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ABSTRACT

This paper argues that electronic text applications in higher education can be conceptualized in terms of three communicational intentions of computer-based systems: informational, instructional, and instrumental (tool-oriented). Product-oriented and service-oriented applications of electronic text are contrasted, and instructional applications are explored through case histories of mature computer-based instructional systems, including TICCIT and PLATO. A discussion of the potential of authoring systems as tools for generating electronic text-based instruction is followed by an outline of perspectives for a systematic/scientific approach to instructional product development. It is suggested that if electronic text systems are to become truly useful resources, the problem of how to integrate the delivery of instructional products with other educational activities that are based on electronic text, must be addressed; such activities would include library data bases, electronic mail, and computer conferencing. A list of references completes the document. (Author/JB)

Electronic Text Consortium

Electronic Text for Higher Education

San Diego State University, University of Wisconsin, University of Nebraska, WGBH Boston

ELECTRONIC TEXT:
AN AMALGAM OF CAPABILITIES
FOR CREATING, INFORMING,
AND INSTRUCTING

Monograph Number Two
of the
Electronic Text Monograph Series

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An Annenberg/CPB Project

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Monograph Number Two
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Electronic Text Monograph Series

Prepared by

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The mandate of The Annenberg/CPB Project over a 15-year period is to create innovative, quality college-level materials and to demonstrate unique applications of telecommunications technologies in higher education problems.

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ABOUT THE MONOGRAPH SERIES

The Electronic Text Monograph Series is a refereed series of scholarly research reports generated from the study of electronic text in higher education. The monograph series includes scholarly reports of research conducted by the Electronic Text Consortium, as well as other scholarly studies of electronic text in higher education.

Electronic Text Consortium

MONOGRAPH 2

ELECTRONIC TEXT: AN AMALGAM OF CAPABILITIES FOR CREATING, INFORMING, AND INSTRUCTING

April, 1985

by

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ABSTRACT: Proposes that applications of electronic text to higher education can be conceptualized in terms of three communicational intentions of computer-based systems: informational, instructional, and instrumental (tool-oriented). Contrasts product-oriented and service-oriented applications of electronic text. Explores instructional applications of electronic text through case histories of mature computer-based instructional systems, including TICCIT and PLATO. Outlines perspectives on instructional product development as applied to electronic text, focusing on a systematic/scientific approach. Explores the potential of authoring systems as tools for generating electronic text-based instruction.

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Members: San Diego State University, University of Wisconsin, University of Nebraska, WGBH Boston

Contents

List of Figures

Preface

The accelerating pace of the computer era has imposed massive new vocabularies upon us. While the nomenclature of the electrical engineer is often excruciatingly specific, many of the terms we need to conceptualize broader uses of computer technology in academe remain elusive. This monograph examines the concept of electronic text as it applies to the needs of higher education and presents an overview for the general reader who wants to know more about how electronic text might be used to improve the effectiveness of the academic enterprise.

As the term is currently used, electronic text refers to a family of computer-based information systems that transmit text and adjunct pictorial displays via computer and cable networks, telephone lines or open broadcast television. This integration of computer and telecommunication technologies (the combination is sometimes called telematics) is proliferating rapidly and now assumes many of the functions allocated to older communication systems such as newspapers, television, telephones, postal delivery, and face-to-face meetings.

The monograph presents a framework for matching the capabilities of electronic text systems to traditional activities associated with the creation and dissemination of knowledge. Arguably, a rational definition of the concept of electronic text would subsume many separate computer applications.

The framework proposes that the various applications of electronic text can be grouped in terms of their communicational intent. The three varieties of communicational intent most important to higher education are informational, instructional, and instrumental (tool-oriented). These intentions also serve as a basis for integrating electronic text systems with other academic resources.

After presenting the general framework, this monograph then examines one of its aspects in greater detail: instructional uses of electronic text. The examination focuses on the problems associated with developing electronic text-based instruction, and on the relationship of computer-based instruction to other forms of electronic text.

ELECTRONIC TEXT: AN AMALGAM OF CAPABILITIES FOR CREATING, INFORMING, AND INSTRUCTING

Electronic text is a Byzantine web of differing hardware standards, information coding schemes, and service networks. Hundreds of different vendors can legitimately claim to be in the business of facilitating the delivery of electronic text. A broad definition of electronic text includes thousands of systems for generating and transmitting alphanumeric symbols to remote users. Computer software ranging from programming languages and statistical analysis packages to library databases and computer bulletin-boards can be used to create and send electronic text to remote locations.

But whatever the source, electronic text is typically delivered to the individual user in the form of displays on a computer terminal or on a modified television. While there is great diversity in the communication protocols that are used to accomplish these transmissions, he resulting messages appear remarkably similar when viewed by the end-user: alphanumeric characters moving across a cathode-ray tube in patterns that are far more homogeneous than any newspaper or magazine. Yet electronic text can support a wider range of communication modalities than most forms of print-based text: print is static; electronic text is interactive.

Electronic Text as a Multi-modal Delivery System

Figure 1 lists some of the modes of electronic text which are especially applicable to higher education. These modes are extensions of the oldest traditions of academic activity: reading instructor-written materials and course texts; exchanging ideas in seminars or with individuals; sorting data and performing calculations; searching libraries for previous writings; getting help from tutors; taking exams; writing and revising drafts; even reading bulletin boards. The question at hand is how to use the capabilities of electronic text to integrate traditional forms of academic communication, to augment and improve them, and to extend their reach to students and professors widely separate in time and space.

Communicational Intent

The similarity of electronic text displays as they present themselves to the user obscures some fundamental differences in the communicational intentions that lie behind various forms of electronic text systems. Most educational activities are an amalgam of three components of communicational intent: informational, instructional, and instrumental.

Informational Applications

news services
library search services
electronic bulletin boards
computer conferencing

Instructional Applications

computer-assisted instruction
computer-managed instruction

Instrumental Applications

word processing
statistical analysis
computer simulations and models
programming languages
data base management

Figure 1. Examples of electronic text in higher education.

While it is possible for users of electronic text to learn from activities based on any of the three intentions (or any mixture), actualizing each intention requires different communication strategies.

Informational Intent vs. Instructional Intent

Communication varies in the extent to which it is aimed at specific learning outcomes and in the guidance which it provides to recipients about how to engage in mental processing of messages. Instructional communication is designed to facilitate acquisition of specific competencies. Informational communication is designed to provide information that may be useful to the learner but which is not directed towards acquisition of specific skills or knowledge.

News services, journal abstracts, bulletin boards, and encyclopedias are all examples of informational applications of electronic text. These communications are provided without any specific intent to improve the skills or knowledge of the user. They offer little additional support for users who do not already have a background in the specific subject matter; they do not provide practice and feedback related to specific performance objectives; and they invariably omit systematic evaluation of any competencies which which might have been acquired by the user.

Practice, feedback and evaluation, on the other hand, are critical characteristics of electronic text products and services based on instructional intent. In applications of electronic text such as computer-based instruction, communication is aimed at developing specific sets of competencies--skills and knowledge of established import. However, it should be noted that the instructional intent of many traditional learning activities (even those associated with formal coursework) is often poorly specified; learners and instructors are frequently unclear about the specific skills or knowledge which should be acquired. To the extent that learning outcomes are unknown or unspecified, such activities might be more appropriately classified as informational or instrumental.

Instrumental Intent

While informational and instructional intentions are realized by imparting information, instrumental intentions are actualized by providing users of electronic text with tools for discovering and synthesizing new information. Such applications represent a broad category of tool uses that ranges from computer programming languages to word processing systems. It also includes the many computer-based research and development tools that facilitate production (via analysis or synthesis) of new information (and the various authoring languages and systems designed to facilitate the development and maintenance of electronic text products and services themselves). Instrumental uses of electronic text might be as simple as using a word processor to compose a memo, or as complex as using a statistical analysis package to perform a multivariate analysis; as artistic as using a graphics tablet to develop videotex screens or as clerical as using a keyboard to add a new entry to a database.

One of the most important applications of computers in higher education is to provide computer-based simulations of real-world (or imaginary) systems through which students can explore phenomena and discover knowledge on their own. One of the clearest examples of this type of approach is LOGO, a computer language developed by Seymour Papert and his associates at MIT (Papert, 1980). LOGO is designed so that students can explore mathematics by manipulating a "micro-worl that conforms t nsistent set of mathematical rules. Systems such as these are neither instructional (since they are not designed to teach pre-specified competen ies) or informational (since they do not provide detailed expositions about the rules that underlie the micro world). Rather, they are instrumental since they serve as tools for discovery.

Realizing Communicational Intent through Educational Products and Services

Higher education, like many other segments of the economy, depends on a mix of products and services for realizing communicational intentions. Educational products are characterized by the replicability of their form--films, textbooks and computer software--and by an expectation that they will meet a set of pre-specified needs. Products are typically distributed (and paid for) as discrete units. Product-oriented education is only possible when the costs of development and production can be amortized over a learner population of adequate size. A population of sufficient size can support large-scale product development efforts that incorporate a thorough assessment of needs, careful design, quality production, and extensive evaluation.

Educational services such as lectures, workshops, tutorials, and seminars are, on the other hand, much less replicable. While such services are highly flexible and responsive to changing needs, they are typically labor-intensive. Educational services are most cost-effective when the population of learners is too small to warrant a product-oriented approach, or when the educational activity cannot be easily represented in the form of a product.

Computer-aided instruction is a prime example of product-oriented electronic text; many of the best CAI programs are competency-based and are aimed at developing well-defined skills and knowledge. Other electronic text products are informational in nature and simply provide users with a package of useful information without incorporating practice, feedback or evaluation.

Electronic text systems have also been used as a means of delivering instructional services. The EIES system (Glossbrenner, 1983), for instance, offers distance learning courses (in subjects ranging from computer programming to accounting) through a combination of electronic mail and computer conferencing. Similar applications of electronic text have been demonstrated by the Open University in England using the Prestel system.

Many electronic text systems provide home users with access to a range of educational products and services. Information utilities such as CompuServe and The Source offer a panoply of services and products under a single umbrella. Home videotex systems tend to emphasize informational services and products; educational products play a relatively minor role. Few home videotex systems offer instructional services or products (as they have been defined here) that teach or measure specific competencies.

While the contrast between products and services has been a useful construct in twentieth-century economics, the information revolution is blurring the distinction between the two concepts. The classic criteria for identifying service-oriented educational activity have relied heavily on the presence or absence of human service workers. But it is now clear that a major thrust of the computer revolution is to create software that replaces service workers or augments their productivity. A major activity of systems analysts and software designers involves the analysis of human services and the development of computer algorithms which can serve as a replacement for their services.

Should a large-scale computer system (such as PLATO) that manages extensive sequences of instruction and which incorporates diagnostic and tutorial functions be considered a product? Or is it more like a service? A fruitful reconceptualization of such systems may be to liken them to automated factories that are capable of assembling customized products according to unique specifications required to meet the needs of the learner. Alvin Toffler's concept of demassification is useful here.

As Toffler (1980) notes, the use of computer-managed factories now makes it feasible to produce very small quantities of customized products such as pharmaceuticals and electronics, and even to prefabricate customized housing at costs which would have been impossible under a labor-intensive, service-oriented system. The American innovation of the mass-produced automobile "built" to the customer's oru from hundreds of different options represents another example of the demassification. In a similar manner, researchers who submit a profile of professional interests to a computer ut:lity such as The Knowledge Index can request a monthly file of newspaper clippings and journal abstracts unique to their interests. Sophisticated, large-scale CBI systems such as PLATO and TICCIT reflect a similar use of automation. Essentially these systems rely on a large stock of discrete modules design d to teach specific skills or to provide specific types of instructional support. A centralized management program measures student performance and other student characteristics and then assembles an appropriate set of modules or components to create a product a:lapted to individual needs.

Instructional Media vs. Instructional Messages

Promoters of innovative communications systems are always ready to ascribe new benefits to the systems they advocate, and it is not uncommon for advocates of electronic text to point to its potential as a medium of instruction. Yet twenty-five years of media-effectiveness research clearly indicates that the capabilities of various delivery systems--whether they are based on print, television, film, radio or computers--play a relatively minor role in what people learn (Clark, 1984). Instructional scientists have been unable to demonstrate any consistent results which favor one particular medium as a teaching tool. What counts, according to Clark, are the learning strategies and instructional strategies that are used to organize the messages transmitted by various media. How do students become interested in learning and how do they find out what is expected of them? How are key ideas presented and reinforced? How are skills and attitudes modeled? What kinds of opportunities for practice and feedback are provided? What kind of help is available? How is competence defined and evaluated? In sum, the way instructional messages are designed has a much greater effect on student performance than the way messages are delivered. The selection of one delivery system over another improves learning only when such a choice results in educational strategies that are more appropriate to the desired educational outcome. In education settings at least, the medium is not the message.

Many questions about the appropriate use of electronic text in higher education will remain unproductive unless they focus on how the capabilities of various available systems can be used to implement effective instructional strategies.

Computer-based Instruction and the Design of Instructional Products for Electronic Text

Much of our current understanding of the instructional-design implications of electronic text derives from 20 years of experience with CAI and CMI. Two of the most advanced CAI systems are PLATO and TICCIT (Two-way, Interactive Computer-Controlled Instructional Television). These systems merit attention for they way in which they attempt to implement instructional strategies through electronic text displays.

PLATO

PLATO was a pioneering development in the delivery of instructional products via electronic text. PLATO can be classified as a videotex system because it transmits programs from a central terminal to remote users and because it uses special protocols for transmitting graphics. The University of Illinois and the Control Data Corporation (with National Science Foundation funding) began designing PLATO instructional products in the early 1960's (Suppes & Macker, 1978). Today, the PLATO library contains the largest collection of electronic text-based instructional products in existence: over 12,000 hours of instruction in basic skills, technical training, and higher education (Miller, 1983).

PLATO courseware is generally intended to supplement, not substitute for, classroom instruction. An important feature of the PLATO system is its CMI capabilities; because the central computer is extremely powerful, PLATO's record-keeping and information-processing capacity is far superior to that of TICCIT (Callison,1981). This feature allows for constant improvement of instruction based on empirical data on student performance.

Most users gain access to the PLATO library via on-line PLATO terminals located in PLATO learning centers or in private facilities owned by client organizations. (Control Data Corporation has recruited several Fortune-500 corporations as PLATO users.) In recent years CDC has made PLATO more accessible to the public by developing microPLATO, a stand-alone microcomputer that runs converted PLATO lessons, and through stand-alone PLATO software that has been revised to be compatible with popular microcomputers (Miller, 1983).

CDC has also developed software that converts home microcomputers into PLATO terminal emulators that can access the mainframe computer via telephone modems. However, the narrow bandwidth of ordinary telephone lines results in transmission rates that are much slower than with the dedicated phone lines used with standard PLATO terminals.

PLATO Courseware Design

PLATO courseware is self-paced and competency-based; the user learns at his/her own speed but must periodically demonstrate proficiency before progressing to more advanced lessons. Courseware is developed as part of a complete curriculum whenever possible rather than as scattered bits and pieces of instruction (the shortcoming in many CAI systems).

Individual courses are modularized and can be adapted to several levels of instruction--from review and reinforcement to the delivery of the entire curriculum (Miller, 1983). This makes PLATO more acceptable to teachers who prefer to be in control of the amount of instruction that will be delegated to the computer. PLATO features an electronic mail system which allows learners and instructors to send detailed messages to each other. Messages can be posted or exchanged in real time.

PLATO's high-level authoring language, TUTOR, is a powerful tool that enables teachers and subject matter experts to develop their own CAI modules with a minimum of programming expertise.

TICCIT

TICCIT was developed as a joint venture of the Mitre Corporation and Brigham Young University and represents an approach to instruction that is quite different from that of the PLATO system.

During the early 1970's, C. Victor Bunderson, M. David Merrill and colleagues at BYU received funding from the National Science Foundation to explore the potential of combined television and minicomputer technologies as a delivery system for CAI in higher education (Suppes & Macker, 1983). Utilizing small, local minicomputer systems (in contrast to PLATO's mainframe computer), TICCIT was designed to replace classroom instruction with self-contained CAI packages. TICCIT's visual display capabilities are superior to those of PLATO. TICCIT terminals are modified color TV monitors that allow instructional developers to integrate film, slide and video images with computer text and graphics (Alderman, Appel, & Murphy, 1978). There are at least 13 TICCIT systems in use in the U.S. (Stone, 1982). Prospects for wider use of TICCIT were improved by the recent decision of Hazeltine Corporation to market a commercial version of the system that uses specially-adapted versions of the IBM Personal Computer linked to laser-optical videodisc players.

TICCIT Courseware Design

TICCIT differs from PLATO and most other electronic text systems in two important respects: it provides the learner with control over the sequence of instruction and it utilizes formal instructional theory in the development of its courseware.

The developers of TICCIT were inspired by research which indicated that the conditional branching found in most tutorial CAI programs dampens the enthusiasm and motivation of the learners (Bunderson, 1975). They believed that the learner, not a computer program, is best able to determine what instruction he/she needs to master a new skill, and they designed a system in which the learner controls the selection of instructional components.

TICCIT also incorporates M. David Merrill's Component Display Theory. Merrill devised a flexible theory for designing instruction that is based on the function or purpose of each display: presentation of generalities, specific instances, "helps" that relate the specific case to the generality and so on. These components are seperate, modular units of instruction that learners can adapt to their own strategies for learning. With TICCIT, the learner is relatively free to choose the order in which the instructional components will be sequenced, to repeat any section at any time, to study as many examples as he/she sees fit, to take a practice quiz at any time, and to move on to the next lesson when he/she feels ready. The learner also has some control over the difficulty of instruction and can request a more concrete (or more abstract) version of the lesson segment.

Merrill and other TICCIT designers argued that TICCIT's user-control features could increase learners' motivation and improve their ability to acquire effective learning strategies that could be transferred to other educational settings (Bunderson, 1975).

A recent innovation in the TICCIT scheme is the addition of the "intelligent advisor." When a student makes an unexpected response or uses an ineffective learning strategy, TICCIT interrupts the lesson and recommends an alternate strategy. The student can choose to either accept or ignore the recommendation (Stone, 1982).

Reports on TICCIT's effectiveness are mixed. In one study (Bunderson, 1978), students who received instruction solely from TICCIT performed as well as students receiving conventional classroom instruction. The completion rate of the TICCIT students, however, was markedly lower. In this respect, TICCIT appears to share a common problem with other systems for delivering instruction by electronic text: many students seem to need the encouragement and supervision of a human instructor to remain motivated.

Instructional Design Implications

Much has been learned from PLATO, TICCIT and other CAI systems about the application of instructional design principles to electronic text. As a better understanding of these issues is gained, new questions and concerns arise.

Some of these are listed below.

- o Both TICCIT and PLATO designers envision a future capability to discern the learner's own learning strategies that enable him/her to learn most effectively, and to provide an individualized instructional program based on those strategies and the learner's performance (Stone et. al., 1982).
- o There is no well-developed theory of coaching. What information should be provided to a learner who needs assistance, and how and when should it be provided (Burton & Brown, 1979; Allen & Merrill, 1984).
- o Many CAI programs present lengthy expository material that is difficult to read on computer display devices. Perhaps these long verbal presentations are best delivered by an accompanying print-package that is coordinated with the CAI program. (Becker, 1982).

Approaches to Instructional Product Development

Many of the problems associated with product-development for other media also appear as obstacles to the development of instructional products for electronic text systems.

Instructional product development can be divided into three phases. The Design phase includes analysis of the instructional problem, specification of the desired performances or competencies, and the selection of an instructional strategy. The Production phase accomplishes the actual creation of the product prototype. Validation focuses on evaluation of the prototype--the measure of its effectiveness for achieving instructional goals.

Perspectives on instructional product development vary, but Reigeluth, Bunderson and Merrill (1978) describe two approaches that are widespread: artistry and raw empiricism. A third approach described by Reigeluth is still in its infancy and involves the systematic application of scientific principles of instructional design through validated procedures and techniques. These three approaches are diagrammed in Figure 2.

The use of <u>artistry</u> in instructional design depends on the intuition, taste, and experience of the designers. The artistic approach often eschews clear statements about what competencies the product will teach; the product then becomes a personal creative statement rather than a means for achieving specified instructional goals. While the artistic approach can result in products which are aesthetically pleasing and which have apparent "face validity," the instructional effectiveness of the product is rarely evaluated. The ability of the product to perform as specified then remains in doubt, especially if the artist or writer has limited experience with instructional psychology appropriate to the desired competencies if such competencies have in fact been specified.

When development is based on <u>raw empiricism</u> the artistic approach is augmented by testing; formative evaluation of intuitive solutions to design problems is carried out on samples of the target audience. Data from these formative evaluations is then used to improve the product prototype. However, this trial-and-error method is

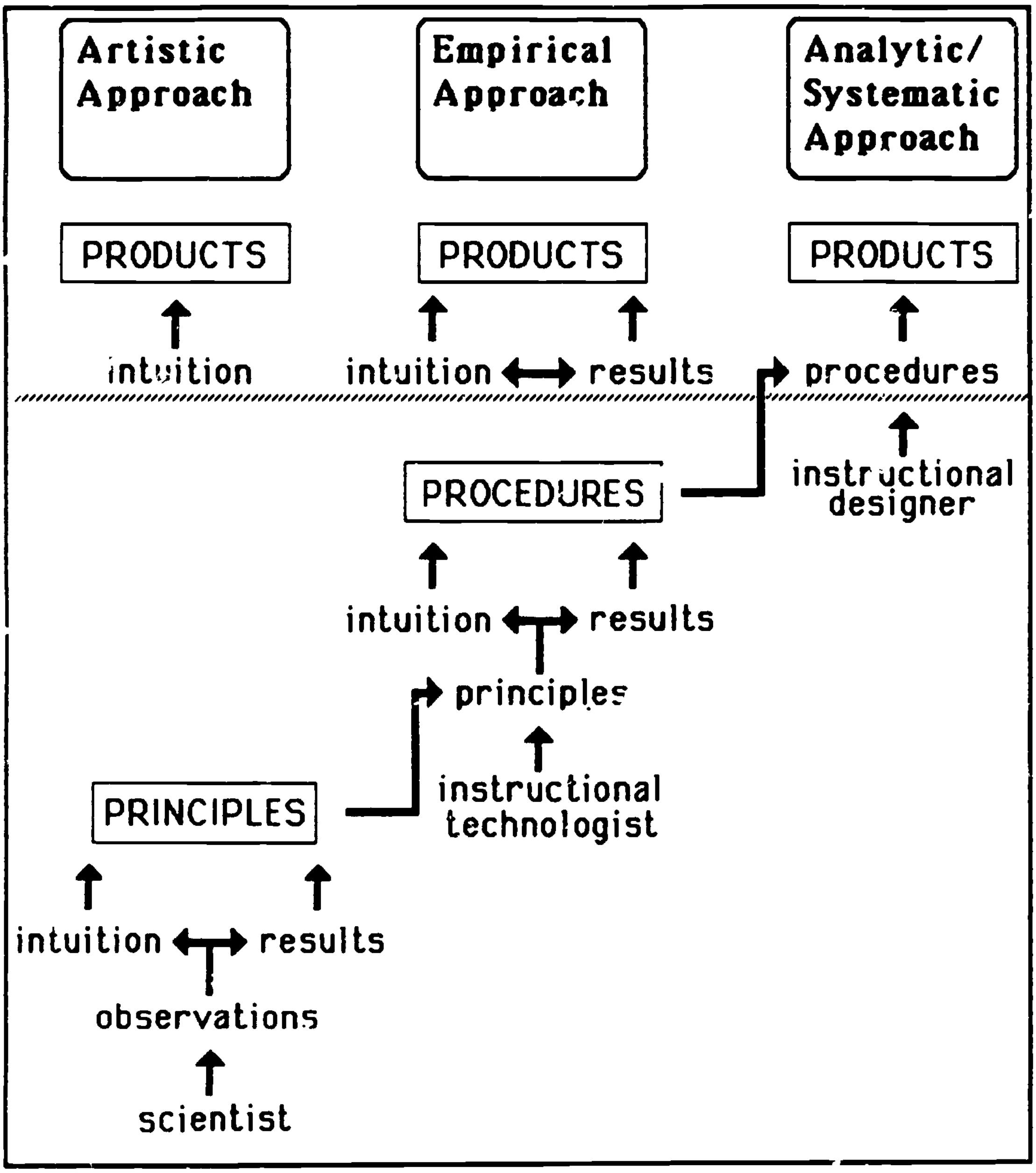

Figure 2. Three approaches to the development of instructional products.
(Adapted from Reigeluth, Bunderson and Merrill, 1978.)

expensive and time-consuming, and it may be difficult to determine which component of the product is at fault. The experience gained through formative evaluation cannot easily be generalized; test results tend to be product-specific. Designers and producers may improve their individual intuitive skills through successive trial-and-error cycles, but knowledge of results is difficult to transfer to other people or product development efforts.

As Reigeluth and his associates note, the fundamental limitation of raw empiricism is its dependence on intuitive talent. Intuition is a valuable asset--a personal characteristic that requires time, experience and special circumstances to develop. Dependence on intuition and artistry is often a bottleneck to lowered product development costs. While designers with a proven track record of intuitive problem solving may be appropriate in the high-stakes world of advertising and entertainment, the exclusive use of the intuitive approach for achieving specified instructional outcomes is not cost-effective for routine use in training and instruction.

The third approach to instructional development identified by Reigeluth et al is akin to engineering and might be called the <u>analytical/systematic</u> approach. It is particularly appropriate in the use of mass communications for instructional purposes and in the development of large-scale instructional systems where the costs of research and development can be amortized over a large audience base and over many product development efforts. In this approach, instructional technologists draw on scientifically-established principles of human learning to derive validated procedures and techniques for creating instructional products. The use of validated procedures and principles reduces dependence on intuition. It often lowers the level of experience and artistic talent required to design and produce effective products and it tends to reduce the number of trial-and-error cycles required to produce effective results. More importantly, it contributes to a general knowledge-base of techniques and principles that are more easily transferred to other individuals and products.

But there are several problems with the analytic/systematic approach. Instructional science is still in its infancy, and scientific knowledge of the learning process is still quite limited. There are economic impediments to the use of the analytic/systematic approach as well. Instructional engineering requires funding of an R&D base--a commitment to basic research and procedures development. Such funding is beyond the capabilities of many product development organizations. Another problem is that rapid advances in communications and computing technologies mean that delivery systems are often available for years before their properties are well understood by instructional scientists. It takes time for instructional technologists to test out the various design procedures which would be compatible with a scientific understanding of these properties.

A major obstacle to the wider use of instructional products in higher education is the difficulty of accurately specifying the competencies that will be acquired. The engineering of instructional products depends on clear statements of desired performances--descriptions of what learners will know or be able to do after using the product. Methodology for efficiently producing descriptions of complex intellectual skills (in a form that can be used by product developers) is clearly a priority research area for instructional scientists.

The creative contributions of artists--writers, photographers, graphic designers, programmers and others whose contributions to product design are mostly based on intuition--will always remain an important factor in product development efforts. The artistic approach is often very effective in the pioneering stage of a new technology where intuition can be a crucial short-cut to innovation. Nevertheless, the reduction of dependency on the artistic approach will play an important role in the effort to make cost-effective use of electronic text for delivery of instructional products.

Instructional Development Models

The systematic design of instructional products is a relatively new concept. The first models for controling product development efforts appeared in the 1950's in response to military training needs. They are often referred to as instructional systems development (ISD) models. By the 1970's, ISD had become common in most aspects of military training and had begun to appear in industrial and commercial training applications. Numerous alternative models have been developed over the last two decades, but most represent a refinement of the three phases described earlier: design, production, and validation.

One instructional development model that has played an important role in the development of instructional products for delivery via electronic text is the Courseware Development Process. The model was created by Control Data Corporation and is used extensively in the development of products for PLATO. (See Figure 3.)

As summarized by Gustafson (1981), the Courseware Development Process (CDP) is an input-output model: the results of one phase of development are used as input for the next phase. The model is arranged as a circular process to indicate that development may begin at any one of several phases. In phase one, Analysis, efforts focus on an assessment of the need for instruction and a determination of its scope. If instruction is found to be necessary, a

CDC Courseware Development Process

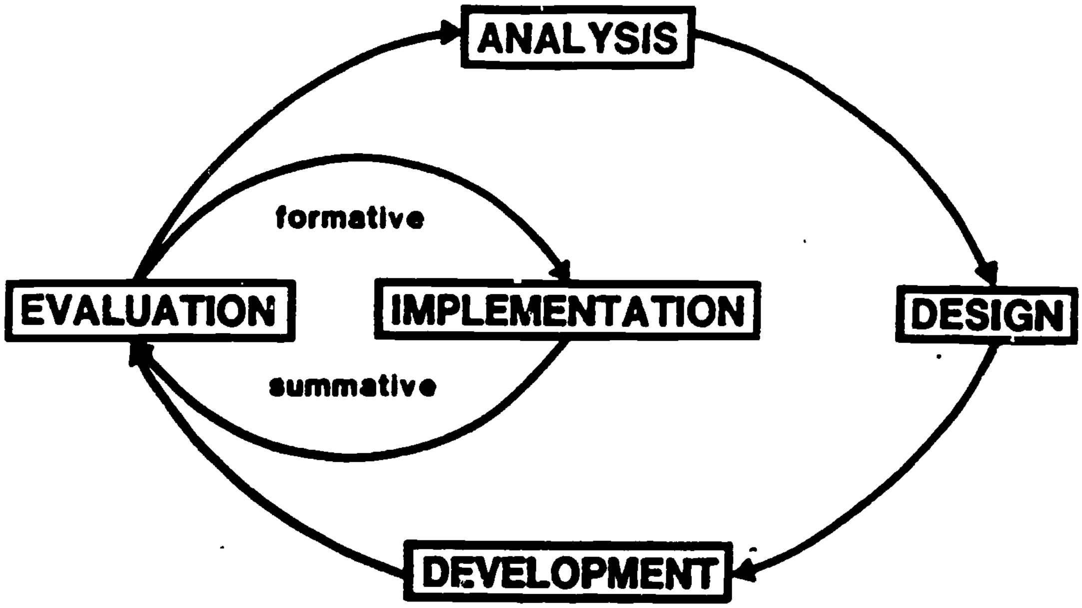

Figure 3. Control Data Corporation's instructional development model.

management plan is developed.

Phase two, Design, is broken into seven steps (adapted from Gustafson for this discussion):

(1) analyze the skills and knowledge that will be learned;

(2) specify competencies to be acquired;

(3) define skills and knowledge which are prerequisite to product use;

(4) determine the order in which new competencies will be learned;

(5) specify the system which will be used to measure learner progress;

(6) specify the strategies and activities which will be used to teach the competencies;

(7) specify the system which will be used to evaluate performance when learners complete their use of the product.

The output of phase two is used as input for phase three, Development. This phase includes the design of specific lessons and the development of test items keyed to competencies defined in the design phase. Product prototypes, including screen layouts, management routines, and supplementary text or audiovisual materials, are developed. Inspection and editing of the prototype materials complete phase three.

The fourth phase of the process is Formative Evaluation. Try outs of the prototypes are conducted with representative learners and revisions are based on the results. Audiovisual materials and print packages are then produced and piloted on small groups. Additional revisions and editing are completed during this phase.

<u>Implementation</u> is the fifth phase of the CDP. This includes replication, distribution, and use of the prototype, the establishment of support services, and the training of course managers and instructors. The product is put into place at actual sites and data is collected on system and learner performance.

In phase six, <u>Summative Evaluation</u>, data from the implementation phase is analyzed to determine whether the over all goals of the project were achieved. This may be an ongoing process: when results of summative evaluations indicate that there is a need for revision, the product may be recycled through the CDP and updated.

The circularity of the Control Data model is unique among major instructional development models. It reflects two important advantages of PLATO (and other electronic text systems) over more traditional systems for delivering instructional products: (1) the ability to collect performance data on larger numbers of users through on-line processing and (2) the ability to store student response data and to use it for making timely decisions about how to improve the product. PLATO has exploited these advantages of electronic text on a much larger scale than any other system now in use.

Current Status of Instructional Systems Development

While the systems approach to instructional product development has considerable promise as a tool for development of electronic text-based products, it has its limitations. Scientific scrutiny of the systems approach has been minimal. The validity of the more widely used models rests on the fact that they have resulted in effective products. But this kind of raw empiricism does little to elucidate how the individual components of the models contribute to product effectiveness. A comprehensive theory of product development based on validated principles of model construction is yet to emerge.

In theory, instructional designers should be able to generate consistent results by applying validated procedures based on scientifically established principles. In actuality, the body of procedures required by designers is still immature, primarily because the principles and theories (on which the procedures are based) have not yet been fully derived and validated. Thus, the quality of products developed using systems models is still crucially dependent on the intuitive and artistic skills of developers.

The current state of the art is such that the analysis, evaluation, and revision steps that are so essential to the systems approach are often time-consuming and expensive; they remain suspect in the eyes of producers whose efforts are often evaluated on the basis of a product's appearance rather than on empirical measures of instructional effectiveness.

Computer-based Instructional Development Tools

One way to reduce the costs of developing instructional products for electronic text systems is to use computer-based tools that facilitate the various activities of the instructional development process. Authoring systems, such as those developed for PLATO, allow designers and subject-matter experts with limited programming experience to produce relatively sophisticated CAI and CMI programs.

Merrill (1982) suggests that computer programming tools can be represented on a continuum based on their relationship to the fundamental circuitry of computer hardware (See Figure 4). Those at the left end of the continuum are closest to the architecture of the computer. Languages close to the machine architecture allow great flexibility and control in the design of computer programs, but they require much technical knowledge of the interstices of the machine. Higher level languages are adapted to specific programming tasks, sacrificing flexibility for ease in programming. Machine-language programming is based on a manipulation of binary codes that instruct the computer to perform specific operations. This is a very specialized

← Ease of use →

machine languages	assembly languages	high-level languages	authoring languages	authoring systems

← Flexibility →

Figure 4. Continuum of computer programming tools (after Merrill, 1982).

operation that is rarely exercised beyond the confines of computer company R&D labs. Assembly language is a step further along the continuum: machine-language instructions are represented as mnemonic commands that are easier to understand and use. Assembly languages retain a great deal of flexibility and control over the computer while removing some of the burden of the programming task. Nevertheless, the use of assembly languages requires a relatively high level of programming skill.

Assembly-language commands and machine-language codes are used to create high-level languages such as BASIC, COBOL, and Pascal. These tools are adapted to the more specialized needs of computer users. They are more convenient to use and require less programming skill to achieve a given result than does assembly language. Nevertheless, high-level languages require a good deal of expertise to be used effectively, and programming with them is a time-consuming process.

High-level languages have built-in assumptions about use which restrict their problem-solving capabilities. For example, BASIC (Beginners All-purpose Symbolic Instruction Code) is specially adapted for interactive programming of simple text and graphic displays, while COBOL (COmmon Business Oriented Language) is designed for business applications such as accounting and billing.

Authoring languages represent a very high degree of specialization in that they are designed specifically for instructional applications. PILOT is one of the earliest and most widely used authoring languages. At the simplest level, PILOT allows the designer to use English-like commands and simple mnemonics to create programs that display text, accept a response, compare the response to a set of anticipated responses, and branch to appropriate feedback and remediation. PILOT allows instructional designers to create CAI programs much more quickly than in a lower-level language. However, there are many programming tasks that it cannot perform.

All authoring languages rest on certain assumptions about the nature of instruction. While these assumptions facilitate the development of instructional products that are consistent with the assumptions, they restrict designs based on other assumptions. PILOT, for example, assumes that instruction will be conducted in the form of a dialogue between the student and the computer and that the instructional strategies employed by the designer can be represented as a series of <u>frames</u> which can be selected by the computer, based on its analysis of the learner's responses. These assumptions severely restrict PILOT's ability to teach skills which require complex psychomotor skill or which attempt to teach problem-solving skills by allowing the learner to participate in computer simulations or models of real-world events.

Authoring systems attempt to provide even more assistance to instructional designers than is commonly found in authoring languages. The goal of these systems is to allow the designer to produce CAI and CMI without the necessity of mastering a programming language. Authoring systems prompt the author through a set of decisions about program design and then use this information to write the actual computer program. The author selects various options for screen layout, test-item formats, response handling, scoring, and so on, from a limited set of options supplied by the system. Some systems incorporate advanced production features such as readability guides that flag uncommon words and long sentences and suggest simple alternatives.

Most authoring languages fail to offer more than limited assistance with the underlying problems of design: the description of competencies, the organization of subject-matter content, specification of motivational and instructional strategies, and so on. Merrill (1982) argues that the authoring systems currently in use might be better described as "packaging languages" since they help with the formatting and layout of the product but provide little assistance in making more fundamental decisions about design.

Automated Instructional System Development

One of the more promising approaches for making CAI and CMI applications of electronic text more cost-effective is the development of integrated computer tools that assist with all of the phases of product development. The complexity of product development activities makes this a challenging effort. Nevertheless, considerable progress has been made and much ongoing research is being carried out in this direction.

The PLATO and TICCIT systems both provide lesson templates that help with the sequencing of the content material, but these features are currently quite limited. Military applications are at the forefront of automated ISD research--in part because the military faces a shortage of skilled instructional designers. The CASDAT system, developed for for military aircrew training, provides for the generation of task lists, hierarchies of competencies, and lesson specifications once the necessary data has been entered by a content specialist (Kearsley, 1984). The Naval Personnel Research and Development Center is now at work on the the development of a computer-based system to help designers with critical steps in the use of the Instructional Quality Inventory, a system for evaluating and improving existing instructional products. The system will guide and monitor product designers as they work on various instructional development tasks and will facilitate access to relevant databases (test-item files, classifications of performances, etc.) and selection of alternative forms of instruction.

High-level authoring systems and automated ISD systems represent an important step toward reducing the cost of developing electronic text-based instructional products. Research and development in this area will probably continue for at least a decade, and the more sophisticated tools discussed above will not be available to higher education in the near future.

Summary

The general concept of delivering instructional products to university and college students via electronic text is not a new idea. PLATO and TICCIT represent successful applications of a general approach that may have come before its time. Electronic text systems seem likely to grow in power and sophistication, but the methodology for developing products for electronic text systems is still in its infancy. ISD concepts have been slow to gain acceptance in higher education in part because they are perceived as based on a narrow, skills-oriented approach. Wider use of electronic text for instructional applications in higher education probably depends on a greater acceptance of product-based instruction. This in turn requires a greater awareness of curriculum components where specific competencies can be identified and a clearer targeting of those aspects of the curriculum which are amenable to delivery via electronic text.

This article has argued that the use of electronic text to deliver instructional products depends on a clear specification of educational outcomes. However, product-oriented instruction is only one component in the total mix of activities that comprise education as it has been defined here. If electronic text systems are to become truly useful resources, they must address the problem of how to integrate the delivery of instructional products with other educational activities based on electronic text such as library data bases, electronic mail and computer conferencing.

The future of electronic text in higher education is likely to be based on a complex web of informational, instructional, and instrumental (tool-oriented) intentions. Each of these approaches to communication can result in learning; but when successfully integrated, they form a much richer educational environment.

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