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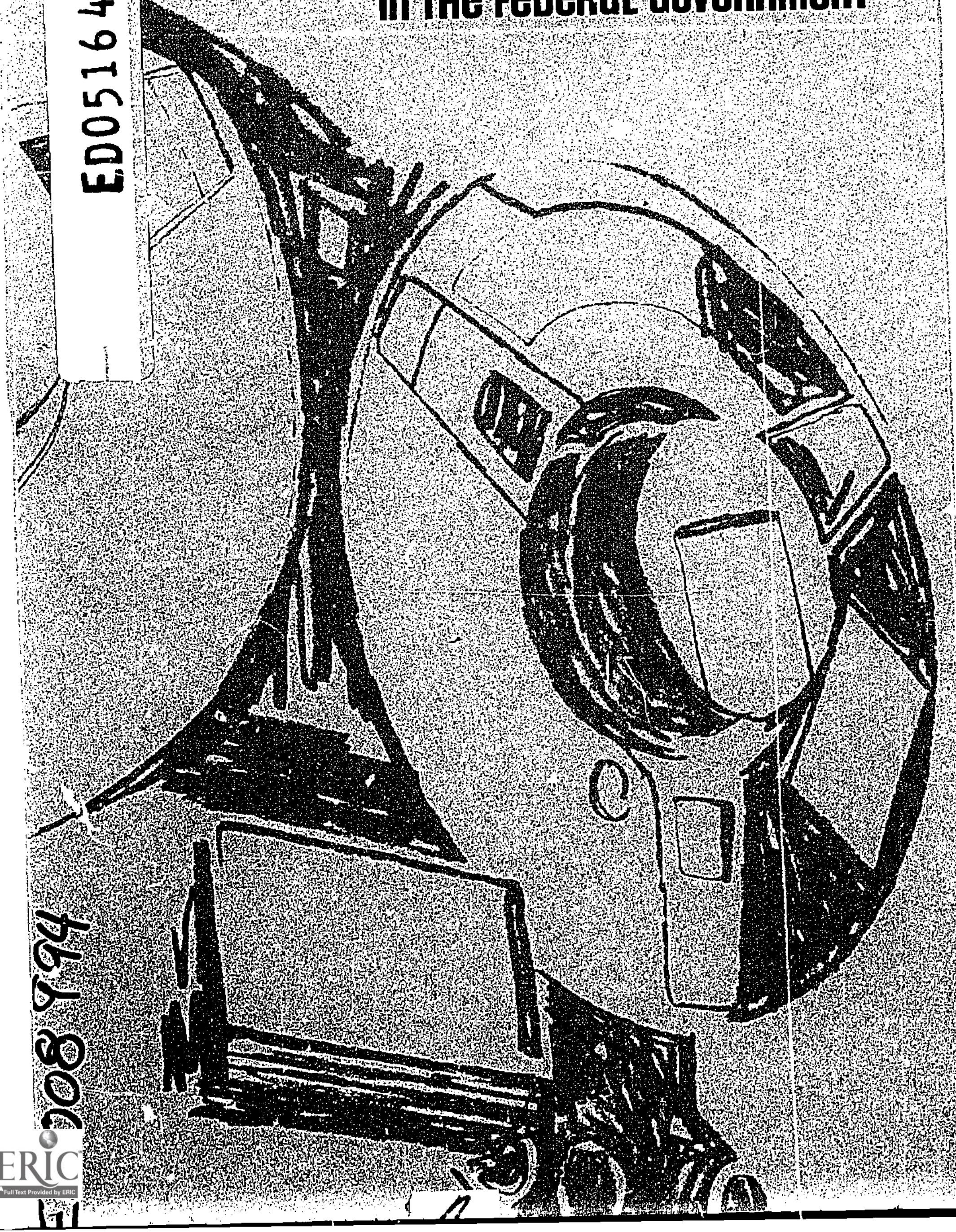
ABSTRACT

A conference, held in Washington, D. C., in 1967 by the Association for Educational Data Systems and the U.S. Office of Education, attempted to lay the groundwork for an efficient automatic data processing training program for the Federal Government utilizing new instructional methodologies. The rapid growth of computer applications and computer use was cited as the reason for the overwhelming need for such a training program. Specific needs for data processing personnel in the Federal Government were considered with special attention to the need for systems analysts and managers. Training needs for data processing personnel in higher education and industry were also identified. Training objectives for managers and systems analysts were outlined as a basis for defining subject-matter content. The structure and content for curricula for a management training program and a systems analyst training program were agreed upon. The possibility that new educational media, particularly computer-assisted instruction (CAI), could be used in this training program was examined. A request for proposals for a pilot project to conduct training in data processing for the Federal Government was drawn up. Abstracts of conference papers summarizing the major features of CAI and of programed instruction are appended, along with a directory of selected organizations involved in educational technology and major CAI centers. (JY)

RELATIONSHIP OF AUTOMATIC DATA PROCESSING TRAINING CURRICULUM & METHODOLOGY IN THE FEDERAL GOVERNMENT

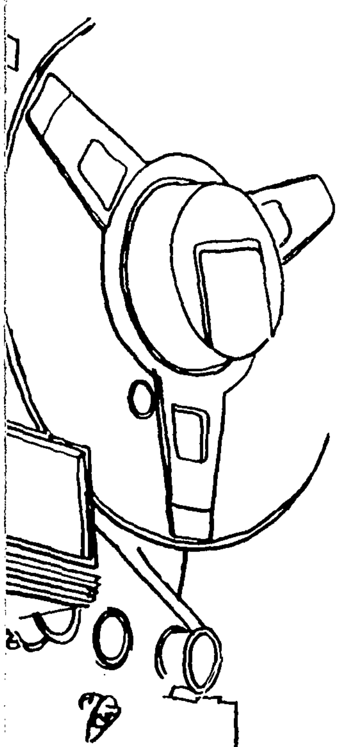


OE-80066

RELATIONSHIP OF AUTOMATIC DATA PROCESSING TRAINING CURRICULUM & METHODOLOGY IN THE FEDERAL GOVERNMENT

REPORT OF A CONFERENCE

May 15–20, 1967, Washington, D.C.



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foreword

Most of the large agencies within the Federal Government and many in State and local government either operate data processing centers or have a need for such services. Operational personnel within these agencies need to understand how to use these services with their capabilities and limitations. Both the operational personnel and the data processing personnel need to learn to communicate effectively to make the greatest use of the service. The rapid proliferation of data processing in government as well as in the private sector of our economy has resulted in a severe shortage of qualified people in both sectors.

This document is the report of a conference which was held with the purpose of addressing questions of who needs training, what kind of training is required, what should be the nature of the training, and how it can be provided. Richard B. Otte, Research Associate with the Bureau of Research, played a key role in the conduct of this project and in the preparation of this document.

This report is intended for the use of agencies interested in the problems which are suggested above. The final section of this report is a draft of a Request for Proposals that might be used to develop and procure an effective training facility.

ROBERT E. PRUITT, *Acting Director*
Division of Comprehensive and Vocational
Education Research

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CHAPTER I

introduction

CONFERENCE OBJECTIVES

A conference entitled "The Relationship of Automatic Data Processing Training Curriculum and Methodology in the Federal Government" was conducted in Washington, D.C., May 15–20, 1967, by the Association for Educational Data Systems and sponsored by the United States Office of Education. The conference objective was to determine recommendations for establishing an efficient Automatic Data Processing (ADP) training program utilizing new instructional methodologies. Since Federal agencies, such as the Office of Education, Civil Service Commission, National Bureau of Standards, and the Bureau of the Budget, have an immediate and pressing need for defining curriculums and bodies of subject-matter knowledge required by computer systems analysts and manager users, the conference participants attempted to determine the training development goals for the two latter groups and to list in general terms the subject matters which should be contained in training programs for them. In addition, and equally important, the participants tried to determine how multimedia courses could produce effective training results.

The major portion of this report is directed to reporting the results of the conference in achieving these purposes. However, the major impact of the conference and of this report will come from the actions taken to accomplish the recommendations outlined. Effective implementation with multimedia courses requires a pilot project to create and carry out an operable prototype training program.

The pilot project and related subsequent activities would achieve these additional objectives:

1. Devise a methodology to determine who needs training in automatic data processing.

2. Develop a sequential and modular array of curriculum segments which would give the student training only in those modules which he requires. This would avoid duplication and overlap prevalent in existing programs.

3. Create a technique through which the practitioner or student could diagnose his own training needs.

EVENTS LEADING TO THE CONFERENCE

The need for new and innovative training programs has been under consideration for several years. In 1964, the U.S. Civil Service Commission released a report through the U.S. House of Representative, Post Office and Civil Service Committee titled "A Study of the Impact of Automation on Federal Employees." Page 37 of the report (under Section V, Summary of Findings and Statements of Approved Actions) contains this reference to the establishment of a Joint Agency Commission:

> Joint Agency Commission action is being taken to prepare for the future, in addition to improved forecasting of changes: The Civil Service Commission is establishing machinery for continuous discussion and action with the agencies in all personnel management program areas affected by automation. Cognizance will be maintained of developments in automation technology and applications. Future problems will be identified and action taken to mitigate their effects, as early and as rapidly as possible.

In a letter dated October 29, 1964, Irving Kator, Executive Vice Chairman of the Civil Service Commission, referred to the establishment of an interagency advisory group, called the Committee on Automation and Manpower (IAG–204). Hugh W. Scott, Personnel Management Specialist, Bureau of Programs and Standards, was named Chairman of the Committee.

At the first meeting of IAG–204 on December 16, 1964, the stated purpose of this Committee was:

> ". . . to provide a medium for executive branch collaboration on the personnel management and manpower aspects of automation in order to facilitate its utilization and to mitigate its adverse effects on personnel. ADP will be the primary concern of the committee, but the effects of other types of automation will also be of concern to it."

Five task forces of IAG–204 were established in March 1965 to examine their assigned subject area in depth and to make appropriate recommendations. These task forces were designated as follows:

Task Force 1.—The need for a special Civil Service examining program for computer specialists. (Sam McDonald, Census Bureau, Chairman.)

Task Force II.—Increased education of managers and key personnel in how the computer functions, its potential, and its shortcomings. (Fred Dyer, Department of the Navy, Chairman.)

Task Force III.—Improving placement programs for displaced workers. (Chet Evans, Department of the Treasury, Chairman.)

Task Force IV.—Establishment of governmentwide standards for projecting and reporting direct and indirect effects of automation on manpower requirements. (Leon Greenberg, Department of Labor, Chairman.)

Task Force V.—Keeping abreast of advances in automation technology and applications, and evaluating the extent and time of impact of the advances on personnel and manpower requirements. (Howard Gammon, National Bureau of Standards, Chairman.)

At about the same time (March 1965), an extremely important document, Senate Document 15, "Report to the President on the Management of Automatic Data Processing in the Federal Government," was released. The report had been prepared by the Bureau of the Budget and submitted through the U.S. Senate Committee on Government Operations. Page 3 of this report refers to the personnel problems facing the Federal Government and makes specific reference to the Civil Service Commission study, previously mentioned.

This report led to Circular No. A–71, from the Executive Office of the President, Bureau of the Budget, dated March 6, 1965, defining the responsibilities for the administration and management of automatic data processing activities. This document made the following recommendations:

> The Civil Service Commission is responsible for providing executive branch-wide leadership and assistance in the personnel management and manpower aspects of automatic data processing. In this connection, the Commission will foster programs designed to—
>
> (a) Staff automatic data processing activities effectively by, among other things, (1) formulating position classification and qualification standards, (2) developing necessary special recruiting techniques, (3) devising improved testing and selection services, and (4) stimulating and coordinating necessary training.
>
> (b) Educate executives and other key personnel to achieve greater effectiveness in ADP management.
>
> (c) Anticipate and minimize, to the greatest practicable extent, any adverse effects of automatic data processing upon the people involved.
>
> (d) Provide a medium within the executive branch to focus and coordinate preparation for the future personnel management and manpower effects and requirements of automatic data processing.

All of these documents indicate the importance of the work already begun by IAG–204, primarily through its task forces.

One task force subgroup which examined identified areas of automation advances was concerned with Programed Instruction and was chaired by Dr. Chester L. Guthrie, National Archives and Record Service. This subcommittee investigated the status of Computer Assisted Instruction (CAI) and its potential effect on the training of Federal personnel in Automatic Data Processing (ADP). Conversations with Francis Keppel, Dr. R. Louis Bright, David Bushnell, Col. Gabriel O'Fiesh and others resulted in a decision to investigate programed instruction and computer assisted instruction as a means of solving certain personnel training problems in ADP.

This recommendation to the full Committee on Automation and Manpower was subsequently sent to the U.S. Civil Service Commission by Mr. Scott, Chairman of IAG–204. After a number of meetings, Civil Service Commissioners, John Macy (Chairman), L. J. Andolsek, and Robert Hampton, authorized proceeding with the concept of CAI for ADP training and assigned CSC responsibility to the Office of Career Development.

Discussions for funding a program involving CAI training were then directed to the U.S. Office of Education. At this time, plans for a working conference were discussed. It was determined that such a conference might result in a request for a proposal (RFP) for a CAI system to train Federal employees in automatic data processing.

CONFERENCE PARTICIPANTS

The conferees, experts in CAI and ADP, included:

Fifteen topical specialists in subject matter, curriculum and education, and educational media technology.

Ten Federal Government officials concerned with the administration of ADP programs and associated training.

Two major resource specialists in the field of programed instruction and CAI.

Eighteen additional resource specialists, including top Federal Government ADP executives, educational technology manufacturers, members of ADP training consulting firms, and ADP executives of industrial firms. A list of participants is contained in appendix I.

Government officials whose efforts were particularly significant in the events leading up to the conference and in their leadership during its deliberations included:

Howard Gammon, National Bureau of Standards
Chester Guthrie, National Archives
Joseph Lowell, Civil Service Commission
Richard Otte, Office of Education
Hugh Scott, Civil Service Commission

WHY ADP TRAINING?

Estimates given by the Civil Service Commission, including the Presidential Task Force on Career Advancement, disclosed that two and a half million Federal employees need some kind of training either in new skills or in updating the skill areas in which they now work. Why, then, should computer training be chosen as the subject of this conference? The answer is that ADP skills are among the most critical needs in both the government and private sectors. Since these skills are fundamentally the same in both sectors, training improvements developed by the Federal Government will have almost total transferability to industry. Furthermore, the innovative methodologies developed for ADP training can be utilized across a wide range of other subject-matter and skill areas. Thus, the results of this conference could stimulate thinking and action that might have a major impact on all types of training, not just in ADP.

CHAPTER II

the environment and need for ADP training and development

IMPACT OF THE COMPUTER

It is probably true that nothing since the industrial revolution has had so profound an impact on technology as the computer. Indeed, as John Eberhart of the National Bureau of Standards expressed it, "We are in the process of passing from an Industrial to a Systems Revolution re: the impact of technology on society." Although the applications are somewhat different for government and industry, the implications are essentially the same. In industry, automation is used for production planning and process control; in the Federal Government it is used for information processing and communications networks.

A report of the Senate Committee on Government Operations gives this description of the impact of the computer in the Federal Government:

> No single technological advance in recent years has contributed more to effectiveness and efficiency in Government operations than the development of electronic data processing equipment. Most of the important advances that have been made in such diverse fields as space exploration, research of all types, weather forecasting, and atomic energy would not have been possible without the computer. In the field of large-scale clerical operations such as insurance processing, checkwriting, and the tax system, the computer has materially assisted in producing major economies. Furthermore the computer is becoming increasingly useful to managers in solving complex problems involving interrelated types of information. The most notable of these have been in the military areas and in supply management. . . . the impressive advantages to the Government already achieved through automatic data processing (ADP) are but steppingstones to the future.[1]

In industry, advances are equally spectacular. With the proliferation of products in the automobile industry, for example, processing paperwork by the former manual systems method would require as many employees as the industry now uses for both production and management.

[1] U. S. Senate, Committee on Government Operations. *The Management of Automatic Data Processing in the Federal Government.* 89th Congress, 1st Session, March 4, 1965.

The extent to which better applications and improvements can be made with computers appears to be limited only by the availability of trained people. The Presidential Task Force on Career Advancement discusses the need for training people in ADP as follows:

> Without question, the single most critical problem in ADP training is the need for understanding and support by top management
>
> and
>
> The second most important problem in ADP training is the acute shortage of ADP personnel.[2]

GROWTH OF COMPUTERS AND COMPUTER APPLICATIONS

Technology has been changing so rapidly that it is difficult to predict the future applications of computers. What is the yardstick of measurement? To say that installations have grown from 1,000 in 1955 to an estimated 50,000 in 1970, (the American Federation of Information Processing Societies (AFIPS) estimate)[3] is meaningless unless consideration is also given to the fantastic increase in capacity, for example, 1,000 to 1 reduction in cost to perform calculations. By any measure, the actual and predicted growth is phenomenal.

According to the AFIPS study, the actual 1965 and estimated 1970 installations and the impact on manpower needs may be summarized thus:

	1965	*1970*
Total installations	30,000	50,000
Systems analysts	60,000	200,000
Programers	60,000	200,000-650,000
Operators	43,000	80,000

The impact of computers in the Federal Government is difficult to assess because of the large amount of government work done by outside contractors. Within the Federal Government, expenditures on hardware and software alone during the 3 most recent fiscal years averaged $840 million per year. The growing share of the expenditures devoted to software (42 percent in fiscal year 1964 to 51 percent in fiscal year 1966) has definite implications for personnel needs.

No precise measure of the impact of computers in industry is immediately available. However, it is expected that computer usage in industry and government will expand rapidly in the next few years.

In education, the President's Science Advisory Committee stated that "After growing wildly for years, the field of computing now appears to be

[2] National Bureau of Standards, *Training for Automation and Information Processing in the Federal Service.* October 1966.

[3] White House, President's Science Advisory Committee, *Computers in Higher Education,* The White House, February 1967, p. 58.

approaching its infancy." In 1965, the capital value of college and university computers was 1/26 of the U.S. total, and the cost of computers used in instruction, 1/220 of this total. Annual expenditures by 1971–72 will amount to about $400 million if the recommended level of usage is attained. The implications for training in all sectors is evident.

THE ROLE OF THE FEDERAL GOVERNMENT IN ADP TRAINING

Aside from the Federal Government's vast expenditures in education and its interest in training at all levels, there are other reasons for Federal interest in ADP training. First, there is tremendous need for trained personnel within government, present and future, as this report will show. Second, government is in serious competition with industry and other users of computers for ADP personnel. Efforts directed to training the universe of ADP personnel will relieve the shortage and turnover in government. Finally, by developing improved methods and technology for ADP training, the government will help to solve problems of education and training in other areas.

CHAPTER III

automatic data processing personnel needs in the federal government

During the conference, participants collected and analyzed information concerning the tasks and skills of systems analysts including staffing needs, input sources, and training needs. This section reports on ADP personnel needs in the Federal Government. Subsequent sections look at the broader national need and at related curriculum and technology.

THE SYSTEMS ANALYST—RESPONSIBILITIES AND DUTIES

The Civil Service Commission recently established the following position description for Computer Systems Analyst (GS 9–12). This was used as the starting point for the conference.

> Computer Systems Analysts develop basic plans or "computer applications" by which subject-matter processes can be organized and accomplished by computer methods. They require a comprehensive understanding and analysis of subject-matter work processes, actions, criteria, as well as supporting controls, reports, documentation, etc., involved in the function to be automated. Also essential is the ability to devise procedures, to develop methods for generating and processing data, and to integrate these into data processing systems and plans. Typically, specific assignments may include: Feasibility or "profit-ability" studies; the development of detailed systems logic charts and diagrams; the development of data reduction and coding instructions, dictionaries, data banks, and the like. In addition, these positions require a substantial knowledge of computer capabilities and processes, and a basic understanding of programming principles and methods. They analyze and organize subject-matter work processes and functions so that they can be converted into workable computer programs and routines. Furthermore, systems analysts must be able to foresee some of the specific problems posed in the subsequent programming processes required, as well as some of the possible solutions.

This definition is in terms of output or end product. It reflects the typical limitation in job descriptions. What is needed to develop curriculums is information about what the systems analyst should learn to permit him to bring the desired skills to the work situation.

Although the conferees generally agreed that this description represented the job of a systems analyst, some felt that the depth of skills inferred by the position description was greater than the supply of personnel which could be hired or retained at that grade level. Reflecting this feeling, one participant commented that "this description is for a much heavier person . . . consequently, persons doing systems work are frequently occupying other positions and higher grades."

A slightly different concept of the systems analyst's job was expressed by a number of Federal agency executives and consulting firms engaged in systems training. They summarized the system analyst's job as being concerned with logical problem-solving and designing as expressed in the following comments:

> An understanding of the intellectual tools capable of being used to look at the relationships between complex activities.
>
> Probe and evaluate objectives. Determine best methods for achievement. Design systems to accomplish and follow up to assure conformance.
>
> Find the simplest ways of taking each objective in implementing a program and devising the methods and procedures that would attain the end result forecast.
>
> Plan, factfind, analyze, determine findings, develop general systems design and documentation and oversee implementation.
>
> Design of workable problem solutions for users.
>
> Plan and design information systems in cooperation with various user groups in an organization deeply involved in implementation.
>
> To take a logical approach to improvement of the system of the organization.

Perhaps the most significant statement was the one developed at the end of the conference which defined the objective of the system analyst's training as follows:

> To provide those individuals who have adequate background in computer programing with the knowledge and skills necessary to contribute meaningfully to all basic phases of a systems project under competent technical supervision.

All of these opinions of the systems analyst's responsibilities were taken into account in developing curriculum recommendations for the training program.

THE NEED FOR SYSTEMS ANALYSTS

The current and future shortage of systems analysts was reinforced in discussion at the conference. The 1966 Presidential Task Force on Career Advancement listed the acute shortage of ADP personnel as a critical problem second only to the need for understanding and support by top management. This shortage was attributed to the increasing numbers of installations and uses to which data processing has been applied. Current recruitment and salary structures place the government in an inferior competitive position in securing and retaining the services of topflight systems analysts. Turnover was determined to be over 18 percent. This same report estimated the current shortage of systems analysts in the United States at 35,000 and the projected 1970 shortage as 130,000.

It is difficult to determine exactly the on-board count and future need for systems analysts in the Federal Government because: (1) duties of systems analysts are being performed by other personnel, (2) there are discrepancies between military and civilian job descriptions, (3) large numbers of systems analysts working for contractors are not accounted for individually, and (4) agency sharing of systems analysts makes individual count difficult. The degree of shortage is suggested by one medium-sized agency's statement that it had 45 vacancies out of a total of 181 authorized positions.

On the basis of available information, the conferees made the following quantitative estimates of systems analysts and related personnel needed by 1970:

Number of systems analysts needing training in government	
1. Direct, full involvement and needing full training	
Systems analysts and senior programers performing system analysis activities	18,000
Management analysts who need to be fully trained in system analysis procedures	9,000
Total	27,000
2. Closely related personnel who need considerable training	
Subject-matter specialists oriented to, and participating in, system analysis	30,000
Administrative officials in responsible staff positions who require some knowledge of system analysis procedures	30,000
Total	60,000
Number of system analysts in industry	
Available system analysts (1966)	60,000
Additional analysts needed (1966)	35,000
Total	95,000
Other related occupations needing considerable training in system analysis (1966)	200,000
Total	295,000
Projected estimated needs for analysts by 1970	200,000
Projected estimates for other related occupations by 1970	300,000
Total	500,000

Turnover of personnel in government	*Percent*
From one systems analyst job to another (change of agencies)	16.0
Leaving government	2.2
Hires from outside government	27.0

Estimate of new input to the "profession"	
System analysts and senior programers expected to do systems analysis work	3,000 per annum
(system analysts, 2,000 per annum)	
Extent of training needed for updating	
All system analysts need for intensive updating a year	5 days
Existing system analysts needs (other than updating)	
Programer background only	
General management principles and methods	6 weeks
General management analysts background only	
Basic mathematics	4 weeks
Operational instruction in a basic programing convention	4 weeks

SOURCES OF INPUT TO SYSTEMS ANALYST MANPOWER

Conferees also studied the major sources of input to the supply of systems analysts in the Federal Government to recommend subject matter for a training program. Although no quantitative measures could be determined, there was general consensus that the sources, in order of magnitude, were: (1) Programers from other jobs, (2) college hires, (3) technicians, operators, and methods analysts from related systems jobs, and (4) subject-matter personnel.

THE MANAGER IN THE FEDERAL GOVERNMENT

In stating the need for managerial training, the Presidential Task Force on Career Advancement wrote:

> Without question, the single most critical problem in ADP training is the need for understanding and support by top management . . . . Although confirming data are not available to support the point, it is strongly believed that as many as 30 percent of upper level Federal Government managers and long service career employees do not understand, or even fear, the advent of ADP operations in their areas.
>
> Parallel to the need for top management understanding and support is familiarization training for middle management and staff personnel.

Conference participants unanimously agreed that most managers need to be familiar with computers. They also were in agreement about what and how the manager should learn. This is not surprising in view of the existing and projected application of computers in government operations. Managers need to know computers as users. They also need to know about computers in order to close the "gap" between automatic data processing personnel and management, a gap that unquestionably is costly in terms of time, proficiency, and utilization of computer capability.

The conferees also felt that manager users constituted a vital and large group of potential candidates for a training familiarization program. However, it was difficult to estimate the exact number of people needing training for the following reasons:

1. The impending retirement of a large percentage of Federal Government managers. (According to one estimate, 70 percent in grades 11 – 16 would retire in 2 years.) The question arises as to what extent, if any, these persons should be trained.

2. The extent to which agency chief executives understand, appreciate, and would permit or encourage agency employees to attend ADP familiarization or training programs.

3. The extent to which ADP development programs should be directed to specific subject-matter content or peculiar agency uses rather than a general overall familiarization program.

TRAINING NEEDS

In spite of the difficulty of forecasting the need for managerial training and development, the conferees were in agreement that an enormous training need existed. An examination of the following data which was a consensus of the thinking of the conference provides a measure of this need.

The number of managers needing ADP training in the Federal Government was estimated as follows:

Heads of agencies	120
Top staff in agencies	1,200
Program officers	4,000
Managers with program officers	20,000
Field equivalents (grades GS 14-18)	75,000
Total	100,320

These figures equal 3.3 percent of the total Federal work force and they apply to positions from agency director through lower middle management. Military officer personnel in managerial positions are also included in these figures. Training for one-third of the above personnel was considered urgent, with training for the remainder highly desirable.

The following figures show the number needing training:

Federal employment, grades GS-15 and above, (and equivalent pay scales)	32,691
Field GS-14's having substantial responsibilities	25,000
Military performing executive duties	35,000
Total	92,691

The conferees also agreed that a number of GS–14's in the Washington area probably also should receive managerial ADP training because they are ready for promotion. Possibly 5,000 to 8,000 persons would be in this category.

On the whole, conference deliberations reaffirmed the conclusion that a training development gap of serious proportions exists in the Federal Government. Existing training organizations, such as Civil Service Commission, Department of Defense Chief of Information, ADP Management Training Center, do an excellent job but at current training rates are not meeting attrition losses.[1]

[1] Presidential Task Force on Career Advancement, *Training for Automation and Information Processing in the Federal Service* (Project E: Training for Specialization) National Bureau of Standards, October 1966.

CHAPTER IV

training needs in industry and in higher education

ADP TRAINING IN INDUSTRY

Industry, like government, faces the same general problems of providing adequate training for its ADP personnel and for management users. The problem in industry is simpler than in government for these reasons:

1. In any industry or company, products or services are specialized. Consequently, ADP problems to which training is directed can be more narrow in scope. Moreover, this type of instruction lends more to the on-the-job training.
2. Systems analysts generally come better prepared because they are recruited from other companies and from colleges.

Even though the industrial environment is less complex, industry in general and the computer industry in particular are witnessing an "educational explosion." Between 1965–67, there was a 58 percent increase in ADP "in-house" training programs.[1] Equally as important is the increasing attention given by top management, including company presidents, to ADP training.

Because of the wide variations in the nature and needs of individual firms, no "typical" training program could be identified for systems analysts. The ADP training needs for managerial personnel are more clearly defined. Despite considerable variation in the source of managerial ADP training and the time devoted to it, some common elements of subject matter do emerge. These include:

Information systems, including concepts, components, and functions.

How a computer operates, including operation of system components, input-output devices.

Programing and software, including practice in operating programs.

Planning, including costs, feasibility studies, scheduling.

Implementation, including systems design, conversion, and new applications.

Personnel and organization, including impact.

Role of management, including support and management uses.

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[1] Farr, Robert N., "EDP Education and the Objectives of Management," *Systems*, April 1967, p. 13. An issue devoted to ADP training.

Although no specific quantitative measures were available for comparison, conferees felt that the depth and scope of training in industry, particularly at the managerial level, was somewhat less than in the Federal Government. However, the growing amount of training that does exist in industry reaches more people in the organization.

ADP TRAINING IN COLLEGES AND UNIVERSITIES

The potential for ADP in the university and college community is broader in scope than it is in either industry or government. Besides using computers for research and operational functions, higher education has expanded all instruction in the fields of ADP, systems, computer sciences, management science, and related computer areas. In 1962, only four institutions offered degree courses in computer sciences; in 1968, one could earn such degrees at more than 200 institutions in the United States.[2] In the short space of 2 years (1962–64),[3] digital computers in use at colleges and universities rose from 397 to 1,065. This does not infer that all of these computers were being used for ADP training education or for instructional purposes. However, the reader can predict for himself the enormous increase in computer education in the future if the recommendations of the President's Science Advisory Committee are even partially adopted.[4]

More pertinent to the purposes of this report is the extent to which systems-type courses are offered at colleges and universities. These have been rapidly growing in numbers. A 1966 study conducted by the Systems and Procedures Association[5] estimates that about 35 percent of the schools in the country will probably offer a degree in management systems by 1971 and about 50 percent will offer a minor or major in this area. An indication of the growth is the fact that over 50 percent of the systems courses being taught in 1966 had been introduced within the previous 3 years. The Systems and Procedures Association divided the 70 courses being taught in 1966 into four groups:

Introduction to data processing.
Computer programing.
Management and general business systems.
Mathematics and engineering.

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[2] *Ibid.* Of interest is the approach to systems education taken by the Carnegie Institute of Technology. As long ago as 1963 doctoral students were permitted to major in "systems" in five disciplines, all of which had "a common core devoted to techniques of analyzing and synthesizing complexity." Reported by Herbert Simon in Koontz, Harold, *Toward A Unified Theory of Management*. McGraw-Hill, 1964, p. 83.

[3] The latest date for which census data were available. Taken from *Automated Education Handbook*, Detroit: Automated Education Center, 1965, p. VII A 1.

[4] *Computers in Higher Education*, Report of the President's Science Advisory Committee. Washington, D. C.: The White House, February, 1967.

[5] *Systems Education in the United States*. Cleveland: Systems and Procedures Association, 1966.

In summary, the need for trained personnel currently exceeds the number available. The information also indicates that training facilities are not adequate to provide training for the additional people who will be required in the immediate future.

CHAPTER V

development and training objectives

Educators and others who design or administer training programs believe that the teaching-learning process must be related to training objectives which includes some predetermined knowledge or behavioral change on the part of the learner.[1] For example, it is of little use to teach systems theory to an analyst unless it will result in improvement of some sort. Similarly, "hands on" experience for the manager serves no purpose unless it results in better communication with ADP personnel, improved application in his own area, or some other benefit.

Preconference instructions and questionnaires asked participants to consider the matter of behavioral and other objectives of a training program. The matter of objectives and the expected end result of training were basic to all other discussions and were constantly reflected in questions such as these:

What do you look for in a systems analyst?
What are the responsibilities of a systems analyst?
How much does a manager need to know and why?
Can you teach an analyst to sell?
How do we close the manager-analyst gap?

Before conferees attempted to develop and refine curriculums, they clarified the "image" of a systems analyst and the "educated manager." They then established the following objectives of this training as a basis for defining subject-matter content.

THE MANAGER

Discussions of the management function involve a degree of complexity and some confusion because there are many *levels* of managers. Their various needs for knowledge of ADP prescribe the subject matter to which they should be exposed. Add to this the specific nature of ADP applications according to their subject-matter area or agency, and the result is prolif-

[1] "The objective of training or education can be framed in terms of the problems to be solved." Quote from a conference paper delivered by Dr. Lawrence Stolurow of Harvard University on Computer Assisted Instruction. Similarly stated by Richard Shetler, President of General Learning Corporation, "The end process is learning, not teaching. I cannot emphasize this too strongly." See "Innovation in Education," *Educational Technology,* Washington, D.C.: The Aerospace Education Foundation, Spring 1967, p. 9.

eration at best. The conferees resolved this problem by distinguishing two managerial groups, top management and other managers, and by devising a curriculum common to both.

The following objectives for top management which were arrived at by consensus of conference participants emerged:

1. Orient and familiarize the manager with the information processing system so that both he and the system will be more productive by —
   a. Establishing the role of ADP in the organization,
   b. Providing tighter control over production of paperwork,
   c. Getting the manager involved in problem solving (EDP doesn't solve problems; people do),
   d. Utilizing talents already in the organization,

2. Close the understanding and appreciation "gap" between management and ADP operations.[2]

3. Familiarize the manager with the capability of the computer for improving management, effectiveness, and productivity through information.

Objectives for lower levels of management were stated in more "practical" terms. Whereas top management objectives were directed more to an appreciation and understanding of computer technology in relation to the manager and his organization, the lower level management objectives were more concerned with how managers could use computer technology. Comments such as "enough training to understand the computer technician" or "so he can communicate with the analyst," were translated into these objectives.

Subsequently, during curriculum development and in establishing specifications for a pilot training project, the objectives for manager users were merged into one:

> To provide the manager with the knowledge and skills necessary to identify, understand, and evaluate the potential and performance of the computer system in the accomplishment of his operations and mission objectives.

THE SYSTEMS ANALYST

The Civil Service Commission description of the duties of a systems analyst, discussed earlier, has certain inadequacies. These shortcomings revolve around the analyst's inability to think like a manager in designing

[2] "Almost no single action can be taken that would provide equal return in agency operations improvement, than for top officials to adopt a direct, favorable position toward ADP use and ADP training. Other ADP actions will be ineffective or even unsuccessful if such top management support is not forthcoming." *Op. Cit.*, p. 3, *Presidential Task Force on Career Advancement.*

systems and to communicate. This feeling was expressed by conferees and consultants in phrases such as:

The Systems Analyst . . .

should be trained to use ADP as a management tool.
should bridge the gap between problem desk (input) and machine configuration (output).
must know how to solve problems on the computer.
must know salesmanship and communication.
must be a diplomat—know when not to use a computer.
must understand input/output use of information—not throughout.

An analysis of the discussions and questionnaries from the conferees yielded an image or profile of the systems analyst which requires that an effective training program provide:

1. The tools and techniques of systems analysis, design, and implementation (e.g., hardware, programing, documentation, scheduling, work processing, etc.).

2. Management principles. (Objectives, performance standards, and the place of information in planning and controlling are needed in order to design information systems for management use.)

3. Logic and problem solving.

4. Systems theory and concepts. (Integrated systems, feedback principles, decision theory, application of management science to problem solving and design.)

5. Written and oral communications, including salesmanship.

CHAPTER VI

recommendations for curriculums

MANAGEMENT TRAINING PROGRAM

Participants and consultants were in basic agreement on the content and structure of a curriculum for a management training program. Major topical and subtopical subject-matter headings for this curriculum follow:

Curriculum for Federal Government Managers

Hardware and how it operates

Objective: To take the mystery out of computers and bring an understanding of how they operate, their capabilities, and their limitations.

Topics:
- The workings of a computer
- Capabilities, limitations, and potential
- Input-output devices
- Software considerations
- File organization and maintenance
- Input-output documentation and display
- New technology

"Hands on" experience

Objective: To create an appreciation and understanding of how problems can be solved with a computer.

Topics:
- Programing in one language which will include writing a program to solve one or more problems
- Other language and subroutine programing options

Computer applications

Objective: To make the manager aware of potential computer applications in his job so that he can better utilize and participate in ADP applications.

Topics:
- Basic (existing) applications
- Advanced applications
- Future applications

ADP in the Federal Government

Objective: To place ADP operations in perspective within specific constraints of the Federal Government and to describe cost, feasibility, and time considerations so that the manager will participate in and direct systems planning and utilization.

Topics:

Information economics—costs of ADP, cost-utility tradeoff

Planning for the system—costs, feasibility, maintenance, planning

Environment of ADP in the Federal Government—legislation, regulations

Agency problems and plans

Information systems theory

Objective: To familiarize managers with information theory and the basic principles and theory of analysis and design, so that his effectiveness will be improved by design participation.

Topics:

Management, information, and the computer

Information systems design

Analysis and basic design techniques

Data processing as an aid to decisionmaking

Objective: To show the manager that people, not computers, solve problems; to improve this decisionmaking and problem-solving ability so that he may become more effective with the computer system.

Topics:

Logic, problem definition, and problem solving

Problem solving with the computer

Techniques of problem solving—linear programing, operations research, simulation

Examples and practice in problem solving

Organizational implications of the computer

Objective: To get the manager to adopt a favorable position toward ADP, and ADP training, and to provide an environment in which the effectiveness of ADP is optimized.

Topics:

Impact on personnel and staff

Organizational changes and manpower consequences

Role of ADP personnel

ADP training

SYSTEMS ANALYST TRAINING PROGRAM

During the initial efforts to develop a curriculum for systems analysts, attempts were made to establish separate curriculums for programers, operators, and methods analysts. This approach was replaced by a more practical one in which an ideal or "total" body of knowledge required by an analyst was defined and the prospective trainee, by means of a diagnostic process, selected those modules or elements of the "total" curriculum which he required. This approach, of course, would apply as well to the existing analyst who required updating.

Participants and consultants evidenced remarkable agreement on the structure and content of the total training program curriculum for the systems analyst, as they had agreed earlier on the development program for managers. Major topics for this analyst program follow:

Curriculum for Systems Analysts

Analysis and design concepts

Problem solving

The theory and practice of logical decisionmaking and creative thinking, the use of these and other problem-solving principles in an analysis and design of systems.

Organization principles

Classical and contemporary principles of organization design and analysis, an understanding of the structure, decision centers, information flow, and other organizational considerations in systems design.

Management

The basic functions of management with special emphasis on planning and controlling through information systems, consideration and understanding of facilitating the management process with systems.

Systems planning

Determination of systems objectives and planning time, cost, resource allocations, design proposals, PERT and CPM input/output considerations.

Systems theory

Theory of information systems operation and design. Control theory, integrated and total systems concepts, planning and control through information feedback systems.

Systems evaluation

Measurement of efficiency against goals, review of input-output and objectives.

Human interaction in systems

Promoting understanding and acceptance of ADP, impact of automation on personnel, getting cooperation, developing interpersonal relationships, and using applied psychology.

Quantitative techniques in systems design

Application of operations research and other management science techniques, formulation of decision rules, simulation, and modeling.

Analysis and design techniques

Systems planning

Network analysis technique for logical structuring of planning, preliminary systems survey, feasibility study, cost evaluation and analysis, analysis of time requirements, planning quality elements of the system.

Systems analysis and design

Analytical techniques and documentation, work measurement, flow charting, forms design, source data automation, input/output alternatives, communications, interviewing, and selling, principles of systems design.[1]

Implementation and follow up

Planning, site preparation, personnel, organization, other considerations, training the user, evaluation, and audit.

Computer concepts and capabilities

Hardware characteristics

Mainframe capability, peripheral equipment remote terminals, input-output devices, time sharing, and on-line communications systems.

Software

Language options (COBOL, ALGOL, FORTRAN, etc.), other software options (compilers, subroutines, etc.).

Additional skill requirements

Programing

Ability to program in one language

Quantitative techniques

Management science techniques in systems design

Communications

Graphics and visual presentations, oral and written staff reports.

STRUCTURE AND TIME CONSIDERATIONS

Federal Government representatives involved in ADP training made it quite clear from the beginning of the conference that the subject matter of the programs should be designed in modules: standard units of subject-matter content, clearly defined and distinguishable so that the trainee would be instructed only in those areas which were unfamiliar to him. This approach was variously described as a "menu" or "shopping list" from which the student could select those areas in which he required updating or initial exposure.

[1] A new body of systems principles analogous to principles of management. See Ross, Joel E. and Sullivan, J. W., *Development of Systems Theory*, Colorado Springs: Foundation for Administrative Research, 1967.

Structuring the program in this fashion provides maximum training in minimum time. In the conventional seminar or training program, the audience almost invariably has already gained varying degrees of familiarity with the subject matter. The scheduling of participants for the total program, therefore, can result in lost time, duplication, and boredom. The modular approach, particularly if individualized, is more efficient, takes less time, and results in better quality instruction.

Some interest was also expressed in a sequential or "building block" concept of instruction. This approach is illustrated by the usual sequence of instruction in mathematics—arithmetic, algebra, calculus, and differential equations. This is also the approach used in programed instruction—moving from the simple to the complex.

The conference did not reach an agreement on whether to use the modular or the building-block approach. The complex environment of the Federal Government makes such a decision difficult, and could, in fact, result in a need for both kinds of training.

The conferees also discussed the amount of time that should be devoted to the program. Time is a function of several unknowns, such as manager's time, level of knowledge brought to the course, and the desire of the agency head. They recommended that managers have between 40 and 80 hours of training to complete the training program, whereas, systems analysts would need between 120 and 180 hours to complete their training.

CHAPTER VII

educational media and ADP training

AUTOMATION AND TECHNOLOGY IN EDUCATION

It was not the purpose of this conference on ADP training, or of this report, to undertake a review of the status of educational technology. However, some understanding of relationships between educational technology in general and ADP in particular is necessary as background for effective development and application of training programs.[1]

There can be little doubt that educational technology in the United States stands on the threshold of becoming a major industry.[2] Properly applied, technology holds great promise for upgrading and increasing the productivity of our educational effort in all areas. Some of the promises, problems, and cautions surrounding the application of educational technology were expressed at a recent seminar held by the Aerospace Education Foundation:[3] For example, R. Louis Bright, the Associate Commissioner for Research, U.S. Office of Education, noted that the education market ranks second to defense and that interrelated problems of education and technology require a systems approach between educators and industry. At the same seminar, Richard Bolt, Chairman, Bolt, Beranek, and Newman pointed out that the technological transformation of the classroom is inevitable in the face of the population explosion and the increasing demand for education. Another speaker, Calvin Gross, Dean of the School of Education of the University of Missouri, urged acceptance of the cost/effectiveness concept in education and explained how increased capital investment

[1]For those readers who wish more detailed information, several bibliographic and other sources are available. For example, see the annotated bibliography (appendix E) of this report. Also, Hickey, Albert E., *Computer-Assisted Instruction, A Survey of the Literature.* Newburyport: ENTELEK, Inc., 1967 (ONR Contr. 4757(00)). Also, *Automated Education Handbook,* Detroit: Automated Education Center, 1965. Also, "Innovation in Education," *Educational Technology,* spring 1967. Annotated references to particular subjects may also be obtained from the Defense Documentation Center.

[2] "The American economy was built around the railroads in the last half of the 19th century, around the automobile in the first two-thirds of this century, and it will be built around education in the balance of this century." Witness before hearings of Subcommittee on Economic Progress of the Joint Economic Committee, U.S. Cong., *Automation and Technology in Education,* 89th Congress, 2nd Session, August 1966.

[3] Educational Technology, *op. cit.*

in technology can achieve greater productivity and effectiveness. Another seminar observation was made by Richard Shetler, President of General Learning Corporation, who said that "validated learning systems" should be sought through a system approach, including equipment, procedures, materials, and personnel.

In spite of its great promises and prospects, educational technology has not been widely adopted in the educational environment. Computer-assisted instruction, in particular, has been confined largely to laboratory and experimental situations. Much of the equipment needed for educational technology is still being developed and experimented with and educational "software" is still being developed. The Subcommittee on Economic Progress of the Joint Economic Committee says that the potential contribution of educational technology in the future will be governed by these factors:

1. Effectiveness of research in learning theory and its application to educational development.
2. Improvement of curriculum programing, particularly in defining and meeting educational objectives.
3. School system organization and curriculum planning.
4. More effective use of teachers.
5. Recognition of the potential in educational technology by teachers and educators.[4]

It appears that any "widespread" adoption and use of educational technology does, indeed, face many problems. However, the conclusion emerges that most of the prerequisities to application of technology for ADP training have been solved. Given the objectives, environment, curriculum, and other prerequisites to ADP training in the Federal Government, conferees saw no substantial reason why such training should not proceed with full utilization of available technology.

PRESENT AND FUTURE USE OF MEDIA IN ADP TRAINING

Somewhat different approaches and interests in using media in ADP training were expressed by equipment manufacturers, ADP executives and consultants, and other conferees.

Equipment manufacturers' representatives at the conference (appendix I) were enthusiastic about the application of multimedia and educational technology. They reported that their companies were planning extensive marketing efforts, and predicted substantial sales and profits. They also mentioned that top level corporate attention was being given to this growing market.

This group also agreed that the industry and its applications were complex. The answer for education, they reasoned, lies not in the development

[4] U. S. Congress, Automation and Technology in Education, *op. cit.*, p. 8.

and marketing of specific items of hardware but in the systems approach; the "orchestration" of media, software, and the educator's acceptance and use of media potential. In the systems approach, a variety of talents and resources are necessary in the systems approach to insure the coordination and utilization of an educational "package" instead of the piecemeal approach taken to date. And yet, events are moving so rapidly that the user can scarcely wait for standardization and proven validity in either hardware or software. Indeed, to wait for or enforce standardization and maturity in development would stifle the creativity and experimentation, elements that are so badly needed in the current state of development.

These representatives further agreed that computer assisted instruction (CAI) was much broader in its application than the simple tutorial dialog envisaged by the general public and most educators. They pointed out that CAI includes simulation, problem solving, and the use of all forms of media.

In many respects, CAI is a broader and more sophisticated application of programed instruction (PI) which conferees also liked. They agreed that experience with written PI provides the experience and head start necessary to move into CAI. Only one manufacturer (IBM) reported significant use of CAI for ADP training. Results were not considered sufficiently validated for release to the general public, but one participant, Dr. Sylvia Charp of the Philadelphia School System, reported enthusiastic response from experimental use of the program in her city.

Without exception, equipment manufacturers' representatives reported the development of software as the number one problem. The hurdle was not machine languages but the shortage of subject-matter specialists who could define educational objectives, arrange instructional material in programed format, and otherwise program the curriculum material for application and use on technological hardware.

Without exception, manufacturers' representatives were enthusiastic about the possible use of multimedia technology. Most predicted that software costs, both in time and effort, could and would be reduced with new knowledge and technology. In general, the opinions were that CAI in its broadest sense and in its several modes contained the answer to individualized, effective ADP training.

ADP executives and consultants at the conference, with two or three exceptions, reported that their ADP training techniques were conventional and that typical media consisted largely of chalk and blackboard. (See appendix I.) They agreed that something must be done to fill the training gap but felt that individual companies lacked curriculum material programed for media and could not afford to develop it individually.

Most of the executives and consultants reported that PI materials had been used with good results when students were properly supervised. Some had used TV tapes or motion pictures where these were available.

Each member of this group singled out managerial training for special attention. They noted the scarcity of time available to managers and their reluctance to undergo classroom or formalized instruction. The required media approach, devised to get and hold their attention, was variously described as "schmaltz" or "show business." One executive reported that the well-designed program using slides, movies, television, modeling, graphics, and other media can cut down the time required by a factor of 10 to 1. There is, of course, no reason why this approach would not work for other groups (i.e., systems analysts) as well.

An outstanding exception to the mediocrity of most structured in-house company training is the American Telephone and Telegraph Company in New York City. Terminals are used for enterprise modeling, simulation, and programing.

Other conference participants represented a wide range of subject-matter specialists, curriculum and education specialists, PI and CAI technical specialists, and Federal agency officials concerned with ADP training. (See appendix I.) They reported a wide range of experiences with educational media. About half of these participants stated that ADP training in their organizations consisted largely of conventional lectures and discussions, sometimes accompanied by slides or other visual aids. Other media described as successful include PI material, programed films, television, and simulation. Virtually all of these conferees, with the possible exception of Federal Government participants, reported the use of multimedia. Many were planning for increased utilization of PI and CAI.

No consensus developed among Government participants regarding the future use of educational technology for ADP training. This is to be expected because of the complex nature of the environment in which ADP training takes place. As one participant stated, "You can't determine reliability and validity of specific media for particular purposes until objectives of the program are clearly identified. Time, money, and place constraints, as well as variability of individuals entering the program, are all more significant than the media to be utilized."

The participants also felt that the use of multimedia (films, filmstrips, slides, audio tapes, television, simulation, computers, PI, CAI, etc.) improved instruction. The majority felt that CAI in its broadest sense held great promise for ADP training, provided adequate software became available. There was common agreement that, if cost considerations could be ignored (a subject not adequately discussed at the conference), some form of CAI with modular design of subject-matter approach was probably the best approach to individualized mass instruction for ADP training in the Federal Government. The general acceptability of multimedia and CAI for ADP training is reflected in the recommended specifications for a pilot project contained in appendix II.

THE PROBLEM OF "BRAINWARE"

No other single item of discussion surrounding educational technology received more attention than the problem of "software" development.

This is the effort required to convert subject matter to a form which can be retrieved by the learner in a manner that will achieve the educational objective. This problem remained central to all considerations of utilizing CAI and other media. Many felt that the term "software," having the connotation of programing the hardware, did not adequately express the task or resource required for programing the course content. The term "courseware" or "brainware" therefore was deemed more appropriate for this difficult task which so often is the bottleneck in adequate utilization of educational hardware.

There is little question that the foregoing problem is central to any consideration surrounding the development of an ADP training program in the Federal Government. It was well expressed at the conference by a representative of one of the Nation's largest companies involved in educational technology, "The preparation of curriculum or instructional programs is a long process requiring careful professional effort. It can only be handled by a group of professionals including teachers, media specialists, technologists, etc., operating in a carefully planned and scheduled development program. 'Hardware' is basically not a problem, but 'software' is the intelligence of the system and therefore the critical item. One should be particularly wary of 'GIGO' in instructional systems." He defined GIGO as "Garbage in, garbage out."

Appendixes

Appendix I. Conference Participants

PANEL A: *Panel of Federal Government ADP Executives*

Miss Ann Lamb
Bureau of the Budget
Washington, D.C.

Edward Dwyer
Assistant Commissioner, ADP Management Services
General Services Administration
Washington, D.C.

John P. Eberhart
Director, Institute for Applied Technology
National Bureau of Standards
Washington, D.C.

Carl Clewlow
Deputy Under Secretary of Defense
Department of Defense
Washington, D.C.

Charles Sparks
Deputy Director
Bureau of Management Services
Civil Service Commission
Washington, D.C.

PANEL B: *Panel of Educational Technology Manufacturers*

Dr. Robert D. Gates
Director, Educational Operations
Philco-Ford Corp.
Fort Washington, Pa.

William Greiner
Manager, State and Local Marketing
UNIVAC, Division of Sperry Rand Corp.
Washington, D.C.

Dr. Edward L. Katzenbach, Jr.
Vice President
Raytheon Co.
Lexington, Mass.

Len Muller
Director, Instructional Systems Development
IBM Corp.
Armonk, N.Y.

William Kilroy
RCA Instructional Systems
Radio Corporation of America
Palo Alto, Calif.

PANEL C: *Panel of Consultant Firms—ADP Training*

Dave Allison
Brandon Applied Systems
30 E. 42d Street
New York, N.Y.

Frank Reilly
Booz, Allen & Hamilton
Management Consultants
Cafritz Building
1625 Eye Street, NW
Washington, D.C.

Dick Sprague
Touche, Ross & Bailey
60 East 42d Street
New York, N.Y.

Jack Veale
Technical Operations
1701 North Kent
Washington, D.C.

PANEL D: *Panel of Industrial Firms—ADP Executives*

Lyle Brewer
Director, Systems
Eastman Kodak
Rochester, N.Y.

Robert Parsons
Vice President, Systems
Eastern Airlines
Miami, Fla.

H. J. McMains
Director, Analytical Support Center
American Telephone and Telegraph
150 Williams Street—Room 1116
New York, N.Y.

SPECIAL SPEAKERS

Dr. Gabriel O'Fiesh
Director of the Center for Educational Technology
Catholic University
Washington, D.C.

TITLE: "Vital Concepts of PI and CAI for ADP Training"

Dr. Lawrence Stolurow
Director, Computer Center
Harvard University
Boston, Mass.

TITLE: "The Process of Machine-Learning and Employee Training"

Subject Matter Specialists

Dr. William Atchison
Director, Computer Sciences Center
University of Maryland
College Park, Md.

Dr. Sylvia Charp
Director of Instructional Systems
Philadelphia City Schools
21st and Parkway Streets
Philadelphia, Pa. 19103

Dr. Ralph Van Dusseldorp
Associate Superintendent
State Department of Public Instruction
University of Iowa
Iowa City, Iowa

Dr. Malcolm Gotterer
Professor of Business Administration
Pennsylvania State University
University Park, Pa.

Dr. Herman Limberg
Director of Management Reporting
Office of Administration
Office of the Mayor
New York, N.Y.

Fred Simmons
Director of Computer Technology
University of West Florida
Pensacola, Fla.

Curriculum and Education Specialists

Dr. William Katzenmeyer
Department of Education
Duke University
Durham, N.C.

Walter Corvine
Assistant Professor
Chicago State College
6800 South Stewart
Chicago, Ill.

Dr. David Shirley, Professor
College of Business and Public Administration
University of Arizona
Tucson, Ariz.

PI and CAI Technical Specialists

Dr. Donald Hartford
Associate Director
Computing Center
Auburn University
Auburn, Ala.

Dr. Lawrence Stolurow
Director, Computer Center
Harvard University
Cambridge, Mass.

Federal Agency Participants

Park Anderson
Assistant Director
ADP Training Center
Civil Service Commission

Frederick Dyer
Office of Civil and Manpower Management
Navy Department

Howard Gammon
Assistant to Director
Center for Computer Science and Technology
National Bureau of Standards

Richard A. Gay
Chief, Systems Management Staff, Personnel
Public Health Service

Dr. Chester L. Guthrie
Deputy Assistant Archivist for Records Management
National Archives and Record Service

Joseph Lowell
Director, ADP Training Center
Office of Career Development
Civil Service Commission

Dr. Richard Otte
Project Officer
Human Resource Branch
Division of Adult Vocational Research
U. S. Office of Education

Dr. Hugh Scott
Automation and Manpower Policy Officer
Civil Service Commission

William J. Shickler
Office of Manpower Policy
Evaluation and Research
U. S. Department of Labor

Appendix II. Specifications for a Request for Proposals (RFP)

REQUEST FOR PROPOSALS (RFP)

Expert opinion from conference participants resulted in the following description of and specifications for a request for proposals (RFP) for a pilot project to conduct ADP training in the Federal Government.

General Nature of the Project

The objective is to establish a training facility in the Washington, D.C., area designed to serve as a pilot effort in the use of individualized instructional media and hardware. This facility will serve as a prototype of similar facilities to be located in other key cities in the United States.

The project involves the development of two training packages, one on each of the curriculums listed in the main body of this report. Two groups of participants, 25 to 150 each, are to be trained: (1) managers, and (2) systems analysts. The specific objectives of the training courses are:

Management course	*Systems analyst course*
To provide the manager with the knowledge and skills necessary to identify, understand and evaluate the potential and performance of the computer in the accomplishment of his operations and his organization's mission.	To provide those individuals who have adequate background in computer programing with the knowledge and skills necessary to contribute meaningfully to all basic phases of a system project under competent technical supervision.

The courses should be aimed at individualized instruction using the most advanced valid instructional media, including computer assisted instruction. The potential contractor shall explore and report on proposed instructional media to be used, identify, specify, and locate the equipment necessary to conduct the demonstration projects.

Participants in the pilot courses will be selected from a variety of agencies and activities by the designated agency. Selection of participants will be made according to the following criteria:

Management	*Systems Analysis*
GS-14 or above, or equivalent	Experience or hands-on training in computer programing.
Persons who are not now and have not been "computer professionals"	Passing of a mathematical aptitude test equivalent to first year college algebra.
No prior computer knowledge is assumed	No single pattern of Federal experience will be assumed. However, students will be selected on the basis of general experience and need.
Participants will be mature individuals; however, no formal educational background beyond high school will be required.	

Participants will have varying degrees of education, experience, and academic background. Those in the systems analyst course will be from a variety of input sources, including programers, methods analysts, systems analysts, and new college hires.

The time required for each of the groups should be between 40 and 80 hours for managers and 120 to 180 hours for systems analysts.

Specifications for Instructional Program

1. Instructional materials will be prepared for the curriculums outlined in the main body of this report.

2. Program materials should be organized into modular units to permit independent selection of only those units in which the student is not proficient.

3. To implement the instructional program and the concept of individualization, the system must be devised to allow the choice and sequence of modules appropriate for students with various levels of knowledge and performance requirements. The system may require a description of selection criteria (for example, IQ, mathematical aptitude, education, experience, etc.) for each student and a procedure to test criteria. The system will be diagnostic in the sense that it will help the program director determine the participant's entry level.

4. Instructional program development must include recommendations for methodology in each module, including media alternatives, such as PI materials, texts, films, CAI, and pedagogical techniques.

5. Where the contractor bids preparation of instructional programs only, such efforts shall result in the actual material production.

Specifications for Media Hardware

1. All hardware should be adaptable to both central and remote utilization and should be capable of being expanded to increase the number of students that can be accommodated.

2. Presently available equipment will be used as much as possible.

3. To the extent that new equipment is developed for the pilot project, its human engineering capacity should be approved to assure a good learning environment.

4. Contractor proposals should recommend specific media and instructional modules.

5. Classroom instruction together with remote units to provide for individualized instructional sessions should be developed. For example, a lecture in simulation could be supplemented with individualized learning to explore the effects of various inputs.

6. Provision must be made to employ conventional training aids such as chalkboard, screens, and closed circuit TV.

7. The following general characteristics are considered desirable in the instructional system. However, cost-effectiveness tradeoffs should be examined and considered.

   a. Multimedia presentations
   b. Computer controlled information

c. Human engineering factors
d. Mechanical equipment "sign on" and student identification methods
e. Modular design. Major components should be sufficiently independent to facilitate replacement of the instructional unit if the system fails.
f. Self-checking. Equipment must be designed to provide sensing devices to detect component failures. Such information should be relayed to a central monitoring source. This design should be augmented by a student trouble indicator to serve the same purpose.
g. Individual media requirements

Manual

Full typewriter keyboard

Light pen (or other provision for entering data by touching the face of the tube)

Five to 10-key response keyboard

Audio

Speaker and headset with stereo capability

Audio level under program and student control

Normal and compressed speech mode

Speech compression level under both program and student control

Voice

Provision for voice response

Voice recording and playback

Visual

Provision for rear projection of filmed media on face of the Cathode ray tube (CRT). Brightness to be under both program and student control. Closed circuit TV with random access video tape image selection

Rear Projection Screen

Projection device to be cartridge loaded by student (film or slide) with capability of projecting individual frames randomly, or switching picture either to the screen or through CRT to the tube face. Projection speed to be under program control.

"Fixed" Instruction Panel

Capable of displaying a minimum of 10 lines of 25 characters each. Illumination of appropriate line will be under program control and lines will be so constructed that they can be modified in content to fit the authors' requirements.

h. Acceptance and selection criteria

System Components

The contractor should be able to demonstrate the reliable functioning of all system components under conditions of simulated usage. Testing should be for a period of no less than 100 hours, the last 40 hours of which must have at least 95 percent up-time. There should be no more than 10 failures overall and of these six must be for periods of less than 5 minutes.

Equipment Performance

Given similar equipment, design, and functioning, preference in selection will favor those contractors whose equipment demonstrates superior quality in the following areas of human engineering (to include esthetics):

Low noise levels
Sharpness/resolution of image projection
Audio outputs
Functional layout of display elements and controls
Rapidity of component response
System restart in the event of computer and/or power failure

Contractor Criteria

1. The contractor shall have demonstrated competence in effectively developing and using multimedia, computer equipment, and software.

2. The proposal should list the qualifications and relevant experience of all personnel proposed for the job.

3. Any substitution of personnel in Item 2 will be with prior approval of the Federal contracting officer.

Time Schedule

The time schedule for design and implementation of the pilot project follows:

Event	*Cumulative calendar days from Request for Proposal*
Expression of bidder interest	30
Receipt of proposals	104
Selection of contractor	194
Contract awarded and signed	224
Preliminary report of contractor	254
Installation available (including declaration by contractor of readiness to accept student groups)	700
Start courses	790
Final report due	850

Milestone reports will cover detailed outline of curriculum, media, and software. In addition, monthly project reports will be required of the contractor.

One or two expert consultants should be engaged to assist the contracting officer in the supervision of the contract.

Appendix III. Extracts from Papers Delivered at Conference

COMPUTER ASSISTED INSTRUCTION

Excerpts from a paper delivered by Dr. Lawrence M. Stolurow of Harvard University

There seems to be a real place for CAI in meeting the ADP training problems with which we are faced. The problem is to see where it fits and how it can be put to use.

We should think of the CAI investment as serving a dual purpose: first, to determine its limitations and capabilities as an instructional technique, and second, to get mileage out of it in instructing students. In other words, this type of instruction should not be investigated in a laboratory remote from the real situation. Ideal places for initial efforts already exist in systems capable of time-sharing, multiple access, and teleprocessing, e.g., airline scheduling.

CAI is not programed instruction. CAI is computerized, machine augmented instruction based on a concept quite different from PI. It certainly is possible to dump existing PI onto a computer system but there is little advantage from making such a simple transfer.

At Harvard, CAI provides a means of pretesting and developing instructional materials. When the materials are later marketed or used, they may take a very different form. PI, of course, does not have this capability for testing, developing, and refining.

The basic concept in machine augmented instruction is that it is individualized. Moreover, a computer-based system has two capabilities not present in other media: logic and memory. Thus, the computer provides a nervous system for the media you want to employ for instruction. Basically, then, machine-augmented instruction uses a multimedia approach and it also provides a multimode capability.

(The speaker showed and commented on each of five slides.) These slides show examples of currently available CAI equipment. Most existing consoles are adaptations of input/output equipment designed for other purposes. They are still primitive in relation to their potential. Much more human engineering needs to be done to provide a truly effective learning environment.

In *Slide* No. 1, the console is a small cathode ray tube (CRT) and keyboard, with an IBM 360/50 as central processor. It is used at the University of California to teach mathematics. The instructional burden is carried primarily by the teacher but individualization comes in by allowing the student to see a display of his own concepts. For example, in teaching a mathematical function, the student can enter variations in the parameters and see what the function looks like.

Slide No. 2 shows a system individually designed for CAI but concerned primarily with display rather than response. The left-hand display is a rear view projection of a 35 mm. film. At the right is a display for messages which are repeatedly used. The film display is a step toward the kind of learning environment which is needed because it provides for inexpensive information storage.

Slide No. 3 is an IBM 1050 typewriter, capable of operation in a teleprocessing manner. To the left is an additional display area. The top segment is a screen for a random-access slide projector which is synchronized with the text display. This is essentially an audiovisual console.

Slide No. 4, from Philco-Ford, uses a standard TV tube modified for CRT display and permits showing of tapes and TV displays, or live broadcasting. It is also adapted for keyboard and light pen response. The light pen adds capability but it also adds to the costs in coding and programing and results in delays in preparing materials.

Slide No. 5 shows the console for the IBM 1500 system. It contains the keyboard, the CRT, an image projector, audio, the light pen, and a microphone for recording vocal responses.

All of these developments attack the CAI problem but they do not solve it. They show inadequacies in human engineering and these inadequacies are major sore spots in the whole input/output problem for CAI. However, the slides served their major purpose; they showed that CAI is multimedia. If this multimedia integration capability can be put together in an appropriate educational package, it will be feasible to move ahead in terms of our training requirements.

The second major point about CAI is that it is multimode.

The problem-solving mode was one of the first capabilities to be developed. In problem-solving, we are dealing with a situation in which the capabilities of the computer as a calculating system are being employed. Each individual sits at a console and puts in his data, defining his processing program, and getting the system to perform what it has been designed to perform, namely to calculate. BASIC is a language which is being used on the GE systems. It is readily learned by students and is powerful enough to take care of most physics, math, chemistry, and statistics problems. Essentially the console is used as an elaborate desk calculator. The faculty or staff in the educational institution need to know little more than they now know about computers, computer languages, and time-sharing. The schools do not have to add to their instructional staff either; they simply let their students learn a computer language and the staff then assigns the usual problems—perhaps more problems because the students now have a capability to handle more problems and get more problems solved.

Drill and practice is another CAI mode. In this mode, the instructional staff has to make decisions about what kind of drill and what kind of practice the students are going to need in support of the instructional effort. They then have to work with computer programers to generate instructional materials or write them themselves, in which case there is greater instructor involvement, teacher involvement, or author involvement in the process. The student responds in natural language to natural language displays and so he needs to learn very little about computer technology in order to use such a system. The main advantages are that the student can be given specific and tailored practice to his particular needs. Once these needs are determined, the system can support the skill development.

The third mode, called the inquiry mode, is used for information retrieval. Application of the system in this mode has different system requirements. Operation of a system in this mode requires algorithms and an analysis of the data base. It is necessary to set up and maintain files. One example is the application used by System Development Corporation when they took the Golden Book Encyclopedia, loaded its content on the system, and then set up research algorithms for information retrieval. The student can ask why it rains and the Golden Book answer to that question will be displayed on the student console.

The fourth mode is the tutorial mode. In this mode, machine-augmented instruction takes the responsibility for helping individuals move from some minimum level of confidence to a higher level. Formulation of teaching strategies is one of the problems faced by those who would develop and use the tutorial mode. Another problem about which decisions have to be made is the allocation of materials to the various media.

The fifth mode is the author mode. This mode is the most primitive but potentially the most important, particularly at this stage of the game. In this mode the curriculum writer uses the system to generate instructional materials from general specifications.

Effectiveness of this mode depends upon determining the kinds of modules to use and the algorithms needed to combine modules into texts for particular instructional objectives. The system's capability for the author mode depends upon its ability to generate specified kinds of materials, load them on the system, and present them in modules which economize the teaching-learning effort.

So far, the author mode has been used to generate syllogisms in support of a logic course. It was not necessary to write every syllogism in advance or even to know what syllogism the student was going to get. For example, if the appropriate syllogism is abstract, the student gets it in a's and b's, or x's, y's, and so on. If it is concrete, he gets a verbal description.

Because the tutorial mode seems to be one of the most immediately useful computer capabilities for ADP instruction, it may be well to return to a discussion of it in more detail. The tutorial instruction by computer is approached in two phases, the pretutorial or preparation and selection phase, and the tutorial or direct instruction phase. These are shown in figures 1 and 2.

In the pretutorial decision process, the inputs are student characteristics and specific behavioral objectives of the instruction so that a teaching program can be selected. Figure 1 shows three alternative search strategies for program development. The top one indicates several possible programs and use of efficiency criteria for selecting the best one. The middle section indicates a single available program to be refined and implemented. The bottom section shows what has to be done when no program is available to meet training requirements and one has to be created. One possibility is a change in entry level. For example, a candidate for a statistics course might be deficient in algebra and need an algebra refresher before he can proceed. Another possibility is to risk taking individuals with low entry levels but high aptitude. This aptitude may ultimately increase the take in terms of potentially trained people. Another possibility is to change the set of required topics, the time allotment, or the final performance level in order to achieve desired quotas. These changes or combinations of them can be set up in a priority schedule so that the system will automatically process individual students and give them appropriate instruction. The capability for performing these pretutorial decisions needs to be built into the total system.

FIGURE 1. *The pretutorial decision process*

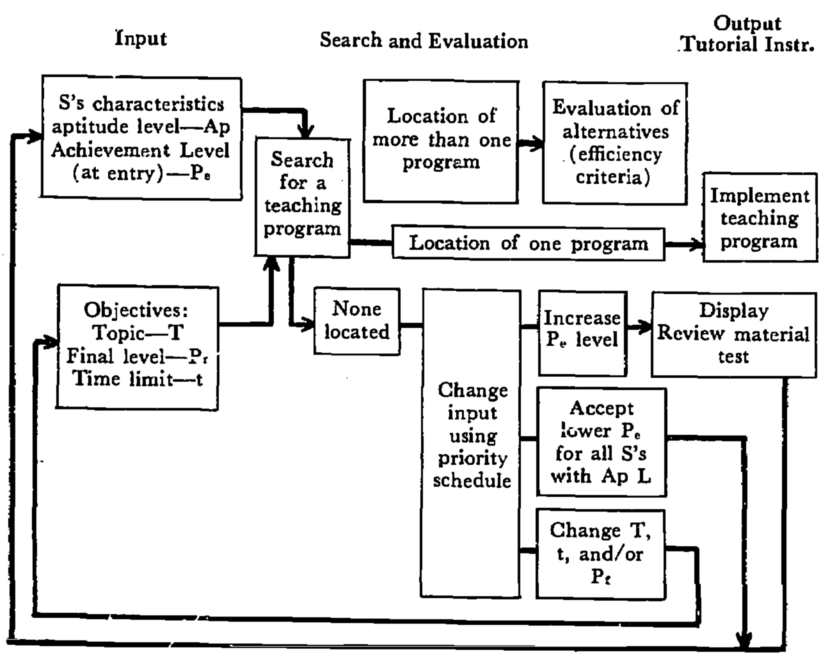
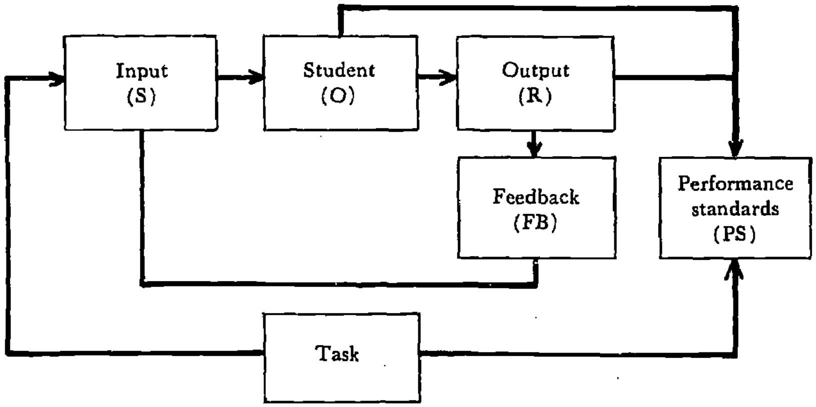


Figure 2 shows the basic elements and relationships in the tutorial or direct instruction process. Feedback, which includes the idea of reinforcement, is explicit and recognizes the need to make selected events contingent upon response. It should be distinguished from the cue and other stimulus eliciting functions. Feedback recognizes that school situations involve both informational contingencies and reinforcement contingencies to move learning forward.

FIGURE 2. *The tutorial instructional system*



Performance standards act as critical functions in the making of decisions in experimental studies of learning. They can no longer be left unnoticed when the learning task is defined; hence, their function needs to be made explicit in all instructional situations.

Precisely defined, performance standards are the principles used to generate the criteria employed in making decisions about the correctness of each response. They may vary with school grade and with a student's ability in the same way that teachers impose different standards on different students in a class, thus defining different tasks for these students.

Performance standards used by the teacher at an early period can be taught to and used by students at later periods. As part of the material covered in a course, the standards are available for student use to evaluate their own performance later. For example, the student who is taught rules of grammar can then apply these to his own writing. When he does this, he becomes his own teacher by supplying himself with knowledge of results. If he verbalizes the rule when he corrects his own work, he even supplies himself with information feedback. Applied to CAI, this kind of feedback links the rule to the material cues, thus strengthening effective association for later use. The machine's capabilities are thus used by the student to improve both what and how he learns.

PROGRAMED INSTRUCTION

Abstract of a presentation by Dr. Gabriel O'Fiesh,
Director of the Center for Educational Technology, Catholic University,
Washington, D. C.

A recent document signed by the Commander of the Air Training Command, the largest training establishment in our Nation, says that the programed instruction concept has proved itself so effective that it will be applied across the board to all air training programs. This is one of many examples where instructional techniques are being adapted to cope with educational crises.

Attempts to cope with a variety of educational crises have contributed to the development of a new field, the science of education. How does one concentrate limited resources on developing the technologists needed to turn out the massive amounts of materials demanded in our society? What kind of education is needed to design and produce the systems which will be adaptable to the society's accelerating requirements? The sheer force of the mushrooming population and its expectations makes traditional education inadequate. The expedients taken to meet today's needs will be totally inadequate tomorrow.

The rapid accumulation of information in almost every discipline and endeavor has forced a search for new methods of acquiring, assembling, analyzing, and disseminating the almost overwhelming new knowledge of our age. The development of techniques and devices, such as educational television, teaching machines, audiovisual communication, and the programed instruction process, has been hailed as revolutionary and capable of solving problems associated with the knowledge explosion.

These devices and aids are not revolutionary in themselves but they are revolutionary in meeting the needs of education. They can help relieve teacher shortages and eradicate illiteracy. They can increase curriculum effectiveness. They can improve the process by which human beings learn. Packaged learning systems have some of the same assembly line advantages that Bessemer brought to steel and Ford brought to the automobile. They have potential for improving both the quality and the quantity of learning so that individuals are better able to solve the rapidly accelerated problems of our society.

Illustrations of these problems include increasing technological change, exploding world population, the need for commencing better education earlier in life and continuing it to a higher level of achievement than in the past. An educated citizenry is one of the most effective tools we have for economic and political growth and development. Statesmen and economists have long recognized that the only thing more expensive than education is the lack of it. Society's problems are not likely to be resolved as long as that society puts more money into the programing of major TV networks in one week than it does in all educational TV in one year.

A new, vigorous approach is needed to make the best possible instruction available to every individual, including the teachers. Through the process used in programed instruction and computer-assisted instruction, this possibility can become a reality.

Through programed instruction, the best tutorial methods can be packaged and mass-produced for students. Through packaged tutorial learning systems, master teachers and the master "teachers of teachers" can be relieved of the routine didactic process and devote their creative energies to those precious interpersonal moments between student and teacher and between teacher and student-teacher.

Industry has retooled over and over again to provide better products and gain wider markets. Education might profit by industry's example. It isn't unusual, for example, to see a coffee vending machine with numerous knobs so that customers can get sugar and no cream, cream and no sugar, heavy sugar and cream, light sugar and light cream, and other combinations to suit their taste. Yet students all go into the classrooms and get the same black coffee curriculums. Is there any reason why the same resourcefulness should not be applied to provide a variety of continuous education to meet individual needs?

Retooling in education is long overdue if the profession is to cope effectively with ever-changing educational needs. Innovation is needed to move from conventional and outmoded pedagogy to a functional kind of learning that keeps up with the times and helps to shape the future. It is not enough for today's teachers to teach as they were taught.

Imagine a school which can operate continuously whenever students are there, a school where teachers are not needed for conventional kinds of work. Learning systems based on the process of programed instruction would make up for shortages of skilled teaching manpower and provide effective tools for carrying out needed learning. Such innovations might be far more effective than conventional remedies such as increasing the number of specialist personnel, or building more school rooms.

What is needed is a whole set of inexpensive learning systems to meet this need directly. Educational engineering can be used to develop a wide variety of packaged courses which will help minimize shortages of competent master teachers and classroom facilities and at the same time help students select and manage effective learning. The programed instruction process is basic to this packaged education.

Through programed instruction, the tutorial approach can be simulated, or packaged. The student can be led one optimal step at a time along the learning path. To one student, it may be a small step, but one he can take with confidence; to another student, it may be a large one. The student's response always carries him a little closer to the ultimately desired learning.

In 1964, Wilbur Schramm, in his review of research in programed instruction, stated unequivocally that 5 years of intensive research had demonstrated that students do learn from programed instruction. Like no other approach to teaching, this system of instruction essentially drops what is "disfunctional" from learning experience and develops and builds on what is truly functional. This is not to say that programed instruction will provide all the answers; nor does it guarantee that programed instruction is in and of itself the only learning technology society needs. It does mean, however, that adherents of the system have been testing the experiences which they hypothesize will lead to successful learning.

Programed instruction applies engineering techniques to solve educational and training problems. It does not mechanize education but rather seeks to develop learning technology to the point where a bullet approach can be used instead of a shotgun. Within ADP there is a tremendous need for this kind of training. The expansion of the industry itself has necessitated the training of thousands of programers and operators. Conventional training has not been efficient. Some companies have devised programed texts to teach the fundamentals of computer programing and provide instruction for particular machines. The effort to use the ADP system itself to train programers and operators is minimal, although programers have spare time while awaiting debug runs and operators have relatively idle periods while long jobs are being run. The potential now exists, through time-sharing, teleprocessing, and multiprocessing, to use the machine for both production and instruction.

There has been some tendency to think the task simply mechanizes the classroom approach or the textbook. CAI is much more than this. It is the application of the programed learning approach. What, specifically, does the person need to learn? How can one know when he has achieved these objectives? What is the best strategy for presenting the material to give optimum reinforcement and retention? It takes time and money to do the job right. To shortcut the process may cost time and money to do the job wrong.

Perhaps what is needed is a new specialty, "the educational systems engineer," to bridge the gap between basic research and technology. Such engineering would require better understanding of the impact of stimulus-configurations (message designs) imposed upon students and would identify those which actually produce changes in behavior.

Once a process or method can be isolated with confidence that "this particular set of stimuli, presented in this format, under these specific conditions, to these particular individuals, will reliably produce these specific changes in their behavior," the second question must be: How can the packaged process be instrumented, replicated, and mass produced? The answer to this question requires engineering which combines the learning design and hardware adaptations required to carry the instructional load.

Appendix IV. Selected Organizations Involved in Educational Technology

THE ADMINISTRATIVE MANAGEMENT SOCIETY
Willow Grove, Pa. 19090

AMERICAN MANAGEMENT ASSOCIATION, INCORPORATED
135 West 50th Street
New York, N.Y. 10020

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway
New York, N.Y. 10007

THE AMERICAN UNIVERSITY
Center for Technology and Administration
Downtown Campus
2000 G Street, NW.
Washington, D.C. 20016

ANALYTICAL ASSOCIATES, INCORPORATED
420 Lexington Avenue
New York, N.Y. 10017

APPLIED DATA RESEARCH, INCORPORATED
Route 206 Center
Princeton, N.J. 08540

ARKAY INTERNATIONAL DIVISION
Comspace Corporation
2372 Linden Boulevard
Brooklyn, N.Y. 10108

THE ASSOCIATION FOR BANK AUDIT, CONTROL, AND OPERATION
205 West Touhy Avenue
P.O. Box 500
Park Ridge, Ill.

ASSOCIATION FOR COMPUTING MACHINERY
211 East 43d Street
New York, N.Y. 10017

ASSOCIATION FOR EDUCATIONAL DATA SYSTEMS
1201 16th Street, NW.
Washington, D.C. 20036

AUTOMATION INSTITUTE OF AMERICA
Subsidiary of C-E-I-R, Inc.
760 Market Street
San Francisco, Calif. 94102

AUTOMATION SCIENCES, INCORPORATED
275 Madison Avenue
New York, N.Y. 10016

AUTOMATION TRAINING CENTER
Box 3085
Papago Station
Scottsdale, Ariz. 85257

BONNER & MOORE ASSOCIATES, INCORPORATED
500 Jefferson Building
Houston, Tex. 77002

BRANDON APPLIED SYSTEMS, INCORPORATED
30 First 42d Street
New York, N.Y. 10017

C-E-I-R, INCORPORATED
Institute for Advanced Technology
5275 River Road
Washington, D.C. 20016

COMPUTER COMMAND AND CONTROL COMPANY
Suite 1315
1750 Pennsylvania Avenue, NW.
Washington, D.C. 20006

UNIVERSITY OF CALIFORNIA EXTENSION
Los Angeles, Calif. 90024

CENTER FOR PROGRAMED LEARNING FOR BUSINESS
Bureau of Industrial Relations, Graduate School of Business Administration
The University of Michigan
340 South State Street
Ann Arbor, Mich. 48104

COLUMBIA UNIVERSITY
Executive Programs, Graduate School of Business
Uris Hall
New York, N.Y. 10027

COMPUTER RESEARCH INSTITUTE
9506 Magnolia Avenue
Riverside, Calif. 92503

COMPUTER USAGE EDUCATION, INCORPORATED
Subsidiary of Computer Usage Company
51 Madison Avenue
New York, N.Y. 10010

COMRESS, INCORPORATED
2120 Bladensburg Road, NE.
Washington, D.C. 20018

Control Data Institute
Division of Control Data Corporation
3255 Hennepin Avenue
Minneapolis, Minn. 55408

Data Processing Management Association
International Administrative Headquarters
505 Busse Highway
Park Ridge, Ill. 60068

Detroit Research Institute
12 East Hancock
Detroit, Mich. 48201

Digitronics Corporation
Albertson, N.Y. 11507

Documentation, Incorporated
4833 Rugby Avenue
Bethesda, Md. 20014

Electronic Computer Programming Institute
Empire State Building
New York, N.Y. 10001

Emory University
School of Business Administration
Atlanta, Ga. 30322

Entelek, Incorporated
Newburyport, Mass. 01950

Florida Atlantic University
College of Business and Public Administration
Boca Raton, Fla. 33432

Friden, Incorporated
Subsidiary of the Singer Co.
2350 Washington Avenue
San Leandro, Calif. 94577

General Dynamics
One Rockefeller Plaza
New York, N.Y. 10020

Georgia Institute of Technology
Rich Computer Center
School of Information and Science
Atlanta, Ga. 30332

Industrial Management Center
370 Concord Road
Weston, Mass. 02193

Industrial Management Society
330 South Wells Street
Chicago, Ill. 60606

Informatics, Incorporated
5430 Van Nuys Boulevard
Sherman Oaks, Calif. 91401

The Institute for Management and Computer Education, Inc.
135 West 50th Street
New York, N.Y. 10020

International Academy Division
LSI Service Corp.
Washington, D.C. 20036

International Accountants Society, Incorporated
209 West Jackson Boulevard
Chicago, Ill. 60606

International Business Machines
Education Department
Poughkeepsie, N.Y. 12601

International Correspondence Schools
Scranton, Pa. 18515

Learning Foundation Institute
Executive Division
505 Fifth Avenue
New York, N.Y. 10017

Ling-Temco-Vought Incorporated
Arlington, Texas

Management Development Institute
130 West Lancaster Avenue
Wayne, Pa. 19087

Management Science Training Institute
A Division of the Diebold Group, Inc.
430 Park Avenue
New York, N.Y. 10022

University of Michigan
Institute of Science and Technology
College of Engineering and Extension Services
Conference Department
412 Maynard Street
Ann Arbor, Mich. 48104

3M Company
Visual Products Division
Box 3100
St. Paul, Minn. 55101

National Association of Accountants
505 Park Avenue
New York, N.Y. 10022

National Business System Association, Incorporated
5856 Northwest Highway
Chicago, Ill. 60631

National Cash Register Company
Main & K Streets
Dayton, Ohio 45409

National Microfilm Association
P. O. Box 386
250 Prince George Street
Annapolis, Md. 21404

University of New Mexico
Albuquerque, New Mex. 87106

New York University
The Management Institute
School of Continuing Education and Extension Services
Washington Square
New York, N.Y. 10003

Philco-Ford Corporation
TechRep Division
Tioga and C Streets
Philadelphia, Pa. 19134

Purdue University
Lafayette, Ind. 47907

Programming and Systems Institute
33 West 42 Street
New York, N.Y. 10036

The Service Bureau Corporation
1350 Avenue of Americas
New York, N.Y. 10019

Scientific Methods, Incorporated
Box 195
Austin, Texas 78767

Southern Illinois University
Computer Center
Department of Management
Vocational Technical Institute
Carbondale, Ill. 62901

Stanford University
Stanford, Calif.

Systemation, Incorporated
P. O. Box 1188
Tulsa, Okla. 74101

System Development Corporation
1923 Centinela Avenue
Santa Monica, Calif. 90404

Systems and Procedures Association
P. O. Box 549
Contrecoeur
Quebec, Canada

Univac Division
Sperry Rand Corp.
1290 Avenue of the Americas
New York, N.Y. 10019

The University of Wisconsin
University Extension
432 North Lake Street
Madison, Wis. 53706

Wharton School of Finance and Commerce
University of Pennsylvania
Department of Industry
Philadelphia, Pa. 19104

Major CAI Centers

Dedicated Systems

IBM Yorktown
IBM Poughkeepsie
IBM Los Gatos
University of California/Irvine
University of California/Santa Barbara
Darmouth College
MIT MAC
Systems Development Corporation
AF Electronic Systems Div.
Bolt, Beranek and Newman
Penn State University
University of Illinois
Harvard Computation Laboratory
Florida State University
University of Texas
University of Pittsburgh
Stanford
Westinghouse

Public Utilities

General Electric Time-Sharing Service
Bolt, Beranek and Newman/TELCOMP

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