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Historical Foundations

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ABSTRACT

Research and practice in educational technology are rooted in a primordial human drive to find ways of teaching in ways that are more efficient. Every civilization has developed formal methods of education more efficacious than the trial-and-error of everyday living. In the first decades of the 20th century, individuals and, later, groups of affiliated professionals made that quest a central focus, thus establishing educational technology as a field. Their first activities aimed at enriching the learning experience with visual and later audio-visual resources. As radio broadcasting grew in the 1930s and then television in the 1950s, these mass media were accepted as ways to reach even larger audiences, in and out of school, with educative audio-visual programs. In the 1960s, the wave of interest in teaching machines incorporating programmed instruction based on behaviorist psychology engulfed the field, engendering a shift in identity. The proper study of the field expanded from audio-visual technologies to all technologies, including psychological ones. By the 1980s, the center of gravity had shifted to the design of instructional systems, especially the adroit application of instructional methods, enlivened by fresh insights from cognitive and constructivist perspectives. As computers became ubiquitous in the 1990s, they became the delivery system of choice due to their interactive capabilities. With the rapid global spread of the World Wide Web after 1995, networked computers took on communication functions as well as storage and processing functions. The 21st century began with educational technology increasingly focused on distance education, the latest paradigmatic framework for its ageless mission to help more people learn faster, better, and more affordably.

KEYWORDS

Constructivism: In learning theory, a set of assumptions about human learning emphasizing the central role of the mind's active construction of new knowledge.

Distance education: An educational program characterized by the separation, in time or place, between instructor and student and in which communications media are used to allow interchange.

Technology: The application of scientific or other organized knowledge to practical tasks.

INTRODUCTION

The area of research surveyed in this handbook—educational communications and technology—is broad and complex. The constructs on which the individual chapters focus sometimes have vague boundaries and often overlap with other constructs. The research surveyed is rooted in many different disciplines, each with its own history and subculture. Any attempt to impose a coherent story line on such a variegated drama must necessarily be a bit complicated, with plot lines that crisscross frequently. This brief history makes no claim to originality or heterodoxy. It strives for the opposite effect: to tell the story of the evolution of educational communications and technology as it is understood by mainstream observers. It draws heavily on well-known sources, such as Saettler's (1990) comprehensive history and the most recent overview of the main constructs of the field (Januszewski and Molenda, 2008). It is animated by the editors' goal of beginning this handbook by making explicit the assumptions on which research has been based. It takes the vantage point of the membership and readership of the Association for Educational Communications and Technology (AECT) and its predecessors over the past century. For simplicity's sake, the term *educational technology* will be used as the name of the field whose story is being told.

HISTORICAL FOUNDATIONS OF WHAT?

The Very Beginning

Humans have succeeded as a species largely due to their ability to learn from their experiences and to pass along their wisdom to succeeding generations. Much learning and acculturation happens spontaneously, without planning or structure. Through the ages, as human society has become increasingly complex and organized, communities have consciously set up particular arrangements, such as apprenticeships, schools, and other educational institutions, to help their members develop the cognitive and functional skills needed to survive and flourish.

The history of organized education and training can be viewed as a long struggle to extend opportunities to more people and to devise means of helping those people learn better than through the events of everyday life. Institutions established for education and training revolve around activities intended to help people learn productively, individually or in groups, in classrooms or at a distance. Schools, colleges, corporate training centers, and other educational institutions provide many sorts of facilities to facilitate learning.

Learning goals in educational settings are often complex, difficult, and protracted. Throughout history, educators have devised means to help people learn that are easier, faster, surer, or less expensive than previous means. Some of these means could be classified as technological, by which we mean applying scientific or other organized knowledge to the attainment of practical ends, a definition proposed by John Kenneth Galbraith (1967). These developments may take the form of hard technologies, including materials and physical inventions, or soft technologies, including special work processes or carefully designed instructional templates that are applicable beyond a single case. This chapter aims to recount some of the milestones in the history of these developments.

Precursors of the Modern Era

The ideas that have propelled educational technology during its modern history have their roots in philosophical, pedagogical, and psychological theories stretching back to the 5th century B.C., when Athenian culture was at its zenith in the West and when Confucius was establishing his philosophy, which came to dominate East Asian thinking. (Confucian thought, however, was not known in the Western world until the translations of Italian Jesuit missionary Matteo Ricci around 1600.)

In classical Athens, the Sophists taught provocative, often relativistic, notions of epistemology. The works of Socrates, Plato, and Aristotle in organizing philosophical thought can be seen as a reaction against the Sophists' position that a good argument is one that prevails, if only through rhetorical manipulation, regardless of truth value. Their frameworks for discussion of cognition and knowledge were largely lost during the Dark Ages in Europe but were gradually rediscovered and reexamined as medieval scholars

gained access to texts saved in Arabic. During the 15th century, Yi T'oegye in Korea was developing a neo-Confucian philosophy that focused on moral principles but also treated epistemology. His Steps of Practical Self-Cultivation, procedures for thinking through problems, are comparable to the maieutic method of Socrates. (Socrates considered his educational practice to be similar to midwifery in that he helped individuals deliver ideas; see Kim, 2003.)

By the Renaissance era, European philosophers of education such as Comenius were elaborating pedagogical principles and practices that are recognizable to the modern educator—for example, arranging the classroom for efficient management, systematically incorporating visuals into text presentations, organizing the curriculum according to the developmental stages of learners, and engaging children in playful activities instead of punishing drills.

Advances in communications media came to education slowly in the 18th and 19th centuries. Maps, globes, and scientific apparatus were standard equipment in the better schools and colleges in the 18th century, but it was not until early in the 19th century that a new general-purpose media format—the blackboard—came into widespread use. The Scots claim that the blackboard was invented by James Pillans, headmaster of the Old High School in Edinburgh in the early 1800s, who used a blackboard and colored chalks to teach geography (Scots Community, 2007). By 1830, the blackboard, usually locally made by painting planks with black paint, had become an essential part of classroom furnishings. Its ability to make teacher or student writing or drawings visible to a large group expanded the teacher's capabilities exponentially. Bumstead (1841, p. viii) proclaimed that the "inventor or introducer of the blackboard system deserves to be ranked among the best contributors to learning and science, if not among the greatest benefactors of mankind."

The hand-held stereoscope became popular in education in the mid-1850s, promoted by Sir David Brewster in England, who carried out basic research in stereoscopy and became a firm advocate of its value in visualizing the curriculum (Anderson, 1962).

EARLY VISUAL MEDIA

Slide Projection

The origins of the modern field of educational technology can be traced to the efforts of practitioners in the late 19th and early 20th century to use projected visual images to supplement lectures. Slide projection evolved from 17th-century handpainted slides illuminated by oil lamps. The so-called magic lantern provided entertainment for paying audiences throughout the 19th century (Petroski, 2006). The use of slide projection in education was restricted by the high cost of purchasing and operating these early devices. They ran on gas, oil, or hydrogen combined with lime (so-called limelight, first used in the Covent Garden Theatre in London in 1837), all of which had a high cost per hour of use. Edison's invention in the 1890s of incandescent lighting powered by electricity made slide projection affordable, and by the end of the 19th century lantern slides were in common use in education.

Silent Films in Education

The direct ancestors of educational films were the nontheatrical short films that began to emerge around 1910. British and French cinematographers exhibited films showing amazing sights such as microscopic creatures, insects in flight, and underwater seascapes. Films of news events and travel adventures played to rapt audiences. Silent films began to be used in schools as early as 1910 (Saettler, 1990). In 1912, the Lycée Hoche de Versailles in France had gained international notice for its exemplary incorporation of films into science teaching. By the 1920s, many different individuals, companies, nonprofit organizations, and government agencies attempted to supplement the existing supply of theatrical films and newsreels. Educators could find many types of films to use: theatrical films edited for special purposes, industrial films, government films, and a smaller number of films produced specifically for the classroom. Schools that wanted to be viewed as progressive rushed to build collections of films. Despite the marginal value of many of the available films, interest and usage continued to grow, and by the end of the 1920s many education agencies had units devoted to film or visual education, and thick catalogs documented the thousands of films available to educators.

VISUAL INSTRUCTION MOVEMENT

Enthusiasm for the use of still pictures and motion pictures as educational resources grew to become the Visual Instruction movement, an increasingly organized effort by enthusiasts to promote wider use of these new technologies. This movement is regarded as the first paradigm in which the field found its identity. Under this paradigm, advocates sought to make visual materials widely available throughout school districts, postsecondary institutions, and adult education institutions. At first these resources were included in the collections of educational museums; the first in the United

States was established in St. Louis, Missouri, in 1905, based on exhibits saved from the World's Fair held in that city in 1904 (Saettler, 1990). Later, collections of visual media were gathered into visual resources centers of their own, and the leaders of the emerging field of visual instruction were the directors of these centers.

The earliest formal research on educational applications of media was Lashley and Watson's program of studies on the use of World War I military training films on the prevention of venereal disease with civilian audiences (Lashley and Watson, 1921). An early large-scale effort to design and produce a set of films specifically for schools was the *Chronicles of America Photoplays*, produced by Yale University in the late 1920s. Knowlton and Tilton (1929) studied the use of these history films in seventh-grade classrooms. One of their major conclusions was that the educational value of such films lay not only in the quality of the materials but also in how well teachers used them. This finding, that the instructional value of any media product is determined largely by how it is used, would be rediscovered by each succeeding generation with its new media: radio, then television, then programmed instruction, then computer-based instruction, and now Internet-based learning environments.

The making of films for educational use in the early years was not explicitly guided by pedagogical theories. Producers generally chose subjects that were visual in nature then applied the methodology of one of the existing film genres: drama, travelogue, documentary, ethnography, historical reenactment, nature study, scientific experiment or demonstration, lecture, procedural guide, and the like.

During the 1920s, visual instruction enthusiasts formed a number of organizations. In 1923, one of them, the National Education Association's Department of Visual Instruction (DVI), emerged to become the preeminent organization of professionals concerned with the use of visual media to improve instruction. The name changed to Department of Audio-Visual Instruction (DAVI) in 1947 as its boundaries expanded to include auditory media: sound films and various forms of recorded sound, beginning with phonographs and later including radio broadcasting, sound filmstrips, and audiocassettes.

AUDIO-VISUAL INSTRUCTION

The phonograph record, introduced in 1910, was the first widely available format for recorded sound and was used almost exclusively for music. Although magnetic tape displaced the phonograph for recording purposes in the 1950s, vinyl records remain in use into the 21st century. As soon as the phonograph was invented, film producers tried various methods of using this new technology to add sound to motion pictures, but in the late 1920s the technique of adding an optical sound track to the film itself became the preferred format for sound films. Interestingly, there was considerable resistance to sound films in the education community. Some methodologists felt that the practice of having the classroom teacher add narration to silent films added a level of customization and personalization to film showings. Administrators worried about their installed base, the large investment they had made in silent film projectors. As late as 1936, a survey showed that schools owned ten times more silent film projectors than sound film projectors (Saettler, 1990). The slide format had become standardized at the 2×2-inch frame size, using 35-mm film, which was also used for the filmstrip, which later became the most popular format for commercially produced audio-visual materials. Audio resources were added to the growing base of visual resources. By the 1930s, schools maintained equipment pools that contained (in order of frequency): lantern slide projectors, radio receivers, 16-mm silent film projectors, 35-mm silent film projectors, filmstrip projectors, opaque projectors, micro-slide projectors, 16-mm sound film projectors, and 35-mm sound film projectors (Saettler, 1990).

EDUCATIONAL RADIO

Initiation of Radio Services

In the 1920s and 1930s, broadcast radio became the prime mass communication medium around the world. In most countries, broadcasting facilities were directly managed by the government, although after the founding of the British Broadcasting Corporation (BBC) in 1927, many countries (such as Japan's NHK and Canada's CBC) followed its model of a quasi-autonomous public corporation. Providing cultural and educational programming was assumed to be a primary responsibility of these organizations; such programs were often among the first to be broadcast. The first school programs in Canada began in 1925, in England in 1926. By the mid-1930s, there were school broadcasting services in virtually every European country as well as in Australia, Japan, South Africa, and India.

Educational Radio in Japan

Japan's NHK initiated nationwide school broadcasts in 1935 and soon developed a policy of programs to complement the school curriculum, "to fill in areas

unreached by the conventional teaching" (De Vera, 1967, p. 23). Following reorganization after World War II, NHK went on to become an international exemplar for its ambitious and high-quality programming in radio and later (beginning in 1953) in television.

Educational Radio in North America

In Canada, the first large-scale school broadcasts were actually offered by the Canadian National Railways (CNR) system. This radio service was established to entertain rail travelers, but it also reached the towns and cities along its route, and the CNR broadcasters were quick to provide programming that would appeal to school audiences. The CNR school service built a loyal audience by deliberately building participative activities into the programs. The service was subsumed into the CBC in 1933. In the early 1920s, many American universities obtained licenses to operate radio stations, often as technical experiments in electrical engineering. A large proportion of these died out in competition with commercial stations, but some put down roots. The operations that prospered were the ones in which radio played an integral part in the university's mission—bringing educational opportunities to audiences beyond the campus (Wood and Wylie, 1977).

Educational Radio Programming

By the mid-1930s, many Ameican school districts operated radio stations, which developed sophisticated educational programming, often incorporating innovative pedagogical techniques. At the Cleveland, Ohio, Board of Education's radio station, WBOE, in the 1930s they pretested programs by creating rough drafts and trying them out with student audiences. This practice foreshadowed the later notion of improving lessons and validating their worth through formative and summative evaluation (Cambre, 1978). Educational broadcasters offered programs in every conceivable subject, including foreign languages, health, social studies, home economics, science, music, art, and many other subjects. BBC programmers worked closely with advisory boards of teachers in every subject area to find niches into which audio material might add value (Bailey, 1957). They reached thousands of schools in each country; for example, in 1936 in England and Wales some 4600 schools were registered users (Parker, 1939). However, in the Americas and many European countries, programming tended to be what Levenson and Stasheff (1952) referred to as "informally educative" rather than directly instructional. Radio services had difficulty playing core instructional roles. For one thing, the advantage of broadcasting is its coverage of a broad area, but that meant crossing school district and even state and provincial boundaries. It was difficult to create any lesson that would meet the content, scope, sequence, and timing demands of multiple schools across multiple jurisdictions. For another thing, teachers, the gatekeepers of the classroom, were reluctant to turn over responsibility for core subject matter, sensing that it would threaten their authority. This pattern of consigning technology-based programming to a supplementary role was to be repeated with television, programmed instruction, and computer-assisted instruction.

EDUCATIONAL MEDIA IN WORLD WAR II

During World War II both the Allies and Axis powers used motion pictures extensively for home-front propaganda purposes, with the German director Leni Riefenstahl setting new aesthetic standards with psychologically powerful documentaries, such as *Triumph of the Will*. Such films provided rich material for a generation of researchers in psychology and media studies in the United States and Europe. The need for rapid mass training of literally millions of combatants and industrial workers brought films to the forefront of military training. The British and American armed forces made extensive use of 16-mm films for training and motivational purposes, but the U.S. effort was the most pervasive of any of the combatant nations. Between 1941 and 1945, the Division of Visual Aids for Military Training—with major participation by Hollywood directors and actors—produced over 400 sound films and over 400 silent filmstrips, enabling a military mobilization far broader and faster than the Axis strategists had expected (Saettler, 1990).

During the war, as films were being produced and used in training, the U.S. Army commissioned a series of psychological studies, later published as *Experiments on Mass Communication* (Hovland et al., 1949), which tested hypotheses about various filmic techniques and their instructional effectiveness. Because of the concentration of time, money, effort, and research expended on these productions, a genre of instructional film came into its own. New filmic conventions were established, for example, showing procedural tasks from the performer's viewpoint rather than the viewer's and using a first-person stream of consciousness narration to model the thought process of the performer.

EDUCATIONAL MEDIA IN THE POST-WAR PERIOD

Research on Media

After the war, instructional film research continued under U.S. Navy sponsorship at Pennsylvania State University, a research program that yielded over a hundred publications (Hoban and Van Ormer, 1970). Some of the experiments dealt with utilization techniques, but most explored presentation variables, such as camera angles, pacing, narration, music, and color (Saettler, 1990). The U.S. Air Force also commissioned a series of studies in the early 1950s that explored the possible interactions between film and programmed instruction techniques and broadly examined the value of learner response during film or video viewing. Research within the field received a major stimulus with the founding in 1953 of the journal *Audio-Visual Communication Review* by DAVI, the predecessor of AECT. The National Defense Education Act passed in 1958 provided a flood of funding in the United States for audio-visual research under Title VII.

Basic Research

Most of the basic research on visual and auditory perception has been done outside the field of educational technology. The most relevant strand of visual learning research began in Germany with Gestalt psychology in the first half of the 20th century, pioneered by Max Wertheimer (1944) and elaborated by Kurt Koffka and Wolfgang Köhler. They were attempting to describe how humans and other primates perceived stimuli and used cognitive processes to understand and solve problems. Another strand, focusing on the formation of mental models, was begun by Kenneth Craik (1943) in England and elaborated by Johnson-Laird (1983). Generalizations gathered from these sorts of basic research were compiled by Fleming and Levie (1978) in the form of message design principles.

Audio-Visual Instruction in Practice

The period between World War II and the advent of personal computers in 1982 could be viewed as the audio-visual instruction period. Immediately after World War II, educational technology practice revolved around the media formats that had become widely available to teachers by 1946: 16-mm films, 35-mm slide/filmstrip projectors, opaque projectors, radio receivers, and record players. These formats were owned by schools at the rate of at least 1 per 100 teachers. Television receivers reached this status in 1958 and overhead projectors in 1960 (Finn et al., 1962). Magnetic tape recording was invented in Germany in 1935 and was introduced to the United States by servicemen who brought back recorders after the war. By 1956, reel-to-reel tape recorders had joined the ranks of media devices found in mass use in schools (Finn et al., 1962). Cassette audio recorders were introduced by Philips in the Netherlands in 1962 and became the standard audio format in schools around the world by the early 1970s.

Meanwhile, the actual rate of use of audio-visual media by K–12 teachers during this era would have to be characterized as moderate. Utilization rates were strongly affected by accessibility. Teachers were likely to use materials that were stored in their own classrooms, somewhat less likely to use those housed in a center in their building, and even less likely to use items, such as 16-mm films, that had to be delivered from outside the building on a scheduled basis. Surveys in the 1940s and 1950s in the United States indicated that about 40% of elementary teachers and 20% of secondary teachers used films frequently. Evidence from various sources indicates that the average teacher used about one film per month (Cuban, 1986, pp. 14–18). The reasons given by teachers for the low rate of use of film and similar media, in addition to accessibility, included lack of training in the technology, unreliability of projection equipment, limited school budgets (for rental of films and purchase of projectors), and difficulty integrating the material into the curriculum. Surveys in the 1990s identified the identical barriers to teachers' use of computers.

The animating vision of the audio-visual paradigm, represented by Hoban et al. (1937), was to replace empty verbalism or rote memorization with meaningful learning. Dale (1946), an early advocate of rich learning environments, expanded the notion of visual instruction by proposing in his Cone of Experience that learning experiences—including direct personal experiences, field trips, and dramatizations as well as audio and visual media—could be arrayed in a spectrum from concrete to abstract, each with its proper place in the tool kit.

EDUCATIONAL TELEVISION (ETV)

The BBC began regular television broadcasts in 1936, and regular programs were being offered in the United States, Germany, France, and the Soviet Union before World War II, which brought developments to a standstill. After the war, television grew rapidly; for example, the NBC commercial network was broadcasting by 1947, and NHK began regular television service in

1953. In most European countries, the radio formula was carried over to television, with the state broadcasting agencies expanding into this new medium, funded by license fees, and continuing their tradition of bringing cultural and educational programming to the populace.

ETV in Europe

The BBC began school broadcasts in 1957; by 1974, over 80% of all schools were making regular use of BBC programs (British Information Services, 1974), a pattern that carried on into the 21st century. Guided since the early days of radio by a School Broadcasting Council that includes strong representation of teachers, programs are carefully designed to be integrated into the national curriculum. In other European countries, the general pattern is for the state television corporation to devote a small percentage of its broadcast hours to programming aimed at in-school audiences and adult education.

ETV in North America

Like the United Kingdom, Canada also operates a national television network, the CBC, which is supported in part by commercial advertising. The CBC began to provide school broadcasts when television operations commenced in 1952. They continued to offer a limited schedule of in-school programs throughout the 1960s and 1970s as the various provinces gradually undertook their own program production. Just as in the United States, Canada's K–12 education system is controlled by provincial authorities rather than the national government, and by the mid-1960s most of the provinces were producing in-school programs tailored to their specific needs. Beginning in 1970, TVOntario, a public noncommercial network serving Ontario, offered school-oriented programs, some of which attained international recognition and distribution; thus, both national and provincial programs are available for school use.

During the 1950s, dozens of noncommercial television licenses were granted to universities and community groups in the United States, and educational television programs began to be beamed to school and college audiences (the first being KUHT at the University of Houston in 1953) and adults and children at home. Many of the same parties that had experimented with radio also did so with television, essentially replaying the radio scenario. Because this was a period of rapid school population growth there was a general shortage of qualified teachers. Television was seen by some as a way to reduce the need for additional teachers by replacing the presentation function with broadcast lessons.

In the late 1950s and through the 1960s in the United States, programs were distributed on a regional basis, such as by the Eastern Educational Network and the Midwest Program of Airborne Television Instruction (MPATI, a precursor of satellite broadcasting), and a few on a national basis, such as Continental Classroom. During this period, the Ford Foundation and the federal government were subsidizing the expansion of television in higher education through grants for closed-circuit TV construction and program production. By the end of the decade of the 1960s, tens of millions of school and college students were receiving televised instruction on a daily basis. After the popularization of videotape recording (later, videocassette recording), ETV programming was increasingly created and used as off-the-shelf packaged units rather than being received through broadcasting.

ETV Programming

As with educational films, ETV programs tended to emulate the familiar genres: lecture, demonstration, voice-over visualization, interview, panel discussion, dramatization, field trip, or documentary (Wood and Wylie, 1977). The production processes were comparable to those used in commercial radio and television: "We borrowed from commercial television certain ideas about what constitutes a program, and we have not shaken free from these concepts" (Suchman, 1966, p. 30). American ETV presentations, particularly those beamed to college audiences, tended to be more verbal (featuring the so-called talking heads) than European productions (Tanner and Woerdehoff, 1964). European programs, particularly those of the BBC, were notable for their emphasis on visualization. The BBC collection became a major international archive of exemplary programming that was drawn upon by producers from around the globe.

A break from this expository pattern began in the 1960s under the influence of the so-called Cognitive Revolution, which suggested that television should be participative rather than passive. It should ask questions, pose challenging problems, and spark discussion and search for answers. In short, it should trigger inquiry (McBride, 1966). The discovery learning movement eventually led to the production of a number of educational television series, especially in science and social studies, that portrayed problematic situations and invited learners to discuss them. The *Jasper Woodbury Problem Solving Series* in the 1990s represented the culmination of this movement.

ETV in Developing Countries

As television was later in coming to the less industrialized countries, so were educational applications. In many countries educational television came with the financial and technical support of industrialized countries, intending to help expand educational opportunities as part of nation building; for example, in 1961 UNESCO and the Ford Foundation established a pilot project in Delhi, India, to offer televised physics, chemistry, and English lessons to secondary students in that city (Mohanty, 1984). In 1966, a project was initiated for communicating agricultural information to farmers in some 80 villages outside of Delhi; the programs were viewed communally and were followed by group discussion.

This pattern of urban in-school programs and rural agricultural development support was followed in many other developing countries. During the 1960s and 1970s, educational television projects were undertaken in more than a dozen countries in Latin America (e.g., El Salvador and Colombia) and like numbers in Africa (e.g., Ivory Coast and Niger) and Asia (e.g., South Korea and India). In Oceania, the entire educational system of American Samoa was restructured around television in the 1960s.

In many cases, these projects were not intended to be permanent; in any event, most were not sustained. Tiffin's (1978) system analysis of ETV projects in Latin America indicated that although the lessons themselves were educationally effective the overall projects suffered from systemic problems. Clayton's (1979) analysis echoed these findings, noting that systems in which major components are absent or dysfunctional tended to perish.

In the post-colonial era, ETV was viewed as a means of expanding the reach of disadvantaged education systems while improving the quality of the education that was offered. The evidence indicated that from a strictly economic standpoint these early projects were difficult to justify. Reform based on television may be a faster means of changing the curriculum and improving teaching methods but it is also more expensive in these settings and often not locally sustainable (Carnoy, 1975).

THE COMMUNICATION PARADIGM

Information Theory

During the later days of educational radio and the earlier days of educational television, communication theory became a dominant paradigm both in the physical and social sciences. Flowing from Shannon and Weaver's (Shannon, 1949) information theory, through Wiener's (1950) cybernetics and Berlo's (1960) Process of Communication model, thinkers in educational technology were viewing teaching/learning problems as communication problems. Improvement of communication depended on detecting where the weak points in the process were and ameliorating them: choosing a more visual medium, building more redundancy into the message, matching the receiver's language capability better, providing the sender with better feedback about the receiver's response, and the like.

Semantics

During the 1940s and 1950s, theories of communication not only sparked the emergence of information science but also attracted attention in the social sciences. General Semantics, conceived by Korzybski (1933) and interpreted and popularized by Hayakawa (1941), offered a new way of studying the meanings evoked when humans communicated through various media. It added the human dimension to the technical process of communication addressed in other communication theories.

A New Paradigm for Audio-Visual Education

The communication perspective became a new paradigm for defining the audio-visual instruction field. It was embraced wholeheartedly by a segment of the field; for example, the name of the academic program at Syracuse University changed from Audio-Visual Education to Educational Media to Instructional Communications in the mid-1960s. The first formal definition of the field in 1963 used the term *audiovisual communications* as the central concept. When the time came to change the name of DAVI in 1971, there was nearly equal support for *communications* and *technology* as the key terms, so both were incorporated into the new name: Association for Educational Communications and Technology (AECT).

RADICAL BEHAVIORISM

Application to Instruction

The term *behaviorism* refers collectively to several related but different theories in psychology. One of them, radical behaviorism, has had the greatest practical impact on educational technology due to the application

of its primary technique, operant conditioning, to teaching-learning problems (Burton et al., 2004). As discussed in the chapter by Lockee and colleagues in the Technologies part of this handbook, B.F. Skinner's analysis of the problems of group-based traditional instruction led him to the invention of a mechanical device for applying operant conditioning to academic instruction (Skinner, 1954). Referred to as a *teaching machine*, the device gained national attention. The arrangement of stimuli, responses, and reinforcers in teaching machines became known as *programmed instruction*, and programmed instruction lessons in book format were published in great profusion in the 1960s.

Impact of Teaching Machines

The Department of Audiovisual Instruction (the hyphen between audio and visual was dropped in 1960) joined the new programmed instruction movement by publishing *Teaching Machines and Programmed Learning: A Source Book* (Lumsdaine and Glaser, 1960). The 1959 DAVI convention program had a single paper devoted to programmed instruction, but there was a major session in 1960 entitled "Programmed Instructional Materials for Use in Teaching Machines." This title gives a clue to the link between audio-visual administrators and programmed instruction: the machines that were initially used to deliver the programmed lessons. When schools and colleges acquired teaching machines someone had to take care of them: the audio-visual coordinator! The primacy of the machine was indicated by the name that marked this special-interest group at the next several DAVI conventions: the Teaching Machine Group.

Emergence of Educational Technology Paradigm

Gradually the emphasis shifted to the process of designing self-instructional systems. This design process dovetailed with the notion promoted earlier by James D. Finn that instructional technology could be viewed as a way of thinking about instruction, not just a conglomeration of devices. Thereafter, technology began to take on the dual meanings of application of scientific thinking and the various communications media and devices (parallel to the distinction between hard and soft technologies found in the second edition of this handbook). Further, by the mid-1960s, Skinner also came to view programmed instruction as a practical application of scientific knowledge to education, and he referred to his instructional strategies as a *technology of teaching* (Skinner, 1965, 1968). Other authors converted this term to *educational technology*; an early example is *Educational Technology: Readings in Programmed Instruction* (DeCecco, 1964).

Between 1960 and 1970, the research focus of what had been the audio-visual education field shifted sharply toward work on teaching machines and programmed instruction, prompting the change of the name of the field from audio-visual education to educational technology. Torkelson (1977) examined the contents of articles published in *AV Communication Review* between 1953 and 1977 and found that the topics of teaching machines and programmed instruction dominated the journal in the 1960s. In fact, between 1963 and 1967, these topics represented a plurality of all articles published in that journal.

This reorientation of the field can be seen as a major paradigm shift, from the creation and use of audio-visual media or the communication of messages to the design of learning environments according a specific set of psychological specifications. The dominant psychological theories would change over time, but the role of applied psychologist would remain at the core.

Behavioral Technologies

Research and development in behaviorism led to other innovations such as programmed tutoring, Direct Instruction, and Personalized System of Instruction, which are discussed at greater length in the chapter by Lockee and colleagues in Part III. These technologies established an enviable record when compared with so-called conventional instruction in experiments in which paper-and-pencil tests were used as the measure of learner achievement (Lockee et al., 2004). As communication technology advanced, these frameworks were incorporated in mechanical, electromechanical, and ultimately digital formats, such as computer-assisted instruction and online distance education.

SYSTEMS APPROACH TO INSTRUCTIONAL DESIGN

Evolution of Systems Approach

The essence of the systems approach is to subdivide the instructional planning process into steps, to arrange those steps in logical order, then to use the output of each step as the input of the next. The systems approach traces its origins to concepts that emerged from military research during World War II. An analytical technique that grew out of submarine hunting was called *operations research*, in which computers were used to make the calculations required. After the

war, this approach to analyzing, creating, and managing man/machine operations, now referred to as the *systems approach*, was applied to the development of training materials and programs.

During the post-war period, each of the U.S. military services developed its own model for training development, and all of them were based on the systems approach, a soft science version of systems analysis, itself an offshoot of operations research. The systems approach was viewed in the military as a paradigm for combining the human element with the machine elements in man–machine systems, an antidote to purely mechanistic thinking. From the entry of the systems approach into the field of educational technology, it was recognized by its advocates as a loose set of guidelines that were applicable to the complex problems of human learning only by analogy and not the sort of completely deterministic and tightly controlled methodology described by some of its detractors.

The concept of systems approach probably was introduced to educational technology leaders in the United States by Charles F. Hoban in his keynote address, "A Systems Approach to Audio-Visual Communication," presented at the second Lake Okoboji leadership conference in 1956 (Noel and Noel, 1965). The conference spotlight coincided with a series of articles by James D. Finn published around the same time. Together, they helped create momentum behind the idea of the systems approach, which eventually became a hallmark of the field.

Instructional Systems Development Models

During the 1960s, the systems approach began to appear in procedural models of Instructional Systems Development (ISD) in American higher education. Barson's (1967) Instructional Systems Development project, conducted at Michigan State University and three other universities between 1961 and 1965, produced an influential model and a set of heuristic guidelines for developers. During this same period, Leonard Silvern at the University of Southern California began offering the first course in applying the systems approach to instruction (Designing Instructional Systems), which was based on his military and aerospace experience. He also produced a detailed procedural model that influenced later model builders (Silvern, 1965).

A Model for Schools

These early activities in the consortium that included Syracuse, Michigan State, U.S. International University, and the University of Southern California (later joined by Indiana University) culminated in a joint project, known as the Instructional Development Institute (IDI). The IDI was a packaged training program on instructional development for teachers, and between 1971 and 1977 it was offered to hundreds of groups of educators. Because it was usually conducted by faculty and graduate students from nearby universities, the IDI became an extremely influential vehicle for disseminating ideas about the ISD process among educational technology faculty and students across the United States.

A Model for the Military Services

The Center for Performance Technology at Florida State University was selected in 1973 by the U.S. Department of Defense to develop procedures to substantially improve Army training. As recounted by Branson (1978), the ISD procedures developed for the Army evolved into a model, the Interservice Procedures for Instructional Systems Development (IPISD), that was adopted by the Army, Navy, Air Force, and Marines. The detailed procedures clustered around five major functions: analyze, design, develop, implement, and control. The IPISD model eventually had enormous influence in military and industrial training because its use was mandated not only in all of the U.S. armed services but also among all defense contractors.

A Generic ISD Model

The 1980s brought a proliferation of ISD models for education and training. They differed in details but typically adhered to the common conceptual framework of analyze, design, develop, implement, and evaluate. This conceptual framework came to be called by its acronym, ADDIE. During the 1970s and 1980s, advocates for the systems approach attempted to promote its use in K–12 and higher education. These efforts were largely unsuccessful, possibly for reasons related to the social and economic dynamics of these institutions; however, ISD was welcomed in corporate and military training, where it became the reigning paradigm for the next 20 years as a way to standardize design practices and make training more efficient and effective.

ISD as a Paradigm Shift

The ISD movement can be viewed as another paradigm shift in the history of educational technology. By the end of the 1980s, skill in instructional design was viewed as the core competency of the educational

technology professional. By contrast, the development and production of audio-visual materials became a niche specialization, one that was often outsourced.

Critical Questioning of ISD

By the late 1990s, however, an accumulation of pressures—new digital capabilities, intense cost competition and the need to reduce human resources costs, and the increasing pace of change—led to increasingly critical questioning of the ISD orthodoxy (discussed from an international perspective in Tennyson et al., 1997). In particular, the design of more complex computer-based learning environments in which learners are expected to take the initiative in pursuing knowledge and to collaborate with others in doing so challenges conventional ISD procedures (Häkkinen, 2002). Lowyck and Pöysä (2001), among others, have called for new models that emphasize co-construction of knowledge and indeed co-design of the learning environment.

ADVENT OF COMPUTERS IN EDUCATION

Mainframe Era

The first attempts to use computers to present and control instruction began in the early 1960s before the microprocessor, when mainframe computers used punched cards for input. The early experiments in computer-assisted instruction (CAI) began just at the time that programmed instruction was at its peak, so many of the early CAI programs followed a drill-and-practice or tutorial format. A correct response was confirmed, while an incorrect response might branch the learner to a remedial sequence or an easier question. Beginning in the mid-1960s, the CAI research and development program at Stanford University, later the Computer Curriculum Corporation, created successful drill-and-practice materials in mathematics and reading, later adding foreign languages (Saettler, 1990).

Minicomputer Era

More innovative and more learner-centered programs were developed in the TICCIT project at Brigham Young University in the 1970s after the introduction of the microprocessor and the proliferation of minicomputers. These sophisticated programs yielded successful programs in mathematics and English composition; however, both the Stanford and TICCIT programs failed to gain major adoption in their intended sectors: K–12 and community college education (Saettler, 1990).

The PLATO project at the University of Illinois began in 1961 and was aimed at producing cost-efficient instruction using networked inexpensive terminals and a simplified programming language for instruction, TUTOR (Saettler, 1990). Most of the early programs were basically drill-and-practice with some degree of branching, but a wide variety of subject matter was developed at the college level. Over time, terminals at outlying universities were connected to the central mainframe in a timesharing system, growing to hundreds of sites and thousands of hours of material available across the college curriculum. As software development continued, many innovative display systems evolved, including a graphical Web browser. With experience and with more capable hardware, more varied sorts of instructional strategies became possible, including laboratory and discovery oriented methods.

The PLATO system pioneered online forums and message boards, e-mail, chat rooms, instant messaging, remote screen sharing, and multiplayer games, leading to the emergence of what was perhaps the world's first online community (Woolley, 1994). It continued to grow and evolve right through the early 2000s, sparking the expansion of local CAI development and finding a niche in military and vocational education.

COGNITIVIST AND CONSTRUCTIVIST THEORIES

Cognitivism

Like behaviorism, *cognitivism* is a label for a variety of diverse theories in psychology that endeavor to explain internal mental functions through scientific methods. From this perspective, learners use their memory and thought processes to generate strategies as well as store and manipulate mental representations and ideas. The Scottish psychologist Kenneth Craik (1943) theorized that thinking and reasoning take place through the internal manipulation of mental models. A generation later, Johnson-Laird (1983) built on Craik's foundation, elaborating a theory that when people participate in discourse they construct a mental model of the situation being discussed. Other theories that would later become very influential were being developed in the 1920s and 1930s by Jean Piaget in Switzerland and Lev Vygotsky in Russia, but these did not have significant impact on American educational psychology until translations were widely circulated in the 1960s. Cognitive theories gained momentum in the United States with the publication of Jerome

Bruner's *The Process of Education* in 1960, the dissemination of Piaget's and Vygotsky's works, and the emergence of information-processing theory (leading to cognitive load theory) in the 1960s. By 1970, when the journal *Cognitive Psychology* was born, the cognitive perspective had gained not only legitimacy but also dominance.

Constructivism

A perspective on learning and instruction known as *constructivism* entered the vocabulary of the educational technology field in North America by means of a provocative presentation by David Jonassen at the 1990 meeting of Professors of Instructional Design and Technology (PIDT), a presentation later recorded and amplified in Jonassen's column (1990) in *Educational Technology* and in a lead article in *Educational Technology Research and Development* (1991). He challenged instructional design and technology people to question the "objectivist epistemology" underlying practice in the field. He attributed the field's failure to change in a revolutionary way to its acceptance of this epistemology, which he claimed undergirded both behaviorist learning theories and cognitivist learning theories.

Early advocates of constructivism used the term as an umbrella term for a wide range of innovative instructional methods drawn primarily from recent developments in cognitive psychology (see Bednar et al., 1991; Duffy and Cunningham, 1996; Duffy and Jonassen, 1992). Piaget and Vygotsky were frequently cited as foundational influences on the development of this perspective. Because of the importance of social and cultural influences in Vygotsky's theory, it is termed a sociocultural approach to learning and the branch that follows this theory is often termed *social constructivism*.

The difficulty of defining a canonical version of constructivism is discussed in Robinson et al. (2008). In view of these many differing streams of thought, Driscoll (2005) concludes "there is no single constructivist theory of instruction" (p. 386), and she cites as constructivism's common denominator the assumption "that knowledge is constructed by learners as they attempt to make sense of their experiences" (p. 387). This assumption actually overlaps with those of earlier cognitivist theories of learning. Where constructivists (some of them) seem to differ from cognitivists, according to Driscoll, is that they argue that "knowledge constructions do not necessarily bear any correspondence to external reality" (Driscoll, 2005, p. 388). This subjectivism aligns with the epistemology of von Glasersfeld (1984, 1992), the founder of radical constructivism.

Constructivist Movement

Irrespective of ambiguity about its theoretical basis, the constructivist message struck a chord among many academics in educational technology. For those attracted to postmodernism, constructivism shared a foundation in a subjectivist epistemology. For those leery of behaviorism's reductionist tendencies, constructivism projected a vision of holism. It hearkened back to the era in which Bruner called for a learner-centered approach to meaningful learning. Perhaps most importantly for those in educational technology, it coincided with the new capabilities of digital media.

Constructivism recommended instructional strategies that followed several broad principles, according to Driscoll (2005, pp. 394–395):

1. Embed learning in complex, realistic, and relevant environments.
2. Provide for social negotiation as an integral part of learning.
3. Support multiple perspectives and the use of multiple modes of representation.
4. Encourage ownership in learning.
5. Nurture self-awareness of the knowledge construction process.

At least the first three of these principles lend themselves better to technology-based delivery than face-to-face conventional instruction. First, complex, realistic environments (or microworlds) can be created using simulation software. Second, e-mail, chat rooms, and threaded discussions can facilitate social negotiation. Third, the World Wide Web platform enables designers to link pictures and moving animation clips to verbal presentations, all of which can be navigated according to individual needs and interests.

Many of the instructional strategies promoted by constructivists were mentioned in the early article by Bednar et al. (1991): situated cognition (associated with cognitive apprenticeship), anchored instruction, problem-based learning, and collaborative learning. These strategies were subsequently supported by the American Psychological Association's *Learner-Centered Psychological Principles* (APA, 1995), an authoritative position paper on approaches to teaching and learning.

Constructivism as a New Paradigm

Advocates on the American side, such as Thomas Duffy and David Jonassen, and on the European side, such as Joost Lowyck, converged on several joint projects (see Duffy et al., 1993), contributing to a growing wave of interest on both sides of the Atlantic. Having gained momentum by the mid-1990s as the

constructivist movement, this could be viewed as another paradigm shift in the identity of the field. From that time to the present, the conversation has centered on using the tools of educational technology to create learning environments suited to experiential learning: WebQuests, problem-based learning, microworlds, simulations and games, blogs, and wikis.

Emerging Syntheses

In recent years, theorists have been seeking a resolution to the paradigm wars among the competing learning theories. A synthesis offered by M. David Merrill (2002) suggests a lesson design framework incorporating behaviorist, cognitivist, and constructivist conceptions. Merrill's (2002) framework, which he refers to as *first principles of instruction*, proposes four phases to the instructional process: (1) activation of prior experience, (2) demonstration of skills, (3) application of skills, and (4) integration of these skills into real-world activities, with all four phases revolving around a problem or realistic task. Diana Laurillard (2002) of the British Open University characterizes academic instruction as essentially a conversation, an iterative dialog between a teacher and a student that is focused on a particular topic or goal. She proposes that media may play four roles in the instructional dialog: discursive, adaptive, interactive, or reflective. These roles reflect the emphasis of the different psychological perspectives; hence, Laurillard's model also may be viewed as an attempt at a theoretical synthesis.

THE DIGITAL AGE

Microcomputers and Personal Computers

The role of computers in education began to change dramatically with the development of microcomputers in France and in the United States in the 1960s and 1970s. Microcomputers became increasingly commercially successful after the introduction of new models in 1977 by Apple and RadioShack and in 1981 by IBM. By the end of 1982, the rapid proliferation of the personal computer was acknowledged by *Time* magazine by being named Machine of the Year, a break from the magazine's tradition of Man of the Year. Apple's Macintosh model in 1984 enticed even more novices to venture into the computer world. Previously, students encountered mainframe or minicomputers in labs, where they served as tutors that typically controlled drill-and-practice exercises. Now, both students and teachers could have access to user-friendly desktop computers in the classroom and at home as well as productivity tools such as word-processing programs for writing, spreadsheets for organizing quantitative data, and presentation software to create graphs and slide shows.

School Adoption of Computers

An international survey in 1989 revealed that in most industrialized countries widespread school adoption of computers began around 1983 and increased at a steady rate each year thereafter. By 1989, several countries (Luxembourg, Switzerland, the Netherlands, France, United States, and British Columbia in Canada) had reached the plateau of having approximately one computer per classroom; however, as had been discovered earlier in the audio-visual era, access to the hardware does not equate to use. This survey as well as later surveys indicated that only a small percentage of teachers who had access to computers actually integrated their use significantly into their teaching (Pelgrum and Plomp, 1991; Plomp and Pelgrum, 1993). In these early years, student usage was primarily to learn about computers rather than to learn with computers.

As access to computers grew, eventually reaching recommended levels by about 2005, student usage continued to lag behind availability. In the mid-1990s, student use was still rather mundane, often limited to a few hours per week of drill programs or routine word-processing applications (Anderson and Ronnkvist, 1999). By the mid-2000 decade, it appeared that more students were using computers for many more hours (U.S. Department of Education, 2005) and possibly for uses more central to the curriculum, although this is debatable.

From the 1980s through the 1990s, the pendulum was swinging from analog media to digital media as the primary source of instructional materials in schools, colleges, and corporate training centers; however, traditional media formats such as textbooks, the overhead projector, and videocassettes have continued to be used heavily by teachers at all levels right up to the present. As an example, three fourths of all corporate trainers reported that they use manuals and textbooks and over one half use videocassettes (Dolezalek, 2004, p. 34).

Internet and World Wide Web

As profoundly as personal computers changed the information environment in the 1980s, the advent of the Internet in the 1990s changed it even more. The rapid increase in connections to the Internet in the early 1990s vastly expanded the potential for sharing information at a distance. The invention of graphical user

interfaces allowed the World Wide Web to become the most popular Internet protocol around 1993. Because of its ubiquity it became the *de facto* standard platform for sharing resources. Being structured according to hypermedia principles (links and nodes) it largely displaced the earlier concept of hypermedia programs residing in a local computer system. With programs residing on the Web, they could be tapped from any place in the world that could access the Internet.

Distance Education

What is now known as distance education can be traced back at least to 1840 in England, when Isaac Pitman began offering shorthand lessons through the medium of mail. Correspondence study was well established in Germany, as well, before the first American correspondence study program (Society to Encourage Studies at Home) began in 1873 in Boston. Correspondence study attained respectability in the United States when major programs were offered at the University of Chicago and Columbia University early in the 20th century. In 1956, Chicago City Junior College launched TV College, using broadcast television to offer post-secondary education degrees to viewers in the Chicago area. It was immensely popular and it also happened to be on the itinerary of a visiting group of professors from the United Kingdom in 1964, a group known as the Brynmor Jones Committee. The 1965 report of this committee (*Audio-Visual Aids in Higher Scientific Education*) was a watershed in the evolution of educational technology in the United Kingdom (MacKenzie, 2005), and it inspired the vision of an "open university," which became part of the Labour Party's platform in 1963.

The British Open University

The establishment in 1969 of the British Open University became a landmark in distance education in several regards. First, it was designed as an open-access, degree-granting institution. Second, it was expected to scale up to serve tens of thousands of students at a time. Third, although broadcast television in partnership with the BBC provided the most visible part of its instruction, it was designed to integrate television, other audio-visual media, print, telephone help systems, and face-to-face tuition in a seamless whole. The British Open University eventually became the model for most of the distance universities that came later. In particular, the broadcasting partnership has been emulated by the Open University of Hong Kong, the Bangladesh Open University, and the Korean National Open University (Bates, 2005).

Mega-Universities

The subsequent years have seen the flowering of a series of large-scale distance universities, referred to as *mega-universities* by Daniel (1996), such as the China TV University System, the French Centre National d'Enseignement à Distance, Indira Gandhi National Open University, and Indonesia's Universitas Terbuka, among others. Perhaps the largest is Anadolu University, based in Turkey, which serves over 500,000 students from Germany to Cyprus.

Web-Based Courses

The impact of the computer on distance education was first manifested through courses based on computer conferencing. Boise State University was offering a master's degree program in educational technology via computer conferencing in the 1990s. More recently, however, it is the mushrooming of the World Wide Web that has fueled growth in distance education. The Web makes it feasible for higher education institutions and corporate training operations to offer their courses at a distance economically. Instead of requiring video studios and expensive transmission systems, Web-based courses use existing computer infrastructure at no extra cost to deliver their courses to users. Web-based courses began to appear around 1995. The University of British Columbia offered its first entirely Web-based credit courses in 1996 (Bates, 2005).

These demonstrated successes created a brief land-rush mentality among American universities in the late 1990s to try to capture a commanding share of the market for online distance education. By the end of the 1990s, courses delivered via Internet were offered at 60% of all colleges, compared with 22% only 5 years earlier (U.S. Department of Education, 1999). Within a few years, the investment fever had waned and the field was left to the slow-but-steady providers of reliable, good-quality courses. Over 30 states formed distance learning consortia to pool their resources and give students a wider menu of choices. Consortia such as UMassOnline and Illinois Virtual Campus experienced double-digit growth in enrollments between 2000 and 2006 (Bichelmeyer and Molenda, 2006). In Europe, the Open University of Catalonia, which opened in 1996 as a public, fully online university, was serving 25,000 students by 2004 (Bates, 2005).

Virtual Schools

During the past decade distance education also became a major phenomenon at the K–12 level in the United States. Many school districts, especially those in urban centers facing competition from home schooling, char-

ter schools, and private alternatives, started virtual schools to try to retain students who were drifting outside the public school system. A major national survey in 2003 found that students in more than one third of public school districts enrolled in distance education courses: 76% at the high-school level and another 15% in combined or ungraded schools (Setzer and Lewis, 2005).

Computer-Based Residential Courses

The use of the Web grew not only for off-campus distance courses but also for on-campus residential courses. By 2004, most American universities had adopted a standard course management system (CMS), a suite of applications, tying together Web presentations, e-mail, discussion forums, and other applications. Blackboard.com, introduced its first CMS, CourseInfo, in 1999. By 2006, Blackboard had merged with its largest rival, WebCT, and dominated the field of college and university CMSs, although rival open-source software CMSs were also being developed, such as Moodle and Sakai. The widespread adoption of CMSs blurred the line between distance and residential courses, as it allowed residential students to carry out more of their course activities on a computer, making distance a matter of degree rather than of kind.

Growth in distance education created a demand for distance course designers and developers, making this one of the key growth areas for educational technologists. By 2006, the work of educational technology had shifted heavily into the digital domain, moving the field closer to the field of informatics; however, the identity forged in the pre-computer era—the designer of learning environments—remains central, supplemented by the even earlier identity as promoter of sensorially rich learning experiences.

CONCLUSION

Since its inception, the field of educational communications and technology has been characterized by changes in technology and radical shifts in its underlying paradigms. Beginning as visual instruction, then audio-visual instruction, adherents were attracted by the prospect of enriching the learning experience through involvement of the senses. Advances in broadcasting technology encouraged another vision: to bring educational opportunities to audiences hitherto beyond the reach of schooling. New psychological theories came along, holding out the promise of devising frameworks for lessons that would facilitate learning in dramatically improved ways. Then digital technologies captured the field, enabling designers to create learning environments in which verbal and visual media could be combined under the inspiration of various pedagogical theories into expository lessons, problem-solving laboratories, collaborative work spaces, or hybrids thereof—all made available to almost anyone, anywhere.

The field has also been and continues to be thoroughly interdisciplinary. Certain individuals and institutions have provided a measure of continuity over the years, but discontinuity has been a recurrent problem. Each media revolution and each paradigm change bring new people with different backgrounds into the field. From visual instruction to radio, from audio-visual media to programmed instruction, from instructional design to distance education—each transition has tended to mean reinventing the wheel in terms of the questions asked in research and in terms of grand dreams about revolutionizing education.

Likewise, the field has been and continues to be international in scope. Although the geographically diffuse components of the field are only loosely articulated, ideas have been able to flow sufficiently to allow rich cross-fertilization of both theories and practices. As the Internet has made communication and collaboration an order of magnitude easier, it appears that the coming years will knit participants even more tightly together.

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* Indicates a core reference.