass roots" computer-using educator movement).

Unlike problems children lay to rest with the tiny Guatemalan doll figurines, these seven new problematic developments will not disappear with the dawning of tomorrow. Their significance is much more enduring; their collective convergence on the field of educational technology is destined to have a lasting impact, both in the redefinition of the profession and of the competency requirements of those engaged in it, and in stimulating a wider acceptance and accommodation of the educational system to new media practices.

Behind these new directions and developments is an evolving array of technological innovations popularly known as "the new information media," or "cutting-edge" technologies. Included in this array are such communication media and technology applications as satellite broadcasting; the microcomputer; the videodisc; new cable television formats; audio, video, and computer conferencing; interactive video, filmless cameras, teletext and videotext; electronic mail, automated information networks, local distribution networks, digital telephone networks, and telecommunication modems; the use of discs and chips as information storage technology; and much more.

The growing presence of these new information tools in education stems in large part from the boom in home marketing and use of technology. To quote John McAllister, marketing vice-president for the Zenith Radio Corporation:

> Nearly 14 million color TV sets were sold in the U.S. last year. But there is more to it than that. It also means that the TV set is no longer just a TV. It has become a multiple display terminal for the 10 million video game units, 5 million personal computers and 30 million cable connections in American homes. (Morch, 1984, *Scene* p.1)

The growing presence of these new information tools in business, home, and educational settings gives shape to what some have described as "one digital world in which transmission, processing, computing, storage, and switching of voice, pictures, and data will be inextricably intertwined, both in communications facilities and in their use" (Pierce, 1980, p. 624). Consequently, the technological prospects for the immediate future are promising, as are the implications of these cutting-edge developments for the educational technology profession itself.

The New Information Media in Focus

The New Information Technology in Education (Hawkridge, 1983, p. 18) presents characteristics of a model that establishes four principal functions of new information technology: making, sending/receiving, storing, and displaying information. *Making* information is sub-divided into creating, collecting, selecting, and transforming. The *sending* of information is, of course, complemented by the receiving of information and the capacity for both human-human and human-machine interaction to take place on a real-time and delayed basis, and at the convenience of the sender(s) or receiver(s), which new electronic technologies now make possible.

The figure on page 14 (Hawkridge 1983, p. 18) summarizes these characteristics and provides a useful framework for putting the significance of the new information media in focus.

Integration of these communication functions into a number of technological devices has given life to the information society and to a series of explosive developments in electronic information exchange, both for instructional and professional purposes. Such integration holds significant promise as a mechanism for responding to education and training needs of society, and in the process may become a major influence on the way society generates, obtains, uses, and disseminates information in work, in teaching and learning, and in leisure.

In education, the new information technology already provides opportunities to learn in more than one medium and to distribute education and training to students, both

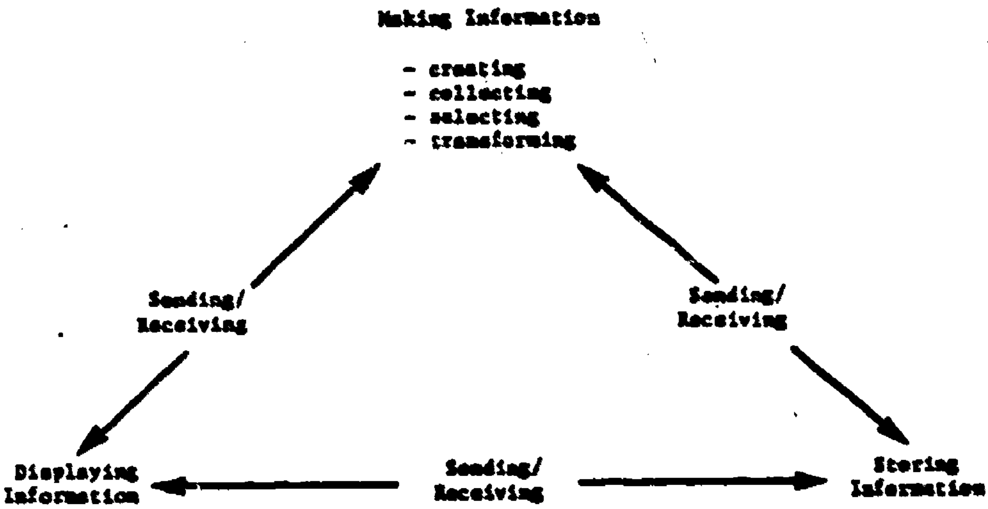

Figure 1. A Model of Functions of New Information Technology

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geographically and over time, in the home, at work, in a hospital, or in other locations within reach of a telephone, an electrical outlet, or a television monitor.

In a report on the role of new information technology in education, released in 1983 by the Office of Technology Assessment of the United States Congress—*Informational Technology and Its Impact on American Education*—information technology is defined to include communication systems such as direct broadcast satellite, two-way interactive cable, low-power broadcasting, computers (including personal desk top computers and the new hand-held computers), and video technology (including videodisc and videotape cassettes). Among the multiple conclusions of the OTA Report is the observation that "the full range and form of the technologies are yet to be determined, but it is most likely that hardware and software developments will be integrated to form new, yet to be specified, types of information products and services that will blur the traditional distinctive characteristics between and among media" (p. 5).

The OTA report concludes that although it is impossible to predict which of the new technologies and information media are likely to surface as priority items for educators, for the foreseeable future, information technology will continue to undergo revolutionary changes. Leading these new developments will be "the microprocessor—an inexpensive, mass-produced computer on a chip" that will "become ubiquitous in the home and office—not only in the easily identifiable form of the personal computer or word processor, but also as a component of numerous other products, from automobiles to washing machines and thermostats" (p. 5). High-speed, low-cost communication links will be available in such forms as two-way interactive cable, direct broadcasts from satellites, and computer-enhanced telephone networks. Illustrative of these latter developments is the array of telephone options now provided by the reconstituted American Telephone and Telegraph Company (AT&T). Cary Pepper, in an article on the subject (1984, p. 49), describes this future available today:

> AT&T now offers phones that remember. The TOUCH-A-MATIC 1600, which sells for about $160, features a key pad similar to automatic banking machines and uses computer technology to dial up to fifteen numbers automatically at the touch of a button, including three color-coded emergency numbers. It also offers one-touch redialing of the last number called, features a display screen that tells you what number you are dialing, the last number dialed, and any of the programmed numbers (called reper-

tory numbers), continuously flashes the time and date and has an automatic timer for clocking calls (and anything else), up to 99 minutes and 59 seconds.

At the top of the new AT&T phone line is the Genesis telesystem. Its key pad provides one-touch dialing of ten repertory numbers, and its console has a twenty-character display screen that can also be used as an electronic scratch pad to jot down numbers or make notes during a conversation. You can also put calls on hold, make calls without lifting the handset and have others listen in on the conversation via a built-in speaker. Snap-in cartridges and modules leave room for updating the Genesis as new innovations come along and currently provide the extra flexibility of call-waiting, call-forwarding, an electronic phone directory, and an electronic padlock for security. The Genesis, which works with both rotary and touch-tone phones, is available for about $350, with add-on cartridges selling for about $40 each.

Also from AT&T are emergency call systems that guard your home against fire by tying in with smoke detectors and automatically calling for help if a fire breaks out and a medic-alert system that enables a sick or disabled person to call for help at the touch of a button.

Such developments in telephone technology also make possible many other changes in educational technology embodied in the use of the microcomputer for electronic information exchange and networking, as well as related interactive video products facilitated by enhanced telephone networks. New video technologies, such as the videodisc and high-resolution television, are now being integrated to form new and unexpected types of information products and services, such as videotex and online information retrieval systems that can be provided over telephone or air waves directly to the home (OTA, 1983, p. 5).

Challenges to the Educational Technologist

If the picture of the information society presented by the OTA report is one that we can accept, what, then, is in store for educational technology in the near-term future? Which cutting-edge developments of tomorrow are already here today, or at least just around the bend? What should we be doing so tomorrow does not just suddenly take educational technologists by surprise?

First and foremost, much like the Guatemalan doll analogy, we must focus attention on just a handful (perhaps no more than six or seven) of the new technologies and not be overwhelmed by the complete galaxy of electronic apparatus, as well as the requisite software, which the crystal ball forecasts.

Second, educators, together with instructional technology professionals, must determine what the new technology will require of them and what they will expect of the new technology. The stage of development is such that both the technology-developers and the technology-users influence and determine its future applications today.

Among the handful of technological developments with which we should be most engrossed, given the demands they place on education today in terms of changing both what we *now know* and what we *must know* to continue full participation in modern society and our profession, are the following:

1. Micro- and hand-held computers and their use for such purposes as *electronic mail* and professional information exchange and networking;
2. Interactive video technologies, including the videodisc, videotex, and teletext; and
3. Satellite teleconferencing, involving audio and video, as well as computer conferencing—all of which will see increased use in an era of shrinking educational travel budgets and increased air fares.

It is rather ironic that these three technologies, often viewed as luxuries in the past, are likely to become necessities in a period of economic difficulty which causes us all to work more and more with a "priority and tight budget" mentality. Consequently, educational technology is likely to move out of its "frills and luxury" stereotyped image of the past, as higher priority is placed on transporting information and ideas, rather than people, from one place to another.

In addition to their growing influence in the redefinition of knowledge and requisite education skills, the above three categories of new information technologies are important for other reasons. Each has the potential to make the acquisition of information and knowledge in a variety of formats, and for all types of organizations and groups, much simpler, less costly, and perhaps more enjoyable.

The Microcomputer

By means of a microcomputer one can perform a variety of tasks—such as printing, calculating, completing business and budget transactions, drawing visuals and graphics, communicating long distances over telephone lines with a variety of groups and individuals; writing, editing and re-editing drafts; or storing and accessing information from magnetic tapes and diskettes. A particularly good illustration of the microcomputer diskette capability as an information storage and delivery resource is SOFTIE, the informational diskette on microcomputer software products in mathematics, science, and language arts for grades K-12. Developed by the staff (Ingle, 1982, 1983) of Project BEST (Basic Education Skills through Technology) at the Association for Educational Communications and Technology (AECT), in cooperation with six school districts across the United States and the ERIC Clearinghouse on Information Resources at Syracuse University, the SOFTIE diskette permits individual microcomputer users to screen an inventory listing, description, and evaluation of instructional microcomputer software being used by schools. The SOFTIE diskette also is a current example of developments cited earlier in this article—namely, a move away from mass media to an individual, personal control of media; the trend toward the use of this new information technology for professional information exchange and school management/planning; and the placing of the technology in the hands and direct control of the classroom teacher or technology-user.

Other important microcomputer peripherals like a "modem" enable individuals to plug their microcomputers into a telephone network that links one computer to another via telephone lines and to a "disc drive." The latter allows one to save data for later retrieval on "floppy discs" or diskettes which resemble small 45 rpm phonograph records. The modem, in turn, leads to electronic mail services such as BEST NET, the successful two-year effort of the U. S. Department of Education and AECT to link State Education Agencies electronically via a network of microcomputers, for the purpose of exchanging information on current practices and classroom experiences with microcomputers. The BEST NET electronic mail system (reincarnated in January 1984 as TECH NET, a commercial electronic information network for educators) is an "electronic highway" used to gain access to a variety of important groups, ideas, and current practice and experience in applying the new technology. The use of electronic mail is a further example of efforts to make computers and humans communicate with one another in an easy, enjoyable, and cost-effective manner. It also underscores a trend which blurs distinctions between and among media; print formats, the telephone, the television monitor and the microcomputer are joined to permit people to transmit and receive messages that can vary from one or two words to several pages with a content that covers a wide range of issues, concerns, and work activities.

Other useful applications of computer technology are embodied in the *hand-held computer*, which "is somewhat larger than a normal pocket calculator and contains a microcomputer chip and sufficient memory to allow simple programs to be entered and run; it sells for only a few hundred dollars" (OTA, 1983, p. 44). A promising short-term future application of this instrument is its use as an inexpensive terminal. The OTA study report suggests that:

> The hand-held computer could also be used in conjunction with a communications network connected to one or more larger computers. In an educational setting, for example, students might use their personal hand-held computer by itself wherever possible. For assignments that require more capacity, the hand-held computer could be linked over a phone line to a larger system at the school. (1983, p. 45)

Video Technology

The near-term future of educational technology also will likely see a host of important developments in video technology. These new developments will form the basis for information products and services that are already revolutionizing telecommunications, and seem likely to cause a number of "technological mergers" as these technologies integrate.

Described below are several new video information services that promise considerable growth in the near future. The list is not complete, of course, because it is impossible to predict "how entrepreneurs will use these new capabilities to bring innovative communication services to the home, business, and school market place" (OTA, 1983, p. 49).

- **Filmless cameras.** A photographic tool "which combines video and computer technology to 'write' a picture on a very small, reusable floppy disk. . ." (Ely, 1982, p. 9). Developed by Sony, these cameras operate electronically and the pictures they produce may be viewed on a television screen.

- **Videotex.** Videotex is the term used to describe an online, video-based system for the electronic transmission and viewing of text and graphics on a standard television set. It permits users to select particular materials they desire to view. In its *teletext* form, it permits one-way interaction, while in its *videotex* form two-way interaction is possible. With the videotex systems, literally hundreds of pages of materials may be accessed; captioning services are also supplied for the benefit of hearing-impaired persons, as well as database services such as CompuServe and The Source. It is predicted that, by the 1990s, more than half of all American homes will be able to use videotex services.

- **Electronic delivery services.** Services such as the electronic delivery of newspapers and magazines, at-home shopping and banking, electronic mail services, and accessing of information networks (BEST NET, BET NET, DEAF NET, ED LINE, SPECIAL NET, SPIN, The Source, CompuServe, and others) also are likely to become more common as outgrowths of this new video technology. No doubt they will be combined with existing cable television systems and low-power television, satellite delivery, telephone lines, and computers to provide a variety of new "teleservices." Major communication companies such as The New York Times, Times Mirror Corporation, and AT&T are already involved with experimental demonstrations in this area using principally cable and telephone transmission. A $5 billion to $10 business in this field is predicted by the end of this decade. (Green, 1983, p. 31)

- **Videodisc technology.** One last video technology which educators need especially to understand better is the videodisc. Already growing in use, the videodisc itself resembles a phonograph record. It permits the storage and playback of a variety of graphic, video, and television programming; it is best described as an "encyclopedia" for the storage of video and graphic images. The instrument currently functions as a durable, inexpensive tool for the storing of and random access to large amounts of data and programs. Videodisc has elicited much interest from the educational community because of its library storage capacity and for its capability for being linked to a microcomputer under an interactive control mode. With the advent of laser light technology and with decreasing costs, the videodisc is likely to play especially significant educational roles in libraries and in industrial and military training.

Teleconferencing and Computer Conferencing

Interest in teleconferencing has increased considerably as a result of curtailed travel budgets and the energy crisis. Among its various forms are audio bridges and one-way and two-way video over a satellite (including such networks as the PBS ConferSat service involving the nation's 285 public television stations); the PSSC (Public Service Satellite Consortium); HI-NET (the Holiday Inn's satellite transmit/receive network for meetings); and BIZNET (the U.S. Chamber of Commerce teleconferencing service).

Teleconferencing is a technique which permits multiple individuals or groups of individuals who may be separated geographically literally thousands of miles from each other, but who are joined electronically, to exchange two-way video and audio information and to have interactive question-and-answer sessions as well. To accomplish these things, a variety of technologies—everything from telephones and microwave relays to satellites, computers, and print support materials—are used. For example, an audio teleconference brings together three or more parties through regular telephone lines for a simultaneous group conversation on what may be termed a giant "telephone party line." Audio conferences generally are effective when a video or visual component is not necessary or is too costly to provide. It is here where other media, such as print packages mailed beforehand, facsimile transmission, teletyping, or slow-scan video, can be used to augment the audio. Another option, cited by Green and currently used in a number of educational settings in higher education, is the electronic blackboard which "translates strokes on a pressure-sensitive surface into electronic signals, sends them over phone lines, and reconverts them on a TV monitor at the other end" (1983, p. 49).

In the simpler video teleconferencing format, the most commonly used technique is one-way video, which is considerably cheaper to use than the two-way type just described. Video conferencing involves the simultaneous transmission of television or video signals via satellite from one central location to participants at any number of sites across the country who have access to a satellite down-link.

With the advent of the microcomputer and a telecommunications modem, teleconferences are also now being convened by interconnecting microcomputers in a network linked via telephone lines, a computer communications software package, and their telecommunications modem. As the number of microcomputers in schools increases, no doubt computer conferencing will become considerably more common than it is today.

Educators are becoming convinced of the values of teleconferencing partially through such recent efforts as those of Project BEST (mentioned earlier). As a complement to the BEST electronic mail system, the Project also used audio, video, and computer conferencing to convene 45 state education teams over a period of two years (an average of one teleconference every two and one-half months), for a collective sharing of their experiences in handling technical assistance needs of their schools, particularly as they face the introduction of new information technology. Project BEST responded to a unique problem in education today: the absence of a knowledge or research base to support users of the new information technologies (microcomputers and interactive telecommunications). Continuing changes in hardware and software, and in their resulting applications, generate an ever-expanding base of new information. But most of this information is at the level of *current* *experience*, not research. What educators need, as perceived by the developers of Project BEST, is to have ways to tap and stay in touch with this changing base of personal experience. Telecommunications (interactive audio and video teleconferencing and electronic mail; fixed videotape media) of several types were brought to bear on the problem. The content of most of the information that moved through these links dealt with microcomputers, since participants viewed them as their most serious concern.*

Reflective observations of the Project BEST staff about its experiences illustrate the importance of an earlier exhortation in this article advanced as a guide to the educational technology profession. Namely, we, as professionals, mus learn more precisely what this new technology will require of us and be prepared to meet those requirements. And we must also draw conclusions from research and from perceptive "hands-on" experience with the new technology about what we, as users, expect of it.

Conclusion

It has been predicted by a number of privately and government-funded national educational study groups that by the year 2000, over 80 percent of all instruction and instructionally-related activities will make systematic and consistent use of the new information technology just described. Electronic learning is indeed just around the corner and George Orwell's 1984 is with us today as part of a multi-billion dollar information revolution that shows no signs of abating. Those of use who design, produce, now use or manage these new information tools and their associated software must recognize their diverse capabilities and multiple applications, both big and small. In the process, we must realize that today, more than ever before *change* is what our profession is all about. Like the constantly changing state-of-the-art in the technology itself, we, too, must be constantly changing and reflecting on *what is*, *what could be*, and *what will be* in our field.

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*A number of interesting observations, generalizations, and guidelines evolved from the Project BEST experience in teleconferencing and electronic mail. They have been reported in the Project's final documentation to the U.S. Department of Education and, more recently, in two articles by the Project BEST staff and Associate Director, Lewis A. Rhodes (see Rhodes, August 1983; October 1983).

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Trends in Instructional Technology Research*

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In an effort to find a point of departure for this chapter, I asked a number of associates for their perceptions of the state of research in instructional technology. Since my ability to construct survey instruments is virtually nil and my ability to interpret survey data is considerably less, it seems only logical that I share the more-or-less unrefined data with the readers of this article.

Question 1: What do we know?

Answers: (1) Very little. Some things work sometimes with some learners under some conditions. Corollary: You can't fool all of the people all of the time. (2) Learning is a function of methods, not of media. (3) Media, at best, establish different learning conditions; media, at worst, do nothing or even inhibit learning.

Question 2: What don't we know?

Answers: (1) What are the criteria for discriminating between good and bad research? (2) When should we use which medium? (3) How do learners organize and interpret language? (4) How does one translate research into practice? (5) What elements of the systems concept are necessary in instructional development? (6) Can learners be taught to use learner-control effectively? (7) Can "intelligent" CAI be effective? (8) What makes an authoring system effective? (9) Is there a conceptual framework that provides a structure and rationale for research in our field? (10) Does it pay to spend any more time researching imagery and media attribute questions?

Question 3: Where do we go?

Answers: (1) Format variables (type size, white space, line length, etc.) in learning from CAI. (2) The events of instruction and their effects on learning and instruction. (3) Naturalistic research methods. (4) Issues of affect and metacognition. (5) The systems approach. (6) Escape from the computer craze.

Actually, I have two reasons for beginning the chapter in this manner. First, although the responses reveal a considerable diversity, there are some very interesting common concerns. The other reason is that I think these informal answers to even less formal questions provide an interesting backdrop against which to project the conclusions found at the end of this chapter. Put somewhat differently, I hope that when you come to the end of the chapter, you will return to read these questions and answers once more.

In his "From the Editor" column of the Fall 1983 issue of *Educational Communications and Technology Journal* (*ECTJ*), William Winn wrote, "Good journals can also survive

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changes in the basic paradigms that guide scientific inquiry, as *ECTJ* has done in the past." Readers of that journal are aware that it reflects a paradigmatic shift in basic research. But whether that or any other journal in our field has reflected a change in the type of research related to instructional technology, as opposed to basic research, is the question that we shall examine in this chapter.

What Is Research?

Tuckman (1978) defines research as a systematic attempt to answer questions. If we accept this definition, which is more or less equivalent to the definitions given in most texts on educational research, we need to adopt or develop a method for classifying questions. It seems reasonable to assume that the classification of research questions requires a continuum, not a dichotomy. Perhaps this is a partial explanation of the fact that research professors find that teaching students to identify, to say nothing of formulate, a research problem is the most difficult step (Tuckman, 1978).

The difficulty is compounded when we consider such topics as basic vs. applied research, action research vs. engineering research, historical vs. correlational research, and descriptive vs. causal-comparative research. Even if agreement were reached on which of these are critical and which variable attributes of the concept research, we would still face difficulties. Sooner or later, we must confront problems such as evidence and interpretation, either or both of which may affect the way a question is formulated or categorized.

If one wants to study research trends in instructional technology, one must have a method for classifying questions. Perhaps that method ought to permit a finer-grained classification than yes-no. First, however, we must consider the context in which the research is conducted.

What Is Instructional Technology?

If scholars like Ely (1963, 1983) and Silber (1970) could not answer that question definitively, certainly this author cannot. Nevertheless, some boundaries must be established. It hardly needs repetition, but audiovisual education and media technology are not synonyms of instructional technology. More than a decade ago a colleague and I wrote that instructional technology is the application of scientific knowledge to the production of useful instructional materials, devices, systems, or methods, including design and development of prototypes and processes (Gerlach and Kearns, 1973). That description is nothing more than a paraphrase of the National Science Foundation (1965) definition of *development*. During the past decade I've found it necessary to make only one change in that description: the word "scientific" seemed unnecessarily restrictive, so I've dropped it. I shall explain later why I think that kinds of knowledge other than scientific may be applied to production, design, and development.

What Is the History of Research in Educational Technology?

I have selected eight reviews of research as the source of data for answering the question "What has research in educational technology produced?" Or, if we cannot find a definitive answer to that question, we should be able to identify the kinds of questions that have been studied.

Torkelson (1977) summarized the trends in both research and theory for the 25 years before his review. His data source was the research reported in *Audiovisual Communication Review* (now *Educational Communication and Technology Journal*). Asserting that we do have a body of theory, he argues that it has not been and is not now adequate for organizing inquiry on any agreed-upon path. Most research failed to gather evidence about the effects of systematically varying the internal structure of media. Although Torkelson doesn't say so explicitly, it seems fair to conclude that the research he reviewed was not addressed to the study of legitimate problems. Research wasn't asking the right questions. He argues for studies of the effects of such variables as (1) coding systems and information forms, (2) attention focusing structures, and (3) iconic and propositional information systems. He also argues that greater attention must be given to the problem of selecting appropriate research methods for these three kinds of studies. As we shall see shortly, Torkelson is not the only reviewer who contends, or at least implies, that something was wrong with the methods used by most researchers who published their findings in the professional journal of the media and instructional technology field.

In 1980 Wilkinson published a review of 60 years of research dealing with media in instruction. On the basis of the reports covered in his review, one would have to say that there is no discernible cause-and-effect relationship between instructional media and pupil learning. Media are passive agents, or vehicles, not active agents in the learning process. In a critique of Wilkinson's review, Clark (1982) points out that the most serious shortcoming of research for those 60 years is that the questions asked were, in the main, the wrong questions. (Later we shall look at the kinds of questions Clark considers right and wrong.) However, Clark does recommend the purchase of the Wilkinson review; the purchaser should think of it as a pamphlet handed out at a funeral; it details the life and death of media research before affording it a decent but very final burial.

Research in educational psychology and research in instructional technology overlap. Consequently, it is essential that we look at reviews in the former field to ensure that all significant trends are examined. Glaser's (1979, 1982) two summaries, the first dealing with "schooling and learning" and the second with "instructional psychology," present a less pessimistic picture, but he is looking at a different dimension. Many of the studies he examines deal with how pupils learn, not with how instructional technologists must behave (i.e., perform) if they are to produce effective products and programs. Like Clark, he argues for rigorous attention to the kinds of questions we investigate. However, much of what Glaser advocates lies in the domain of the educational psychologist. If one believes that educational psychology and instructional technology are distinguishable in practice, then Glaser's suggestions don't provide guidelines which the *instructional technologist* can use to validate a choice of research questions and methods of studying it.

Two reviews of research in instructional technology that appeared in the *Annual Review of Psychology* merit our attention. Resnick (1981) used specific elementary and secondary curriculum areas, while Gagne and Dick (1983) concentrated on identifying the threads of inquiry in broad or generally psychologically oriented areas that cut across subject matter categories. According to Resnick, research in instructional technology is now largely cognitive. She cites six recent edited volumes in support of her characterization of instructional psychology as a part of cognitive science. Although her review does not include such topics as instructional design or instructional technology, it is, I think, a fair representation of the kind of research people in our field are beginning to do. Those who aren't doing this kind of research are quoting it, generally with approval. The problem is that the development of instructional design models and the validation of prescriptions for development do not evolve from research involving direct instructional interventions. Unfortunately, most of Resnick's citations are illustrative of that kind of research.

Gagne and Dick assert that theories of instruction ought to provide, at least, "a rational description of causal relationships between procedures used to teach and their behavioral consequences in enhanced human performance" (p.264). Simon (1968) defined design as a linking science between theory and practice. Gagne and Dick maintain that most instructional theorists say that their efforts fall into what Simon calls sciences of the artificial;

they do not view their work as primarily a design activity.

Models of instructional design, according to Gagne and Dick, are a distinctly different matter. The model builder's aim is to identify efficient procedures for designing instruction; although some do, most model builders don't concern themselves with causal relationships.

The review by Gagne and Dick is particularly relevant to our discussion because it emphasizes the proposition that there is a noticeable difference between research aimed at producing a theory of instruction and research that produces a model for instructional design. The aim of the model builder is to identify and describe procedures for designing instruction. Historically, the model builder has rarely attempted to discover causal relationships between (1) design rules or prescriptions and designer behavior or (2) designer behavior and instructional products/programs or (3) instructional products/programs and pupil learning. There are virtually no published records of research that attend to the chain of events from design prescriptions to products/programs to learning.

Two reviews by Clark (1983a, 1983b) merit our attention. In the first, he says that research directed at finding the best instructional method for all students has been nonproductive at best, counterproductive at worst.

This assertion is interesting in the light of research that shows the near impossibility of finding aptitude-treatment interactions in which instructional methods are consistently good for well-defined groups of learners. Is it possible that research will ultimately lead to the conclusion that the validity of instructional methods cannot be demonstrated? Clark concludes that research in our field has not progressed to the point at which findings can be used to solve instructional design and development problems. Why not?

Clark contends that for the past two decades researchers have not exercised adequate experimental control over such variables as content and type of learner. His assessment of the published research is that, in terms of desired learning outcomes, few studies show marked success or failure; most show equivocal, largely uninterpretable, results. Worse, the few studies that do show positive results are, because of design errors, susceptible to rival hypotheses. In his list of the kinds of research that are minimally beneficial, the media-learning question holds first place. So what does he suggest?

He says that we must place a greater emphasis on prescriptive research and theory. Instead of focusing on a single explanation of how pupils learn (e.g., a basic theory of learning), instructional technologists ought to try to develop sound, empirically-based generalizations about how pupils might learn, given realistic constraints and goals. His description of kinds of problems worthy of our research efforts does deserve careful consideration. Among other desirable trends, he lists research in analogies, keyword trends, transfer technologies, and mental processes underlying inductive reasoning.

Clark's (1983b) *Review of Educational Research* article is a meta-analysis of the research on learning from media. It is not just another look at the research literature that Torkelson and Wilkinson reviewed. The article is too compact, too tightly written to permit any useful precis in this chapter. I believe that most readers would agree with the reasoning that leads Clark to conclude that there is no evidence that media are a causal factor in pupil learning. In fact, he goes farther than that. He says that "symbol systems or attribute theories seem to be of limited utility in explicating the necessary conditions that must be met by effective methods." He also says that "recent studies dealing with learner attributions and beliefs about media seem particularly attractive even though there are no media variables in attribution research. . . . It seems reasonable to recommend. . .that researchers refrain from producing additional studies exploring the relationship between [illegible]a and learning unless novel theory is suggested" (p. 457).

Occasionally there are indications that some educational technologists are interested in research that is based on nontraditional models. Titles of papers delivered at recent American

Educational Research Association and Association for Educational Communications and Technology conventions provide tentative evidence that some researchers prefer, for example, philosophical foundations for a design and development model. One symposium at the 1983 AECT convention dealt with naturalistic inquiry and evaluation. Another dealt with the question of whether or not instructional development is a design science or a clinical discipline. (Unfortunately, few of these presentations are available in writing at the present.) One sees the same kind of unrest in other, older disciplines. There is a tendency to decrease the emphasis on numerical data. The tools of experimental psychology, which formed the basis for much of the training for most researchers in instructional technology, no longer seem to be perceived as the infallible instruments of discovery that they once were. Indeed, it is this scholarly questioning (in many disciplines) of the absolute infallibility of scientific methods that has led me to drop the word "scientific" from my own definition of instructional technology. It seems to me that we are at a point in history when we must question the notion that only those who deal with *discovered* (i.e., scientific) knowledge should be admitted to the forum of scholars; it is possible that experts in *received* knowledge or *constructed* knowledge might have something significant to tell us about finding valid answers to valid questions. For instance, there are fragments of an organic or holistic bias or foundation in several modern theories of sociology or social philosophy that stress progressive change in several, if not many, disciplines. Perhaps instructional technology should begin to attend to those few faint voices that are suggesting we consider alternative paradigms if we are to escape the paradigmatic level that the reviewers cited have found wanting. It is beyond the scope of this paper and the ability of this writer to suggest exactly how this could be done. However, I shall describe a limited departure from tradition and I shall review efforts that several of my associates and I have undertaken that represent a tentative foray into a kind of research that has a different focus. But before we leave our consideration of what was and what is in instructional technology research, we need to look at the state of the art in the computer realm.

What about Computers?

The most comprehensive review of research in computer based instruction available at the time of this writing is the summary by Kearsley, Hunter, and Seidel (1983). In the main, computers in schools have two functions: to deliver drill-and-practice on low-level paired associate learning tasks or to provide an atmosphere within which pupils acquire high-level cognitive skills usually described by the term discovery or inquiry. In one sense, the latter hardly warrants comment because the supporting research is subject to the same criticisms that the reviewers cited in the third section of this chapter leveled at media-learning research. The fatal flaw in the discovery-inquiry method is the assumption that subverbal insight is superior to verbal insight, that generalizations aren't "fully" understood unless the learner discovers them autonomously, and that pupils can learn best by imitating the activities of mature scientists. As one reads the Kearsley et al. review, one wonders how many of the writers they cite have encountered any of the research literature that shows the loss of time in discovery learning, that demonstrates the effectiveness and efficiency of expository teaching, or that shows the optimum instructional strategies for dealing with the acquisition of subject-matter content, learning problem-solving skills, or mastering a scientific method. Granted, studies do occasionally show that pupils learn different things from discovery and expository methods; the evidence, however, is not conclusive enough to permit meaningful generalizations.

It's important to bear in mind that the Kearsley et al. review concentrates on research published since the advent of the microcomputer. Of the studies cited, 46 were published from 1959 to 1978, 55 since then. Theirs is indeed a review of *current* literature. With that kind of evidence at hand, they conclude that none of the potential benefits of computers are inherent in computer-based instruction (CBI). What does make CBI effective in the cases when a positive effect has been shown? "Dedication, persistence, and . . . good teachers. . ." (p. 94). Their first conclusion: "While technology can be a tremendous multiplier of good ideas, it does not, in itself, produce them" (p. 94).

Other conclusions of these reviewers: (1) We know little about how to use CBI to individualize instruction. (2) We do not know much about the effects of major instructional variables underlying CBI; for instance, we must rely on intuitive guidelines regarding the use of graphics in CBI because research doesn't show what, if anything, they contribute to the learning process. (3) Research does show that there is a need for new courseware development tools and techniques. The corollary is that computer courseware is bad at the moment. (4) We have barely scratched the surface of what CBI can do. (5) Twenty years ago the same issues were being discussed that are being discussed today.

Kearsley et al. are heartened by their belief that the level of discussion today is much more sophisticated than it was years ago, even though the issues are the same. I disagree. The deficiencies that Torkelson and Clark identify in media research are present in CBI research. Wrong questions are asked. Wrong methods are used. Wrong conclusions are drawn. The student of the history of education doesn't find this surprising. It happened with films, with television, with programmed instruction. As evidence of this fact, consider this quotation from the report of a series of research studies on programmed instruction:

> Our research experience has led us to question the external validity of much of the corpus of currently available self-instructional research. Manipulation of such variables as response mode, stimulus presentation techniques, step size, etc., are indeed of interest. But so long as investigations are conducted without adequate controls of classroom contingencies which likely account for greater variance than the main effects being investigated, the results can have little value. The most likely practical outcome is "no significant difference." The few significant differences that are isolated stand little chance of being generalizable to other situations. (Schutz, Baker, and Gerlach, 1964, pp. 129-130)

Written 20 years ago, this sounds as though it might have been taken from the Torkelson or Clark reviews.

However, there is one characteristic which makes CBI unique. There is an inordinate emphasis on the phrase "research shows" in computer magazines and journals. When one looks at the source, four things become apparent. (1) The citations for the research basis of the assertions are rarely given. (2) Most of the references to research do not actually report research; rather, at best, they consist mainly of theoretical discussions, assertion, wishful thinking, descriptions of existing courseware or programs, and enthusiastic but completely subjective testimonials regarding the glories of computers in education. (3) As Clark discovered when examining the evidence on media in an earlier era, the few reasonably well-controlled areas of research in CBI show negative results. (4) Those few studies that do report positive findings either fail to control the really significant variables or employ questionable analysis. History does repeat itself; Ausubel (1968) found the same shortcomings in the research on creativity in school learning. As he said then, we might say today: the enthusiasts for CBI have been supporting each other research-wise by taking in each other's laundry and by generalizing wildly from equivocal or even negative findings.

Why does this phenomenon occur over and over? Schutz (1982) offers some interesting observations. He identifies four stages of innovation: (1) A technological innovation is hailed as a panacea for all of education's ills. (2) Shortly thereafter, a few "minor" problems surface, but the driver of the bandwagon assures us that success is just around the corner. (3) As more and more deficiencies become evident, it becomes apparent that the innovation is really a failure that never got started. But rather than admitting that they perpetrated a media hoax, the bandwagon drivers now jump off, blaming the schools for "foolish expenditures for items that now are sitting on shelves." (4) The cycle begins again with the advent of the next technological innovation.

While it is extremely difficult to establish a historical point of reference while history is in the making, it seems that we are in stage two with computers in education and possibly in stage one with videodisc technology. It seems to me that there is a close parallel between the four stages of technological innovation and the stages that characterize research in educational technology.

Whether computers are "any good" or not remains to be demonstrated. The research to date indicates that their usefulness is restricted to highly specific situations. Even then, the effectiveness and efficiency of CBI are somewhat limited; when CBI does "work," we simply don't know why. In that respect, the computer is nothing but another medium in a long list of media. That it escaped the Wilkinson interment is due only to its recent birth. However, CBI will probably continue to flourish as long as three conditions are met: (1) The profession ignores the fact that the body of research that undergirds efforts to broaden computer use in schools is extremely thin. (2) The profession ignores the total absence of research concerning the educational value of available courseware. (3) The marketing of hardware without waiting for the development of validated software continues to pay rich rewards to the hardware vendors.

Can Research Lead to the Development of Models?

The essence of training in instructional technology is the production of professionals who design and develop demonstrably effective products and programs that are replicable. In terms of research, design and development of instruction or training is a problem. It is generally assumed that this problem can be solved by a proper application of knowledge. If a solution is published, there ought to be some likelihood that the solution will be effective for either more than one user or for more than one example of the class of problems for which it was formulated.

One exemplary instance of this kind of research is the Merrill and Tennyson (1977) model for developing instruction for learning concepts. Their book presents detailed step-by-step procedures for designing and developing instructional materials of a defined class. The entire set of prescriptions was tested and validated in a series of six research studies; citations for and abstracts of these studies are included at the end of the book.

Their effort is unique and, I think, laudable because the authors were concerned with the behavior of the instructional technologist. They used knowledge of how learners attain or acquire concepts. They translated this knowledge into rules for designing instructional materials. They cast these rules into the form of a set of instructions, or a model. They tested and revised the model. They carried out a summative evaluation. The net result is a design model based on research for a rigidl_ specified set of instructional problems.

The work of Merrill and Tennyson led to the conception of a paradigm which my associates and I used. We assumed that a pressing need in instructional technology is the development of rules or prescriptions so powerful that, when applied by a developer in an appropriate context, they will be instrumental in the forging of effective and efficient solutions to instructional problems. In a sense, the paradigm that we employed demands that we look at the *behavior of the developer* as the dependent variable. The knowledge (i.e., the design rules) generated during the inquiry is the independent variable which ought to cause the developer to perform in a desired manner. Stated differently, a behavioral objective is attained when the design rules elicit a desired developer behavior. Some standard or criterion of that behavior is needed. That criterion is stated in terms of the level of performance of the learners who use the developer's product or program.

This paradigm requires the developer to generate rules or procedures that will shape another developer's behavior. This is the new knowledge which is expected of a disciplined inquiry. The test of this knowledge lies in its successful application to the solution of a previously unsolved instructional problem from a precisely defined class of problems.

At least three examples of research-development based on this paradigm have been reported: Cooper (1983), Israelite (1984), and Ingram (1984). Cooper and Ingram each developed and tested a model for the design of instruction for a different kind of non-mathematical problem solving. Israelite developed a model of formative evaluation in which learner self-evaluation data was used instead of traditional paper-and-pencil test results. The result of conducting this kind of inquiry should be an increasingly powerful body of procedures arrived at by methods that are epistemologically defensible.

Conclusion

Research is like tennis. The proposals of Torkelson and Clark and my own suggestion for a different paradigm are nothing more than an attempt to play a good game with the net up; without a net, anyone can perform all kinds of meaningless prodigies. As instructional technology moves from adolescence to adulthood, it must manifest signs of maturity. One of these signs will be a change in the kind of research conducted. If accepted inquiry follows exclusively and forever what was done in the past, it runs the risk of becoming a parochialism. This is the opposite of disciplined inquiry, which is perhaps difficult to master, but which, once mastered, unites all its initiates in a common pursuit and a shared beauty.

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Instructional Systems Technology in Business and Industry

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If you seek a full range of appropriate and excellent applications of instructional systems technology (IST), go first to those examples that can be found in business, industry, military, and government environments. In recent years, the number of really competent practitioners of IST has increased dramatically and they continue to do truly creative work. Consequently, it will be necessary here to generalize and synthesize the available literature to highlight the more important recent developments in the field. I hope to clarify the context in which those applications are made and to compare developments in educational situations with those in industry.

To start with, it is useful to distinguish the "hardware" from the "software" of IST. In a given use of IST, the "technology" in itself might not be what the word usually conjures up: Many applications of IST require no machines, no computers, no electricity, none of the "hardware" we usually identify with "technology." In itself, IST is a "software." It is an approach, a method, a system-oriented procedure—a "program," if you will. People who use the "program" of IST successfully are able to choose the best kind of "hardware technology" to meet given instructional situations.

Thus, a textbook employing the latest strategies for improving learning from text is a proper application of IST. So is a well-designed lecture. On the other hand, many people today are using "hardware technology" in education without systematic planning or special knowledge of how that hardware can be used effectively. The results, though they might employ the latest in videodiscs, microcomputers, and other hardware, may well not be Instructional Systems Technology at all, but run-of-the-mill instruction more widely distributed through more powerful hardware. Indeed, such is often the case.

Nevertheless, many of the most successful applications of IST involve a creative application of the hardware of technology—computers, audiotapes, film, television, radio, slides, and other media. Still, it is very important to keep in mind that the "technology" in IST is not the same as the "technology" meant by people who refer to our time as an "age of technology." The technology of IST is "a technology of mind," which may or may not make use of machines and electronics to meet its goals. And this technology of mind builds upon what careful scientific research has taught us—and continues to teach us—about learning and human performance.

The most distinguishing characteristics of IST in business, industry, military, and governments are:

- the users and trainees are paid,
- the managers are fully responsible and accountable for the achievement of planned outcomes, and
- the consequences for bad training can be a disaster, and the rewards for good training are often high.

These conditions profoundly impact planning, training, and educational programs in those environments and the fact that the trainees are paid probably represents the most critical difference between such activities in education and industry.

Scope of Technology

Having admitted effective research-based techniques of any useful form to the IST club, we can provide examples of the full range of potential applications. Some of the most important are:

Minimum capital investment. In the early 1970's Jack Taylor and his associates (Taylor, Michaels, & Brennan, 1972) at the Human Resources Research Organization (HumRRO) implemented a program to improve training results in the all-volunteer Army. They applied mastery learning principles, hands-on training, and criterion-referenced performance testing to make dramatic improvements in basic training results.

Figure 1 shows the reductions in the number of trainees failing various testing stations. In the first cycle of trainees, some trainees failed as many as 14 testing stations. By the 19th cycle, substantially fewer stations were failed. To accomplish these improvements, the results of prior training cycles were used to revise the training. Training managers could use the systematically collected performance data to find and correct weaknesses in the training program. But no matter how good the initial course was, and it was much better than the traditional, it would not have improved without direct management action to cause the improvements.

I mention the work of Taylor and his group first because it required *no investment in any kind of new capital equipment or hardware!* It did require a modest investment in job analysis and instructional systems development to find out what the key goals of basic training were and to design instruction to meet those goals. Taylor's work is a fine example of IST that accomplished a specific purpose and required a minimum of hardware or organizational change. These IST procedures are in the public domain and are available to any educator who would choose to employ a systematic management approach to improving results.

High capital investment. At the other extreme of the investment continuum are the full-scale full-motion simulators used to train astronauts, military and airline pilots, and nuclear power operators. Here, the consequences of inadequate job performance can be disastrous! Simulators provide high-fidelity representation and opportunities for practice on all normal and emergency operations that occur or have even a minute possibility of occurring. Accordingly, any training methodology that serves to develop adequate performance and to reduce the chances of a catastrophe is given full consideration (see Blomberg, Heyer, & Sjostrand, 1982; Trollip & Johnson, 1981-2).

Other applications. Between the two investment extremes just mentioned lies the Army's Computer-Based Job Skills Education Program (CBJSEP), which is aimed at teaching soldiers the job related prerequisite basic skills necessary to learn their jobs. In good economic times, Army volunteers tend to have less well developed academic skills than are required by the jobs they will perform. As high technology creeps increasingly into the military, the requirements for better educated entering personnel also increase. Thus, the gap widens between the recruits available and the soldiers required.

To close that gap, the Army analyzed the key jobs making up more than 85% of its requirements. From this, they analyzed each task to reveal its basic educational skills components. When that analysis was complete, Florida State University and the Hazeltine Corporation teamed to design instruction for delivery on two computer-based instruction (CBI) systems: Control Data Corporation's PLATO and Hazeltine Corporation's TICCIT. Both of the CBI systems had been developed through grants from the National Science Foundation in the early 1970's.

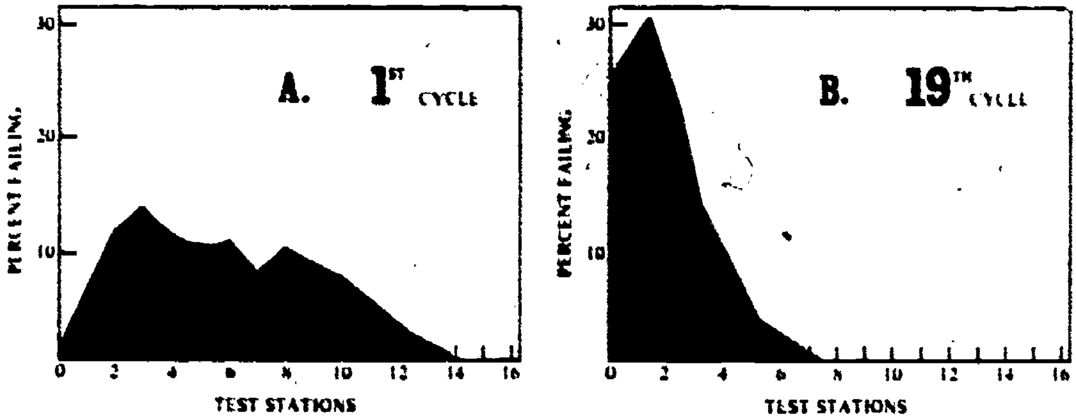

Figure 1. Error reduction as a function of evaluation and revision of instruction between the first and nineteenth cycles in an army training program.

Source: Human Resources Research Organization Tech. Rep. 72-7. Courtesy HumRRo, Monterey, California.

When the CBISEP project is complete, soldiers will have available some 420 hours of instruction on the particular prerequisites necessary to learning their jobs. A diagnostic testing program will compare their deficiencies and the requirements of their military jobs so that each soldier will receive the minimum amount of instruction necessary to achieve adequate job performance.

Additionally, these soldiers will be taught research-based learner strategies that are intended to make them better learners throughout their Army careers. While the better students invent or adopt good and efficient learning methods early in their schooling, poorer students do not. Accordingly, less capable students must be given instruction, drill, and practice in those learner strategies where they are deficient.

Teleconferencing. Using the telephone as a means to carry the audio portion of instruction is one application of teleconferencing. The hands-on materials or other visuals can be supplied by slow-scan video or by sending materials in advance of the teleconference. Teleconferencing is often presumed to be inferior to instruction delivered directly by a teacher. But we need not presume; there is research on that question. And IST gains its power not by presuming, but by relying on research findings, no matter how badly that hurts one's assumptions.

Here was the situation. Laboratory technicians from small hospitals around the South needed to learn how to identify tubercle bacilli with a microscope. There was already a method for teaching them this. They were being transported in groups to Atlanta where technicians at the Center for Disease Control taught them.

Rushton (1981) designed an experiment to test whether or not these technicians could learn their task just as well through teleconferencing. He developed learning materials to teach the skill and distributed slides and workbooks to hospitals in several states. Then the instruction itself was delivered by teleconferencing.

The experiment showed that trainees achieved satisfactory results on the regular examination, regardless of whether they were trained in the laboratory or by teleconference.

More important, the experiment uncovered a potential for large savings in travel and living expenses when compared to the practice of taking all technicians to Atlanta for two weeks. The value of the IST was clearly established.

Whether these potential savings will be realized, however, depends on the decisions made by the managers—to use teleconferencing or to continue with the traditional methods.

In this case, IST demonstrated that a real-world problem, being solved by one educational method, could also be solved at greatly reduced cost through another method. I wonder myself if that skill could not be taught just as well using even more appropriate and less expensive technology—audiotapes. IST leads one to ask just such questions, and to design research to answer them.

The Investment Concept

In deciding whether to invest in instructional technology, many military and industrial organizations use Life Cycle Systems Acquisition and Management Models. The use of such models is one area in which the military-industrial approach is substantially different from that taken by schools and universities. A second critical difference is in calculating the cost effectiveness of alternatives.

My university discovered years ago that a traditional lecture hall filled with students was the most "cost effective" (i.e., least costly) means of instruction available. To become more efficient, it was necessary only to increase the number of seats in the hall while holding the number of professors constant, thus increasing the professor-to-student ratio.

Available processes versus required results. The university and school offer what Hemphill (1969) has called "opportunity to learn" where schools are judged on attributes of their programs rather than the results of instruction. Consequently, since no specific outcome is required, the teaching process can be applied to larger and larger numbers of university and school students. The least cost alternative is a perfectly rational choice under those conditions of evaluation.

When specific results must be obtained, however, it becomes much more reasonable to use cost effectiveness evaluations and life cycle cost models. If a goal can be stated, and must be achieved, then alternative means can be considered. The total cost of ownership of a system can be calculated before it is acquired and alternative approaches evaluated. One definition of training effectiveness is:

> Training is effective to the extent that the expected proportion of qualified trainees reach the minimum expected performance standard within the required limits of time.

With training effectiveness being so defined it is possible to identify alternative means, and, by comparing alternatives, make more rational economic choices. It is important to remember, however, that all choices are not rational. Sometimes economic arguments can be used to influence political decisions, and sometimes they cannot. We could all make a careful analysis of the new cars available, estimate maintenance and repair costs, subtract salvage value, and come up with our projection of the "best" car to buy. But, as *Consumer Reports* learned years ago, people most often do not buy cars based on the lowest cost of ownership. Business executives and military leaders don't often buy training that way either.

There is, though, an encouraging trend in the government, military, and industrial sectors toward considering more alternatives and choosing more rationally. At least, that trend is encouraging to me since I have a strong vested interest in seeing more good applications of IST. One essential element of that increase must be a careful analysis and *consideration of alternative means* to provide and manage instruction. It seems to me that consideration of alternatives is important for two reasons: First, it requires a careful definition of instructional goals and objectives in order to make comparisons, and, second, it introduces new ways to accomplish the same outcomes.

Murphy (1979) pleaded with corporate human resources development (HRD) managers to become considerably more familiar with the finance and operations of their businesses.

In so doing, he argued, the HRD executive would be in a much better position to compete for investment resources to improve job performance through training. If an investment in training is as good as or better than alternative uses of the money, the training investment is more likely to be funded. Well managed training investments meet their expected returns and make it easier to obtain funds for future needs.

The most important warning label that could be put on any box of IST might read something like this:

> This box contains products that have high potential for improving training outcomes. Properly installed and managed, this product should give years of satisfactory service. Warning: Instructional technology products by themselves do not achieve results. *Only managers achieve results!*

One way to look at any industrial application of IST is by analyzing the numerator and denominator separately. In Figure 2, the denominator refers either to the number of people that will be served, or to the value of service to each person served by the technology. The numerator refers to the resources required (reduced to dollars) to produce and manage the application.

Two systems can thus be compared by comparing the ratio of the alternatives.

System 1	System 2
Total life cycle costs of the project	Total life cycle costs of the project
Number of people served multiplied by the Value of service to each person	Number of people served multiplied by the Value of service to each person

Figure 2: A comparison of alternative means to reach the same instructional goal.

Notice that, in Figure 2, the denominator is influenced either by the *number* of people served or by their *value* to the mission—or both. The National Aeronautics and Space Administration will never have many astronauts compared, say, to the number of pilots at United Airlines. But the mission value of each individual astronaut is extremely high when compared to the mission value of individual airline pilots. Nevertheless, both astronauts and pilots must be trained in all normal and high risk emergency procedures.

Accordingly, elaborate mission simulators, training personnel, instructional psychologists, and other resources are dedicated to their projects because it is the only way they can be sure of success. The first flight in a single seat aircraft is always a solo flight. Moreover, an exceptionally high but unpredictable percentage of the emergency procedures "curriculum" will never be used.

In many business, military, and industrial applications, the value of training results is so high that the costs may be virtually ignored. Boris Sichuk (1981) reported to the Training Research Forum about a new plant his company was building and for which he had to provide a total complement of employees ready to bring the plant on line as soon as it was completed.

The plant equipment was totally new—no one had experience operating it. Further, if production were not started by the end of the calendar year, his company would lose a significant investment tax credit. The value of the instruction was so high and the number of people was so large, that the size of the denominator became virtually irrelevant. It did not matter whether it was X, 2X, or 4X; the potential for gains or losses was so great that his only choice was to invest in redundant training to be sure that all aspects of the plant could be operated correctly and in a short start-up period.

Computer-Based Instruction

Computer-based instruction is a term used now to combine several earlier terms into one overall concept. It includes computer-assisted instruction, computer-aided instruction, computer-managed instruction, and similar terms. The technological developments in the computer industry have been detailed elsewhere and need not be reviewed here. The conclusions that one can draw from this literature are literally mind-boggling. If any prediction is safe, it is prudent to say that computers will have an increasing impact on military, industrial, business, and government training (see Kearsley, Hillelsohn, & Seidel 1982; O'Neil, 1981).

There has been a dramatic increase in the amount of embedded training contained in new computer systems. Some systems have special built-in programs that teach users how to operate the equipment. This embedded training is of two varieties, that which is intended to let the user learn how to use the particular system, and that which provides instruction on topics unrelated to the system on which the instruction is delivered.

A "user-friendly" machine or software package allows new learners to control the rate at which they acquire knowledge about the package, then permits the suppression of coaching or prompting features as the user becomes more proficient and relies more and more on memory. Some researchers regard the feature of learner control as an essential element in successful adult instruction.

Interactive Videodisc

The interactive videodisc provides what many have called an "ideal" teaching machine. Its virtues include high resolution video, still frame, high density information storage, high quality audio, and availability of a variety of interactive modes (see Currier, 1983). More recent systems have had both good improvements in reliability and good random access search times; also, they are lighter and more compact than their predecessors. Branson and Foster (1980) have provided descriptions of alternative configurations of random access interactive videodisc players and computers and have compared these configurations to various needs.

In 1982, the Florida Children's Medical Services Program developed several computer based interactive videodisc lessons to train staff located in all parts of the state. They used a Coloney interface to combine a Pioneer PR 7820-1 random access player with an Apple II computer. In this case, the computer can be used to control the instructional program on the disc or used independently as a computer.

One advantage of the videodisc that made it particularly useful in our studies was its ability to store large numbers of slides to train nurses to differentiate eligible clients. Storage of these visuals in any other medium would not have proved cost effective. With as many as 10,000 slides and other still graphics on a videodisc, however, there was still space to have some 20 minutes of full motion video instruction.

While individual units of the Apple-PR 7820-1 represent a substantial capital investment, the use of such equipment provides a reasonable alternative to transportation and expenses of getting employees to training sessions and a real improvement in data processing capability at remote locations.

As the use of random access interactive videodiscs increases, we can expect to see some reduction in prices for equipment and for discs as well. Further, as the features requirements become better defined and more standardized, improved systems designed to meet these critical features can be value engineered to achieve further price reductions.

For example, one small company in Huntsville, Alabama, Inter Active Video Disk Systems, Inc., has patented a process for storing lesson control information on the disc, thus reducing substantially the required level of sophistication of the control device. This technique permits designers to provide fully interactive instruction on inexpensive players, and without using an external computer. The same distributed control techniques also apply to interactive random access videotape.

Those who have developed interactive videodiscs are aware of their severe audio limitations: audio is available only when the disc is playing at the 30 frames per second rate. Audio is not available for still frames unless the still frame is repeated thirty times per second. Thus, even though there are about 54,000 video frames, if narration is desired, these are used at thirty per second. This negative feature, probably the worst influence that entertainment industry players have had on instructional devices, is likely to be slowly overcome as the technology advances. The high-density storage of visuals is perhaps the most important feature of the disc, but when one must have full motion video to get narration about a single slide, much of the advantage is sacrificed. When the audio problem is solved, I fully expect to see a dramatic increase in the use of interactive videodiscs.

The Learning Industry

The decade of the 1970's saw the growth and influence of the learning industry vastly increase in the military, industrial, government, and business environments. These generally small companies offer IST services to clients needing effective and efficient training. The thrust of that business is to custom design and systematically develop an appropriate learning environment to solve the client's training problems regardless of the subject matter or content of the tasks. By using proven techniques in instructional systems development, these organizations are changing the way many organizations acquire new knowledge.

Traditionally, when the Army bought weapons or equipment systems, it bought hardware and technical manuals from the vendor. As technical sophistication of equipment increased, however, soldiers found themselves unable to read the manuals. The Army then required in hardware procurement contracts that all manuals, training materials, and media be subjected to the specifications in the Interservice Procedures for Instructional Systems Development (Branson et al., 1976). Small companies then began to specialize in the systems engineering of training to meet job requirements and served the larger contractors in developing systematic training for all equipment systems.

By considering all the capabilities of IST, such organizations have vastly improved the precision of training programs. Some training programs for pilots now have a sequence of ground school, cognitive pretraining for flight, training devices, part-task trainers, position simulators, and full scale full motion mission simulators. These alternative training strategies take full advantage of the available technology and use the least costly method of instruction for each of the separate requirements. By offering a fully integrated training program, it is now possible to minimize the amount of time spent in the aircraft or other equipment, thus reducing the number of aircraft required, saving fuel, and vastly increasing safe operations (see Trollip and Johnson, 1981-82).

IST and Education

The second issue of the 1982-83 *Journal of Educational Technology Systems* was devoted to the question of technology in education. While there has been an increasing emphasis on science and mathematics instruction in recent years, microcomputers and other de ices that can be used in IST are being extended to other parts of the education system. There are several provocative articles in that issue (see also Kulik & Bangert-Drowns, 1983-84). Regardless of the potential for IST in education, however, there still remains the problem of agreeing on objectives and considering alternative means of reaching goals. While schools and universities may buy lots of computers, the use of *IST* in school classroom settings is not likely in the near future.

Conclusions

There are many important differences between IST in industry and government and IST in education. Having studied IST usage in the various sectors for a number of years, I have tried to discover why IST is not used more in education. Perhaps it is because there are so few areas in education where an absolute outcome is required. If an absolute outcome must be reached, then many alternatives of reaching it must be considered, and IST provides an excellent way to do this.

As more and more states adopt minimum competency testing programs and demonstration of literacy and other necessary survival skills becomes an absolute requirement, it is reasonable to predict that responsible educators will turn to IST as a means to achieve those required outcomes. When the results of the testing programs are compared on a school-to-school basis in the Sunday papers, it seems certain that those schools or colleges not performing well may have to turn to IST for improvements.

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Changing Professional Prospects in Educational Technology

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"There is nothing permanent except change." This insight by Heraclitus over 2,000 years ago is an apt description of the present state of educational technology (ET). Changes are occurring within the field itself, within education in general, and within society as a whole. All such changes have implications for persons who presently identify with the ET field as well as those who plan to enter it. In this article, we will first describe some important movements occurring within education and society. Then, we will examine current changes within the ET field. Finally, we will discuss some implications of these events for the near future of educational technology.

Change in Society and Education

After more than a decade of relative obscurity, education is again in the spotlight. Numerous reports and studies about it have been released recently; most are critical of current trends and practices and call for reform and a renewed effort for excellence.* In general, these reports urge curriculum revision, raising of standards, better preparation of teachers, and increased school funding (McGrath, 1983, pp. 58-66).

The reports also have brought to light several interesting statistics. For example, student enrollments in elementary and secondary schools have been sliding downward lately and will continue to do so for several more years; as a result there is a reduced demand for new teachers. Experienced teachers are leaving the profession to accept more challenging and higher paying jobs in other fields. The calibre of new persons who do enter the teaching profession is said to be low and continues to decline; SAT scores of education majors in college are well below those of their peers who major in the physical, biological and social sciences, business, communications, and the arts (Feistritzer, 1983, p. 88). Thus, a somewhat stagnant and probably lower quality teacher population is likely to inhabit the public schools for the near future.

As a result of the recent economic recession and community tax revolts, public schools have had to operate under strict financial constraints. Media/library personnel have been curtailed or dismissed. A recent study predicted a steady decline in school library positions through 1990 (King Research, 1983; see also Howe, 1982).

The much-publicized *Nation at Risk* report issued by the National Commission on Ex-

*See, for example, *A Nation at Risk: The Imperative for Educational Reform*, by the National Commission on Excellence in Education (Washington, DC: U.S. Department of Education, 1983); *Educating Americans for the 21st Century*, by the National Science Board Commission on PreCollege Education in Mathematics, Science and Technology (Washington, DC: National Science Foundation, 1983); *High School*, by the Carnegie Foundation for the Advancement of Teaching (New York: Harper & Row Publishers, 1983); *Making the Grade*, by Twentieth Century Fund Task Force on Federal Elementary and Secondary Education Policy, (New York: Twentieth Century Fund, 1983); *Academic Preparation for College*, by the College Board (New York: College Board, 1983).

cellence in Education, however, was positive toward the role of educational technology in the classroom. Its authors called for an upgrading of textbooks and other tools of learning and teaching, believing that new instructional materials should reflect current applications of technology in curriculum areas, the best scholarship in each discipline, and research in learning and teaching (National Commission, 1983, p. 29). However, the report did not mention the need to teach children information utilization, visual literacy, or media evaluation skills.

As the verbal battle continues over the health of public education and what might be done to ameliorate its ills, the computer revolution continues to sweep across all areas of education. The impact of this revolution has been felt at all levels, but its effects have been best documented in the public schools. The estimated number of microcomputers (average) per school is 4.3 for elementary schools, 7.2 for junior high schools, 10.4 for senior high schools, and 9.7 for combined K-12 schools. This means approximately 350,000 micros are available for instructional use (National Science Board, 1983, p. 52). Within the past three years six states have required their schools to teach students computer skills, twelve others have officially recommended it, and, in all, 47 states are encouraging their schools to impart such skills (Christensen and Gladstone, 1983). While in some schools the library/media center staff is involved in decisions regarding the acquisition/use of computers, in many instances subject matter experts, for example, science and math teachers, determine the uses of this technological hardware. Whether in the future, computers and their uses for instructional purposes throughout the school will come under the purview of library/media specialists remains problematical.

Higher education, too, has been impacted by the computer movement. But, again, educational technology professionals have seldom spearheaded this activity. In the majority of cases, personnel in the campus computer center or in the engineering, science, or mathematics departments have been responsible for demonstrating the need and controlling the acquisition and use of the computers. Offices of instructional development and campus media centers typically have had relatively little influence over CAI uses.

A recent study has documented the decline in the number of campus-wide instructional/faculty development centers which were established in higher education institutions over the past two decades. As least 25% of these centers have closed and more are at risk. Interest in instructional, faculty, and organizational development in higher education may be waning (Gustafson and Bratton, 1983).

Major changes which impact the ET field may also be noted in business and industry. Training has become a major focus as companies reposition themselves in the market place. As the recession fades, industrial, marketing, and service organizations are revamping to take advantage of new technologies related to production and information flow. In addition, many companies are now establishing "corporate colleges" which grant degrees, thus creating competition for postsecondary education institutions (ASTD, 1983a, p. 4)).

Claiming that the educational system has failed to prepare persons for the workplace and acknowledging that job-retraining is inevitable in these times of fluctuating markets and technological breakthroughs, companies are also expanding their in-house training facilities or using the expertise of training companies and private training consultants to help with these problems. It has been projected that the training budgets for hardware, custom-designed and off-the-shelf programs, and outside professional services in organizations with 50 or more employees will total more than $3 billion in FY 1983 (ASTD, 1983b, p. 38).

Educational technology is frequently used in training, including computer-assisted instruction and interactive video. Public school and higher education teachers are seeking jobs as trainers to capitalize on this new demand with its promise of high salaries. In many cases, however, they, too, must undergo re-training when they find their traditional pedagogical skills are not suited to results-oriented adult corporate demands (Zemke and Zemke, 1981).

Change within the Educational Technology Field

Changes occurring within the ET field are reflected in the various professional associations, journals, and academic preparation programs.

The Association for Educational Communications and Technology (AECT), which claims to serve as an umbrella organization for all persons interested in educational technology and draws much of its membership primarily from state library/media groups, has witnessed a declining membership. In contrast, training-related associations like the National Society for Performance and Instruction (NSPI) and the American Society for Training and Development (ASTD) have g own in membership. Over the past ten years, for example, AECT membership has fallen from approximately 10,000 to 6,000 while NSPI and ASTD have grown from 1,300 to 2,000 and 9,000 to 22,000 respectively.

Journal readership figures have also changed over the past decade. The circulation of education-focused publications like *Instructional Innovator* has declined from 7,800 to 4,900 and *Educational Technology* from 7,800 to 4,800. During this same period, training-related periodicals have enjoyed expanded readerships: *Performance and Instruction Journal* from 2,000 to 3,000; *Training and Development* from 12,000 to 28,000.

Likewise, the focus of these publications has altered. The majority of the articles (52%) centered on education-related areas in 1973, but by 1983 the majority (70%) emphasized business and industry training-related topics. The attention to professional education and government/military training has remained about the same throughout this period.

A decade ago the articles stressed media management/production (38%), instructional development (24%) and performance technology, evaluation, and computer assisted instruction (38%). Today, the articles deal mostly with performance technology, evaluation, CAI, and interactive video (57%), followed by instructional/training development (28%), and media management production (15%). Likewise, in 1973 these journals devoted nearly 75% of their advertisements to hardware and software products aimed at media managers and media producers; now approximately 60% of the ad space centers around instructional/training products, pre-packaged training programs, and consulting services aimed at instructional/training managers, instructional/training designers and computer/interactive video specialists.*

As reported in prior editions of the *Educational Media Yearbook*, efforts have been underway for several years to establish within the AECT organization accreditation and certification programs. Installation of these programs, it is believed, will help to professionalize the ET field. For background information on accreditation activities, see Grady (1983) and Wilkinson and Grady (1982); for information on certification, see Galey (1981).

Basic and advanced guidelines for the accreditation of programs in educational communications and technology have been adopted by the National Council for the Accreditation of Teacher Education (NCATE), one of the largest accrediting agencies of higher education institutions. The guidelines are aimed at both undergraduate and graduate professional preparation programs. NCATE is scheduled to begin using them in September 1984.

The AECT professional certification program has not yet developed fully. It was proposed earlier that competencies and subsequent certification tests be prepared in three specialty areas: media management, instructional development, and media design and production. To date, competencies have been identified only in the latter two. The Instructional

*The authors wish to thank Ms. Elizabeth Ladd, a graduate student at Governors State University, for her research data on the circulation and contents of the journals.

Job Skills \ Job Settings	Elementary/Secondary Education	Postsecondary Education	Academic/Research	Health Care	Professional Education	Government/Military	Business/Industry	Software Development Companies	Private Consulting
Media Manager	P	P	P	P	P				
Media Producer	P	P	P	P	P				
Instructional Designer		P	P	P/F	P/F	P/F	F	F	F
Evaluator						F	F	F	F
CAI/Interactive Specialist			F	F	F	F	F	F	
Performance Technologist						F	F	F	F

Figure 1: Shifting Pattern of Educational Technology Employment: Past (P) to Now and Near Future (F)

Development Certification Task Force has been quite active. During the last year, for example, it joined with the Standards Committee of the National Society for Performance and Instruction to form a Joint Certification Task Force for Instructional/Training Designers. This group has developed and evaluated one assessment simulation and continues to work on other testing procedures (Bratton, 1984a). The Joint Task Force represents a unique blend of talents and philosophies of professionals representing the education and training sectors. It is hoped that other organizations with similar interests in human performance and instructional/training technologies may soon join the Task Force (Bratton, 1984b).

The ET academic programs have not escaped changes. While the majority of student applicants have a background in education, an increasing number of them are coming from non-educational fields such as communications, business, health sciences, and human resource development. A greater number of graduates are taking positions as instructional/training designers and as CAI and interactive instruction specialists; fewer graduates plan to seek positions in the traditional education settings. There appear to be more students in ET programs who can be characterized as adult-learners, who have high level responsibilities in other fields (e.g., physicians, personnel administrators, theologians, law enforcement officers), and who plan to return to these positions and put their new knowledge to practical use. Such graduates will most likely retain their primary identity with their original field and not view themselves as professionals in the ET field. Classroom teachers from K-12 settings, community colleges, technical schools, and colleges and universities, also are enrolling in ET courses, but again, most of them do not intend to become ET professionals. Two more trends: more women are seeking ET degrees, and there seems to be a rise in the number of foreign student applications in some programs. Generally speaking, there is a greater diversity than ever before in the sex, age, background, and future employment aspirations of ET graduates.*

Implications for the Educational Technology Field

A major trend that emerges from the above discussion is that the ET field itself has changed dramatically over the past decade and there are no indications of a reversal of the process. To see a field in mass transition, one has only to look at (a) the current problems within education, (b) the rise in the importance of training, (c) the changes in association memberships and journal content and readership, and (d) the varied backgrounds of persons who are now seeking ET academic degrees, and (e) their likely employers.

Figure 1 shows the shifts that are underway in terms of job roles and job settings. In the past, the ET field was almost exclusively the province of media producers and media managers dedicated to the improvement of instruction in traditional educational settings. Their titles were media specialist (later, library/media specialist), media producer and instructional product developer; they found employment in K-12 settings, postsecondary institutions, professional schools (e.g., medicine, nursing, engineering), and in government/military settings. Roles in these settings remain viable today, but on a reduced scale due to changes in society and education, as described earlier. So far, there is little optimism that the growth period of the past decade will reappear for these positions/settings. In fact, some positions, most noticeably those for the school library media specialist, may see still further decline if current predictions are accurate.

Today, and for the near future, the trend is toward more ET job roles in such settings as health care, government/military, business/industry, software development companies,

*The information regarding the academic programs was gathered by the authors via telephone conversations with selected program directors across the United States.

and private consulting. Such professionals are experts at instructional/training design, evaluation, CAI/interactive technologies, and performance technology. This trend has been building for the past few years; the authors believe that it will continue to grow for the next few years, particularly if there are no major changes in national political policies.

Some specific implications for current ET professionals and persons who will consider entering the ET field are:

- *Individuals now in the field who possess only media production or management skills and who work in traditional education settings may be at risk.* Retraining, particularly in computer applications and instructional design, may help secure some positions. Others may have to undergo more extensive retooling to qualify for positions in the "in demand" jobs in other settings.
- *Many individuals who are currently in academic roles in professional preparation programs also face a need for retraining in several areas.* One is computers and interactive procedures and devices. Traditionally leaders in introducing technology to members of the ET field, many faculty members now find themselves in an uncustomary position of instructing students who know more about certain technologies than they do. Academicians, too, must acquaint themselves with new employers of their graduates. This means moving outside institutional boundaries into such nontraditional areas as business/industry, health care, professional education, and training companies. A major problem facing academics in doctorate-granting institutions is finding relevant scholarly endeavors for Ph.D. students headed for non-academic positions.
- *Leaders of the professional associations are faced with a dilemma: change directions in light of the current trends or stay the course in hope for a return to old norms.* AECT, NSPI and ASTD are the organizations most affected. As noted earlier, AECT has suffered the most; the other two have gained members and visibility. There are no easy answers. Historical precedent, philosophical values, and financial implications will influence the decisions that are made. The Joint Certification Task Force for Instructional/Training Designers, consisting of members from AECT (Division of Instructional Development) and NSPI, is evidence that cooperative ventures are possible among professional associations.
- *Current trends may force a reconsideration of what truly constitutes the domain of educational technology.* A book on that subject reflected the zeitgeist at the time it was written (AECT Task Force on Definition and Technology, 1977), but recent developments have brought about new awareness and sensibilities in larger environments. We may be witnessing the emergence of a number of unfamiliar specialties, much like medicine has seen in the past twenty years. Unlike medicine, however, there may not be enough commonalities among the subgroups for all to subscribe to a common ET domain. Silber foresaw this possibility and warned that splintering within the ET field will "break up what makes educational technology unique, and what gives educational technology its powerful impact" (1981, p. 24). The concept of an "umbrella professional organization" may no longer be viable either, for there may be too many specialties with practitioners in too many diverse settings for one organization to provide state-of-the-art services to each of them.
- *For persons who are now entering the ET field, there are myriad employment opportunities.* The K-12 setting is still viable for applicants who are willing to move. The same is true for postsecondary education positions. Individuals with interests in academic research careers and with expertise in instructional design and computer applications will see job opportunities. The majority of positions, however, are in

the private and government sectors. Here one finds openings in nearly all job skill areas.

Summary

Significant changes are occurring throughout society and education as well as within the ET field. The field, for example, has broadened in terms of the kinds of people who study and take degrees in the professional preparation programs. A decade ago, primarily experienced teachers took ET degrees with the intention of becoming media specialists or managers in education environments. Today, teachers in fewer numbers seek ET degrees while professionals from other fields are increasingly pursuing such study. Many of these practitioners use the degree to legitimize and retain their present positions but will most surely continue to identify professionally with their original fields.

The types of jobs performed by people within the ET field are expanding. In the past, the field consisted mostly of media managers and instructional product developers. Now, the roles have broadened to include instructional designers, CAI and interactive instruction specialists, and evaluators, as well as performance technologists.

Job settings have changed, too. Once employed mainly in K-12 and postsecondary education positions, ET professionals now find employment in business and industry, health care, the military, software development companies, and private consulting firms.

By all indicators, such job placement changes are here to stay. They may even intensify and further fracture the domain of educational technology as we once knew it. Those who do not understand or who do not adapt themselves to these changes may be frustrated when they try to sell their skills to individuals who do not agree with their point of view, cannot afford their products, or do not understand their jargon. Some, unfortunately, may lose their jobs and will have to seek retraining in the "in demand" positions and settings. For persons now employed in academic programs it means adapting to a diverse student population and finding acceptable applied research models and strategies to coincide with existing theoretical research methodologies.

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