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GRADUATE COLLEGE

ANALYSES AND ALTERNATIVE PROPOSED GENERAL DESIGNS OF COMPUTER-BASED CORRESPONDENCE INSTRUCTION SYSTEMS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

CHARLES EHIN

Norman, Oklahoma

1972

ANALYSES AND ALTERNATIVE PROPOSED GENERAL DESIGNS

OF COMPUTER-BASED CORRESPONDENCE

INSTRUCTION SYSTEMS

APPROVED BY

DISSERTATION COMMITTEE

ACKNOWLEDGEMENTS

Comprehensive studies cannot be conducted and formalized without the unselfish support of numerous individuals and organizations.

My dissertation committee provided the most essential assistance. Professors B.G. Schumacher (Chairman), L. Doyle Bishop, W. Cris Lewis, Ronald B. Shuman, and William R. Southard were very generous with their time and advice. Chairman Schumacher helped with the conception of the study and continuously gave needed direction and guidance. Professor Bishop's assistance was invaluable during the formalization of the design phase of the endeavor. Professor Southard was instrumental in helping to finalize the methodology and theoretical basis of the study.

The study could not have been properly conducted without the help and encouragement of Russell R. Meyers, Chairman of the Independent Study Division of the National University Extension Association (NUEA) and Henry Q. Wellman of the National Home Study Council (NHSC). The directors and administrators visited during the case-study phase must also be credited for providing a solid foundation for the project. In addition, the cooperation received from NUEA and NHSC member departments and schools in response to the questionnaire survey is greatly appreciated.

I am especially indebted to my wife, Betty, for her unfailing moral support and the typing of the manuscripts. Without her continued help and encouragement my entire doctoral program could not have been possible. My daughter, Linda, and son, Chuck, must also be commended for their efforts in making the undertaking more tolerable.

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PURPOSE AND ORGANIZATION

Correspondence school and department administrators will be required to make more extensive use of computers in the future with the increasing demand for independent or home study. In addition, the introduction of computer-assisted administrative systems will demand more integrated and systematic design approaches for the attainment of desired results. Therefore, the administrators of correspondence instruction programs must become more familiar with the subject of computer-based management information systems design and application.

Purpose of the Study

Most correspondence schools and departments are not using computer systems in the administration of their respective programs. In institutions where computers are in operation or being shared the systems designs are generally not closely related to general systems theory and fail to fully take advantage of the versatile techniques afforded by advanced information technology. This problem appears to exist due to both the absence of research

and literature specifically dealing with computer applications in independent study administration and the lack of general knowledge about computer systems currently being utilized by some home study organizations. The objective of this study is to demonstrate the extent of the problem by analyzing the methods and the degree of electronic data processing (EDP) systems application by correspondence schools and to propose three alternative general computer-based correspondence instruction systems designs. The three alternative designs demonstrate the general configuration and operation of a tape-, disk-, and service bureau-based system.

This study could be utilized as a guide by the administrators of correspondence institutions or departments who are using, or are planning to use, computers in the operation and administration of their programs. It deals with the general application of computer systems to the basic activities of correspondence schools or departments. The study is not designed to cost justify specific methods or hardware in the implementation of computer-assisted correspondence systems. Cost justification is part of the feasibility study which precedes the decision to order a given computer system. Such an evaluation is unique and must be accomplished separately for each organization. General knowledge, however, of present methods and proposed new designs should enhance future feasibility studies and systems configurations. Some experts have even come to the conclusion that institutions may do better and save time and money by observing developed systems in similar schools instead of

conducting extensive feasibility studies on their own.[1]

Importance of the Study

The nature of the study is both exploratory and descriptive. It is exploratory in the sense that comprehensive research and literature dealing with computer applications in the administration of correspondence instruction is lacking, although some of the larger schools have used computers for several years.[2] The study is descriptive since it portrays the methods and the extent to which computer systems are currently being used in correspondence education. The primary importance of the study is the establishment of a literature and knowledge base dealing with computer applications specifically formulated to assist the correspondence study administrator.

The redesign of a computer system or the initial acquisition of a computer is a complex and time-consuming process. The availability of systems information directly related to the user's field of operation would make the efforts of redesign or initial installation of a computer system more complete and more successful in attaining the established objectives.

Other aspects of the importance of a more comprehensive

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[1]Ralph Van Dusseldorp, "Some Principles for the Development of Management Information Systems," in C.B. Johnson and W.G. Katzenmeyer, ed., Management Information Systems in Higher Education: The State of the Art (Durham, North Carolina: Duke University Press, 1969), p. 35.

[2]The United States Air Force Extension Course Institute, for instance, has employed computer systems since 1960.

knowledge of computer applications in correspondence instruction must also be considered. Increasing population, the "knowledge explosion," and rapid technological change is placing severe strains on the current educational systems. There is an increasing demand for more continuing education which is integrated with life instead of extended education consisting of cramming more and more knowledge in preparation for life.[3] It is estimated that the population of the United States will be between 280 and 300 million by the year 2000,[4] and that human knowledge is doubling every five years.[5] Simultaneously, the rapidity of technological change makes the training an individual receives during his early years inadequate for the duration of his working life and necessitates periodic retraining. Not only is technological change affecting man at work, but also his relationships with his offspring. Parents must continue their education if only to bridge the "generation gap". This problem almost parallels the relationships the immigrants had with their children in the earlier years of this country.[6]

It is also evident that increasing costs induced by rising

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[3]Peter F. Drucker, The Age of Discontinuity (New York: Harper and Row, Publishers, 1968), p. 323.

[4]"Ahead for America--The Biggest 'Baby Boom'," U.S. News and World Report, May 10, 1971, p. 28.

[5]Edgar C. Gentle, ed., Data Communications in Business (New York: American Telephone and Telegraph Company, 1966), p. 9.

[6]Donald N. Michael, "Cybernation and Changing Goals in Education," in Bushnell and Allen, ed., The Computer in American Education (New York: John Wiley and Sons, Inc., 1967), p. 7.

enrollments and continuing inflation in conjunction with static or reduced budgets have placed a severe strain on virtually every campus in the nation.[7] Numerous institutions are reducing faculty and staff, suspending building programs, and cutting operating budgets to the lowest possible levels.[8] Obviously, the demand for education is rapidly increasing while the conventional methods of reacting to this additional demand by adding more teachers, buildings, and equipment to our present schools is being severely limited or curtailed. Therefore, methods of instruction which increase educational output without the expansion of physical facilities and faculty must be more fully explored, developed, and implemented to help resolve the increasing educational requirements.

By 1980 college enrollments alone are estimated to be around 11.7 million.[9] Based on current indicators, the assumption is made that conventional education systems will not be able to satisfy the excess demand for college, technical, and continuing education of the future. It is also assumed that correspondence schools and departments will be required to contribute more extensively to the growing needs of education. Even before the year 2000 learning is foreseen to consist of classroom instruction as

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[7]Gregory H. Wierzynski, "Austerity on Campus," Time, June 14, 1971, pp. 52-3.

[8]"Money Pinch for Colleges: Impact on Students, Campuses," U.S. News and World Report, May 10, 1971, p. 28.

[9]"Record Year on American Campuses," U.S. News and World Report, September 30, 1971, p. 38.

the introductory phase and home study as the second or continuing phase providing constant contact with the dynamic environment.[10] The trend is already in this direction as evidenced by new experimental institutions designed by several cooperating colleges and universities. These new educational systems are referred to as "colleges without walls" and they award degrees for scholastic work accomplished outside the conventional educational setting.[11]

The trend towards more correspondence education is depicted by the increasing enrollments of independent study schools. In 1962 approximately 3.5 million students were enrolled in correspondence institutions[12] and by 1965 this figure had grown to 4.86 million.[13] The latest statistics indicate that in 1970 about 5 million students were participating in various correspondence education programs.[14]

General systems theory must become the primary guide in designing future educational systems. This approach would incorporate all essential media and new information technology into the

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[10]Benjamin H. Pearse, "The Postmaster is the Proctor," American Education, February, 1967, p. 12.

[11]"A Different Type of College: It Comes to the Student," U.S. News and World Report, October 4, 1971, p. 40.

[12]"Summary of Special Research, Practical Studies and Reports Relating to Home Study Education," The Home Study Review, Spring, 1963, p. 13.

[13]"Correspondence Education Survey," The Home Study Review, Winter, 1966, p. 29.

[14]"News You Can Use," U.S. News and World Report, August 30, 1971, p. 72.

development of optimum systems. A multi-media learning system could use computer-assisted correspondence instruction as a base or "linking-pin" for all other media and methods included in the system. Such a system, which would incorporate simple to complex progression, feedback, systematic reinforcement, and progress at an individualized rate is compatible with the current knowledge of instructional strategies and learning processes.[15] Dr. Charles A. Wedemeyer of the University of Wisconsin, one of the world's foremost authorities on correspondence education, succinctly concludes:

> The teaching-learning situation can now be open and unfettered by the old space-time barriers. There need be no deprived persons waiting at the classroom door for learning to begin. The ancient goal of developing self-sufficient learners can be achieved through giving learners experience and confidence in learning independently. The teacher can become the thinker, the problem-solver, the mentor who creates and manages the systems through which individual students progress.16

It is evident that computer systems will have to be applied more extensively in the future in the administration of correspondence or multi-media study programs. Computer systems will be needed not only to cope with extensive and increasing repetitive data processing requirements, but more importantly, to make correspondence instruction systems more flexible and more responsive to

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[15]John P. Young, "Campus Crisis: Responsibilities of the Learning Industry," in O. Mackenzie and E.L. Christensen, ed., The Changing World of Correspondence Study (University Park, Pennsylvania: The Pennsylvania State University Press, 1971), p. 142.

[16]Charles A. Wedemeyer, "With Whom Will You Dance? The New Educational Technology," in Mackenzie and Christensen, ed., The Changing World of Correspondence Study, p. 140.

individual necessities and desires. Consequently, it is vital that more systematic research and literature be developed to assist the independent study administrators in the design and application of computer systems to their programs.

Definition of Terms

A glossary of terms associated with computer applications appears in Appendix I. To avoid confusion, however, it is important that the meanings of "correspondence education," "independent study," and "home study" be clarified.

Correspondence Education

For the purposes of this study correspondence education or instruction can only be associated with education offered through correspondence which requires continuous feedback between the student and the school offering the course. Programs which offer written study materials but do not require or provide appropriate interaction are defined as self-study programs[17] and will not be included in the study.

Independent Study and Home Study

The definitions of "independent study" and "home study" are synonymous with correspondence education or instruction. The colleges and universities offering correspondence courses who are members of the National University Extension Association (NUEA)

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[17]O. Mackenzie, E.L. Christensen, and P.H. Rigby, Correspondence Instruction in the United States (New York: McGraw-Hill Book Company, 1968), p. 4.

prefer to define correspondence instruction as independent study. Accredited private correspondence institutions who are members of the National Home Study Council (NHSC) usually refer to correspondence education as home study.

Research Method

The objective of research is to discover new information or relationships and to extend, correct, and verify existing knowledge, whether such knowledge contributes to the advancement of a theory or the practice of an art.[18] The intent of this study is to extend general systems theory and the art of computer-based information systems design and development in the field of correspondence education. The study makes extensive use of the descriptive method of research. For constructive thinking, the establishment of proper and realistic goals, and the re-evaluation of concepts in use, knowledge of the existing state of the art is essential.[19] The case-study and the questionnaire-survey methods were used as the primary techniques for data collection in the determination of the existing state of the art.

The purpose of the study is to provide a general unified knowledge base for the design and application of computer-based administrative systems in correspondence education. From this standpoint, due to the absence of literature, the study can be

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[18] J.F. Rummel and W.C. Ballaine, Research Methodology in Business (New York: Harper and Row, Publishers, 1963), pp. 2-3.

[19] C.G. Good and D.S. Scates, Methods of Research (New York: Appelton-Century-Crafts, Inc., 1954), pp. 255-6.

classified as basic research. The designs of the proposed computer-based systems incorporate previously advanced theory, research and methods. Consequently, the study must also in part be considered as applied research.

The objective of basic research is to discover elements, relations, and methods and not specifically to test hypotheses. The emphasis lies in the depth of the investigation. For this reason the case-study method of data collection was chosen for the first phase of the study. The case-study method is appropriate when the combination of factors involved with the functioning or behavior of an individual, industry, community, etc., are analyzed to determine the present status and to identify the operation of causal factors.[20]

The case-study phase was designed to build a knowledge base concerning present computer systems configurations in correspondence instruction administration and the formulation of a general hypothesis for the second phase of the study. Personal interviews were conducted with correspondence school administrators who were either involved with or responsible for computer utilization and systems design. The designs and applications of the computer-based administrative systems were thoroughly investigated.

An outline of the areas to be covered and the major questions to be asked was used. This check-list, however, was not intended to structure the interviews to any degree. Interviews

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[20] Ibid., p. 726.

and discussions were directed with in-depth, open-ended questions to assure that pertinent areas received sufficient attention. Areas discussed included enrollment processing; inquiry processing; storage media used for pertinent files; method and frequency of updating and querying the active student file and the transcript file; automatic grading and feedback (when applicable); automatic student progress reminders and cancellation notices; and management reports encompassing inventory control, test item analysis, and course participation and completion rates.

An advantage of the case-study method is that the findings may be used to form a base for general hypotheses.[21] A general hypothesis--that correspondence institutions are not using computers extensively and in instances where computers are applied the design and utilization of such systems is very basic and inefficient--was formulated from the data collected by the case studies. Consequently, the second phase of the study was devoted to the verification of this general hypothesis and further analysis of the present state of the art with the aid of a questionnaire survey.

In the third or applied research phase of the study three alternative proposed general computer-based systems designs were developed. The designs of the recommended systems are based on the synergistic synthesis of the effective methods and techniques selected from the data gathering phases, general systems theory principles, and advanced information technology.

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[21]Rummel and Ballaine, Research Methodology in Business, p. 172.

Scope of the Study

An extensive review of literature revealed no studies which have dealt comprehensively with computer-based correspondence study systems. More precisely, only two generally related short articles were found.[22] One deals with a very limited system in Denmark which processes punched cards on a computer only twice a month. The other primarily philosophizes about EDP applications in the future.

The present study analyzes the computer-based systems of five large correspondence institutions in the United States, including three Federally supported schools. This was accomplished to obtain a basic foundation of present systems configurations and operations. A questionnaire survey of the members of the Independent Study Division of the National University Extension Association (NUEA) and the members of the National Home Study Council (NHSC), which also accredits private correspondence schools, was conducted to ascertain the level and the extent of computer applications in the field.

Limitations of the Study

The analyses and conclusions of the study are limited by several restrictions stemming from the groups selected for the study

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[22]Kaj Sorensen, "Electronic Data Processing in the Administration of Correspondence Education," (a paper presented in Paris at the 1969 Conference of the International Council of Correspondence Education), and P. Lambert, E.C. Koenig, and W.O. Vebber, "New Horizons in Correspondence Education" in Charles A. Wedemeyer, ed., The Brandenburg Memorial Essays on Correspondence Instruction--II (Madison, Wisconsin: University Extension, 1966), pp. 68-73.

and the techniques used for the collection of the required data. Specifically, this study is bound by four main factors: the type of sample used for the case study, the people interviewed, the targets used for the questionnaire survey, and the methods used for the data collection.

Case-Study Sample

The five correspondence schools selected for the case-study phase were subjectively selected, primarily on the basis of size. In this sense the sample may be classified as a purposive judgment sample.[23] The selection was based on the assumption that the larger institutions would be most likely to apply computers and to design such systems in a more optimum manner. It is possible, therefore, that more ideal computer applications were overlooked by limiting the selection for the initial subtask to the larger institutions. This deficiency, however, was partially rectified by the questionnaire survey.

People Interviewed

As indicated before, personal interviews were conducted primarily with correspondence school or department administrators who were either involved with or responsible for computer utilization and systems design. In all instances these individuals were either division or branch heads. Others in the divisions and branches may have been able to supply details which could have been overlooked.

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[23]Rummel and Ballaine, Research Methodology in Business, p. 75.

Also, educators and instructors in these institutions may have been able to substantiate what products they were receiving from the computer-based system and what areas needed further application or redesign. Every study, however, must establish time and fund restraints in order to meet established deadlines. Therefore, the collection of data must be selective and limited.

It must be emphasized that no area during the course of the case study phase met with non-response. The administrators appeared to be very understanding of the problem under study and comprehensive in the presentation of data desired. In addition, samples of all input/output documents were readily made available by all institutions visited.

Questionnaire Population

All of the sixty-three members of the Independent Study Division of the NUEA and the seventy-five[24] members of the NHSC were selected as targets for the questionnaire survey. These two groups were chosen on the assumption that members of the Associations would respond more readily to the survey and furnish the most reliable and accurate information.

Limitations of Questionnaire Survey

A questionnaire survey has two inherent limitations. First, there is the possibility of ambiguity both in the questions asked and the replies returned. Second, for a survey to be useful a suf-

[24]There are approximately 156 accredited private schools who are members of the NHSC. Many of the individual schools, however, are divisions of the 75 main offices surveyed.

ficient percentage of the target population must complete and return the questionnaire. The first limitation was reduced to acceptable levels by the design and prior evaluation of the questionnaire. The second limitation was overcome by the inclusion of a cover letter endorsed by either the NUEA or the NHSC and a self-addressed, stamped envelope with each survey.

In this section of the study the inherent limitations stemming from the method of research and analysis have been presented. The conclusions and generalizations reached by this study must, therefore, be tempered by the knowledge of these factors.

Organization of the Study

The content of the study is divided into four main areas: background, analysis of the data gathered, presentation of the alternative proposed general computer-based systems designs, and conclusions.

Chapter II summarizes the history of correspondence education in the United States, the advantages and disadvantages of the independent instruction method, and some of the innovations which have been adapted by the home study schools. In Chapter III, important aspects concerning the development of management information systems are described. This includes the review of general systems theory, computer hardware and software, and systems design considerations and methods.

Present computer-based correspondence instruction systems are analyzed in Chapter IV. Compiled results of the questionnaire

survey are presented and analyzed. In addition, the most desirable aspects of present systems are portrayed on the basis of the case studies.

In the next two chapters three alternative proposed general computer-based independent study systems designs are presented. Chapter V contains the design characteristics and describes the configuration of a tape-based system. The basic designs of a disk-based system and a service bureau- or utility-based system are displayed in Chapter VI.

The final area is embodied in Chapter VII. It includes the summary and conclusions of the study. Furthermore, possible areas of future research and recommendations for correspondence study administrators are contained in this section.

Supplementary information is presented in three appendices. A glossary of applicable computer system terms appears in Appendix I. The second appendix contains detailed descriptions of the cases investigated. Finally, Appendix III includes a copy of the questionnaire survey used for the study.

CHAPTER II

BACKGROUND, METHOD OF INSTRUCTION, AND INNOVATIONS

The purpose of this chapter is to establish a brief historical and methodological setting for the study. It is not intended to be a detailed discussion of the development of correspondence instruction from its inception to the present. This has already been skillfully accomplished by established authorities in the field.[1]

Background

It has been customary for authors to trace the origin of correspondence instruction even as far back in history as the Sumerian and Egyptian civilizations.[2] The assumption is made that instructive letters were exchanged between priests and learned laymen and that such an exchange of letters constituted a form of correspondence instruction. On this basis any exchange of letters

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[1]Three of the most noted works include: John S. Noffsinger, Correspondence Schools, Lyceums, Chautauquas (New York: The Macmillan Company, 1926); W.S. Bittner and H.F. Mallory, University Teaching by Mail (New York: The Macmillan Company, 1933), and O. Mackenzie, E.L. Christensen, and P.H. Rigby, Correspondence Instruction in the United States (New York: McGraw-Hill Book Company, 1968).

[2]Kurt Graff, "Correspondence Instruction in the History of the Western World," The Home Study Review, Spring, 1967, p. 19.

having some degree of instructional content could be considered as independent study.

Realistically, however, home study should be conceived as an instructional system. The basic parts of a system usually are input, processing or operations, output, and a means of feedback for control. The requirements of the components and the entire system are defined by its objectives and form the basis for the design and application of a system. The objective of any method of instruction is a deliberate effort to influence the environment of an individual in such a way as to cause or enable him to act in a prescribed manner under specified conditions.[3] Therefore, as a definite system or method, correspondence instruction was initiated in Germany in 1856 by Charles Toussaint and Gustav Langenscheidt.[4] The two men founded a correspondence school for teaching of languages in Berlin.

In the United States the impetus for correspondence instruction came from the country's massive demand for education and training. The continuous westward expansion, especially after the completion of a transcontinental line, the Industrial Revolution, and the role of woman in society exerted considerable pressure on the conventional education systems in the 1870's.[5] The extensive demand

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[3]Mackenzie, Christensen, and Rigby, Correspondence Instruction, p. 2.

[4]Noffsinger, Correspondence Schools, p. 4.

[5]Mackenzie, Christensen, and Rigby, Correspondence Instruction, p. 13.

for education during this early period can be compared to the current pressing requirements of our society for more education, especially continuing education, which the existing educational systems seem inept to cope with.

Correspondence schools in the United States emerged at approximately the same time from three sources: a voluntary society, universities, and a private organization. In 1873 Anna Eliot Ticknor, the daughter of a Harvard professor, founded the Society to Encourage Studies at Home.[6] It's members were primarily women who sought the advantages of education and learning. The primary contribution of the Society to correspondence instruction was the introduction of monthly letters between teacher and student which Miss Ticknor devised. The Society dissolved after its founder's death in 1897.

At the university level, correspondence study also began in 1873 at Illinois Wesleyan University.[7] Through correspondence instruction, examinations, and thesis writing an individual could earn degrees, including the Ph.D. The undergraduate and graduate non-resident programs at the university, however, were discontinued by 1906.

In 1883 thirty-two scholars from Johns Hopkins, Harvard,

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[6]Elizabeth C. Agassiz, "Society to Encourage Studies at Home," in O. Mackenzie and E.L. Christensen, ed., The Changing World of Correspondence Study (University Park: The Pennsylvania State University Press, 1971), pp. 27-30.

[7]Walton S. Bittner and Hervey F. Mallory, University Teaching by Mail (New York: The Macmillan Company, 1933), pp. 15-16.

Wisconsin and other colleges formed a loosely-knit association called the Correspondence University.[8] It was intended to supplement the curricula of the resident institutions and did not have the authority to grant degrees. The Association did not persist as long as Miss Ticknor's Society.

The inclusion of correspondence instruction departments in the extension divisions of universities soon followed. "In keeping with the trend in universities during this period, on July 14, 1891, the Regents of the University of Wisconsin approved a faculty resolution for the development of university extension correspondence study courses."[9] Independent study at the University of Wisconsin, after eighty years, is still a very vital part of the University Extension. In 1892 William R. Harper became president of the newly founded University of Chicago.[10] Harper, considered by many as the father of correspondence instruction, had experimented with the method since 1881 and, therefore, made provisions for the inclusion of correspondence instruction at Chicago. The University of Chicago, however, discontinued its independent study program in 1964.

The founder of the first private home study school was

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[8]Ibid., p. 14.

[9]Roger W. Axford, "W.H. Lighty--Fountain of Idealism," in Charles A. Wedemeyer, ed., The Brandenburg Memorial Essays on Correspondence Instruction--I (Madison: University of Wisconsin, University Extension, 1963), p. 57.

[10]Mackenzie, Christensen, and Rigby, Correspondence Instruction, pp. 27-29.

Thomas J. Foster.[11] He was not an educator but a newspaper editor and publisher in Pennsylvania. As early as 1870 Foster began publishing articles on mine safety, hoping to help reduce mining accidents by combatting ignorance. In 1886 questions and answers were included in the articles dealing with the state required examinations for mine foremen. By 1891 Foster's company was marketing a short correspondence course on coal mining which was the beginning of the International Correspondence School. Today the school enrolls approximately 150,000 students annually worldwide. The American School, which currently is also one of the largest home study schools, was chartered in 1897 and subsequently numerous other private technical schools entered the field.[12]

Undue damage has and is being done to legitimate private correspondence schools by fraudulent schools or "degree mills." To an extent, this also has a negative effect on the programs offered by the universities and colleges.

In 1926 John S. Noffsinger[13] conducted an extensive study of the private correspondence industry. His findings and efforts lead to the establishment of the National Home Study Council (NHSC), a voluntary association of private home study schools. From its inception, the NHSC has helped the Federal Trade Commission and

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[11]"The Workingman's School," in Mackenzie and Christensen, The Changing World of Correspondence Study, pp. 31-34.

[12]Herold C. Hunt, "Home Study--Retrospect and Prospect," The Home Study Review, Summer, 1966, p. 5.

[13]Correspondence Schools, Lyceums, Chautauquas (New York: The Macmillan Company, 1926).

other agencies to close disreputable schools. The Accrediting Commission of the NHSC was approved by the Office of Education in 1959,[14] becoming the only agency authorized to accredit private home study schools.

There are numerous "degree mills" active even today and more concerted regulative effort is needed on the part of state and federal governments. It was estimated in 1968 that close to one thousand private correspondence schools were in operation.[15] As late as 1971 only one hundred and fifty-six of these schools had been accredited by the NHSC.[16]

There are many sources for correspondence education. As indicated in Chapter I, at least five million students are currently enrolled in correspondence study programs. Of this number, 2.2 million are studying courses offered by the armed forces and federal agencies, 1.8 million participate in private home study courses, 313,000 are enrolled in university and college offered independent study programs, and the remainder are active in courses made available by business and religious organizations.[17]

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[14]Hunt, "Home Study--Retrospect and Prospect," p. 6.

[15]Mackenzie, Christensen, and Rigby, Correspondence Instruction, p. 116.

[16]Directory of Accredited Private Home Study Schools (Washington, D.C.: Accrediting Commission of the National Home Study Council, 1971).

[17]"News You Can Use," U.S. News and World Report, August 30, 1971, p. 72.

The System and its Effectiveness

Basic Functions

Correspondence study is a system of instruction. It must be emphasized again that a system is designed and applied in accordance with pre-defined objectives. The goals of correspondence education are the same as those of resident or classroom instruction. That is, in correspondence study programs the basic system is different but the mission is the same.

Correspondence instruction is based on sound and accepted teaching-learning principles which are applicable to any method of education.[18] First, learning is an active process and, therefore, most effective if the student desires to participate in a given program. Further, learning is progressive and advances from the simple to the complex using as a guide the student's level of development. Finally, for best results, learning should be frequently reinforced through application and feedback.[19]

The interactive components of a correspondence instruction system consist of written course materials and supplements divided into a series of lessons or volumes, a given number of exercises for every lesson, an effective feedback loop between the students and the instructing institution for progress evaluation and guidance, a final examination covering the entire course, and an

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[18]C.A. Wedemeyer and G.B. Childs, New Perspectives in Correspondence Study (Chicago: Center for the Study of Liberal Education for Adults, 1961), p. 7.

[19]Owen G. Birtwistle, "ECI: Escalator to Advancement," in Mackenzie and Christensen, The Changing World of Correspondence Study, p. 63.

administrative network for the efficient coordination of all activities. It must be emphasized that an important part of the course materials package used is the study guide or syllabus. Drs. Wedemeyer and Childs explain:

> The syllabus sets forth the objectives of the course and of its subdivisions, provides for over-all organization, directs the students to sources of information, indicates reading to be done and activities to be carried out so that the purposes may be achieved, provides information supplementary to that to be secured from other courses, explains difficult concepts, introduces new ideas, and indicates reports and other evidences of achievement which are to be submitted to the correspondence study department.20

Two key words concerning the operation of the correspondence study system are interaction and feedback. The interaction of the system's components is directly related to the principles of learning. The course materials are divided into short "digestible" volumes or lessons. The establishment of short, visibly attainable goals is a motivational factor in keeping a student active in a course. In this manner, an individual also advances from the simple to the complex in manageable steps.

Reinforcement is accomplished by both the student and the institution involved. In many instances the student is asked to complete self-evaluation exercises at the conclusion of a section or chapter with the proper responses provided by the materials supplied. This procedure provides immediate reinforcement to a student concerning his progress and accomplishment. In addition, at

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[20]Wedemeyer and Childs, New Perspectives, p. 8.

the end of each lesson the student is required to submit lesson review exercises to the participating school. Through this arrangement a student not only receives further reinforcement, but also appropriate direction and guidance when needed. At the end of a course the final examination serves both as a means of further reinforcement and as a measure of the degree to which course objectives were attained.

The concept of feedback in the correspondence systems environment is extremely important, as is the case with any controlled dynamic system. It is vital, since the teaching and learning aspects of instruction have been physically separated. New information technology is not bound to any noticeable degree by time and distance, therefore, it can be effectively applied to attain designated feedback levels.

The emphasis on feedback should not imply that the correspondence study system is inherently degraded by this factor. On the contrary, an effective and efficient systems design offers the student and the teacher greater flexibility and responsiveness than conventional methods. The student can distribute his time and effort on the course in a more optimum manner. The teacher, on the other hand, is allowed to devote his energies more efficiently towards the preparation of course materials and more extensive tutorial services to individual students who truly require his personal attention.

Advantages

Most authors include economy, flexibility, and system's

effectiveness in the discussion of the advantages of independent study. Mackenzie, Christensen, and Rigby, however, also emphasize psychological soundness.[21]

From an economical perspective correspondence instruction makes possible more efficient use of physical facilities and teachers. It has been estimated, for example, that a college needs a minimum of a hundred and thirty square feet of space per student.[22] Home study, on the other hand, must allocate only enough space to allow for the proper maintenance of student files. More specifically, students records may be stored in filing cabinets or on computer tape or disk files.

Low overhead costs and initial costs allow more funds to be devoted towards operating expenses. That is, more money can be allocated for staff salaries and educational materials, increasing the quality and efficiency of instruction and counseling. It must be made clear that high quality correspondence systems may be more expensive than comparable conventional methods.[23] Such systems, however, can reach a considerably larger audience than equivalent residence systems. Unfortunately, many resident educators still look down upon independent study and, therefore, the system

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[21]Correspondence Instruction, pp. 150-52.

[22]"The Masters," The New Yorker, September 14, 1963, p. 36.

[23]Mackenzie, Christensen, and Rigby, Correspondence Instruction, p. 147.

has not received the backing that it deserves and needs.[24]

The flexibility of home study stems from the fact that the system is individualized in considering the level of a course, the place and time a course is being offered, and the pace an individual must maintain in completing a course. Independent study can:

> . . . be adjusted to any level of ability or background, can present a practically unlimited variety of subject matter, and permits study at any hour or at any place. In addition, it can operate at any educational level from elementary school to graduate college, can be school-related or independent of institutional education, can be completed quickly or extended over a period of time, and can be used alone or in groups of any size. No other educational procedure yet devised begins to approach this degree of flexibility.25

From a practical business point of view correspondence instruction is flexible in that it can accommodate personnel of varied technical backgrounds, it is not hampered by transfers or location changes, and it does not require valuable time to be wasted in waiting for a new term or semester to begin.[26]

Numerous studies have been conducted comparing the effectiveness of correspondence instruction to conventional teaching methods. Such research in general has indicated that home study is as effective, and in some instances more effective, than class-

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[24]Robert Allen, "Must Home Study be a Stepchild of Education?," in Mackenzie and Christensen, The Changing World, pp. 85-89.

[25]Wedemeyer and Childs, New Perspectives, pp. 15-16.

[26]Sterling D. Huggens, "Correspondence Training in Science and Technology for Industry," The Home Study Review, Winter, 1964, pp. 27-28.

room instruction. Bittner and Mallory,[27] as early as 1933, cited studies showing the success of college students taking courses by correspondence. In 1960 and 1965 Dr. Childs[28] reported the soundness of independent study in comparison to classroom instruction based on several extensive studies involving high school and college students. Dr. John L. Davies has concluded:

> We must point out again that the idea of correspondence study is sound. Millions of eager youth and adults have been turning to correspondence study. The military services, industry, and commercial enterprises have adopted and improved this kind of teaching--learning for their particular purposes and needs. Correspondence study programs have grown at about the same rate as other forms of university instruction in spite of the handicaps and restraints that have kept correspondence study chained to conditions and attitudes characteristic of university policy of the 1920's.29

Psychological soundness is an inherent advantage of the correspondence instruction system. Certain individuals possess great fear of embarrassment or failure associated with the classroom environment. Some students fearing to make a mistake or of being criticized will avoid class participation and, therefore, fail to receive adequate feedback. This problem is especially

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[27]W.S. Bittner and H.F. Mallory, University Teaching by Mail (New York: The Macmillan Company, 1933), pp. 131-66.

[28]Gayle B. Childs, "Supervised Correspondence Instruction," in Charles A. Wedemeyer, ed., The Brandenburg Memorial Essays on Correspondence Instruction--I (Madison: The University of Wisconsin Extension Division, 1963), pp. 22-33, and "Review of Research in Correspondence Study," in Charles A. Wedemeyer, ed., The Brandenburg Memorial Essays on Correspondence Instruction--II (Madison: The University of Wisconsin Extension Division, 1966), pp. 126-40.

[29]John L. Davies, "The Demands of the Decade," in Wedemeyer, Memorial Essays--I, p. 19.

acute among adults, affecting participation in programs of continuing education. Such fears are almost completely avoided by correspondence instruction. In addition, dropouts may attain the required educational levels and regain confidence in their abilities through independent study.

Disadvantages

The disadvantages associated with independent study are not exclusively related to home study alone and often also appear with other methods of instruction. Dr. Wedemeyer[30] has emphasized five main problems related to correspondence study. They include:

1. Developing interest in the task
2. Sensing readiness to learn
3. Grasping the structure of the subject matter
4. Learning both analytical and inductive thinking
5. Proper evaluation of progress.

In the correspondence system a student seldom has the opportunity to be personally counseled and motivated by an instructor or teacher. The interest to select a task and bring it to a successful conclusion must come mostly from within the individual. For this reason students who do well in home study programs usually have little difficulty with subjects offered in the classroom environment.

The problem of sensing readiness for learning is equally

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[30]Charles A. Wedemeyer, "Problems in Learning by Correspondence," in Wedemeyer, Memorial Essays--I, pp. 46-54.

applicable to the lecture method of instruction as it is to correspondence study. Students are assumed to be ready after they have enrolled in a course. This is not necessarily true even when the records of the enrollees have been carefully screened.

Grasping the structure of the subject to be learned means that an individual is able to visualize the synergy of all its minute elements. If a correspondence study program limits a student's learning activities to reading alone, it may handicap the learner in finding structure in the given subject. "To perceive structure, demonstrations, lab-type experiences, seeing things, hearing things, doing things--as well as reading about things--are needed."[31]

Students enrolled in correspondence study programs may be at a disadvantage in learning intuitive thinking. When a student receives one lesson at a time and when the syllabus is very inflexible, he may have great difficulty in seeing the subject as a whole.

Finally, it is important that an individual is able to assess his progress through a course. This is accomplished by frequent reference points. A correspondence student is required to submit lesson exercises throughout the course and, therefore, is usually evaluated more often than the classroom student. Such a sense of progressive achievement is, however, misleading if the sources are limited or if the course is old and out of date.

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[31] Ibid., p. 51.

The major study conducted by Mackenzie, Christensen, and Rigby[32] also stresses five deficiencies of correspondence instruction which are:

1. Distance between student and institution
2. Subject matter and student limitations
3. Emphasis on the written word
4. Inaccessibility of special facilities
5. Insufficient support for the method.

The problem of working at a distance is directly related to the speed of feedback. The student is required to wait for his completed lessons or volumes to be delivered, evaluated, and returned which consequently delays feedback. The benefits associated with interaction among students are definitely curtailed. Counseling and guidance difficulties are also to a degree related to distance. This, however, does not appear to be a major problem since only about seventeen per cent of correspondence students turn to the study center for help when they encounter difficulties.[33]

Not all subjects can be taught by correspondence study alone. An engineer must learn to put theory into practice, a future surgeon must participate in surgery, and a student pilot must fly an aircraft in order to attain acceptable performance levels. Further, students who lack the ability to follow simple

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[32]Mackenzie, Christensen, and Rigby, Correspondence Instruction, pp. 160-73.

[33]Gayle B. Childs, "Recent Research Developments in Correspondence Instruction," in Mackenzie and Christensen, The Changing World, p. 230.

directions and who have little self-motivation cannot be expected to complete home study courses successfully. Much of this problem, of course, is related to the emphasis of printed materials and the rigidity of the study guide. The inaccessibility of special facilities, such as libraries and laboratories, to many correspondence students also reduces the effectiveness of the independent study method of learning.

Correspondence instruction is also at a disadvantage since it lacks the proper support of the academic community, even though little evidence is available as to which methods are the best. As a result, resources allotted for independent study have not been equal in relation to other methods of instruction. Good products necessitate proper financial backing. Most problems associated with correspondence instruction systems could be overcome with equitable allocation of funds for systems research, design, and operation.

Innovations

Dr. George E. Arnstein[34] has skillfully pointed out that in the past the United States has mobilized its resources unevenly. Such imbalanced efforts and planning have created problems of abundance in certain areas and deficiencies in other spheres. As an example, enormous investments on research and development in physical sciences by the Federal Government, especially since 1957, have given this country substantial leads in many fields of science

[34]George E. Arnstein, "The Mixed Blessings of Automation," The Home Study Review, Winter, 1964-1965, pp. 4-9.

and technology. These feats, however, have in part been accomplished without due consideration for the social and cultural aspects of the nation. The inequitable emphasis of social sciences, to a degree, is responsible for the negative implications of automation. One crucial aspect which rapid technological advancement has created is the unavoidable requirement of continuing education as a means of economic survival.

Hopefully the "mobilization" of resources in the development of instructional systems and media will be accomplished evenly. It is imperative that new information technology be fully utilized in the advancement of teaching-learning systems and that the design and implementation of the new systems be based on the total systems concept.

Many educators still mistrust and resist the incorporation of advanced technology into the pedagogical domain due to the deficiencies of some previous applications. A general assumption has evolved that there is an inverse correlation between technology and personalized instruction.[35] On the contrary, as stated before, properly designed computer-assisted multi-media independent study systems can be more flexible and responsive to individual demands and necessities. Consequently, every correspondence school and department should periodically self-evaluate the effectiveness and efficiency of its system. The value of such systematic process of

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[35]Alvin C. Eurich, "The Commitment to Experiment and Innovate in College Teaching," The Home Study Review, Spring, 1964, p. 8.

self-evaluation has already been verified by Brigham Young University.[36] It must be reminded that no institution "can wait until the demands of the age are clarified and then in one bold stroke revamp itself to fit those demands. Only through steady, evolving adjustment can a great institution fit itself for another day."[37]

New Media

The inclusion of multi-media concepts in the study requires a brief overview of the types of media which are available or are being used by both private and public correspondence schools. The summary will cover audio, projected, and broadcast media and training kits.[38] Programmed instruction and computer-assisted instruction will also be included.

Audio Media. The incorporation of audio media into home study systems has been more extensive than that of any other technical media. This can be attributed mostly to the development of the cassette tape recorder, making recording more practical and economical. The 33 1/3 RPM and the 16 RPM phonograph records are also being used by some schools. In addition, experiments with compressed speech have been impressive and may have the potential

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[36]Harold G. Clark, "A Self-Evaluation Study of the Correspondence Method," in Wedemeyer, Memorial Essays--II, pp. 120-25.

[37]Davies, "The Demands of the Decade," p. 17.

[38]Most of the information on these items has been extracted from Henry Q. Wellman, "Educational Technology: The Advantages and Problems," NHSC News, February, 1969, Supplement, no pagination.

for wider applications comparable to speed reading.

Projected Media. Projected media have gained acceptance in correspondence programs and their use is anticipated to increase vastly in the future. "The development of less expensive projectors and the availability of films, filmstrips, and slides have helped make projected media practical for home study. Also, the Technicolor 8 mm film cartridge has reduced shipping problems usually connected with the use of films."[39] Some schools are experimenting with video tape, however, currently its cost is generally still prohibitive. Some universities are also employing microfiche and as more libraries install microfiche readers its use should increase.

Broadcast Media. Limited use has been made of FM and closed-circuit television and educational television but rarely has correspondence instruction been used with these media, especially in the United States.

International Correspondence Schools has developed a unique system called "Educasting."[40] Educasting uses FM radio and television to send audio-visual instruction to students either at home or any other desired location. The FM receiver unit has four response buttons for multiple-choice questions which can be used in conjunction with the audio-visual lecture or demonstration.

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[39] Ibid., no pagination.

[40] John C. Villaume, "Integration of New Media and New Methods into Correspondence Education," The Home Study Review, Fall, 1965, pp. 11-12.

When one of the switches is depressed in response to a question the student is immediately informed whether the selection was correct or incorrect. A brief review of the subject matter is also included with the instant feedback for both incorrect and correct responses. Thus, Educasting provides immediate reinforcement to a student concerning his progress and accomplishment independent of other participants.

Training Kits. Training kits are being used extensively with home study instruction. The type and extent of the training aids provided depend on the course objectives. Some of the materials included are color television kits, cameras, broken typewriters, locksmith equipment, and gems. Institutions whose courses do not permit the use of teaching aids generally rely on extensive use of graphics, software, and periodic resident training.

Programmed Instruction. Programmed instruction has exerted considerable influence on independent study systems. This does not mean that correspondence institutions are using or are planning to use programmed instruction exclusively. On the other hand, well designed correspondence courses are inherently related to certain aspects of programmed instruction.

Basically there are two types of programmed instruction depending on the kind of response required of the student: the constructed-response type and the multiple-choice type.[41] The

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[41]Edward B. Fry, Teaching Machines and Programmed Instruction (New York: McGraw-Hill Book Company, Inc., 1963), pp. 3-6.

former requires the student to construct his own answer and is dependent upon the individual's ability to recall data. The latter is dependent on the student's ability to recognize data and asks for a choice among several answers. The constructed-response type requires the use of the linear programming or subject matter sequencing technique. Multiple choice programs, however, allow the use of the branching technique where the actual route through the material is determined by the responses selected. With the latter technique, a student who selects an incorrect answer can be forced into a remedial or review sequence before he is allowed to advance further in a program.

The primary elements of programmed instruction which are exerting major influences on independent study methods are:

1. The requirement to specify course objectives
2. The division of a subject into small steps
3. The provision for frequent student responses and immediate feedback
4. The demand for trial and revision.[42]

The establishment of course objectives or desired terminal behavior allows course writers to approach their tasks in a more meaningful and realistic manner.

The division of a course into small manageable sections permits the student to measure his progress in the subject more precisely. At the same time, it requires the course authors to write clear and complete explanations. The steps in a course, how-

[42]James R. Rechs, "What Correspondence Schools are Learning from programmed Instruction," The Home Study Review, Winter, 1966, pp. 5-10.

ever, must not be so small as to make the student's tasks seem dull and unchallenging. Therefore, programmed instruction is best applied in conjunction with standard textural materials. In this manner, the fundamental concepts are acquired by extensive reading and then reinforced by programmed instruction techniques.

The provision for active participation and immediate feedback reinforces learning. Consequently, correspondence schools are incorporating more self-evaluation exercises into their course materials. It must be stressed, however, that the effectiveness of these techniques is directly related to the challenges that they pose to the student.

Finally, programmed instruction demands testing of new materials and constant monitoring of existing programs. The underlying principle of this requirement is that if a course does not produce the terminal behavior desired, the specific program utilized is at fault and not the student. Such a doctrine is obviously as applicable to correspondence study as it is to programmed instruction.

Computer-Assisted Instruction. Computer-assisted or aided instruction (CAI) is based on the same concepts as programmed instruction. The CAI method of instruction, however, takes advantage of the capabilities of the electronic computer to accept, store, process, and selectively disseminate alphanumeric data. In essence, the fusion of programmed instruction methodology with the speed and flexibility of computer software and hardware has produced a dynamic tutorial system. CAI possesses the capability to

provide:

1. Self-pacing

2. Dynamic man-computer problem solving

3. Sequencing of student-computer interaction based on previous responses and personal history

4. Immediate diagnosis of individual skills and weaknesses frequently neglected by live instructors

5. Normal and remedial or review sequencing of instruction

6. Continuous real-time access to individual and group statistical data.[43]

Although several studies have indicated that students respond more favorably to CAI than to conventional classroom instruction, it must be cautioned that the software development and maintenance costs for such a system may be prohibitive.[44] The cost factor could be especially critical for CAI systems serving relatively small student bodies.

Summary

This chapter has summarized the history of correspondence education in the United States, the advantages and disadvantages of the method of instruction, and some of the innovations which have or can be adapted by the home study schools. In essence, the emphasis has been on signifying whether or not independent study warrants increased attention and general support.

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[43]John Caffrey and Charles J. Mosmann, Computers on Campus (Washington: American Council on Education, 1967), p. 166.

[44]Harold Sackman, Man-Computer Problem Solving (New York: Auerbach Publishers, Inc., 1970), pp. 12-13.

It has been demonstrated that the initial impetus for correspondence study came from the country's massive demand for education and training caused primarily by the continuous westward expansion and the Industrial Revolution. In a similar manner, today's increasing population, "information explosion," and rapid technological changes are placing severe strains on the conventional education systems. The trend is towards more continuing education instead of extended education.

The advantages of the correspondence study method of instruction include economy, flexibility, effectiveness, and psychological soundness. Low overhead costs and initial costs allow more funds to be devoted towards operating expenses. The flexibility of home study stems from the fact that the system is individualized in considering the level of the course, the place and time a subject is being offered, and the pace a student must maintain in completing a course. Numerous studies have in general indicated that correspondence instruction is as effective, and in some instances more effective, than conventional teaching methods. Finally, certain individuals possess great fear of embarrassment or failure associated with the classroom environment. Such fears are almost completely avoided by correspondence instruction.

The disadvantages associated with independent study also often appear with other methods of instruction. Certain subjects, of course, such as surgery or flying, cannot be taught completely by home study. However, most problems associated with correspondence education could be overcome with equitable allocation of funds

and general support for the system of instruction.

Although various innovations have been incorporated by home study institutions, many educators still mistrust and resist advanced technological concepts. A general assumption has evolved that there is an inverse relationship between technology and personalized instruction. On the contrary, properly designed computer-based systems may more effectively bridge the time and distance gap between the teacher and the student.

It must be concluded that correspondence instruction, indeed, warrants greater attention and general support. More intensified research and equitable fund allocations could make computer-based home study systems the bases of elaborate and responsive multi-media instruction systems.

CHAPTER III

DEVELOPMENT OF MANAGEMENT INFORMATION SYSTEMS

As stated earlier, this study is partially designed to extend general systems theory and advanced information technology in the field of correspondence education. Appropriately, the next chapter will be devoted to the review of general systems theory and computer-based information systems. The purpose of the chapter is to establish a basic theoretical and technical background for the development of the alternative proposed general computer-based correspondence instruction systems designs later in the study.

Dr. Otto Peters[1] has theorized that correspondence study is the most industrialized method of instruction and, therefore, is in many ways closely related and dependent on the current industrialized society. In this light the classroom method of teaching remains as one of the last refuges of the pre-Industrial Revolution artisan professions. Instead of incorporating classroom instruction techniques into home study programs, it would be more

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[1]Otto Peters, "Theoretical Aspects of Correspondence Instruction," in Mackenzie and Christensen, ed., The Changing World of Correspondence Study (University Park, Pennsylvania: The Pennsylvania State University Press, 1971), p. 142.

reasonable to borrow concepts from other mass media such as newspapers, radio, and television. More precisely, the methodology of mass instruction or independent study, according to Dr. Peters, should be based more on the theoretical criteria of industrial management than those of traditional instruction. Consequently, such criteria as the division of labor, mechanization, automation, mass production, scientific control, and the application of organizational principles should be used to comprehend and develop the process of correspondence instruction.[2]

It is important that individuals responsible for administering home study programs be more objective in analyzing the theoretical and technological foundations of their systems. Normative values play major roles in the establishment of organizational goals. The progression towards such normative goals, however, should be accomplished on the basis of sound scientific research and analysis.

General Systems Theory

The Need for Systems Theory

Knowledge in the twentieth century has been expanding at a rapid and accelerated rate. The "knowledge explosion" has forced the various scientific disciplines to become highly specialized and has produced very complex societies. In turn, the increasing complexities of science and societies have created the need for a general framework for the comprehension, analysis, and synthesis

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[2] Ibid., pp. 225-26.

of the multi-dimensional relationships. The requirement for a comprehensive theory was recognized as early as 1810 by the famous German poet and scholar Goethe when he remarked:

> The modern age has a false sense of superiority because of the great mass of data at its disposal. But the valid criterion of distinction is rather the extent to which man knows how to form and master the material at his command.3

General systems theory has been the only concept to date in providing a means for inter- and intra-disciplinary integration of information for macro analysis.

What is a system? Webster's defines it as "a set or arrangement of things so related or connected as to form a unity or organic whole." Specifically, a system is an assemblage of related phenomenon with detectable patterns in a set of relationships and a purpose which is served by the arrangement.[4] General systems theory is based on concepts which can be applied to all forms of organic, inorganic and social systems in determining and describing their operation and environmental interactions.

Classification and Characteristics of Systems

The systems concept was applied to technological development from about 1930 to 1950; from 1950 to 1965 it was extensively utilized in technological research, and since 1966 it has received

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[3]Herbert E. Klein, "Information Explosion in the Factory," Dun's Review and Modern Industry, March, 1965, p. 112.

[4]Stafford Beer, Decision and Control. The Meaning of Operational Research and Management Cybernetics (New York: John Wiley and Sons, 1966), p. 242.

increasing attention in the area of socio-economic research and development.[5]

Most authors credit Ludwig von Bertalanffy for the name and basic ideas of general systems theory. He was one of the first to apply the systems concept to the analysis of living organisms.[6]

Von Bertalanffy has classified systems into closed and open systems.[7] A closed system is one which does not have energy (including information) entering or leaving it. On the other hand, an open system has consistent interaction with its environment. The interactions which affect the system are technically referred to as inputs and those affected by the system are called outputs.[8]

All living organisms are classified as open system. Physical and mechanical systems, which have no relationship with their environment, are considered closed. With man's ability to break down certain atomic structures it is questionable whether truly closed systems exist outside the theoretical realm.[9] Social

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[5]C.J. Dorrenbacher, Evolution of the Systems Approach (Santa Monica, California: Douglas Aircraft Company, Inc., 1966).

[6]Ludwig von Bertalanffy, "The Theory of Open Systems in Physics and Biology," Science, January 13, 1950, Vol. III, pp. 23-28.

[7]Ibid., p. 23.

[8]Beer, Decision and Control, p. 273.

[9]Glenn Gilman, "The Manager and the Systems Concept," Business Horizons, August, 1969, p. 20.

systems are termed open systems. Man-made technical systems such as automated production systems and computerized information systems must also be defined as open systems since they have inputs, outputs, and self-regulating subsystems for control.

Open and closed systems possess certain general characteristics. The conformity of these general principles to all types of interactions between systems components is the basis for general systems theory.

In accordance with the second law of thermodynamics, a closed system must eventually reach an equilibrium state with maximum entropy and minimum capability for energy transfer.[10] Entropy is the inherent tendency of any closed system to become disorganized and attain complete stability and to all intents and purposes can, therefore, be considered dead.[11] This is logical since a closed system is not capable of interacting with its environment in order to remain viable.

An open system, on the other hand, may attain a steady state or dynamic equilibrium by continuously absorbing energy from outside the system and affecting its environment by discharging energy. In order to maintain dynamic equilibrium a system must be adaptive and self-regulating. This is achieved through cybernetics or feedback and homeostasis.[12] Cybernetics is the science of com-

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[10]von Bertalanffy, "The Theory of Open Systems, " p. 23.

[11]Robert C. Weisselberg and Joseph G. Cowley, The Executive Strategist (New York: McGraw-Hill Book Company, Inc., 1969), pp. 206-7.

[12]Ibid., p. 207.

munication and control. Viable systems must possess proper affectors and feedback loops connected to a central information processing center in order to maintain effective interaction with the systems environment.[13] In addition, feedback mechanisms must coordinate and balance the actions of all the subsystems of the total system to attain an internal steady state. The achievement of internal balance, especially in living organisms, is called homeostasis.[14]

The concept of equifinality also differentiates closed systems from open systems.[15] The final state of most closed systems is determined by initial conditions. Open systems, however, can attain a steady state independent of initial conditions and are, therefore, equifinal.

Organization of General Systems Theory

Kenneth E. Boulding has contributed to the development of general systems theory in presenting two complementary approaches to the organization of the theory.[16] The first approach would select certain common interdisciplinary phenomena and formulate

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[13]Norbert Wiener, Cybernetics or Control and Communication in the Animal and Machine (Cambridge, Massachusetts: The M.I.T. Press, 1948), p. 96.

[14]Fremont E. Kast and James E. Rosenzweig, Organization and Management: A Systems Approach (New York: McGraw-Hill Book Company, 1970), p. 125.

[15]von Bertalanffy, "The Theory of Open Systems," p. 25.

[16]Kenneth E. Boulding, "General Systems Theory--The Skeleton of Science," Management Science, April, 1956, pp. 197-208.

theoretical models applicable to these phenomena. The selection would include such general phenomena as population, interaction of individuals (man, electron, etc.) with their environment, growth, and information and communication.

Boulding's second approach suggests the arrangement of theoretical systems into a hierarchy of nine levels denoted by degrees of complexity. The levels are as follows:

1. The level of framework or static structure
2. The level of clockwork or simple dynamic system
3. The cybernetic system or the level of the thermostat
4. The level of the open or self-maintaining system (The level at which life begins)
5. The plant or genetic-sociated level
6. The animal system level signified by degrees of mobility, purposive behavior, and self-awareness
7. The human level or a system with self-awareness and the capacity to use symbolism and language
8. The system of human organization or the social system level which incorporates content and meaning of messages, value systems, transcription of images into records, art, and human emotion
9. The ultimates, absolutes, and unknowables or the transcendental systems level.

The hierarchical arrangement of general systems is helpful in giving an indication how far knowledge has progressed. There are gaps in empirical knowledge almost at all levels and acceptable theoretical models extend barely beyond the fourth level.[17]

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[17] Ibid., p. 205.

Application to Socio-Technical Systems

The introduction of the general systems theory to socio-technical systems has produced an integrative effect or trend.[18] In the past an organization was depicted as a structure by the classical management school, the scientific management school viewed it as primarily a process, and the human relations school saw it as an agency for human interrelationships. When the systems concept is used to analyze the activities of an organization all three philosophies are incorporated into the framework. When the organization is viewed as an open system, it becomes apparent that energy is consumed to manipulate the selected process, to maintain the structure, and to solicit and maintain members who identify themselves with the organization as a desirable or necessary agency. Further, a socio-technical system should not only be considered an open system but as an extended open system. This concept does not only include the central agency but also its clients, sponsors, and other individuals or groups with which it must maintain continuing interaction.

It must be remembered, however, that when the energy flows and interrelationships of a system are being selected for analysis, there must be a limit as to what should or can be included in the study. There are three primary reasons why all components of an open system cannot be included in a conceptual system model. First, an open system is constantly interacting with its environ-

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[18]The subject matter of this paragraph is based on Gileman, "The Manager and the Systems Concept," pp. 19-28.

ment in order to maintain dynamic equilibrium. That is, the system is constantly changing. Second, it is physically impossible to include and handle all the elements of an infinite set of relationships and interactions. Lastly, the conception of a system by man is a personal and subjective process. Individuals view systems from their own perspectives and they do not necessarily agree on what they see.

In the final analysis, however, the systems approach is currently the most realistic and appropriate tool for the study of complex socio-technological relationships. It demands the selection and bounding of all relevant elements and interrelationships of an infinite set under consideration, including the criteria for its evaluation.[19]

Application to Correspondence Instruction

It appears appropriate that general systems theory principles receive full consideration in the analysis and design of correspondence instruction systems. The assumption is made that an effective and efficient organization should be formulated to achieve an integrated systems configuration.

Independent study systems can be viewed as excellent examples of open and extended systems. As such, they offer relatively ideal areas for the advancement and application of general systems theory concepts. In addition, the energy or information inputs, processing, outputs and feedback loops of home study systems appear

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[19]Dorrenbacher, "Evolution of the Systems Approach," p. 2.

to be more easily accessible and definable than in other socio-technical organizations. This makes the study of correspondence education systems even more attractive. Advanced home study systems could serve as the bases for the development of large sophisticated multi-media instruction systems. "The learning systems concept may. . .bring about a much greater use of correspondence instruction than ever before, even in conventional schools and at all levels of instruction including the graduate school."[20]

It may be concluded then, that general systems theory offers the distinct advantages of a conceptual framework which demands empirical research and the synthesis of multi-dimensional relationships, especially when dealing with independent study institutions.

Management Information Systems

An effective and efficient information system is a vital tool for the successful management of any socio-technical system. As indicated previously, an extended open system must maintain dynamic equilibrium with its environment to survive. This is accomplished by means of an interrelated cybernetic communications and control network. The basic ingredient of cybernetic feedback loops is information. The primary task of management, therefore,

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[20]Charles A. Wedemeyer, "World Trends in Correspondence Education," in Charles A. Wedemeyer, ed., The Brandenburg Memorial Essays on Correspondence Instruction--II, The University of Wisconsin, University Extension, 1966, p. 13.

is that of designing a cybernetic information network which incorporates not only the interactions of the subsystems of the central agency, but also the extended interrelationships of the organization within its environment.

Basically a management information system is a systematic method for gathering, storing, processing, and disseminating pertinent data necessary for the maintenance of organizational viability.[21] It is an interrelated system composed of people, hardware, software, and procedures designed to provide needed information to all administrative and operational levels. Not only must the system provide the required information to all levels of management, but it must also be accurate, timely, relevant, presented in a usable format, and supplied in optimum quantities. The desired information must be made available early enough to prevent deviations from the norm and to permit adequate decisions to be made after the receipt of the new data.[22]

It is apparent, therefore, that an effective and efficient management information systems design be based on the principles of general systems theory. Further, for optimum timeliness, accuracy, and responsiveness a system's cybernetic network should employ the vast capabilities of computer systems. On this basis, sophisticated independent study management information systems can

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[21]Andrew Muir, "Company Control Systems," Computers and Automation, February, 1970, p. 26.

[22]Scott Nicholson, "The Crisis in Controls," Dun's Review and Modern Industry, July, 1963, p. 61.

be developed with complex feedback channels capable of directing and motivating students and evaluating their progress in the courses offered. Such systems could independently accommodate hundreds of thousands of active students without becoming overloaded and less responsive.

Before the discussion of desirable systems characteristics and design considerations, it will be helpful to first briefly review some of the pertinent advancements and capabilities of computer hardware and software.

Computer Systems

Hardware.[23] The meaning of automatic data processing (ADP) and electronic data processing (EDP) are not synonymous, although they are related. ADP encompasses both electronic digital computers and electromechanical devices. Electrical accounting machines (EAM) (also known as tabulating equipment and unit record devices) function electromechanically by using optical photo-cells or sensing brushes to detect the absence or presence of punches in cards and by applying mechanical devices to punch holes into cards. Depending on the available tabulating equipment, punched cards can be used as direct input to these machines to perform such operations as punching, sorting, minor calculations, and printing. Punched card equipment was developed by Herman Hollerith and first

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[23]The review of computer hardware is primarily based on: Jerome Kanter, The Computer and the Executive (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967) and Harry Katzan, Jr., Computer Organization and the System/370 (New York: Van Norstrand Reinhold Company, 1971).

used by the Bureau of Census for the 1890 census. The machines are still widely used today primarily as data conversion and input devices for electronic computer systems.

Electronic data processors or computers convert input data into electronic form (binary digits) within the computer and store and process the data electronically. Output from the system is converted to numerous forms such as cards, printouts or television-like pictures on cathode-ray tubes (CRT). The internal operations of computer systems are performed at the speed of light since there are no mechanical devices involved. For instance, a card reader can only read up to about 1200 cards per minute while an electronic computer can perform over 100,000 additions per second.

A general computer system configuration is depicted schematically by Figure 3.1. The diagram shows most of the components which can be part of a computer system. This does not mean that all EDP systems are composed of the elements displayed by the figure. All computer systems, however, must have four principle parts: input, storage, processing, and output.

Input/output units come in various forms and are used to enter or retrieve data from the EDP system. They can also be used as auxiliary storage, depending on the types of devices available.

The most significant element of the computer is the central processing unit (CPU). The function of the CPU is to control all the operations and execute arithmetic and logical functions. The processing logic of the CPU is performed by five operations: add, subtract, multiply, divide, and compare.

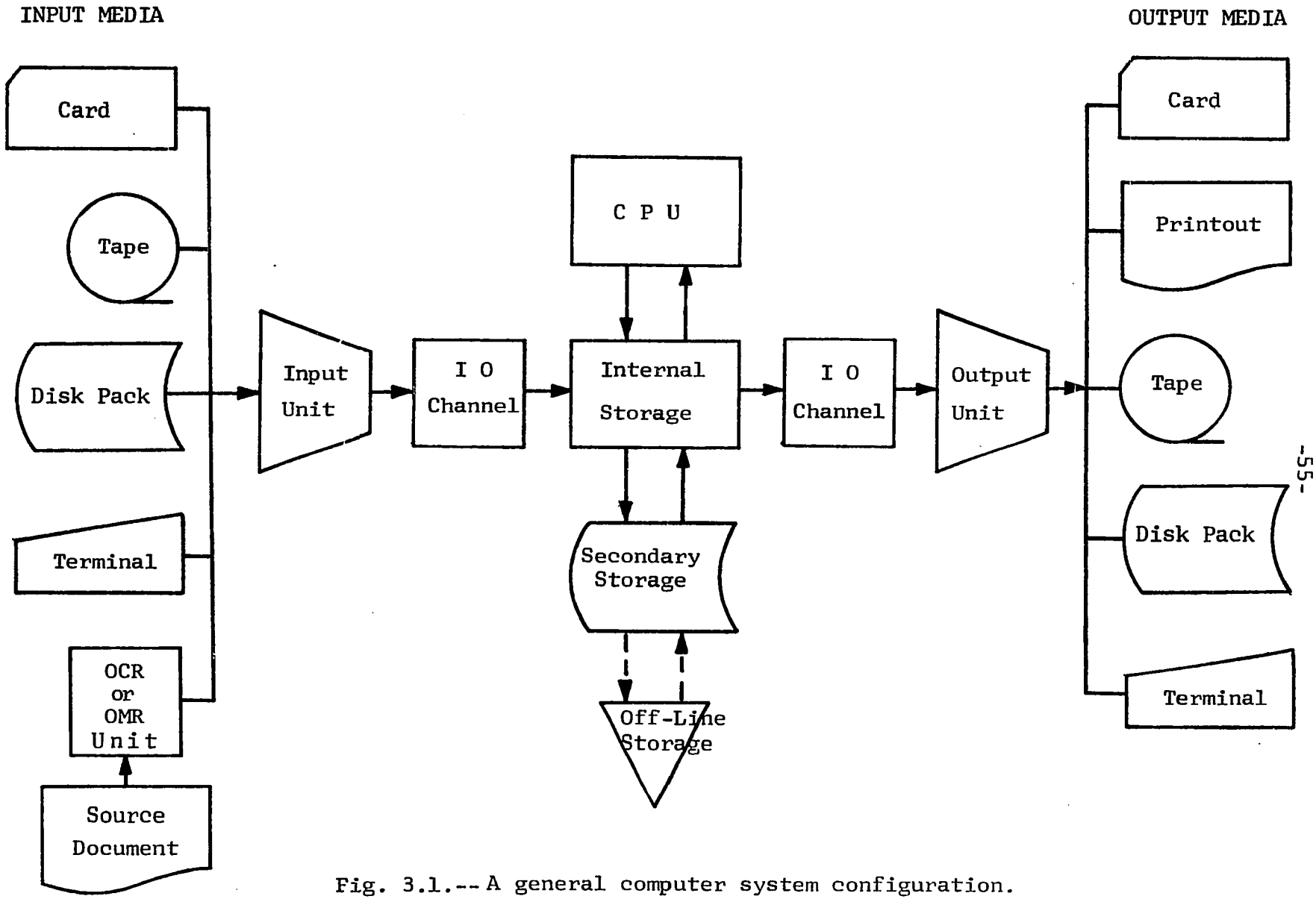

Fig. 3.1.--A general computer system configuration.

Internal storage (also known as core storage) is used to retain program instructions and data to be processed and it is directly addressable by the control unit. The stored program concept has three primary advantages. It allows the CPU access to information at electronic speeds, programs can be changed at any time by input of new instructions, and programs can be designed which can effectively modify themselves allowing for greater system flexibility.

Secondary storage, when available, is used for overflow from main storage and for retention of intermediate results. Offline storage consists of card, tape, or disk files which are physically detached from the active system and retained for subsequent use or as backup files.

The hardware components which are credited mostly for the high performance of today's computers are input/output channels (I O channels). The I O channels control the function of one or more input/output devices. They have direct access to main storage and are, therefore, capable of transferring data independent of the CPU. This permits the CPU to perform more efficiently by allowing it to continue normal processing without having to stop for slow system degrading input/output operations. The I O channels, because of their diverse task capabilities, are frequently referred to as small hardwire CPU's.

It is commonly accepted that computer hardware has so far progressed through three generations differentiated by unique physical properties. The first generation of computers was developed

in the 1940's and the earliest commercial system was the UNIVAC I which was delivered to the United States Census Bureau in 1951. The UNIVAC I, however, was not generally available until after 1952. The first generation of computers is usually confined to the period from 1954 to 1959.

The principle electronic components of the first generation computer were vacuum tubes. Consequently, the systems were very large, consumed much energy, and produced a great amount of heat. The main storage element was predominately drum and accessible in the millisecond range with approximately a 4000 word capacity. Secondary storage consisted of magnetic tape. The system was characterized by punched card equipment feeding a single computer.

Second generation computers became available in about 1959 and dominated the field until around 1964. This generation of computers uses transistors instead of vacuum tubes. For this reason they are smaller, faster, more reliable and require less maintenance than their predecessors. Internal storage for these systems consists of magnetic core and access time is in the microsecond range. The capacity of main storage is around 32,000 words. Secondary storage consists of magnetic tape and high cost random storage. The characteristics of the systems include on-site data processing and the use of small computers as satellites for large systems.

Transistors and microcircuits are the principle components of third generation data processing systems. Main storage uses

magnetic core, thin film or plated wire, and functions in the nanosecond access time range. The storage capacity of the main storage is 50,000 words or higher and secondary storage consists of high-speed and low cost random access modular units. Such system configurations allow for multi-processing with two or more systems being connected either via main storage or through direct-access storage devices. In addition, on-line real-time processing with remote input/output is extensively facilitated.

Software. Programming or software concepts cannot be assigned to different generations as easily as is the case with hardware developments. Generally, however, first generation software progressed from machine language to assembly language programming. This enabled programmers to use decimal notations and mnemonic operation codes instead of binary digits when writing programs. Programming was further simplified with second generation software by the introduction of compiler systems. Compiler languages, such as COBOL and FORTRAN, allow programmers to write programs in less detail and to use simple but structured English language statements.

Third generation software developments have greatly advanced the operating systems[24] concept. These systems, composed of sophisticated and complex programs, are designed to automatically monitor and control the multiple operations of the fast, flexible, and versatile third generation computers.

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[24]Operating systems are also referred to as executive, supervisory, and monitoring systems.

The operating systems concept dates back to about 1956. Gradually assembly systems evolved into operating systems. The early systems were designed to run the computer continuously as much as possible and requiring the operator to only occasionally mount tapes and respond to simple directions supplied by the on-line printer.[25]

The third generation executive systems of today, however, manipulate complex multiprogramming and multiprocessing systems. The performance of these operating systems is no longer measured by the efficiency of individual processing programs but by the degree of optimization of total system throughput. The objective in such an environment is to maximize the utilization of all system resources as much as possible.[26] In single program manipulation the speed of the program is at any point in time limited by one of the system's components. That is, the program is either processor or peripheral bound. Operating systems overlap programs of various types and in this manner achieve a balance between the demands of individual programs and overall available system resources.[27]

Multiprogramming and executive systems concepts were developed on second generation hardware, such as the IBM 7090 and 7094

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[25]Saul Rosen, "A Historical Survey," in Saul Rosen, ed., Programming Systems and Languages (New York: McGraw-Hill Book Company, 1967), p. 15.

[26]Phillip C. Howard, "Optimizing Performance in a Multiprogramming System," Datamation, January, 1969, p. 65.

[27]Ibid., p. 66.

computers.[28] Consequently, the development of third generation software has been much more evolutionary than revolutionary. The impact on computer systems application, however, has been almost revolutionary. Early computer facilities worked primarily on single programs in almost complete isolation from the outside environment. In contrast, current large general purpose computer systems are able to accommodate both on-site batch processing and remote terminal time-sharing demands. Third generation software must be given primary credit for these capabilities.

What are the main responsibilities and functions of third generation operating systems? Six functions can be listed without a considerable degree of overlap. They are:

1. Input/output control (for peripheral and working programs)
2. Scheduling
3. Allocation of memory and storage
4. Control of compilers and library and utility programs
5. Time-slicing
6. Overhead.[29]

First, the operating system must be capable of recognizing input from both remote and from on-site batch processing jobs. Terminal monitoring is accomplished by general input/output controllers (GIOC) which are part of the executive program. There are two pri-

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[28]Rosen, "A Historical Survey," p. 17.

[29]James R. Ziegler, "Time-Sharing and Software," Data Processing Magazine, September, 1966, pp. 39-40 and Bernard Schwab, "The Economics of Sharing Computers," Harvard Business Review, September-October, 1968, pp. 66-67.

mary methods for this operation. One way is for the GIOC to continuously poll all terminals several times a second. When there is an input message GIOC usually transfers the data to random storage (disk) until it is requested by the user program. Input messages can also set some type of flag or interrupt the operating system's routine pre-empting its attention. Some systems use a combination of both methods.

Input/output for on-site batch processing programs is also governed by the operating system. If the active user programs would be allowed to handle their own input/output operations the central processing unit would not be used very efficiently. To offset this waste of resources the active user programs are trapped the moment they make an input/output request. The operating system assumes control and delegates the task to a data channel controller which finds and transfers the data demanded. During this time the operating system continues polling the remote terminals and gives another user program waiting in main storage control of the central processing unit.

The second function of an operating system is scheduling. Essentially this entails the allocation of resources among jobs in the system and also between tasks of active jobs. It includes formation of job and task queues, assignment and handling of priorities in accordance with established procedures, and interchange of programs in and out of the central processor in response to traps, error conditions or time-slicing.

Allocation of memory and storage is another responsibility

of the executive system. Not only must it effectively allocate main storage for processing, but it must also assure proper utilization of all the other storage devices of the computer system. This includes data relocation brought about by memory swapping and protection of data being handled and stored in memory. Consideration must be given to the fact that efficient use of memory requires that switching between main storage and the central processing unit or secondary storage and main memory must be accomplished in such a manner that data put back into any storage does not have to occupy the same location at all times.[30] Such a process is more commonly referred to as the dynamic allocation of storage.

The operating system must also be able to provide service operations consisting of activating various language compilers, utility programs, and debugging services and routines. The executive system overlaps all the above operations with all its other functions in optimizing resource utilization and total system throughput.

Further, a flexible operating system should be capable of using the technique called "time-slicing". The function is closely related to the program interrupt method discussed in conjunction with input/output control and scheduling. When the program interrupt method is used for sharing system resources, the smaller pro-

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[30]Jack B. Dennis, "Segmentation and the Design of Multiprogrammed Computer Systems," in Rosen, Programming Systems, pp. 699-703.

grams with short execution times are usually given the highest priority. This is accomplished to decrease the queuing time of most problems which are short and to prevent the monopolization of the central processor's time by lengthy programs. The concept presupposes the advanced knowledge of program execution times which frequently are not available. To overcome this problem and to give all remote terminal users the pretense that they have complete individual control of the computer, the technique of time-slicing is employed. Essentially with this method the operating system allows each active participant to use the central processor a few milliseconds (a slice) at a time in a round-robin manner.

Finally, the operating system is responsible for certain overhead or bookkeeping functions. The executive system accomplishes these services by examining the entries in its log file and collecting, combining, sorting, and arranging the events which have occurred. This provides the basis for equitable distribution of computer costs and answers to such questions as: How many programs were run? and How much memory was used?

It can be concluded that the effectiveness and efficiency of a computer system is mainly dependent on the speed of the functional units, the overall hardware architecture, and the design of the control and processing programs used to operate the system.[31]

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[31]Katzan, Computer Organization, p. 11.

Systems Design

In planning for a comprehensive computer-based management information or administrative system it is desirable to first establish guidelines as to what the characteristics of the system should be. Subsequently, the design process should advance in accordance with accepted general systems theory principles.

Desired Systems Characteristics. A viable and responsive system should be characterized by anthropocentrism, flexibility, generality, and simplicity.[32] Since administrative systems are comprised of both humans and machines they cannot and should not be fully automated. There has been a selective emphasis on automatic instead of semi-automatic information systems with the consequential neglect of the human factor.[33] Any system is formulated to support and aid man. Information systems are designed primarily for control, planning, and decision making. Here the emphasis is on optimum man-machine interaction. It is the human manager who makes the final decision as to what to plan for and what to control. For best results, however, the administrator should have the support of a comprehensive information system. Such a system has to be anthropocentric or user-centered if people are going to use it to its full potential. Machines should be automated and precisely regimented. Man, on the other hand, should be as free

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[32] B.G. Schumacher, Computer Dynamics in Public Administration (Washington: Spartan Books, 1967), pp. 57-59.

[33] Harold Sackman, Computers, Systems Science and Evolving Society (New York: John Wiley and Sons, Inc., 1967), pp. 32-33.

as possible to use his ingenuity without being restricted by the design of a supporting system.

There are both programmed and non-programmed decisions.[34] If definite procedures have been established for making repetitive and routine decisions they are programmed decisions and can and should be automated. Non-programmed decisions are made in response to unpredicted situations requiring intelligence, adaptivity, and problem-oriented action. To a degree non-programmed decisions can be made using heuristic or trial and error computer programs allowing for greater systems flexibility; however, most must be made by man-machine interaction.

Correspondence instruction systems must be user centered and flexible, both from the viewpoint of the students and the administrators of the central agency. The student demands individualized instruction. Individualized instruction generally requires five learning situations in which:

1. Individuals learn by themselves and at their own pace

2. Students receive counseling and other services from an institution

3. Small groups of students with similar backgrounds engage in a collective task

4. Small groups of students with diverse backgrounds participate in an activity

5. Groups of students attend or are exposed to some type of common mass stimulus, such as a lecture or audio-visual presentation.[35]

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[34]Herbert A. Simon, The New Science of Management Decisions (New York: Harper and Row Publishers, 1960), p. 6.

[35]Don D. Bushell and Dwight W. Allen, ed., The Computer in American Education (New York: John Wiley and Sons, Inc., 1967), p.31.

A flexible and responsive computer-based correspondence instruction system should be capable of allowing an individual to progress on his own, to motivate and counsel or schedule counseling sessions, to plan and notify a student when and where to participate in a small group or mass media session, and to respond rapidly to individual inquiries and lesson exercises.

From the administrative perspective an effective and efficient computer-assisted system should facilitate integrated transaction processing, control and planning.[36] Again, the administrative system should be anthropocentric allowing managers to conveniently interact with all functions of the system at all times.

One of the most critical areas of an independent study instruction system is the operation of the feedback network for lesson and final examination evaluations. Here again it is extremely important from both the learning and motivational standpoints that the system be user centered and flexible. Many correspondence institutions maintain that they offer "personalized" instruction on the premise that constructed response questions are used which are individually "hand" graded by "live" instructors. This appears to be an extremely biased self-evaluation, since in many instances tests are graded routinely by clerks or part-time instructors who periodically encounter peak workloads that cause

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[36]Robert H. Anderson, "Sustaining Individualized Instruction Through Flexible Administration," in John Caffrey and Charles J. Mosmann, ed., Computers on Campus (Washington: American Council on Education, 1967), p. 34.

considerable delays in feedback to the students.

No conclusive evidence has been presented which indicates that essay-type examinations are superior to multiple choice response tests.[37] It has been shown, however, that when objective questions are used, completion rates increase since students find it easier to respond and the feedback is more precise.[38] Generally, Federal agencies use multiple choice items exclusively, universities rely on essay items, and private schools use a mixture of both.[39] Obviously, further research in this area is badly needed. As indicated before, routine decisions are programmed decisions and can and should be automated. Unprogrammed decisions can be flagged by an automated system for human intervention. Computer-based systems are not only able to grade objective tests and annotate the scores attained, but they can also supply written feedback on both correct and incorrect test responses. An instructor's time and talents should be saved for handling unanticipated student problems and not wasted on routine well-structured processes.

An effective computer-based system should also be characterized by generality and simplicity. Generality is primarily

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[37] Edward B. Fry, Teaching Machines and Programmed Instruction (New York: McGraw-Hill Book Company, Inc., 1963), pp. 151-52.

[38] James R. Rechs, "What Correspondence Schools are Learning from Programmed Instruction," The Home Study Review, Winter, 1966, pp. 8-9.

[39] Helen Kempfer, "Programmed Instruction in Correspondence Courses: Report of a Survey," The Home Study Review, Fall, 1965, p. 40.

achieved by functional modularity.[40] A system should be constructed on a totally integrated basis, but its functional units should achieve modular independence. That is, the subsystems or modules should function in such a manner that they can be rearranged or substituted at will, changing the total systems architecture in response to dynamic requirements.

The degree of skill required to establish man-machine interaction determines the size of the user public of a given system.[41] Any degree of complexity is appropriate when machine interacts with machine. For maximum utilization of automation by man, however, a system must be as simple as possible.

The Design Process. It is the function of administrators to organize, coordinate, and interconnect all the human, physical, and information resources of an extended organization in the most optimum manner for the attainment of predefined goals. In essence, managers should plan and design integrated systems based on general systems theory principles and utilize the best available hardware and software of modern information technology to facilitate optimum systems interaction. The architectural designs of such systems, therefore, should evolve from viewing organizations from both a macro and a micro perspective.[42]

Five general procedural steps for designing a management

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[40] Schumacher, Computer Dynamics, p. 58.

[41] Ibid., p. 59.

[42] Edward A. Tomeski, The Computer Revolution (New York: The Macmillan Company, 1970), pp. 24-52.

information system have been suggested by Russell L. Ackoff, which are:

1. The analysis of the present decision system or cybernetic network

2. The determination of the information requirements

3. The consolidation of certain decisions

4. The design of a data processing system

5. The design of procedures to keep a system flexible and adaptive.43

First, the analysis of the present system should be conducted by investigating both its comprehensive and extended interrelationship, and the relevant detailed interactions of its subsystems. The total systems approach includes the analysis of the organization's resource elements, administrative functions, and structure which are then synthesized to form a general systems flowchart or model.[44] Flowcharting facilitates the identification of managerial decision points and their interrelationships with other decision centers. The process of flowcharting also reveals deficiencies of a system and indicates where changes in managerial functions, structural relationships, and performance measurement should be made.[45]

Micro systems analysis is concerned with identifying and selecting a finite set of relationships relevant to the operation

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[43]Russell L. Ackoff, "Management Misinformation Systems," Management Science, December, 1967, pp. 153-56.

[44]Tomeski, The Computer Revolution, pp. 35-36.

[45]Ackoff, "Management Misinformation Systems," p. 154.

of a system from an infinite set of internal and external relationships. It is primarily a detailed problem-solving and creative process consisting of problem identification, diagnosis, and resolution.[46] That is, the micro systems approach is used to develop the individual "building blocks" for the synthesis of an integrated system.

The information requirements of an organization should be determined next. As stated previously, there are basically two types of decisions; programmed and unprogrammed decisions. Programmed decisions which are well structured and reoccurring identify their own informational requirements. These decision processes can be directly incorporated into the automated portion of the management information system, since they logically require no human intervention.

Unprogrammed decisions can be made either by heuristic or trial and error computer programs, or by man-machine interaction. Heuristic programs can, in most cases, specify their own informational requirements. Such programs can also be automated and, therefore, embodied in the computerized portion of the system permitting at least comparisons of recommended alternative solutions. Decisions which cannot be programmed require extensive research to determine their relevant information requirements. This can be accomplished in part by analyzing currently available information, information weaknesses of the existing system, new

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[46]Tomeski, The Computer Revolution, p. 41.

requests for information, and information systems of similar organizations. Of primary importance here is the value of information as compared to its costs. The value of information can be generally determined by comparing the effectiveness of the actions of a decision-maker before and after certain information is made available to him.[47]

The third step in the design process should deal with the consolidation of certain decisions which may require the reorganization of an agency. The decision centers which have similar or overlapping information demands should be aggregated, reducing information requirements and increasing task comprehension.[48]

After a decision or cybernetic network has been formulated and its information requirements have been determined, an appropriate data processing system should be embodied into the total information system. Not only must such a system be user-oriented, but it must also assure that all organizational information and processing requirements are satisfied. This is primarily accomplished by the use of a central data base. The centrally accessible data base concept is founded on the single information flow philosophy.[49] With this concept information enters the processing

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[47]Morton M. Bedford and Mohamed Onsi, "Measuring the Value of Information--An Information Theory Approach," Management Services, January-February, 1966, p. 17.

[48]Ackoff, "Management of Misinformation Systems," p. 155.

[49]A.F. Moravec, "Basic Concepts for Planning Advanced Electronic Data Processing Systems," Management Services, May-June, 1965, p. 53.

system only once and is then available to serve all user requirements.

Specifically, the design of the data processing system includes the precise formulation of output, input, data files, and programs. Output specifications are defined first because an information system should be output oriented or user centered. As indicated by Figure 3.1, output can be produced in various forms such as printouts, tapes, or remote terminal displays. A line printer is the most commonly used output device. The particular choice of output media depends on the required response times, whether hard copies are needed, and the value of the information supplied compared to its costs. The following points should be specified for all output:

1. Means of identification
2. Content and format
3. Frequency and volume of output
4. Conditions triggering the output
5. Sequence of production.[50]

The input to a computer system must be in machine readable form. Punched cards are still used as the primary means of data input. The use of punched cards requires manual source document conversion by keypunch operators. As is the case with most repetitive manual operations, "bottlenecks" in the flow of data accrue

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[50]Alan Daniels and Donald Yeast, ed., Systems Analysis (Palo Alto, California: Science Research Association, Inc., 1971), p. 77.

during cyclical peaks. Recording of transactions or other events in machine readable form can prevent input "bottlenecks" and eliminate costly and error-prone duplicate recording by keypunch operators. Optical mark sensing and optical character recognition equipment can be employed for automatic source document conversion. In addition, terminals with visual displays can be used for data input, bypassing card to tape or card to disk conversion.

The choice of input devices is dependent on the computer system used, access speed requirements, source document formats and volumes, and cost effectiveness. It must also be remembered that there are three basic subdivisions of input including external data, internal user data, and internal system data.[51] The first division includes general transactions used to update active files. The second classification of input is concerned with requests for special action and interrogation of files which enables a user to communicate with the system. Internal system data is used to enhance the physical operation of the system.

One of the most critical aspects of data file design is the choice of the primary storage medium. The selection of the medium is dependent on three characteristics.[52] The speed with which information can be transferred from storage to the working area of the computer is the first consideration. If buffers are not available fast internal processing speed is wasted with slow

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[51] Ibid., p. 38.

[52] Ibid., p. 87.

peripheral devices. Second, the arrangement of individual records, either in sequential or random order, is important. Finally, the capacity of the medium should be able to readily accommodate expansion.

Computer accessible files are primarily maintained on punched cards, magnetic tape, or magnetic disk storage media. Card files are organized in sequential order, must be manipulated manually or by slow punched card machines, and have an extremely slow computer input rate. Records on magnetic tape are arranged sequentially but files can be processed by the computer and data transfer is fast. Files stored on magnetic disk do not have to be organized sequentially, can be randomly accessed, and have a very fast data transfer rate.

Systems programming was summarized earlier and requires little further elaboration. It must be stressed that no matter how sophisticated the hardware, the effectiveness and efficiency of the total system is directly dependent on the level of the operating system and processing programs development. Programming is action-oriented since its goal is the activation of problem solutions and minute interrelationships produced by micro systems analysis and design. Although programming is a precise art, the process should incorporate sufficient flexibility to allow for change and expansion. Further, the emphasis on detail demands that all programs be well documented for future reference, especially for personnel changes, and to preserve systems continuity.

The final phase of the general design process should be

devoted to the formulation of procedures which would assist in maintaining the viability of an organization. In a dynamic environment composed of infinite relationships any system will be deficient in some ways. In addition, man-machine systems are always more flexible than completely automated systems.[53] Managers, therefore, should devise systematic procedures for continuous man-machine interaction in order to detect and correct deficiencies and improve the total system configuration. These plans and programs should be future oriented and not chained to day-to-day operations.

All decisions and their predicted outcomes may be considered as essential input to a management information system.[54] Such information should be compared to the actual outcomes of the events predicted to indicate the accuracy and validity of programmed and unprogrammed decisions and information sources. On the basis of decision accuracies or inaccuracies, in collaboration with information specialists, the administrators will be able to make appropriate corrections and changes in the system. This will result in an information system which will enhance organizational adaptability through increased accuracy and generality.

In conclusion, it must be pointed out that an organization does not usually have the resources, time, or patience to

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[53]Ackoff, "Management Misinformation Systems," p. 155.

[54]Ibid., p. 155.

implement a totally integrated information system all at once. A system should be sequentially integrated. More specifically, the overall system should be designed in its entirety in advance but the various functional areas or decision centers should be implemented one at a time based on predefined priorities.[55]

Summary

Important aspects concerning the development of computer-based management information systems have been described in this chapter. It included the review of general systems theory, computer hardware and software, and basic systems design considerations. The intent here has been to demonstrate how an organization should be perceived, how a system should be designed, and what is generally afforded by advanced information technology. In other words, it has been depicted how general systems theory and computer science can and should be extended in the field of correspondence instruction.

It is important that individuals responsible for directing home study programs be more objective in evaluating and re-evaluating the theoretical and technological foundations of their systems. Progress towards predefined goals should be accomplished on the basis of sound scientific research and analysis.

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[55]Ralph Van Dusseldorp, "Some Principles for the Development of Management Information Systems," in Charles B. Johnson and William G. Katzenmeyer, Management Information Systems in Higher Education: The State of the Art (Durham, North Carolina: Duke University Press, 1969), p. 40.

There are excellent examples of independent study organizations where the incorporation of an integrated management information system would be quite appropriate. The State University of New York (S.U.N.Y.), for instance, late in 1971 implemented a comprehensive correspondence instruction program at the college level.[56] It encompasses seventy campuses across the state where individuals can enroll and receive counseling but can do all the work required at home to earn a degree. The primary reason for the activation of the program is to allow S.U.N.Y. to accept more enrollments without the construction and maintenance of additional expensive new physical facilities. The planners estimate that the yearly cost of off-campus education per student can be reduced from $2,300 to $1,150.

The S.U.N.Y. correspondence study program seems to be ideal for incorporating an integrated management information system. The system could utilize complex feedback channels for directing and motivating students and for evaluating their progress in the various courses offered. Specifically, such a system would assist the educators and administrators in scheduling; scoring; record maintenance; and information processing, storage, and retrieval.

Computer programs for a similar system have already been developed.[57] Properly designed programs would enable S.U.N.Y.

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[56]"College Without a Campus," Time, March 1, 1971, pp. 56-59.

[57]John C. Flanagan, "Functional Education for the Seventies," Phi Delta Kappau, September, 1967, pp. 27-33.

students, educators, and counselors to compare individual performances on tests with prior achievements, aptitudes, interest, and general backgrounds. Computer routines could also list instructional unit objectives and long-range goals based on a student's characteristics and progress. In addition, the computer programs could make the total system flexible and adaptive by relying on feedback from individuals and teachers on specific unit values and weaknesses which would be used to continuously improve the programs.

Again, a computer-based management information system is a tool designed to assist the administrator and educator to cope better with the complexities of his dynamic environment. Such a system also facilitates the maintenance of dynamic equilibrium of an institution. The manager's and instructor's time and ingenuity should be directed towards handling unanticipated administrative and student related problems and not wasted on routine well-structured processes. The next chapter of the study will portray the present state of the art of computer applications by home study organizations.

CHAPTER IV

PRESENT SYSTEMS

This chapter of the study is devoted to the analysis of the extent and sophistication of computer utilization by correspondence instruction institutions. The evaluation is based on data gathered by a questionnaire survey and five case studies.[1]

Questionnaire Survey

The analysis of the survey will be presented by first reviewing the characteristics of the populations selected and then summarizing the specific areas covered by the questionnaire. It should be re-emphasized that the conclusions and generalizations derived through the use of the survey be tempered by the inherent limitations of the data gathering methods used.

The Groups Surveyed

All of the sixty-three members of the Independent Study Division of the National University Extension Association (NUEA) and the seventy-five members of the National Home Study Council (NHSC) were selected as targets for the questionnaire survey.[2]

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[1]A copy of the questionnaire used for the survey is displayed in Appendix III. The case studies are presented in detail in Appendix II.

[2]Schools operated by Federal agencies were not included since they are well covered by the case studies.

The two groups were chosen on the assumption that members of the Associations would respond more readily to the survey and furnish the most reliable and accurate information.

Of the 138 schools selected for the study 121 or 88 per cent responded. Questionnaires were returned by 94 per cent of the NUEA member departments and 83 per cent of the NHSC member schools. The high rate of participation was partially attained by sending out 46 follow-up notices.

As indicated by Table I, 13 (22 per cent) of the NUEA departments and 27 (44 per cent) of the NHSC schools are using computers to varying degrees in the administration of their respective programs. In addition, 12 per cent of the NUEA members and 8 per cent of the NHSC members have definite plans for incorporating EDP systems into their operations.

Active enrollments of the university affiliated departments utilizing computers range from 2000 to 12,500 and those not using computers range from 110 to 22,000. The institution with 22,000 enrollments, however, is in the final proposal stages for installing an EDP system with one of the leading computer manufacturers. The largest NUEA member which does not have immediate plans for computer applications carries 17,500 active enrollments.

Of the 62 private home study schools responding to the survey ten declined to indicate the number of active enrollments monitored by their organizations. With that exception, private schools using EDP systems have enrollments ranging from 85 to

TABLE I

STATUS OF COMPUTER APPLICATIONS
BY INSTITUTIONS SURVEYED

	Institutions		
Status	NUEA Members	NHSC Members	Combined Percentage
Operational	22%	44%	33%
Planned	12%	8%	10%

400,000. The range of enrollments of schools not using computers is from 80 to 100,000. Interestingly, the organization with 100,000 enrollments has no immediate plans for incorporating a computer system to assist in the administration of its programs. The second largest school with 40,000 enrollments similarly has no immediate intentions of adapting an EDP system to its operations. It should also be noted that 26 per cent of the NHSC members that utilize computers employ the systems only for the maintenance of student financial records.

Specific Modes of Operation

The data in this section has been compiled from the forty questionnaires returned by the institutions that are using computers to varying degrees in the administration of their programs.

Methods of Systems Access. In order to gain access to a computer to realize its benefits an organization must own, lease or share a system or use any combination of the three methods.

TABLE II

METHODS OF GAINING ACCESS TO COMPUTER SYSTEM/S AND FREQUENCY OF PROCESSING BY INSTITUTIONS USING COMPUTERS

Method and Frequency	Institutions NUEA Members (13)*	NHSC Members (27)	Combined Percentage
Method			
Own		7%	5%
Lease		33%	23%
Share	100%**	56%	70%
Other		4%	2%
Frequency			
Daily	15%	59%	45%
Biweekly	15%	11%	13%
Weekly	24%	30%	28%
Bimonthly	8%		2%
Monthly	15%		5%
Other	23%		7%

*The figures in parentheses represent the actual number of the population under consideration.

**In some cases departments lease card devices or terminals but they all share a central computer system. One extension division leases its own computer which it shares with the independent study department.

Table II shows the manner in which correspondence study schools obtain computer time for their data processing needs. Although several independent study departments lease peripheral devices, they all share CPU time with other university departments and divisions. The procedure is logical since most campuses have a central computer facility which attempts to support all data processing requirements.

More than half of the private home study schools also share EDP systems. This is accomplished by the use of service bureaus, sharing a central system by branches located throughout the country, sharing a system with other affiliated resident schools, or in one instance utilizing the computer of a local university. In addition, one third of the NHSC member organizations gain access by leasing computer systems.

The frequency with which data is processed is also depicted by Table II. Obviously, the private institutions update their computer files more frequently than the university departments. This disparity seems to be partially caused by the fact that the private home study schools are more involved with financial transactions than are the independent study departments. On the other hand, NUEA member institutions utilize EDP systems more for the generation of statistical summaries than for the support of day-to-day operations. They therefore require less frequent processing for the maintenance of their computer files. According to the survey 69 per cent of the university department and 59 per cent of the private schools employ computers to produce course

instruction related statistical information.

Modes of Sharing EDP Systems. There are three primary ways in which to share a computer system. First, an organization can have its own keypunch equipment by leasing or purchasing it. In this manner source document conversion can be performed on the premises and data manipulation at a shared computer facility. Second, an institution may have both its keypunching (or another method of data transformation) and processing requirements accomplished at a service bureau or computer center. Such a method is more appropriate for smaller agencies with moderate information handling needs. Third, an institution could purchase or lease one or more on-line terminals tied into a shared computer system located at any distance from the physical facilities of the organization. Input/output of the terminals is either displayed in teletype form or on cathode-ray tubes (CRT's). Depending on the capabilities of the central EDP system, the third mode of sharing a computer is the most responsive and anthropocentric, giving all users the pretense that they have individual control of the entire system.

Table III gives a breakdown of the methods used for sharing computer systems and the frequency with which they are employed. The NUEA and the NHSC members utilize the second mode of shared systems configuration most often. It appears that both groups should give more consideration to the introduction of on-line terminals for more adequate management information realiza-

TABLE III

METHODS OF SHARING COMPUTER SYSTEMS BY INSTITUTIONS USING COMPUTERS

Method	Institutions NUEA Members (13)	Institutions NHSC Members (15)	Combined Percentage
In-House Keypunch Equipment with Processing Accomplished at a Shared Computer Center	23%	20%	21%
Keypunching and Processing Accomplished at a Shared Computer Center	62%	73%	68%
In-House Terminal/s Tied into a Shared Computer Center for Remote I/O	15%		7%
Other		7%	4%

tion. This would be especially appropriate for very small institutions that have not even considered computer applications.

Storage Media Used for Major Files. The importance of storage medium selection in the design of data files was discussed in Chapter III. The critical aspects are the speed of data transfer, the arrangement of individual records, and the capacity of the medium. Punched card files are cumbersome, organized sequentially, and have an extremely slow computer input rate. Records on magnetic tape are arranged sequentially but data transfer is fast. Magnetic disk files can be randomly accessed and they have

a very fast data transfer rate.

The types of storage media used for major files by the surveyed groups is depicted by Table IV. NUEA members use primarily punched cards or a combination of punched cards and magnetic tape for the maintenance of their active enrollment file. The high utilization of punched cards for this file by the universities could be attributed to the extensive use of card devices for statistical compilations by the departments prior to the introduction of EDP systems. The use of business machines for such purposes was well publicized in 1953 by Mary L. McPartlin[3] of Loyola University. As a matter of fact, in some instances lesson and examination grades are posted manually onto punched cards. When a combination of punched cards and tape is used the card file is usually updated on a daily basis while the tape file is processed less frequently.

NHSC members prefer to maintain their active student file on tape or a combination of manual cards and tape. As stated previously, 26 per cent of the private schools maintain only the enrollees' financial records on computer accessible files. Educational records in these organizations are primarily kept on manual cards or in folders. A large number of private organizations, however, utilize magnetic tape for all active student records.

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[3]Mary L. McPartlin, "The Use of Business Machines in the Administration of Correspondence Courses," Proceedings of the International Conference on Correspondence Education, 1953.

TABLE IV

TYPES OF STORAGE MEDIA USED FOR MAJOR FILES
BY INSTITUTIONS USING COMPUTERS

File and Medium	Institutions NUEA Members (13)	NHSC Members (27)	Combined Percentage
Active Student File			
Manual Cards	7%	11%	10%
Punched Cards	46%	7%	20%
Magnetic Tape	8%	26%	20%
Disk	8%	7%	8%
Manual Cards and Tape		26%	17%
Punched Cards and Tape	23%		8%
Manual Cards and Disk	8%	8%	7%
Other		15%	10%
Inactive Student File			
Manual Cards	15%	44%	35%
Punched Cards	15%	4%	8%
Magnetic Tape	8%	15%	12%
Disk		4%	3%
Microfilm	8%	7%	8%
Manual Cards and Tape or Disk	8%	19%	15%
Manual or Punched Cards and Microfilm	38%		12%
Other	8%	7%	7%
Inventory Control File			
Manual Cards	54%	63%	60%
Punched Cards	15%	4%	7%
Magnetic Tape		11%	7%
Disk		4%	3%
Combination of any Four Above	8%	15%	13%
No Records Maintained	23%	3%	10%

Again referencing Table IV, it can be observed that numerous NUEA affiliates prefer a combination of manual or punched cards and microfilm for the maintenance of transcript or inactive student files. The utilization of alternative means is quite evenly distributed among the remaining departments. NHSC members on the other hand, use more manual cards for the storage of inactive student records than any other type of media.

Manual cards are utilized primarily for the maintenance of inventory control records by both groups surveyed. The choice of such a medium by the NUEA members does not seem inappropriate with enrollments not exceeding 12,500 by the departments employing computers. For several of the larger private schools, however, with up to 50,000 enrollments and available EDP systems, the procedure appears questionable.

Modes of Active Student File Input and Access. The methods of computer data input and information retrieval are directly related to the storage media employed. As indicated previously, both groups surveyed utilize punched cards and magnetic tape extensively for the maintenance of active enrollment files. The addition of records to a punched card file can only be accomplished by producing new cards and physically or mechanically placing them into the file. Conversely, the deletions of records kept in a punched card file can be performed only by manually or mechanically extracting individual cards from the file. Input or changes to sequential magnetic tape files can be initiated by the use of punched cards, paper tape, optical mark reading (OMR)

TABLE V

MODES OF ACTIVE STUDENT FILE INPUT AND ACCESS
BY INSTITUTIONS USING COMPUTERS

Input and Access Modes	Institutions NUEA Members (13)	NHSC Members (27)	Combined Percentage
Input			
Punched Cards	85%	89%	88%
On-Line Terminal/s	15%	7%	10%
Other		4%	2%
Access			
Punched Cards	69%	48%	55%
On-Line Terminal/s	8%	11%	10%
Manual	23%	26%	25%
Periodic Printouts		11%	8%
Other		4%	2%

equipment, or optical character recognition (OCR) units. The latter two devices have the capability of converting source data directly to tape or disk.[4]

Table V indicates that all correspondence study institutions employ punched cards almost exclusively to update the active student file. This is logical considering the primary storage media used by the agencies and the almost total absence of OMR and OCR equipment. According to Table V much of the information from the enrollment file is also retrieved by means of punched cards.

[4]Appendix II: Cases 1, 3, 5.

TABLE VI

METHODS USED IN RESPONDING TO WRITTEN STUDENT INQUIRIES BY INSTITUTIONS USING COMPUTERS

Methods	Institutions: NUEA Members (13)	Institutions: NHSC Members (27)	Combined Percentage
All Manually Typed or Written	38%	15%	23%
Some Form Letters	54%	22%	33%
Some Form Letters and Automatic Typewriter Replies		33%	22%
Some Computer Printed Responses		15%	10%
Some Other Combination of the Above Methods	8%	15%	12%

One fourth of the data, however, is manually accessed. Most of this may be attributed to two factors. One reason is that punched card files of the NUEA departments are usually manually searched for information. Another influence is the fact that numerous NHSC members only maintain student financial data on computer accessible files.

Student Inquiries and Reminder Notices. The institutions surveyed that use computers were asked whether replies to all student inquiries are manually prepared. Table VI depicts the manner in which answers to student inquiries are produced. Approximately 38 per cent of the NUEA members and only 15 per cent of the NHSC affiliates respond manually to correspondence from students. Form

letters are most frequently used by the universities, while most of the replies by the private organizations are prepared by the combined use of automatic typewriters and computers.[5]

It should be noted that the use of form letters is perhaps the most impersonal way of responding to queries. On the other hand, computer printed replies and especially correspondence produced by automatic magnetic tape or card controlled typewriters can be made as unique and personal as manually composed letters. In most cases such correspondence is more informative and fluent than routinely prepared replies by clerks or counselors. The NUEA members, therefore, should investigate the possibilities of taking advantage of the above methods in the future.

Table VII shows the percentage of correspondence study institutions utilizing various forms of computer generated student reminders or notices.[6] Apparently the NHSC members are applying information technology more fully in this area, although most of their effort is centered around delinquent accounts.[7] There is much that can be accomplished by all correspondence instruction institutions concerning computer-based motivational subsystems development. It must also be noted at this juncture that 63 per cent of the private schools, as compared to 8 per cent

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[5] Ibid.: Cases 1, 3, 4, 5.

[6] Ibid.

[7] The reduction of delinquent accounts is a major problem area for the private schools.

TABLE VII

TYPES OF COMPUTER GENERATED STUDENT REMINDER NOTICES UTILIZED BY INSTITUTIONS USING COMPUTERS

	Institutions		
Types of Notices	NUEA Members (13)	NHSC Members (27)	Combined Percentage
Extended Inactivity	23%	44%	38%
Cancellation	23%	19%	20%
Delinquent Account	8%	74%	53%

of the independent study departments, use computer printed address labels for sending initial course materials to students. Production of labels is a simple by-product of computer enrollment processing and is very useful both for mailing study materials and inventory control.

Computer Scoring and Posting of Grades. As is indicated by Table VIII, almost no university associated departments and very few private organizations employ EDP systems in scoring lesson tests or examinations. The obvious reason for this is the fact that constructed response questions are used exclusively for lesson tests by the university departments and in most instances by the NHSC members. All of the private schools that do use computers for lesson or examination scoring also utilize the systems for the generation of test result feedback for the students. The feedback includes specific corrective comments or indicates areas

TABLE VIII

EXTENT OF COMPUTER APPLICATION IN TEST SCORING, FEEDBACK, AND ANALYSIS BY INSTITUTIONS USING COMPUTERS

	Institutions		
Applications	NUEA Members (13)	NHSC Members (27)	Combined Percentage
Test Scoring	8%*	22%**	18%
Test Feedback		22%	15%
Test Analysis		19%	13%

*One NUEA member school uses a computer for only final examination production and scoring.

**One NHSC member institution uses a computer for scoring some tests and examinations.

to be re-studied.

It was stated in Chapter III that no conclusive evidence has been presented indicating that essay-type tests are superior to multiple choice response examinations. A study program cannot be assumed to be personalized simply because tests are evaluated by persons instead of machines. Machines are constructed by man and can be as effective as the professionals who design and program the devices.

Test analysis is facilitated by the use of computers.[8] As lessons or examinations are evaluated by an EDP system a test analysis file can be updated at the same time and statistical sum-

[8]Appendix II: Cases 1, 5.

TABLE IX

EXTENT AND METHODS USED FOR POSTING DATES OF LESSON/EXAMINATION RECEIPTS TO ACTIVE STUDENT FILE BY INSTITUTIONS USING COMPUTERS

	Institutions		
Extent and Methods	NUEA Members (13)	NHSC Members (27)	Combined Percentage
Extent	46%	19%	28%
Methods			
Keypunching a Card for Each Test Received	67%	100%	82%
Student Submits a Pre-punched Card with Each Lesson	17%		9%
On-Line Terminal Input After Lesson Receipt	16%		9%

maries can be prepared periodically or by request. Such a vital educational tool could and should be continuously used to assure that lesson tests and examinations are well structured and accomplish desired objectives effectively. No university departments, and only 19 per cent of the private schools, utilize EDP systems for test analysis purposes.

When lessons or examinations are received from the students for instructor grading 46 per cent of the NUEA members and 19 per cent of the NHSC associates that use computers post the dates the tests are received to the active enrollment file prior to distributing the tests to the instructors. According to

TABLE X

MODES EMPLOYED FOR POSTING INSTRUCTOR GRADED TEST/ EXAMINATION RESULTS TO THE ACTIVE STUDENT FILE BY INSTITUTIONS USING COMPUTERS

Modes	Institutions NUEA Members (13)	NHSC Members (27)	Combined Percentage
Keypunching a Card as a Result of Instructor Notification	62%	50%	54%
Optical Mark Reading Equipment Reads Instructor Input		5%	3%
On-Line Terminal Input After Instructor Notification	7%		3%
Generation of Paper Tape After Instructor Notification		4%	3%
Manual Posting After Instructor Notification	31%	41%	37%

Table IX, most of the institutions employ punched cards for posting the dates of test receipts to the student records. After the lessons or examinations have been evaluated by the instructors, punched cards are also the primary means used by all institutions to post grades to the active enrollment file. As indicated by Table X, however, 37 per cent of the grades are entered manually to the student records after instructor notification. Again, this is largely due to the high rate of manual manipulation of punched cards by the university departments and the frequent separation of educational and financial student records by the private schools.

State of the Art

The data compiled from the questionnaire survey has defined the general level and the extent of computer systems application by correspondence study institutions. Based primarily on the case study data, this section of the chapter is designed to portray the most desirable characteristics of present systems.

Inputs

All open systems require certain inputs from the environment in order to maintain dynamic equilibrium. Obviously, this is also applicable to the open and extended correspondence instruction systems. The main external inputs of independent study institutions include initial course inquiries, enrollment applications, financial transactions, lesson tests and examinations, and active student inquiries. Internal inputs deal primarily with file maintenance and queries.

Prospective student input data by private schools appears to be handled best by the use of on-line terminals.[9] The procedure enhances rapid production of mailing labels for sending brochures to prospects, generation of lead forms for the sales force, and analysis of advertisement media effectiveness. Further, the names can be stored at the same time for revival mailing and subsequent sale of the files to other interested organizations.

The use of magnetic tape or card controlled automatic typewriters for preparing replies to initial course inquiries seems

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[9]Ibid.: Case 4.

appropriate for the university departments since these institutions do not operate with a sales force.[10] Both NHSC and especially NUEA members could rely more extensively on programmed automatic typewriters in responding to active student inquiries. In most instances the use of such equipment allows correspondents or instructors to prepare letters by simply selecting the appropriate paragraphs stored on tape. In addition, the use of computer printed replies should be investigated by all institutions. The procedure is particularly effective in handling student requests for general course status or progress summaries.[11]

On-line terminals and OMR or OCR equipment are the optimum means of enrollment data input.[12] With these devices the source data is converted directly to magnetic tape or disk without intermediate keypunching operations. If punched cards must be used for enrollment data input the application forms should at least be designed to facilitate keypunching operations. The use of terminals is especially ideally suited for small or medium size organizations with moderate volumes of data input, since terminal costs are relatively low.

The cost justification of OMR or OCR units requires extremely high daily volumes of form processing. Further, the

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[10] Ibid.: Cases 1, 3, 4.

[11] Ibid.: Case 1.

[12] Ibid.: Case 3 and Tables III, V.

employment of OCR devices is generally limited by the fact that the preparation of source documents for these machines requires keying equipment with specialized type fonts. The majority of all source documents, however, can be redesigned for OMR input when such a device is installed, allowing for more effective and efficient system utilization. All data on OMR readable forms (numeric, alphabetic, and test item responses) can be coded in mark-sense form with ordinary pencils for machine processing.

Objective tests are scored most effectively by OMR equipment.[13] If the volume does not permit the application of an OMR unit, punched cards can be submitted by a student for each lesson or examination.[14] These cards are usually prepunched at the institution to identify the student. When an enrollee completes a lesson he indicates the lesson number and the solutions for each question by pushing out perforated punches at appropriate locations on the card. As the solution cards are received by a school they are used as direct input to the EDP system for scoring and updating of the active student file.

The administration of essay-type tests should also be supported by a computer system. Depending on the availability of the necessary hardware, on-line terminals are most suitable for posting dates tests are received for grading and the evaluation

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[13] Ibid.: Cases 1, 3, 5.

[14] This method is used by Army Extension Courses, U.S. Army Infantry School, Fort Benning, Georgia.

results to the active enrollment file. If punched cards must be used students should submit two prepunched cards with each lesson. This procedure eliminates keypunching requirements for test administration subsequent to enrollment processing. One card would automatically annotate the date a lesson was received[15] and the second would be used by an instructor to indicate the grade attained by pushing out applicable perforated punches on the card. For very high volumes of test inputs OMR readable cover sheets can be utilized for the same purposes.

Whether to use on-line terminals or OMR equipment for internal data input should be dictated by the volume of daily actions. As stated earlier, once an OMR unit is installed most of the file maintenance and query forms can be redesigned for more efficient system utilization. Again, if punched cards are used all of the input documents should be structured to facilitate keypunching.

Files and Access

The most crucial aspect of any management information system is its data base which is necessary for the maintenance of organizational viability. The flexibility and accessibility of the data base is dependent on the media used for its files. To be able to support on-line remote terminal operations an EDP system must have large capacity random access storage (usually disk). It is also important to remember that some OMR equipment must be

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[15]Appendix II: Case 3.

on-line with a computer system for data transfer. This capability is usually only available with third generation systems.

For optimum results all active student records should be maintained on magnetic disk files.[16] This allows on-line terminals to be tied into a computer system for real-time file maintenance and information retrieval. During day-to-day operations data must be added and changes made to the active student records. In addition, frequent references must be made to the file in order to respond to enrollee inquiries. If the enrollment file can be interrogated in real-time the need for keypunching and other manual and time consuming operations is eliminated.

Punched card, paper tape, or OMR/OCR equipment must be employed to query or make changes to magnetic tape files. To facilitate continuous referencing of student records alphabetical computer listings of the file should be maintained at strategic locations.[17] To assure currency of information these printouts should be supplemented each processing cycle and completely revised monthly or bimonthly depending on the volume of new enrollments being added.

Files which are not frequently interrogated are best maintained on magnetic tape.[18] These files, however, can and should be updated each processing cycle. For instance, the test analy-

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[16] Ibid.: Case 4.

[17] Ibid.: Cases 1, 5.

[18] Ibid.: Case 5.

sis, budget, statistical, inventory, and other such files should be processed during every scheduled computer run, but reports based on the content of these files would be generated only periodically or by request. If the inventory file must be continuously referenced it should be stored on disk.

Punched card files should be utilized only if processing is accomplished primarily by accounting machines. If an EDP system is used and magnetic tape is the main storage media all records are best maintained on tape and frequently queried files should be referenced by means of alphabetic computer printouts.[19]

Output

A computer system is only as effective as the need and utility of its output. The user's primary contact with an EDP system is centered around its products. Therefore, the most sophisticated computer system configuration is worthless if the output which it generates cannot be readily utilized by its customers.

One of the most useful output characteristics of a properly designed computer system, discussed earlier in relation to file maintenance and enrollee inquiries, is its ability to search and retrieve student related data in real-time. The output can be displayed on CRT terminals or it can be automatically printed and dispatched to individual students in reply to a status request.[20]

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[19] Ibid.: Cases 1, 5.

[20] Ibid.: Cases 1, 4.

In other words, the computer can assist in making institutional responses more timely, complete, and accurate.

The handling of course materials is enhanced by computer output. As enrollment applications are processed, mailing labels and lists for assembling study material units can be printed by the system.[21] Answer sheets or cards for objective tests or examinations can also be encoded by the EDP system. These answer sheets, in turn, can be used as mailing labels for dispatching of lesson materials.[22]

During each processing cycle the activities of every student can be screened by the computer. Students found to be remaining inactive for excessive time periods and those failing to attain satisfactory grades on lesson tests can automatically be sent periodic reminder notices generated by the EDP system.[23] The development and further emphasis of such systematic motivational programs appears extremely desirable.

Multiple choice response lesson test and examination feedback can also be automatically produced as the tests are being scored by a computer. Depending on the care taken to design a system, brief written statements for each correct or incorrect problem response and a short overall summary of a test can be

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[21] Ibid.: Case 3.

[22] Ibid.: Case 1.

[23] Ibid.: Cases 1, 4, 5.

printed by an EDP system.[24]

Finally, a computer system can conveniently structure and generate all types of management reports.[25] The capability of the computer to formulate such reports is dependent on the data base or files maintained by the system.

Summary

This chapter has evaluated the level and the extent of computer systems application in correspondence education based on a questionnaire survey and case studies. The compiled data indicates that the level of EDP systems utilization in this area, with very few exceptions, is at best at the mid-second generation computer development stage. For instance, only one NUEA and two NHSC member institutions are using disk storage for active student record files. Therefore, it appears that only two organizations (one of the private schools is included in the case studies) could be equally or further advanced than any of those included in the case studies. It must be reiterated that third generation systems were introduced in 1964.

The figures are not much more encouraging when the extent of EDP systems application is considered. Only 33 per cent of all the schools surveyed are using computers for various purposes (some only for financial records) and 10 per cent have

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[24] Ibid.: Cases 3, 5.

[25] Ibid.: Cases 1, 2, 3, 4, 5.

definite plans for incorporating a system in the near future.

The case studies in Appendix II show, however, that computers can be used effectively and efficiently by correspondence study institutions. Although several of the systems studies are quite large, the methodology is there to be reviewed, further developed, and applied in other organizations. The case studies also indicate that the basic philosophies concerning correspondence education should be re-evaluated. It appears that many schools may be still using procedures and methods in the administration of their programs similar to the ones described by Arthur J. Klein in 1919.[26]

The survey has revealed that correspondence instruction departments or schools do not have to be very large to realize benefits from EDP systems. Schools with enrollments as low as 85 are using computer systems in the management of their programs. These benefits can, of course, only be attained by sharing computer systems. Specifically, the use of on-line computer terminals is due much greater attention by the administrators of correspondence study institutions with versatile third generation systems becoming more readily accessible.

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[26]Arthur J. Klein, "The Administration of Correspondence Study Departments of Universities and Colleges," Bureau of Education Bulletin No. 56, 1919, pp. 3-54.

CHAPTER V

DESIGN CHARACTERISTICS AND A GENERAL TAPE-BASED SYSTEM

In the next two chapters three alternative proposed general computer-based correspondence instruction systems will be presented. The reader must be immediately cautioned that although all correspondence study institutions have the same basic objectives, the probability that any two organizations operate in the same exact manner is extremely small. This, however, does not prevent certain generalizations from being made concerning the functions and their interrelationships which are common to the departments and schools under consideration. All systems have definite common characteristics, which were discussed in Chapter III, that provide a means for inter- and intro-disciplinary integration of information.

Design Perspective and Features

Design Perspective

The designs of the proposed systems have evolved from viewing the correspondence institutions from a macro integrated perspective. Micro analysis and design, as summarized in Chapter III, is primarily a detailed problem-solving and creative

process unique to each system. That is, the individual "building blocks" needed for the construction of an integrated system must be developed separately by each organization for its own optimum system configuration. This includes such details as input/output content and format, frequency of production, and conditions triggering output. Since the minute details of every system are unique, cost justification of specific hardware and software is also not in the realm of this study or part of the recommended general systems designs.

Common Functions

All formal organizations, such as correspondence schools, are deliberately designed for the accomplishment of specific goals. To enhance the realization of organizational goals work is divided into specialized functions. The common functions of correspondence study institutions consist of:

1. Handling of mail
2. Responding to inquiries and counseling
3. Registration
4. Dispatching and control of course materials
5. Evaluating lesson tests and examinations
6. Records maintenance and processing
7. Accounting and budgeting
8. Writing and rewriting of courses by subject matter specialists
9. Course production

10. Administration.

Daily incoming mail must be opened and directed to the applicable functional areas. In turn, outgoing mail has to be properly handled to assure effective delivery. Knowledgeable personnel must be available to respond to inquiries from prospective students and active students, in addition to performing counseling tasks. Enrollment applications require screening and the establishment of new records for those individuals who are accepted. As enrollments are processed course materials have to be dispatched to the new students and acceptable inventory levels must be maintained. When lesson tests or examinations are returned sufficient instructors or special systems are needed for timely test evaluations and the generation of feedback. The grades attained by the students must be posted to individual records and files continuously screened for delinquencies. Concurrently, accounting and budgeting records have to be updated and summarized for effective financial control.

In addition to day-to-day operations, new courses are written and old ones revised by subject matter specialists. The new or revised manuscripts are in turn used to produce the additional course materials needed by the organization. Finally, a director or management committee is required for the formulation of policies, allocation of personnel, and the coordination of all functional efforts towards the attainment of institutional goals.

Not all correspondence schools perform every function

listed. Some organizations, for instance, do not write or produce their own instructional materials but procure needed items from outside agencies. Others, such as many Federally supported schools, do not charge fees for their courses and, therefore, have no need for the maintenance of accounting records.

The desired systems characteristics and the design process outlined in Chapter III have been used as guidelines for the development of the proposed general systems. The intent of the recommended general systems, of course, is to incorporate general systems theory principles and the methodology of advanced information technology into the framework of correspondence instruction systems.

The proposed systems deal with the comprehensive and extended interrelationships of correspondence study institutions and not with the detailed operations of its subsystems. Further, the emphasis is on man-machine interaction and not on total automation. As indicated earlier, fully automated systems cannot be as flexible and adaptive as man-machine systems. An effective configuration, therefore, must be user oriented and simple to use. A computer-based system, by being extremely efficient in handling repetitive tasks, allows the administrator and educator to cope better with the complexities of his dynamic environment. In other words, the manager's and instructor's time and ingenuity can be more fully used for solving unanticipated problems and not wasted on routine, well structured processes.

The recommended general systems designs have been devised to facilitate transactions processing, control and planning. More specifically, the proposed systems feature:

1. More comprehensive administration and functional interaction effectuated by an integrated data base

2. Automated record maintenance, including information processing, storage and retrieval

3. More effective programmed learning through branching controlled by lesson test results

4. Consistent evaluation of lesson tests, examinations, and posting of grades

5. Rapid and uniform test evaluation and inquiry feedback

6. Timely student motivation by systematic follow-up notifications

7. Continuous improvement of course materials through statistical analysis

8. Automatic scheduling and notification of multi-media participation when needed

9. Functional modularity through the capability to interchange systems components.

The Tape-Based System

Figure 5.1 depicts the general design of a proposed general computer-based correspondence instruction system which primarily utilizes magnetic tape for the storage of its required files. It is an extended open system capable of achieving internal balance (homeostasis) and dynamic equilibrium with its environment through the application of an interconnected cybernetic information network. The integrated computer system serves

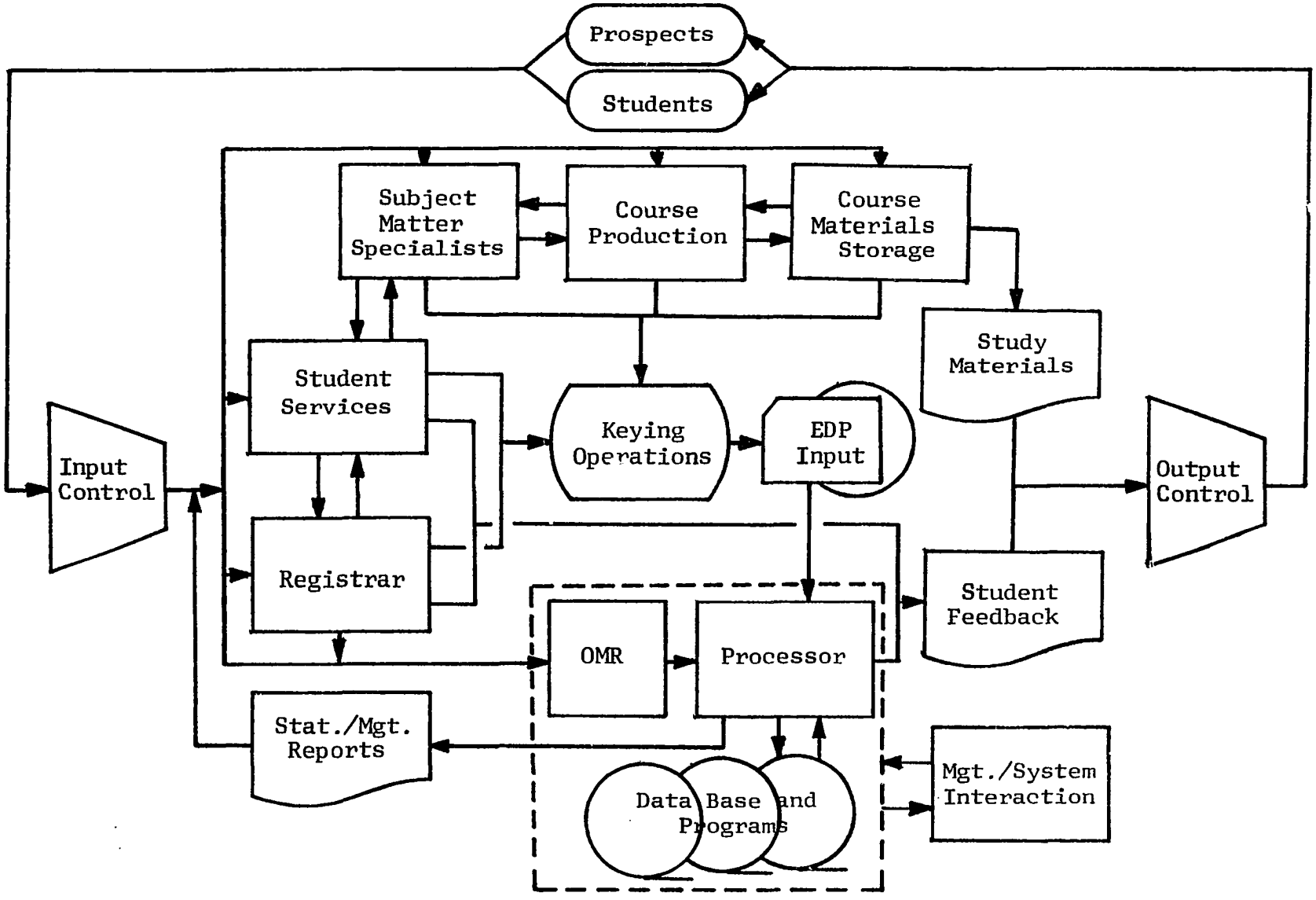

Fig. 5.1.--Tape-based information system

as the nerve center for the feedback loops which carry needed information to and from all the functional areas or affectors.

The proposed design, as clarified earlier, cannot specify detailed input/output formats and the frequency, volume, and sequence of production. General parameters, however, can be established for input/output and for processing and file maintenance which can be modified or curtailed in accordance with local conditions and demands. Information requirements of a system should be defined first in order to enhance user orientation. The description of the proposed system, however, will begin with input to facilitate data flow analysis since output has been conceptually formulated in advance. Further, although the controller and personnel functional areas are an integral part of the total system, their activities are not the focal point of this study and, therefore, will not be elaborated upon.

Input

Every subsystem of an organization must have predefined inputs and outputs in order that the efforts of all the functions are properly coordinated for optimum total system output. For the same reason a comprehensive open system must also have systematic input and output in relation to its environment. The proposed tape system design displayed by Figure 5.1 is arranged in such a manner.

All external system input and output would be centralized

for efficient distribution and delivery. On the flowchart the input and output control centers are separated. In most instances the two centers would be combined and located near the course materials dispatching section because of the continuous and extensive need for postal services by all of the functions.

External Input. External input consists primarily of prospective and active student inquiries, lesson tests and terminal examinations, and enrollment applications and course fees. Depending on the size and mode of operation of the institution, external inputs would usually be handled by three functional areas. Student counseling and the generation of replies to inquiries would be the responsibility of one section (Student Services). Another office would be assigned the registrar functions, consisting mainly of application screening, handling of fee receipts, and transcript file maintenance. If some or all lesson tests must be graded by instructors the task would be assigned to the subject matter specialists who would also be responsible for designing and rewriting instructional materials. Tests to be scored by the computer would be checked for processibility at the input control section and subsequently used as direct input to the EDP system.

In the case of a private school pertinent data from prospective student inquiries, such as individual names, addresses, advertising media triggering the queries, and courses desired,

would be transposed to forms designed to facilitate keying operations. These forms, in turn, would be used by keypunch or data recorder[1] operators to produce punched cards or magnetic tape for computer system input. Correspondence received from prospective students by a university affiliated department would be responded to by means of magnetic tape controlled typewriters. Prompt, well structured, and personal replies dealing with the specific courses under consideration would be composed and typed by these automatic devices.[2] This type of correspondence, forwarded with other appropriate literature, would be considerably more effective than the use of form letters.

Active student inquiries would be primarily handled by the employment of magnetic tape typewriters and the EDP system. Most replies would be generated by a central automatic typewriter pool[3] (not included in the system's flowchart), accessible by all of the functional areas. Obviously, the equipment would also be used for the typing of dictated responses. Special forms would be used to indicate to the machine operators the paragraphs to be used in the composition of individual letters. In addition, these forms would be utilized to show the necessary student record

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[1]Keying operations on data recorders convert data directly to magnetic tape, eliminating the need for intermediate manipulation of punched cards.

[2]Appendix II: Cases 1, 3, 4.

[3]Ibid.: Cases 3, 4.

changes that must be made and/or to specify the initiation of computer produced student feedback. When computer action is required the forms would be given to keypunch or data recorder operators for data conversion, either after the production of letters or directly by counselors or correspondents if the typing pool is not used.

Enrollment application forms of the proposed system would be structured to enhance keypunching operations. For extremely high volumes of data input OMR equipment would be incorporated and all external and internal input documents redesigned for mark-sense coding.[4] Enrollment applications would be screened by the registrar and accepted applications would be distributed to keypunch or data recorder operators or used as input to an OMR unit. Form or automatic typewriter letters would be used to inform individuals whose applications have been rejected for various reasons.

If OMR equipment is not utilized, lesson tests or examinations submitted by a student for instructor grading would be accompanied by two prepunched cards. One card would be used to post the date a test was received to the enrollee's record. An instructor evaluating a lesson or final examination would use the second card by pushing out applicable perforated punches to indicate the score attained by a student, to depict how well each question was answered, and to credit his account for the work

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[4] Ibid.: Case 3.

performed. Objective test answers would be recorded by a student on a punched card, which would be precoded to identify him, by uncovering the appropriate perforated punch locations. The card would then be used as direct input to the computer system for scoring, updating of the student's record, and generation of feedback.

When OMR equipment is employed with the proposed system, two mark-sense forms would be submitted by a student with his constructed response test. The two forms would be used to accomplish the same tasks as outlined for the two punched cards above. For multiple choice tests, an enrollee would display his selections on a mark-sense form which, in turn, would then be used as direct input to the EDP system via the OMR unit.

It should be clarified at this point that OMR equipment does not have to be installed specifically for correspondence study applications. Large private schools, and especially universities with large computing centers, can employ OMR devices for almost any administrative and research activities. OMR equipment can be used not only for test scoring and grade reporting, but for research questionnaires, medical records, registration, attendance records, accounting, materials requisitions, and many other purposes. The high cost of the devices requires that primary consideration be given to cost justification through the analysis of present and anticipated (changes dependent on both

growth and the redesign of most source documents) form processing volumes.

Internal Input. Internal system input is comprised mainly of file queries, record changes, statistical analysis requests, and functional area activity updates. Counselors and correspondents, for instance, must have continuous access to the active enrollee file data to be capable of responding promptly and effectively to student inquiries. Magnetic tape files can be queried only by the use of punched cards or mark-sense forms if OMR equipment is available. When files are processed daily this procedure does not present much of a problem since record printouts can be obtained usually within twenty-four hours.

Under the proposed system if processing is accomplished daily key personnel or sections that require constant access to certain files would be given a supply of precoded, perforated punched cards (one portion of the card is prepunched to identify the person or section). Subsequently, needed data would be queried by simply pushing out applicable perforated punches indicating the file and record number/s desired. These cards would be used as direct input to the EDP system, eliminating considerably the requirement for time consuming keypunching operations. Computer printouts of the records would be automatically distributed to the predesignated persons or sections. If OMR equipment is available, the same procedure as delineated for the perforated

punched cards would be used with mark-sense forms.

When processing is to be conducted biweekly or less frequently, or when data conversion operations are time consuming, alphabetical computer printouts of the active student file or other continuously accessed files would be maintained at strategic locations. Usually it is not necessary that all the information maintained in a file be printed out. A statistical analysis can be made as to what data is most frequently queried. Based on the analysis, constantly needed data would be included in the computer listings. Less frequently required information would be obtained by means of punched card or OMR forms input. How often the printouts are updated would depend on the volume of new enrollments or other transactions processed. Supplemental listings, however, would be produced each processing cycle to assure continuity of information.

Record changes, statistical analysis requests and functional area activity updates would be accomplished in the same manner as prescribed for file queries, using perforated punched cards or mark-sense forms when an OMR device would be utilized. If such procedures could not be implemented, a consolidated form designed to facilitate keying operations would be employed for all internal inputs.

Functional area activity data inputs require further clarification and emphasis. If the recommended integrated system is to function properly and remain viable all subsystems must contin-

uously supply predefined activity or operating information to the central data base of the information system. Without such data the computer-based management information system would not be able to furnish the functional areas comprehensive, timely, and useable operational and administrative reports. Obviously, if this would take place the cooperative efforts of all system activities would be less than the maximum obtainable due to suboptimization. That is, organizational synergy would be lost.

Under the proposed system all of the subsystems would systematically feed data to the central information system. For example, the registrar may indicate the number and reasons for application rejections; student services could depict the number of students counseled and the number of inquiries responded to; the subject matter specialists can reveal what is being written or redesigned, the progress to date, and the estimated completion dates; course production may show the status of course materials printing and possible backlogs; and course storage would show the receipts[5] and salvage for a given time period. Such information would be used to generate periodic (or by request) integrated summaries allowing each functional area to gauge its own performance and that of the entire organization.

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[5]The proposed system would automatically reduce each applicable course materials item in stock by every new enrollment processed by the EDP system.

Processing and File Maintenance

File Media. As stated previously, all major files of the first proposed system would be maintained on magnetic tape. A possible exception would be made with the inactive student or transcript file, depending on the frequency the data in the file would need to be accessed and the number of changes that would be required to be made in the records. Inactive records, dictated by policy not to be updated or changed, are usually most effectively stored on some form of microfilm. Computer output can be automatically converted to microfilm. Therefore, when records are removed from active computer files they would be directly transformed to aperture cards, 16 mm film rolls, 35 mm film, or microfiche[6] for permanent storage.

If students would be allowed to submit lessons and complete courses for limited periods after the established time limit for a course has been exhausted, the "semi-active" records would be kept on tape. Under these circumstances the determination as to when to transfer the inactive student records to microfilm would be made based on statistical analysis of how long most of the records remain active after the expiration of the time limitation. For instance, student records could be maintained on the active tape file for six months after the enroll-

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[6]Harry Katzan, Jr., Computer Organization and the System/370 (New York: Van Nostrand Reinhold Company, 1971), p. 39.

ments have been terminated and then automatically converted to microfiche.[7]

This method is especially efficient from a record maintenance standpoint when tests are scored by a computer. The EDP system would automatically post the grades and, based on the enrollment dates, would at the same time print notices for the cancelled students explaining that credit is not given for work submitted after the time limitation has expired. Considerable clerical work could be saved with this procedure and records would be available to reveal if and when late assignments were forwarded by enrollees.

Program, File, and Processing Characteristics. The application and control programs and files of the recommended tape system would be characterized by functional modularity. Specifically, new application programs could be added and current ones revised or eliminated at will without effecting the capabilities of other program modules. Individual files would also be constructed in such a manner as to facilitate system architectual changes without requiring other files or programs to be revamped. In addition, the necessary control programs would be deliberately formulated to simplify periodic revisions by minimizing concurrent file and application program redesigns.

During each computer production cycle all external and in-

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[7]Appendix II: Case 1.

ternal inputs would be processed to update all tape files. Certain types of functional area activity inputs, however, could be processed less frequently depending on the volume and critical aspects of the information.

Prospects. Punched card or magnetic tape input of prospects from the data conversion section would be sorted and added to the revival mailing file by the EDP system. At the same time the data would be used to update the regional advertising and sales files. Finally, the new prospective student tape would be used to both print mailing labels for brochures to be sent to the candidates and lead forms for the salesmen.

Enrollment Applications. Machine readable new enrollment data in the form of punched cards, magnetic tape, or screened mark-sense application forms would be processed by the computer system to construct and add new records to the master active student file. All active enrollment records would be designed to contain both educational and financial data. In addition, each record would include the name and address of the proctor who would administer the final examination. The enrollment tape would also be utilized to print mailing labels for initial course materials, encode answer sheets or punched cards if objective tests would be employed, and/or produce two punched cards for each lesson to be sent to the students to facilitate instructor graded lesson administration if applicable. Further, the new enrollment data

would be used to update the sales (including sales force commissions) and advertising files, the general course activity file, and the inventory control file.

Tests and Examinations. Input control would open lesson assignments and course examinations submitted for instructor grading. One of the two punched cards (or OMR forms) included with each test would immediately be used as input to the computer and processed to post the dates manuscripts were received to the student records. The other cards with the lessons or examinations would be forwarded to the appropriate instructors for grading. Subsequently, the grade cards returned by the instructors would be processed to update major files and to initiate the generation of numerous computer products.

First, grades would be posted to the appropriate records in the active student file.[8] If an enrollee has not completed all lessons of a course the EDP system would print control cards or a mailing label for the next set of instructional materials to be dispatched to the individual. Not only would the computer automatically indicate which items are to be mailed, but it would make the selection on the basis of the score attained by the student on his last lesson test. In essence, more effective programmed learning concepts would be incorporated by using the

[8]Student records would be filed and identified by social security account numbers.

computer to control and direct branching. In this manner each student would be able to not only progress through the course at his own pace, but also on his own academic level.

If the score placed in a student record is for the last lesson of a course and all other requirements have been satisfied, the EDP system would automatically construct and print a terminal examination for the individual. The questions for the examination would be randomly selected from an item pool based on the materials that a student has covered by the branching method. In addition, the examination would be automatically addressed and dispatched to a predefined proctor indentfied by the student's record.

The posting of a satisfactory final examination grade to an enrollee's record would initiate the production of a course completion certificate by the computer system. On the other hand, a failing score would trigger the printing of a letter by the EDP system explaining to a student precisely what must be accomplished by him to rectify the situation.

Further, when deemed necessary, the computer would consult a multi-media schedule file after a grade is posted to a student record. Based on the progress of an enrollee and the multi-media schedules, a student would be automatically informed when and where to attend a lecture, a group discussion, or when to view or listen to television or radio presentations.

Finally, the lesson test and examination evaluation data would be used to update vital administrative files. This includes the instructor file employed to summarize and credit the work accomplished by individual instructors. In addition, the EDP system would utilize the data to continuously update the test analysis, course activity, pass-fail, and inventory control[9] files.

Processing and file maintenance resulting from computer scoring of lesson assignments and final examinations would basically follow the same course of action as delineated for instructor grading with two exceptions. First, lesson exercises and terminal examinations would be automatically, rapidly, and systematically evaluated by the EDP system. Second, the computer system would generate uniform test feedback based on all the responses chosen and the score attained by a student.[10] This would be accomplished in lieu of inconsistent instructor comments usually written on the lesson assignments submitted for grading.

The objective, as stated previously, of the proposed computer-based system would be to assign all repetitive and semi-repetitive tasks to the machines. It is assumed that this proce-

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[9]As lesson materials are mailed out applicable inventory items in stock would be automatically reduced by the same quantities.

[10]Appendix II: Case 3.

dure would be of greatest benefit to the subject matter specialists allowing them to devote all their faculties to the design and restructuring of study materials. Not only would the computer system permit the education specialists to concentrate more on the instructional methodology and media, but it would also assist the experts by continuously supplying them with a variety of compiled statistical data, such as test item analysis.

Student Reminders. Reminders would consist of follow-up, delinquent account, non-expendable item, and cancellation notifications. During each processing cycle the activities of every student in the enrollment file would be screened by the computer system. Follow-up letters would be produced by the EDP system for students who have not submitted lessons during a prescribed time period or who have been unable to attain satisfactory grades on a given number of the lesson exercises. If desired, the system could also furnish individual names and background information to counselors who could then contact the applicable students by telephone or schedule personal interviews. The computer would also print delinquent account notices for enrollees who have failed to satisfy their financial obligations based on the terms outlined by the enrollment contract.[11] Further, the system would automatically notify individuals who have not returned non-expendable study materials which are overdue.[12] Finally, the EDP

[11] Ibid.: Case 4.

[12] Ibid.: Case 5.

system would generate course cancellation notifications for students who have not satisfied all course requirements during the maximum allotted time frame or who have been grossly negligent in meeting their financial obligations.

Internal Files. Every production cycle functional activity data input would also be processed and the information used to update the inventory control, general activity, and controller file. These files would be continuously posted but summary reports based on the files would be printed periodically or by request. For example, new receipts and salvage data input from course materials storage would be another source utilized to compile inventory control information. In the same manner, the functional activity data would serve to update the comprehensive organizational activity file and the controller accounting and budget files.

Output

Most of the proposed system's output has been described in the discussions dealing with inputs, processing, and file maintenance. Therefore, this portion of the chapter will be devoted primarily to summarizing the specific external and internal output which would be generated by the system.

External Output. The environmental output of the proposed computer-based system would be comprised of:

1. Replies to prospective and active student inquiries, including brochures
2. Study materials
3. Lesson and examination evaluation results
4. Multi-media schedule notifications
5. Student reminders
6. Course completion certificates and transcripts.

Only the method of dispatching study materials requires further elaboration. For effective and efficient handling a predefined portion of all course materials would be prepackaged. How much would be prepackaged or retained in general storage would be statistically calculated and periodically printed out by the computer system.

Two methods would be used to mail individual study units or examinations to the students. For lessons or examinations which would be evaluated by instructors, the two precoded perforated punched cards, employed for test administration, would also be used as mailing labels. The cards would be inserted (by machine or manually) into window envelopes leaving the identification portion of one of the cards exposed. Subsequently, the envelopes with the cards would be utilized to identify the prepackaged study units or examinations to be forwarded and then attached to the selected packages for mailing. The same procedure would be followed with the two mark-sense forms if an OMR device is available. Lessons and examinations scored by the EDP

system would be dispatched by the same method, only in this case the precoded perforated solution cards or the encoded answer sheets would be used for mailing labels.[13] For convenience the punched cards or mark-sense forms would be produced by the computer system in course number sequence.

When the above method cannot be conveniently employed the EDP system would be programmed to print course materials mailing labels for all new enrollments and lessons processed.[14] These labels would also be printed in course number order so that they could be used for the identification and selection of the prepackaged study units to be dispatched.

Internal Output. Organizational information output would mainly consist of:

1. Printouts of requested records
2. Alphabetical or numerical file listings
3. Input data and error listings
4. Lead forms for salesmen
5. Statistical and management reports.

As stated earlier, the emphasis in the architectual design of the information system would be on functional modularity. For additional flexibility and maximum data utilization, the files would be structured to facilitate interrogation of all records by any application program. That is, all files would be part of an

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[13] Ibid.: Case 1.

[14] Ibid.: Case 5.

integrated data base. This, of course, would render the computer system the capability to compile almost any needed statistical or management reports either periodically or by request. The output could consist of, but would not be limited to, the following reports:

1. Test item analysis (1, 5)
2. Pass-fail or test performance (3, 5)
3. Inventory control (1, 3)
4. Course activity (1, 5)
5. Data availability (5)
6. Examination and non-expendable materials follow-up (1, 5)
7. Regional advertising and sales (4)
8. Budget (4)
9. Resource accounting (3)
10. Functional activity
11. Instructor test evaluations and delinquencies (3).[15]

Management-System Interface

A relatively safe assumption is that any of the three proposed computer-based systems will be deficient in some ways. Further, the dynamic environment of an open and expanded system demands continuous adaption to changes. It is, therefore, vital that systematic procedures are developed for the detection and

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[15]Descriptions of the reports are included in the case studies annotated by the numbers in the parentheses following the titles of the summaries.

correction of deficiencies and for the constant improvement of the total system.[16] The responsibility for the design and implementation of the recommended control procedures should not be given to computer specialists but equally distributed amongst all levels of management. Without adequate support and guidance, from the director or president down to the lowest operating level, a system cannot function properly or be user oriented.

With any of the three proposed general systems a permanent planning committee would be organized for the evaluation and improvement of the information system.

The committee would be chaired by the director of the home study institution and would include systems specialists, functional area managers or supervisors, and outside consultants when necessary. Members would be scheduled to meet once every six months or more frequently when conditions warrant more attention.

The committee would study both organizational and environmental conditions. Major reoccurring problems associated with the information system would be analyzed first. Recommendations for the solution of these problems would be strictly based on the availability of resources (financial and human) and established priorities.

General improvements of the system and its products would be scrutinized next. The emphasis here would be on the future (at least two to three years). Evaluations and recommendations

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[16] Russell L. Ackoff, "Management Misinformation Systems," Management Science, December, 1967, pp. 155-56.

would be based on forecasts of technological changes, demands of the environment, and defined long-range institutional goals and objectives.[17] Long-range planning, of course, would also include resource analysis and the establishment of implementation priorities.

The evaluations and proposals made by the committee would be well documented. The quality and content of the written plans would be one of the most significant aspects of management-system interface.[18] The written plans would facilitate progress assessments, re-evaluations brought about by changing conditions, and general planning continuity.

In the next chapter of the study the basic architecture of the proposed tape-based system will be extended. First, most of the tape files will be converted to random access disk files to facilitate the incorporation of on-line real-time CRT terminals. Second, the principal hardware and software of the computer-based system will be physically removed from the organization.

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[17]Robert V. Head, "Planning for Real-Time Business Systems," Systems and Procedures Journal, July-August, 1967, pp. 13-14.

[18]F. Warren McFarlan, "Problems in Planning the Information System," Harvard Business Review, March-April, 1971, pp. 82-83.

CHAPTER VI

GENERAL DISK AND SERVICE BUREAU SYSTEMS

The Disk-Based System

Figure 6.1 displays the general configuration of the proposed disk-based information system. It is apparent from the flowchart that there would be very little difference between the basic structures of the tape and disk systems. Although the comprehensive frameworks would be similar the disk system would be characterized by the increased emphasis on man-machine interaction. Input to the system and information retrieval would no longer be dominated and controlled by time-consuming and error-prone data conversion operations. With the exception of OMR input (when applicable) all of the activity would be centered around on-line real-time CRT terminals.

The modular design of the tape system would simplify conversion to the new system with the assumption that most of the application programs and the files would not have to be redesigned. That is, both systems would be characterized by built-in flexibility in terms of both conversion and growth. Consequently, with the exception of increased user orientation, the internal operations of the disk system would be quite similar to the tape system analyzed previously.

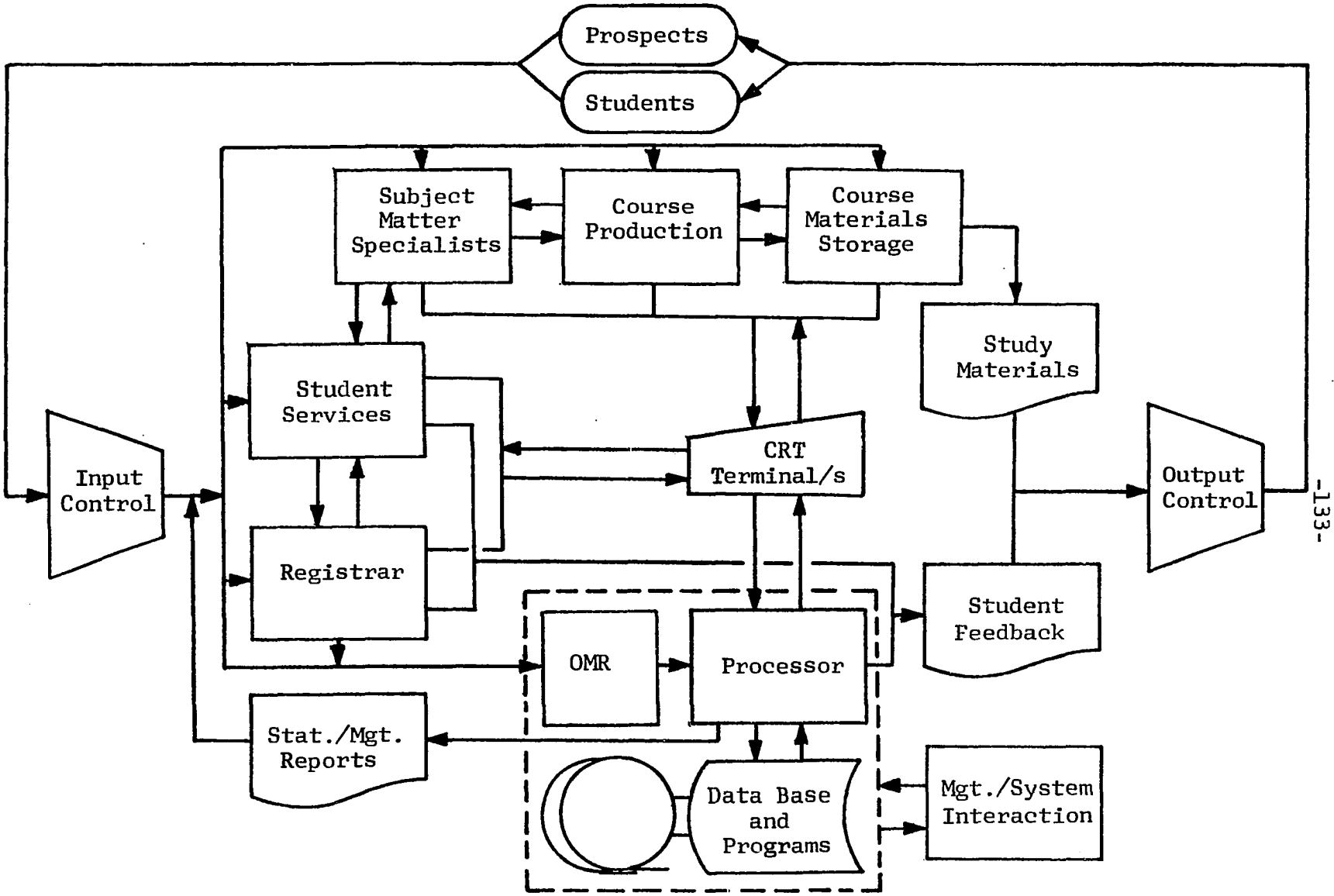

Fig. 6.1.--Disk-based information system

External Input. If the system would be instituted by a private home study school, data from prospective student inquiries would be introduced into the computer system via CRT terminals.[19] This process would initiate the generation of introductory letters, mailing labels for brochures, salesmen lead forms, and revival mailing tapes by the EDP system. In the case of a university independent study department, initial queries would trigger automatic typewriter or similar action as outlined above if revival mailing would be used.

Active student inquiries would be handled by tape controlled typewriters and the computer system. There would be no need, however, to request printouts of student records or to consult alphabetical file listings. Counselors and correspondents would simply reference individual enrollee records for needed data in real-time with the aid of CRT terminals. This procedure would be especially effective in responding to telephonic queries. Further, those records being checked which would have to be subsequently used to produce computer replies would be coded by the correspondents and then automatically set aside by the system in a special file. At the end of each day this file would be utilized to print the applicable letters in a batch mode. Inquiries from students requesting information on the general status of their work could be particularly well handled by such a routine.

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[19]Appendix II: Case 4.

The same types of enrollment application forms would be used as proposed for the tape system. The only exception would be that if OMR equipment is not incorporated, data from the forms would be placed directly on disk via the CRT terminals. Operators would be able to visually check all input on the display screens prior to transferring the information to the active student record file.

Lesson exercises and terminal examinations would also be handled in the same manner as recommended for the tape-based system. That is, precoded perforated punched cards would be automatically produced by the computer system when new enrollments are processed for the administration of both essay and objective tests. These cards would be used to reduce the time consuming and repetitive terminal keying requirements and to permit objective tests to be scored by the EDP system without the application of OMR equipment. No other punched cards would be utilized with the disk system.

Internal Input. File queries, record changes, statistical analysis requests, and functional activity inputs would be made utilizing the CRT terminals. If OMR equipment would be available much of the internal data, with the exception of information retrieval requests, would be fed into the EDP system by means of mark-sense forms.

Processing and File Maintenance

File Media. The major and/or most active files of the sys-

tem would be maintained on magnetic disk. This would obviously include the active student record file and, depending on the volume, the inventory control file. It is most likely that the special statistical and management summary files would be stored on magnetic tape, depending on the availability of random access storage. Inactive student records, including drops, cancellations, and completions, would be converted to microfiche.

Each active student record would include pertinent background information, current course/s data (course number or title, lessons, grades, submission dates, etc.), financial transactions, and the dates and types of responses made to inquiries received from the enrollee.[20] When a student's record is queried all of the above data would be exhibited on the terminal screen. If more comprehensive enrollee records are to be maintained the information could be stored in sections and presented in separate displays.[21] Inactive student records would be retained on disk for six months for administrative expediency (discussed in Chapter V) prior to being transferred to microfiche. Moreover, this procedure would save valuable random access storage space for continuously accessed files.

Processing Characteristics. All external and internal inputs would be processed every work day. CRT terminals would be

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[20] Ibid.: Case 4.

[21] Steven Wood, Willis Seabrook, and Michael Robbens, ed., "Analysis and Proposed Redesign of the University of Wisconsin Extension's Independent Study System," (Unpublished paper, University of Wisconsin, February 11, 1971), pp. 135-36.

primarily located in Registrar, Student Services, and Course Materials Storage (if inventory control records would be stored on disk). Files maintained on random access devices would be continuously updated while the terminals are on-line with the EDP system. The tape files and the special daily disk file used for printing responses to course status requests would be processed in a batch mode at the end of each day.

The specific file maintenance and processing procedures of the disk system would be basically the same as those outlined for the tape system in Chapter V. The primary system's improvements and changes would be effectuated by the introduction of the real-time terminal input/output modes. Furthermore, user oriented statistical routines would be placed on disk with the second system. Consequently, education specialists and administrators could activate one or more of the available routines, using the terminals, and compile any data in the random access files into timely and useful summaries. These summaries would be produced at will in addition to the periodic reports supplied by the EDP system from disk and tape files. Based on cost justifications computer simulation models could also be introduced in the same manner with the disk system.

Output

External output to the students would remain the same as demonstrated for the tape-based system in Chapter V. Internal output, however, would be changed considerably. Files stored on

disk would be queried in real-time, eliminating the need for individual record printouts or the maintenance of voluminous file listings. In addition, as stated above, the system would have the capability to incorporate simulation models and statistical routines which could be initiated at will via the CRT terminals.

The Service Bureau System

The third proposed general system design incorporates the software expertise and hardware capabilities of a large, shared computer facility. This system configuration would be especially appropriate for university departments or other organizations that have access to relatively large central administrative computer systems. As indicated in Chapter IV, there are three primary methods which can be employed to share an EDP system. First, document conversion can be performed at an institution and data manipulation at a service bureau. Second, both data transformation and processing may be accomplished at a service bureau. Finally, on-line terminals tied into a shared computer facility could be installed on the premises of a school or department. This portion of the chapter will be limited to the macro description of the third method.

Characteristics of the Proposed System

The third general system design is displayed by Figure 6.2. It is indeed apparent that the general service bureau or

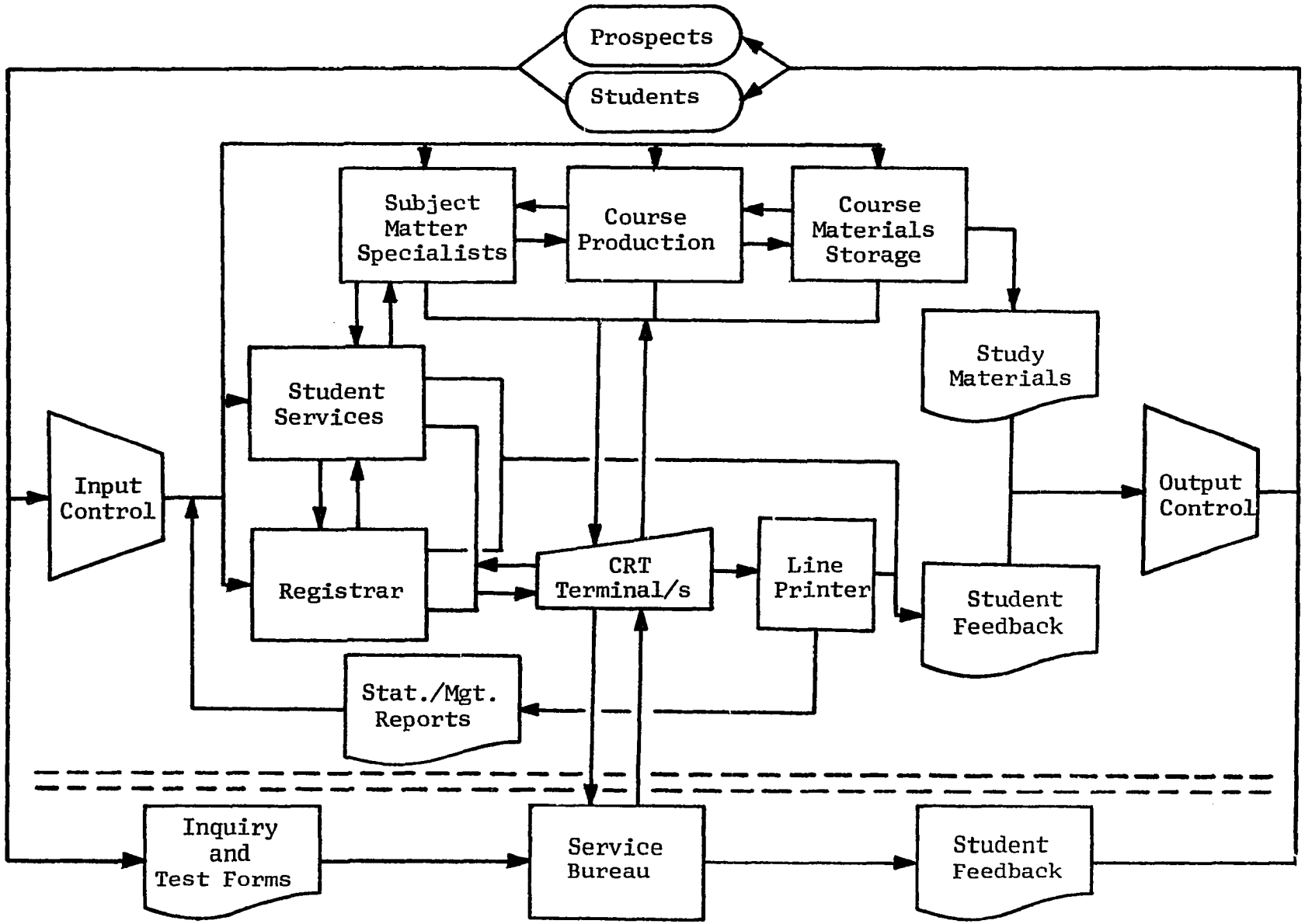

Fig. 6.2.--Utility-based information system

time-sharing system is almost identical to the disk-based system shown in Figure 6.1. Basically all that has been altered is that the computer is now physically removed from the organization. More specifically, (1) external input/output would be controlled by both the user and the service bureau, (2) all organizational EDP system input and most output would be handled by CRT keyboard terminals, and (3) a line printer tied into the shared computer system would be utilized for all internal and some external printed output.

Input. Inquiries from prospective students would be responded to in the same manner as outlined for the second system. Correspondence received from active enrollees, however, would be partially handled by an additional technique. With the third system the cooperating service bureau would be equipped with an OMR device. Owing to this capability, all students would be forwarded mark-sense inquiry forms with their study materials. Subsequently, the enrollees would use these forms to automatically query their computer records or other files for needed information. These forms would be mailed directly to the service bureau. For example, an individual could, by marking specific alphanumeric locations on the form, request a printout of his records, ask for a new schedule of multi-media presentations, or apply for a limited one-time course extension (additional extentions would be controlled by counselors). The inclusion of this procedure would make the system more responsive and flexible for both the students and administrators.

All enrollment applications would be approved by the home study organization. If mark-sense forms would be employed, the approved applications would be forwarded to the shared computer center for processing. All other accepted applications would be input to the system via CRT terminals.

Subjective lesson exercises and final examinations would be evaluated by the independent study institution. Students would receive two forms with each lesson. One form would be used to post dates of assignment receipts to individual records. The second form would be used by instructors to indicate the grades attained by the students and to update the test analysis and instructor activity files. Data from both documents would be input to the system by CRT terminal operators. Students would mail objective test answer sheets directly to the service bureau for OMR input and processing.

Processing and File Maintenance. In the proposed time-sharing mode, all files, with the exception of the transcript file, would be maintained on random access storage devices at the central computer facility. The structure and method of display of the active student file would be identical to that of the disk system design. Inactive student records would be retained in the active enrollee file for six months and then transferred to microfiche. The microfiche transcript file would be located at the independent study school or department.

If necessary, some of the accumulative historical files

used for quarterly or yearly reports could be maintained on tape at the service bureau. Periodic summaries from these files and all other internal reports would be output by the line printer situated on the correspondence study institution's premises. When cost justifications do not allow the utilization of a local line printer, all external and internal printed reports and documents would be produced at the shared computer center and delivered to the participating school or mailed directly to the students.

CRT keyboard terminals would be used mainly by the Registrar and Student Services. Depending on the volume of activity, a terminal could also be placed in the course materials storage area.

Under the proposed system, the participating home study institution would have to determine how long its terminals would have to remain on-line with the central computer system each day for optimum work load accommodation. For maximum flexibility and responsiveness, terminals should remain active for a minimum of six hours a day (three in the morning and three in the afternoon).[22] However, this may not be feasible both from a cost and/or hardware perspective under certain conditions. During the time the terminals would be on-line all files (except tape files) would be continuously updated and accessible in real-time.

The specific file maintenance and processing procedures

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[22]Appendix II: Case 4.

of the service bureau system would be basically the same as those described for the other two systems. The primary difference would be that application and control programs, and hardware development and maintenance would be the responsibility of the central computer facility.

Output. As stated earlier, external input and output of the proposed system would be controlled by both the user organization and the service bureau. Literature and course materials would be dispatched from the home study institution. Mailing labels for brochures and study units would be output by the on-line printer situated at the participating school. If a local printer is not employed the labels would be produced at the shared computer center and delivered to the independent study organization. Encoded control forms for essay tests or mark-sense answer sheets for objective tests would be used as mailing labels for forwarding course materials to the students. These documents would be printed either locally or at the service bureau, depending on the specific system configuration.

Replies to active student inquiries would be mailed out from the participating school with the exception of the responses to the mark-sense inquiry forms discussed under Input. Automatic correspondence feedback could also be triggered by correspondents or counselors using the CRT terminals. All computer generated responses would be dispatched from the service bureau.

Multi-media schedule notifications, student reminders, and course completion certificates would be forwarded to the enrollees

directly from the shared computer center. Terminal examinations, compiled from the examination question pool on the basis of individual branching assignment completions, would also be mailed to the students from the central computer facility.

All internal output, with the exception of lead forms and periodic statistical and management reports, would be handled by the CRT terminals. The lead forms and summary reports would be printed either locally or at the service bureau contingent on the availability of a line printer at the participating institution.

Management-System Interface

The basic functions of the management planning and control committee recommended in Chapter V will not be further elaborated upon. It must be stressed, however, that under the third proposed system the systems specialists and the hardware would not be part of the user organization. Therefore, more emphasis would have to be placed on cooperation and interaction between the participating school or department and the central computer facility. Detailed written procedures should be formulated for input, processing, and output during program development and file conversions. Formal agreements should include the method of billing and the specification of ownership of all documents and software.[23] In addition, continuous improvements in the total system should be sought through cooperative efforts.

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[23]B.G. Schumacher, Computer Dynamics in Public Administration (Washington: Spartan Books, 1967), pp. 43-44.

Extension of the System

The service bureau concept could be expanded to regional, national, or even international dimensions. Systems of this magnitude, of course, could only be designed and implemented by pooling the resources of all the accredited correspondence study institutions. The hardware and software is available for the development and implementation of such comprehensive systems. The cooperative spirit and the motivation for the advancement of new instructional techniques, however, still leaves much to be desired.[24]

Regional or national "Correspondence Instruction Computer Utilities" could provide similar but much more sophisticated products and support as delineated by the three proposed general systems designs to all reputable independent study institutions. Benefits from these systems would appear to be extensive.

First, all of the utility or utilities resources would be devoted to the administration of correspondence instruction programs. It is assumed that specialization would make the systems extremely responsive and adaptive to home study problems. Second, the computer facilities would be designed to offer courses constructed by the "best" course authors. This should considerably reduce the waste of sizeable resources currently being caused by the duplication of courses.[25] Third, elaborate guidance programs,

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[24]O. Mackenzie, E.L. Christensen, and P.H. Rigby, Correspondence Instruction in the United States (New York: McGraw-Hill Book Company, 1968), pp. 212-15.

[25]Ibid., pp. 216-18.

statistical routines, and descriptive and predictive models could be made available to all independent study educators and administrators. Fourth, each participating institution would be able to devote most of its energies to "genuine personalized" tutorial services. Finally, the utilities could easily be redesigned in the future for telephone input and output, making such systems even more user centered.

These correspondence instruction utilities could administer all correspondence study curricula centrally but allow users to maintain local autonomy. For example, participating institutions could charge a fee for each enrollment processed and for the individualized tutorial services provided. The schools or departments in turn, would be charged by a utility for the number of active student records being maintained and the products generated by the central computer system.

The regional or national utilities could serve as the foundation for more advanced multi-media instructional systems. Not only would such systems accommodate future telephonic input and output, but also audio and video transmissions. Further, these systems could facilitate future world-wide educational efforts with the aid of satellites.[26]

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[26]John G. Weihaupt, "Project Satellite: Status Report No. 3," (unpublished paper, United States Armed Forces Institute, 1970).

CHAPTER VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The general hypothesis of the study was that most correspondence schools or departments are not using computer systems in the administration of their programs. Further, in institutions where computers are being applied the systems designs are usually not closely related to general systems theory and fail to fully take advantage of the versatile techniques afforded by advanced information technology. The problem exists in spite of the growing demand for education, especially continuing education, and the increasing limitations placed on funds for physical facilities and staffs.

Based on the above suppositions and facts the study had a dual objective. One was to ascertain the extent of the problem by analyzing the methodology and the degree of EDP systems application by the accredited independent study institutions. The other was to extend general systems theory and the technqiues of advanced information technology in the field of correspondence education. That is, the endeavor was to provide a general unified knowledge base for the design and application of computer-based independent study systems.

Summary and Conclusions

The study was conducted in three primary phases. Initially, five large computer-based correspondence instruction systems, including three Federally supported schools, were analyzed. The intent here was to build a fundamental knowledge base concerning present computer-based systems development and to formulate a general hypothesis for the next phase of the study. This portion of the study could be classified as basic research due to the absence of literature on the subject. Personal interviews were conducted with correspondence school or department administrators who were either involved with or responsible for computer utilization and system design. Interviews and discussions were directed with in-depth, open-ended questions to assure that pertinent areas received proper attention.

Although the organizations for the case studies were chosen on the basis of a purposive judgment sample, the selections appear to have provided more than adequate data on the present state of the art. The questionnaire survey revealed that only two other institutions (one NUEA and one NHSC member) may have equal or more advanced system designs than any of the five agencies investigated for the study. The case studies indicated that selective computer-based methods and procedures have been fairly well advanced in the field. However, none of the institutions visited, in one degree or another, had a fully integrated system configuration. In other words, the basic methodology is there to be reviewed, further developed, and applied in other

home study organizations.

During the second phase of the study 138 questionnaire surveys were mailed to all of the NUEA and NHSC member schools and departments. A total of 121 or 88 per cent of the institutions responded. The survey confirmed the general hypothesis formulated at the end of the initial phase of the study. Only 22 per cent of the NUEA departments and 44 per cent of the NHSC schools are using computers to varying degrees. In addition, 12 per cent of the NUEA members and 8 per cent of the NHSC members have definite plans for incorporating EDP systems into their operations. Further, 26 per cent of the NHSC schools utilizing computers employ the systems only for the maintenance of student financial records. Tables I through X in Chapter IV summarize the results of the survey in detail. The overall compiled data demonstrates that the level of EDP systems application, with very few exceptions, is at best at the mid-second generation computer development stage.

In the final or applied research phase of the study three alternative proposed general computer-based systems designs were developed. The structures of these systems have evolved from viewing the correspondence institutions from a macro-integrated perspective. The recommended systems designs are a synergistic systhesis of the effective methods and techniques selected from the data gathering phase, general systems theory principles, and advanced information technology.

Figure 7.1 summarizes the basic characteristics of the

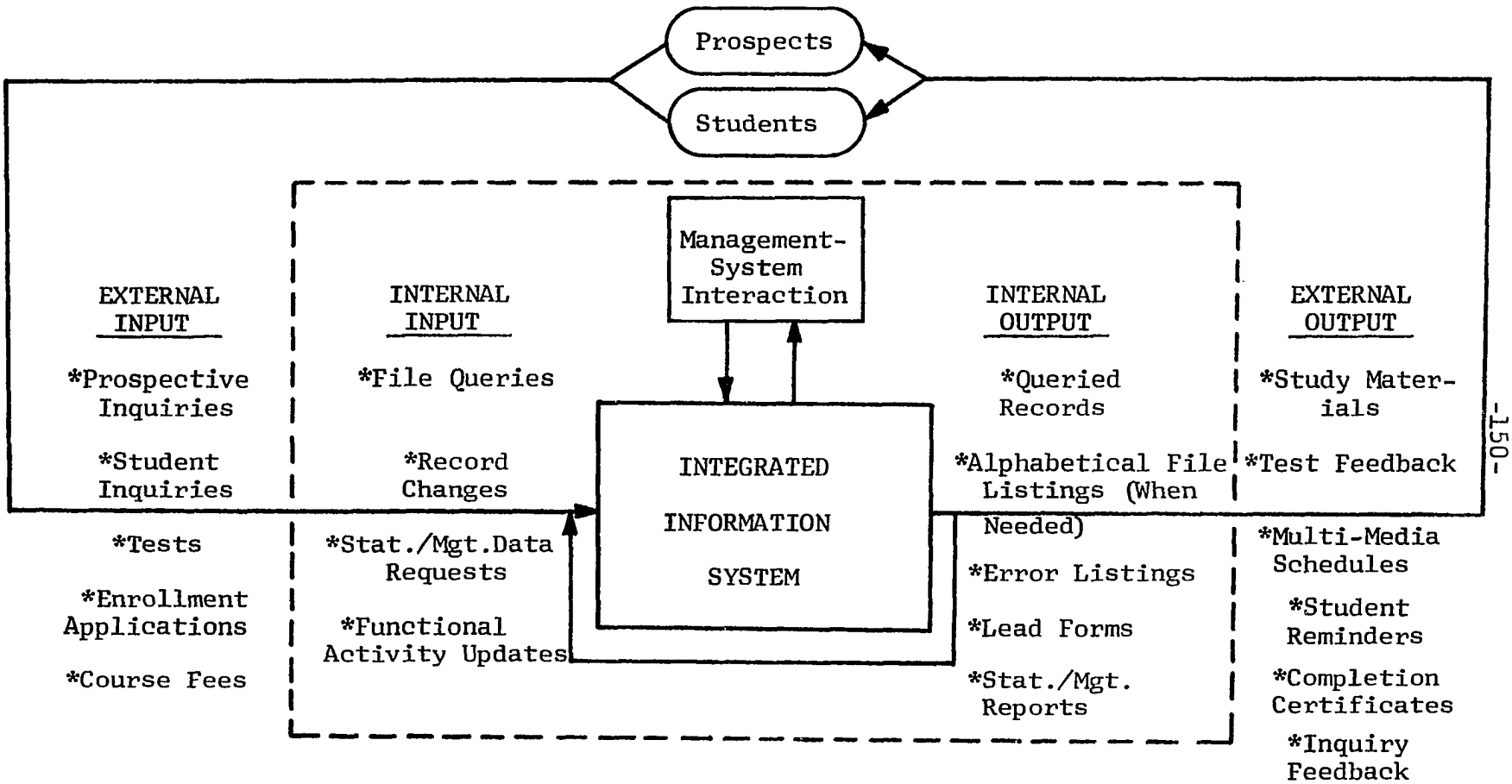

Fig. 7.1.-- General computer-based system configuration

three proposed systems designs. The diagram depicts an open extended system continuously interacting with its environment, thereby minimizing entropy and maintaining dynamic equilibrium or a steady state. Homeostasis and dynamic equilibrium is sustained by means of integrated internal and external cybernetic feedback loops controlled by a central computer-based information system. The design is also characterized by equifinality, since the system is continuously being improved through management-system interaction and the generation of statistical and administrative reports. Although the general design is barely at the fourth level of complexity or that of the self-maintaining system delineated by Boulding,[1] it extends the application of general system theory and information technology further in the correspondence study field.

Suggestions for Additional Research

The absence of comprehensive literature directly related to computer application in the administration of correspondence instruction systems obviously demands more concentrated research efforts in the area. The current study has taken a macro approach in establishing a knowledge base, analyzing the present state of the art, and proposing various systems designs. Future endeavors could place greater emphasis on a micro perspective.

As stated throughout the study, an effective system must

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[1]Kenneth E. Boulding, "General Systems Theory--The Skeleton of Science," Management Science, April, 1956, pp. 197-208.

be user-centered. Therefore, an extensive study of user requirements would be very helpful in determining external system input/output specifications and formats. For instance, Do students prefer essay or multiple choice type lesson tests or examinations? Is prompt and precise computer generated feedback considered more impersonal than that produced by instructors? What is the optimum interval and the maximum number of student reminders that should be dispatched? New innovations demand proper direction.

Another approach may be the design of individual application program packages or modules. Program packages for specific products, such as assignment branching, student feedback, common statistical and management reports, student reminders and multimedia scheduling, could be developed. Only the input/output requirements and formats would have to be modified locally with these program modules.

A more precise determination should be made as to the relationship of correspondence instruction to other educational media and methods. In this study it has been assumed that independent study systems could serve as the basis for sophisticated multimedia instruction systems because of its literal content and cost effectiveness. The German word for correspondence instruction is "Fernunterricht" or distance teaching. One of the questions, therefore, which should be answered is: What methods or media would be best suited to bridge the "distance"?

Finally, a detailed study is needed dealing with a region-

al or national correspondence utility configuration. Such an undertaking would require some type of common effort and should cover specific hardware, software, manpower, and financial requirements.

Recommendations for Correspondence Study Administrators

The data presented in this study and the conclusions reached on the basis of the evidence have been comprehensive in scope but limited in depth in certain areas. Many of the details omitted, however, are normally dictated by local conditions. They include input/output specifications, cost effectiveness, analysis, hardware selection, site preparation, programming, etc. Therefore, independent study administrators should also become familiar with the detailed aspects of systems analysis and design.

It is assumed that managers of correspondence study institutions will be capable of formulating more effective and efficient systems by having information available on the present state of the art and various general systems designs. The content of this study, therefore, can be used as a firm base for future systems developments. However, the data presented cannot be termed final. Continuous technological advances and new environmental demands will require modifications in the methods cited.

Local (or regional) planning committees of the type delineated in Chapter V should be established. These panels should be organized on a permanent basis for optimum effectiveness even

though they will meet only periodically. Their members cannot become too intensely involved in day-to-day operations but must analyze and formulate realistic long-range plans from a futuristic perspective. Above all, the committees should fully incorporate general systems theory principles into the conceptual framework of the planning processes.

Optimum man-machine interaction should be the primary objective of every computer-based management information system. Currently this can be best achieved by the use of CRT keyboard terminals. Correspondence instruction organizations, therefore, should strive to develop systems with terminal capabilities. To further this effort, it is recommended that joint NUEA and NHSC systems studies be initiated for the design and implementation of regional or national correspondence instruction utilities. Such an approach seems quite appropriate in the light of increasing educational demands and limited physical facilities and resources.

Correspondence study administrators and educators must take the initiative to continuously improve the method of instruction. The widely accepted normative assumption that there is an inverse correlation between technology and personalized education, however, is a major deterrent confronting the advancement of new instructional techniques. Computer systems are ideally suited for such repetitive tasks as scheduling, scoring, file maintenance, and information processing and retrieval. EDP systems, therefore,

permit man's time and ingenuity to be used for solving complex unstructured problems instead of being wasted on routine processes. Consequently, computer-based home study systems can facilitate more meaningful and creative student-instructor interaction.

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APPENDIX I

GLOSSARY

ACCESS.--The process of obtaining data from or placing data in storage.

ACCESS TIME.--(1) The time interval between the instant at which data are called for from a storage device and the instant at which delivery is completed (Read Time). (2) The time interval between the instant at which data are to be stored and the instant at which storage is completed (Write Time).

ADDRESS.--A label, name, or number identifying a register, location, or unit where data are stored.

ADP.--Automatic data processing. Data processing performed by a system of electronic or electrical devices.

ALLOCATION.--The assignment of blocks of data to specified blocks of storage.

ALPHABETIC-NUMERIC.--Also alphanumeric. Characters that include letters of the alphabet, numerals, and other symbols.

APPLICATION.--The system or problem to which a computer is applied.

ARITHMETIC UNIT.--The hardware portion of a computer in which arithmetic and logical operations are performed.

ASSEMBLER.--A computer program which translates input symbolic

codes into machine instructions item for item.

BATCH-PROCESSING MODE.--A processing method where a number of similar input items are grouped for processing during the same machine run. Intermixed compilations, assemblies, and executions may be processed in a continuous sequence.

BINARY.--The numbering system based on twos rather than tens which uses only the digits 0 and 1 when written.

BUFFER.--A temporary storage device of relatively small capacity capable of receiving and transmitting data at different rates of speed.

CHANNEL.--A unit which controls the operation of one or more input/output units.

COBOL.--Common Business Oriented Language. A specific language by which business data processing procedures may be precisely described in a standard form.

COMPATABILITY.--The quality of an instruction to be translatable or executable on more than one class of computers.

COMPILER.--A computer program more powerful than an assembler. Where an assembler translates item for item, a compiler will do more than this. The program which results from compiling is a translated and expanded version of the original.

CONVERSION.--The process of changing from one data processing method to another or from one type of equipment to another.

CORE STORAGE.--A form of high-speed storage using magnetic core.

CPU.--Central Processing Unit. The principle hardware unit which

controls the processing routines, performs arithmetic functions, and maintains a quick accessible memory.

CRT.--Cathode-ray Tube. A vacuum tube in which a beam of electrons can be focused to a small point on a luminescent screen and can be varied in position and intensity to form a pattern.

DATA.--A general term used to denote any or all facts, numbers, letters and symbols that refer to or describe an object, idea, condition, situation, or other factors.

DEBUG.--To locate and correct any error in a computer program.

DIRECT-ACCESS STORAGE.--A storage device wherein access to the next position from which data is to be obtained is in no way dependent on the position from which data was previously obtained.

DYNAMIC MEMORY RELOCATION.--Frees the user from keeping tract of exactly where data is located in the system's memory. This enables programs to flow in and out of memory in a highly efficient manner.

EAM.--Electrical accounting machines or tabulating equipment that is predominantly electromechanical.

EDP.--Electronic Data Processing. Data processing performed mainly by electronic equipment.

FEEDBACK.--The use of parts or all of the output of a machine, process, or system, as input for another phase, as when used for self-correcting purposes.

FIELD.--A specified area of a record assigned for a particular

category of information.

FILE.--A collection of related records treated as a unit.

FLOWCHART.--A systems analysis tool that provides a graphic representation of a sequence of operations.

FORTRAN.--FORmula TRANslator. A programming system, including a compiler, allowing programs to be written in a mathematical-type language.

HARDWARE.--The mechanical, magnetic, electrical and electronic devices or components of a computer system.

HEURISTIC.--The trial-and-error procedures or methodology designed to obtain solutions to problems.

INPUT.--Data transferred or to be transferred from an external storage medium into the internal storage of the computer.

INSTRUCTION.--A coded program step that tells the computer what to do for a single operation in a program.

INTERPRET.--To translate nonmachine language into machine language.

MAGNETIC DISK.--A flat circular plate with a magnetic surface on which data can be stored by selective magnetization of portions of the surface. It is usually randomly accessible.

MAGNETIC TAPE.--A storage device in the form of a ferrous oxide coating on a reel of metallic or plastic tape upon which data may be recorded magnetically.

MEMORY.--Synonymous with storage.

MICROSECOND.--A millionth part of a second.

MILLISECOND.--One thousandth of a second.

MODULAR.--A degree of standardization of computer systems components to allow for combinations and large variety of compatible units.

NANOSECOND.--a billionth of a second.

OCR.--Optical character recognition reader or scanner. It recognizes various characters and converts them to machine language.

OFF-LINE.--Systems or devices which are not under the control of the central processing unit.

OMR.--Optical mark reader. Devices attached to a computer for direct reading of marks made by an ordinary lead pencil in specific positions.

ON-LINE.--Descriptive of a system and peripheral devices in a system in which the operation of such equipment is under the control of the central processing unit.

OPERATING SYSTEM.--An organized collection of techniques and procedures for operating a computer system. Operating systems consist of a supervisory control program, system programs, and system sub-routines.

OUTPUT.--Information transferred from internal storage to external storage or to an on-line output device. Also results generated by the computer such as management reports.

PARAMETER.--A definable characteristic of an item, device, or system.

PROCESS.--A term that may include compute, assemble, compile, interpret, generate, etc.

PROGRAM.--A plan for the automatic solution of a problem.

PUNCH.--The process of shearing a hole into a card or a hole in a card that has machine language significance.

RANDOM ACCESS.--A means of information storage and retrieval where the time required to store or receive data is not dependent on the location of the previously handled data.

REAL-TIME.--Pertaining to the performance of a computation during a related physical process to obtain results needed to guide that process.

RECORD.--A set of one or more consecutive fields on a related subject treated as a unit to put data into a storage media.

SIMULATION.--The representation of physical systems and phenomena by computers.

SOFTWARE.--Internal programs and routines prepared to simplify programming and to extend the capabilities of computer operations.

STORAGE.--A general term applied to any device capable of retaining data.

SYSTEM.--An assembly of interrelated components or activities united to form an organized whole.

TAPE DRIVE.--The mechanism that moves tape past sensing and recording heads.

TERMINAL.--A point or device at which information can enter or leave a communications network connected to a central computer.

TIME-SHARING.--A computing technique in which numerous terminal

devices can use a central computer concurrently for input, processing, and output functions.

UPDATE.--The process of posting all current changes, additions, and deletions to a file.

APPENDIX II

CORRESPONDENCE INSTRUCTION SYSTEMS

CASE STUDIES

The five case studies used to provide the initial data for the study are presented in this section.

Case I

Correspondence School I is a Federally supported organization. The school offers 342 courses and carries an average of 295,000 active enrollments at all times. In 1952 it incorporated punched card equipment to facilitate the administration of its programs. The institution began to share the services of a computer center in 1960 and in 1965 started to grade lessons and final examinations using an optical scanner on-line with the computer system.

The main hardware employed by the central computer facility to process the school's data consists of an RCA 5820 Video Scanner, an RCA 301 computer, a Honeywell 200 computer, and a Honeywell 800 computer. The RCA 301 and the Honeywell 200 computers are programmed in machine language and are used primarily as satellites for the Honeywell 800 computer to perform data editing and control of input/output devices.

All data from School I, with the exception of test answers,

must be converted into punched cards for input. The keypunching operations are performed at the institution. The cards are then transported to the computer center where they are processed every other work day. During each processing cycle all of the school's computer files, except the inventory control file, are updated. Inventory receipts are run once a week and transactions every two weeks. Items processed during each cycle include enrollments, record changes, queries to the active student and transcript record files, tests, and curriculum and test key changes. Fees are not charged for any of the courses offered, therefore, financial transactions are not recorded.

All active student records are maintained on magnetic tape. Enrollee records are retained on magnetic tape for five months after course completion or cancellation. They are then converted to microfiche and placed in a permanent transcript file.

Punched cards are the only means of querying files stored on magnetic tape. To facilitate the continuous use of the enrollment file School I maintains alphabetical and numerical computer listings of all the records kept on magnetic tape. The listings are printed twice a month. Obviously, the older these listings become the more frequently must the computer files be queried for needed information.

School I receives enrollment applications from all parts of the globe. The application forms are designed to enhance data conversion to punched cards. When the application forms are received by the institution they are manually screened for complete-

ness, eligibility of the applicants, and the availability of the courses desired. The source documents are then converted into punched cards and transported to the shared computer center for processing.

During the processing cycle the new enrollments are added to the master student record file. The same computer run also produces scanner readable lesson or volume exercise answer sheets for every lesson of an applied for course. Each lesson answer sheet is coded to identify it with a student, course, lesson number, and variable test key. The answer sheet for the first lesson of a course also has the student's address printed on it.

The volume review exercise answer sheets are taken to the school facilities where they are machine-inserted into window envelopes. The envelopes are then attached to prepackaged course materials, thereby serving as mailing labels for the shipment of the required items.

When lesson exercises or final examinations are received by the school they are manually extracted from their envelopes and checked for mutilation, staples, and other conditions which would prevent them from being read accurately by the scanner. At the computer center the video scanner operates on-line with the RCA 301 computer reading the marks on the answer sheets, performing validity checks, and recording the accepted answers on magnetic tape.

The tape with the test solutions, in conjunction with the test key tape, are used by the Honeywell 800 system to grade the

tests and to update the test item analysis file and the master student record file. During this processing phase the computer system also prepares lesson and examination feedback post cards. A lesson feedback card indicates the score attained and the questions which should be restudied. The course examination post card shows if the results were satisfactory or unsatisfactory and directs the student, by means of the course syllabus, to areas which should receive further attention. If a student has successfully completed a final examination the system automatically prints a course completion certificate.

Every processing cycle produces other valuable products. When a lesson exercise score is posted to a student's record the computer checks whether all lessons for a given course have been completed. If all volumes have been graded the system automatically prints an answer sheet for the final examination of the course. The examination answer sheets are inserted into window envelopes by machine on the school's premises. The envelopes are then attached to prepackaged examinations and mailed to predesignated official testing offices. The examinations are administered to the students under supervision. School I must be officially notified that an examination has been destroyed after testing so that the computer records can be cleared. If this is not accomplished the testing office is automatically notified of the delinquency. If necessary, further administrative action is triggered by the computer system.

During each cycle the computer also prints reminder post

cards to all students who have been enrolled for nine months and have not completed a course. An enrollment is automatically cancelled if it is not completed within twelve months and the student is notified of the action taken automatically by the computer system by means of a post card.

Most of the responses to inquiries received by the school are prepared by the computer system or by two IBM Magnetic Tape Selectric Typewriters (MTST's). When a student requests a general summary of his status in a course the reply is usually produced by the EDP system. The post card sent to the student indicates how many lessons have been completed, what the scores are, and if additional answer sheets are being forwarded, depending on the circumstances. The reply further annotates what action the student must take to be eligible to take the final examination, if and where an examination has already been sent, and if an extension has been granted and for how long.

Instructors at the school use the MTST's to compose and prepare more than seventy per cent of the letters in response to student inquiries. The MTST tape files contain paragraphs related to reoccurring student questions and problems. In most instances an instructor is able to construct a letter by selecting the appropriate paragraphs available on tape. The paragraph selections are then given to an MTST operator who prepares the letter and sends it back to the instructor for signature. In this manner a student receives a "personalized" letter in response to his query much faster than would be possible by completely manual means.

The primary management reports produced by the computer system are:

1. Test item analysis
2. Inventory control
3. Monthly course activity summaries.

The item analysis report is printed by request but the item analysis file is maintained on magnetic tape and is updated each processing cycle. The report presents an analysis of every item of a given test as to its ease and validity. It also summarizes the results of an examination showing the number in the sample, range of scores, mean, standard deviation, and the grade distributions.

The inventory control report shows increases or decreases of items in inventory and the new reorder points based on a six month weighted average. It also indicates monthly issues, monthly receipts, salvage, and the previous balance on hand.

The files for the monthly summary reports are updated during each processing cycle and printed during the last computer run of every month. These reports depict the activities in each course for the previous month; indicate total enrollments, completions, failures, and cancellations during the year to date; and present a breakdown between active and inactive records maintained on the master student record file.

It should be added that the institution, with its large volume, utilizes sophisticated automatic packaging equipment. The system collates and uses polyethlene wrapping materials to prepackage course sets. The course sets are then transported to

their designated storage areas by a conveyor belt system.

Case 2

Independent Study Department 2 is affiliated with the extension division of a large state supported university. A total of 410 courses are available for individuals desiring to continue their education through correspondence study. As of October, 1971 the department was carrying approximately 13,000 active enrollments. Card tabulating equipment was introduced in 1965 and currently an IBM 360/20 computer system, with 16K core storage and two tape drives, is being shared by the department with other functional areas of the extension division.

All input to the computer system must be first converted into punched cards. Both keypunching and processing are performed on a daily basis at the extension division's computer facility located in the same building utilized by the correspondence study department. Only enrollment applications and the associated financial transactions are processed by the computer system for the independent study department.

Active student records are maintained on both cards and magnetic tape. Cards are used for course administration. Although the student course activity cards (referred to by the organization as "visi-cards") are produced by the computer for each enrollee, they are not punched cards. The visi-cards are strictly designed for manual manipulation and are primarily used to record when lessons are received, when they are returned, and the grades attained.

In addition to the visi-cards an alphabetical listing of students, printed by the data processing branch, is used to enhance counseling and answering student inquiries.

Transcripts are maintained on cards and microfilm. The file is located in the extension division's transcript office and, therefore, does not fall under the jurisdiction of the independent study department.

Magnetic tape is only used to maintain partial records of students who have satisfied all financial obligations. The tape file contains no course-related data other than indicating the course number/s for which fees have been paid for by individual enrollees. Balance due records are retained on punched cards and the file is used to print delinquent account notices for applicable students. When an account is paid in full the balance due card is simply pulled and destroyed. A student is automatically notified twice of a delinquent account. If he does not respond to the notices the student is informed by means of the computer system that further lesson submissions will not be accepted.

With the present system, there is no need to query the magnetic tape file since delinquent accounts are handled automatically and because the tape file does not contain course-related data. Consequently, only the visi-card file and the alpha listing are referenced manually during normal day-to-day operations.

Independent Study Department 2 receives more than 900 enrollment applications per month from all over the world. Although the application forms are used as input to the computer system

they are not specifically designed to facilitate keypunching operations. This is mainly due to the fact that subsequent to data processing certain information is manually annotated on the forms before they are filed.

When applications are received by the department they are first screened by a registration clerk for obvious conflicts which must be handled by a student advisor. The registration clerk also checks the fees received for the courses, balances the totals, and submits the receipts to the business office of the extension division before the applications are forwarded to the computer center.

At the data processing branch the applicable data is converted into punched cards and then processed on the IBM 360/20 computer system. The processing cycle produces three primary products: visi-cards for the master student record file, similar but smaller cards for the instructors responsible for grading specific courses, and three-part student receipts. The visi-cards and student receipts are placed in a temporary file by the registrar, and the instructor cards and the applications are distributed to the applicable academic departments for approval. When the approved applications are returned to the registrar certain additional data is typed on the visi-cards and application forms. The visi-cards are then placed in the active student record file and the application forms are stored.

The student receipts are forwarded to the course materials

section.[1] One part of the first copy of the student receipt is included with the materials and the other part is used as a mailing label for forwarding the items to the student. The second copy of the student receipt is taken to the book store to trigger the mailing of textual materials to the enrollee. The third copy of the form is retained by the course material section for six months.

When a written lesson is received from a student the date of receipt is posted to the student's visi-card. The assignment is then forwarded to the appropriate academic department where it is given to a designated instructor. After a lesson has been graded by an instructor it is returned via the academic department to the records section of the correspondence study department where the return date and the grade are posted to the student's visi-card. The graded lesson is then mailed to the enrollee.

Final examinations, and when required mid-term examinations, are administered to the students under supervision. After an individual has completed all of the required lessons of a course he must notify the institution that he is ready to take the final examination. When a notification is received from an enrollee an examination clerk checks to see if all course requirements have been satisfied and then submits the examination request to the appropriate academic department for approval. If the re-

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[1]This section only carries study guides, lesson sheets, lesson envelopes, time expiration cards, and guides to independent study.

quest is approved the examination clerk forwards an examination to a predesignated proctor and posts the date the examination is forwarded to the student's visi-card. A student may also choose to take the examination at the university. The same procedure is used for grading examinations as for individual lessons.

For credit courses the visi-card for a student who has completed a course is first submitted to the extension division's transcript office and is then filed in a "drop and complete" file at the correspondence study department. A copy of the transcript is sent to the student. An individual who completes a course for non-credit receives a certificate of completion from the department and the student's visi-card is then placed in the "drop and complete" file.

The type of feedback that a student receives in relation to his program is dependent on his instructor. In most instances the instructor writes his comments on the returned lessons and when necessary the student and the instructor exchange letters. An individual is allowed a maximum of twelve months to complete a course. A student does not receive systematic progress reminders when he falls behind in his work, but individual instructors are free to send out such notices if they deem it necessary.

Written administrative and advisory inquiries from the students are answered manually or by the use of form letters. Of approximately 35,000 letters received from students each year, about one third are handled by means of form letter.

Inventory control records are maintained on index cards,

since the bulk of the textual materials is handled by the university book store. The course materials section tries to maintain approximately a six-month supply of study guides in stock since it takes an average of three months to reorder supplies.

Data processing furnishes the independent study department two management reports on a monthly basis. One report indicates the number of completions and drops by course. The other summary shows the total number of students registered by course and how many individuals enrolled in a course are in or out-of-state residents. It also indicates the number of students taking a course for college credit, continuing education, or high school credit.

Case 3

Correspondence School 3 is a large Federally funded institution and its curriculum is composed of 200 courses. The school continuously monitors the activities of approximately 100,000 independent study students, 60,000 group study members, and 30,000 individuals taking correspondence courses from participating colleges.[2]

The school operates its own computer system which is used three shifts a day and five to six days a week. The basic hardware of the system consists of an IBM 1401 computer with 16K core storage, five tape drives, two disk units, and an NCS "Sentry '70"

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[2]Only the independent study administrative procedures of the organization will be presented.

optical mark reader (OMR). The OMR unit is essentially a modified CDC 160A computer with 8K core storage. The NCS-OMR has just recently replaced an IBM 1230 OMR unit which converted source documents to cards. The NCS-OMR system converts document input directly to magnetic tape and is capable of reading both sides of a sheet in one pass at a rate of 6,000 documents per hour. The new OMR unit is also compatible with third generation computer systems.

With the introduction of the new OMR equipment most of the institution's source documents were redesigned. Consequently, the need for conversion of input data to punched cards has been greatly reduced. In addition, the school has partially changed its method of grading lesson exercises, thereby advancing one step further in automating functional areas relying primarily on "programmed" decision-making. Until recently all lesson tests submitted were individually graded by instructors. Currently, however, the institution is offering nine computer assisted lesson (CAL) courses and has definite plans to increase this number to thirty-five in the very near future. The procedures used to administer CAL courses and the type of feedback this method offers will be covered later.

During the daily data processing runs all of the school's computer files are updated. Items processed include enrollments, tests,[3] inventory, queries to the active and inactive files, bud-

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[3]This also includes manually graded tests discussed later.

get updates, and reoccurring and one-time management reports.

All student records, both active and inactive, are maintained on magnetic tape files. Formerly all queries to these records had to be made by means of punched cards. Now newly designed forms are read directly by the OMR unit resulting in appropriate record printouts and specified record changes. CAL scoring keys, inventory control records, and the program library are stored on disk.

As is the case with most established correspondence schools, School 3 receives enrollment applications from all over the world. On the average 7,000 independent study applications are processed per month. The application forms are designed so that all data required (alphabetic and numeric) can be coded in mark-sense format by the applicants with ordinary pencils for direct computer input via the OMR device. To facilitate faster application processing the forms are also stocked in the field.

When enrollment applications are received at the school they are fed directly into the NCS-OMR unit. Manual screening is greatly reduced since the system prepares its own edit list printed through the IBM 1401 computer. The edit list indicates why any given document may have been rejected (multiple entries, light marks, item omits, etc.). Subsequent to the data input the 1401 system prints a "picking-list" and mailing labels for each enrollment. These products are taken to the course materials center where the picking-list is utilized to assemble individual study units and the mailing labels are, of course, used to dis-

patch the units to the new students. For CAL courses the computer system also prints encoded answer sheets for all the lessons of a given course.

Applicable items in the inventory control file are automatically deducted as each enrollment is processed. Data on bulk issues and receipts is forwarded from the course materials center as input to the data processing system.

When an individual enrolls in a non-CAL course he receives a set of color coded punched cards with his study materials. These cards are prepunched identifying the student and the course. The student submits a green card with his first lesson manuscript. This card is used to record on the student's computer record the date the first lesson was received and to print a mark-sense lesson cover sheet. The lesson with the cover sheet is then forwarded to the appropriate academic department[4] for instructor grading. After the graded lesson is returned to School 3 the cover sheet is used as input to the OMR unit to automatically post the grade to the student's record, and the graded lesson is sent back to the enrollee without delay. Red punched cards are included by the student with subsequent lesson submissions to initiate the same actions. Both types of cards are also used to post address changes.

The mark-sense lesson cover sheets also serve as data input to an important computer generated management report. A daily and monthly report indicates by instructor and department

[4]Most of the non-CAL lessons are graded at a nearby university on a contractual basis.

how many lessons were graded and how many lessons are delinquent (out for more than six days). In addition, the summary depicts the percentage of students submitting manuscripts for specific lessons of a course, the number of individuals receiving passing grades, and the average grade awarded for a given lesson by an instructor.

The test item analysis file for the non-CAL courses is maintained on punched cards, therefore, the file is not updated each processing cycle and item analysis summaries are produced by request only.

As indicated previously, students enrolled in CAL courses receive encoded mark-sense answer sheets for each lesson of a course. When a lesson exercise is received by the school it is read by the OMR equipment. The solutions are then scored by the 1401 system and a grade is posted to the individual's record. The computer system also prints a lesson grade report for the student. This feedback is in letter form and makes appropriate comments for each test item, even if an item was answered correctly. For example, a statement made in response to a correct answer reads:

> YOU ARE COMMENDED SINCE THIS IS THE MOST FREQUENTLY MISSED PROBLEM IN THIS LESSON.

A summary statement is also included at the end of the grade report. The wording of this summary is dependent on the student's level of achievement. A sample conclusion to a lesson well done states:

YOU CERTAINLY HANDLED THIS LESSON WITH EASE. VERY FINE WORK, INDEED.

CAL courses will facilitate test item analysis. An item analysis file for the CAL courses is currently being designed. When it is implemented it will be updated each processing cycle and summaries will be generated by request.

A student is permitted to take a final supervised closed book examination prior to completing all the lessons of a course. Course tests are forwarded to predesignated testing offices by request. In some instances final examinations are also stored at certain testing offices in sufficient quantities to handle reoccurring testing requirements. Tests are strictly accounted for and testing offices are held responsible for proper security measures. All examinations are scored by the computer system. Student feedback includes a military test report, a course completion certificate for successful completions, and a course credit recommendation.

School 3 is in the final stages of implementing a student reminder or follow-up system. Under this program the computer system will print reminder notices to students who have not submitted any lessons in a given period of time, who are taking too much time between lesson submissions, and who are submitting too many lessons which fail to attain passing grades.

Approximately one per cent of the replies to inquiries are manually prepared by the institution. Most responses are produced by a pool of MTST's, computer printouts, or form letters. In addi-

tion, about 26,000 queries per year are handled by telephone. Since inactive student records are maintained on magnetic tape, almost all transcript requests are responded to by means of computer printouts. Of interest is the fact that at least eight clerical positions were eliminated by the introduction of recording equipment and MTST's and the consolidation of typing efforts.

Some of the more important management information reports generated by the computer system include:

1. Test item analysis
2. Test performance
3. Inventory control
4. Annual course activity
5. Resource accounting.

The item analysis report summarizes the selection of response choices of each test item. The test performance report, on the other hand, indicates the number of students a given test was administered to, the average grade attained, and the number of individuals who failed the test.

One inventory control report shows materials utilization by quantity and another presents the same information by the dollar amount. A third inventory summary depicts materials requisitioned during a specific period and the reorder levels based on a nine month weighted trend.

The annual course activity survey is a comprehensive analysis of all courses offered by the school. The three-part report shows how many students were enrolled in a course during the previ-

ous year and what portion of the total resided either in or out of the United States. In addition, the survey indicates how many students submitted a certain number of lessons in a course, how many in each lesson submission group took final examinations, and how many months after enrollment the terminal examinations were administered. Other information, such as the per cent of students who enrolled and passed the final test, is also included.

The resource accounting reports provide the school's administrators with needed information on a periodic basis by relating all planning, programming, and budgeting inputs to specific outputs. Resource accounting files are updated each month and printed reports are produced each quarter.

The data processing system also handles one-time statistical information requests. Efforts are being made to establish a more adequate data base to facilitate further statistical analysis and reporting.

Case 4

Home Study School 4 is a private organization accredited by the National Home Study Council. The school offers 8 correspondence courses and carries an average of 10,000 active enrollments[5] at all times. The organization has been in operation for ten years. In the early 1960's the low volume of enrollments did not even warrant the use of unit record devices. By 1967, how-

[5]The organization caters to approximately the same number of resident students.

ever, the student body of the institution began to increase at a phenomenal rate and a computer system was introduced to support the handling of extended administrative tasks.

Currently the primary hardware used to support the school's management information system consists of an IBM 360/25 computer with 49K core storage, four tape drives, four disk units, and an IBM 2848 Control Unit handling six IBM 2260 CRT terminals. The data processing department updates computer files daily with a two-shift operation. The CRT terminals are on-line with the system from nine to four during the day. Items processed include lead inquiries, enrollments, active and inactive student file queries, financial transactions and budget updates, and posting of cash receipts to student records.

The records of all active students are maintained on disk. Transcript records, on the other hand, are stored on tape. With the introduction of the CRT terminals there is no longer a need to print out active student records, using punched cards as input, in response to student inquiries. During the day when the terminals are on-line, counselors and their assistants can, in real-time, visually check individual student records. This mode of operation is especially advantageous in reacting to queries received by telephone. Since the demand for transcript data is extremely low requests for inactive student record printouts are processed only once a week. Such requests, of course, must be first converted into punched cards for computer input.

School 4 conducts periodic nation-wide advertising cam-

paigns using mixed media to solicit enrollments. When an inquiry is received from a prospective student such information as the individual's name, address, telephone number and age, plus the medium triggering the query and the course desired, is fed into the computer system via four of the CRT terminals. The data processing system prints mailing labels, lead forms for salesmen, and stores the names on tape for revival mailing and subsequent sale of the names to other organizations. The mailing labels are used to send brochures to the prospective students. Regional sales managers receive the computer lead forms and distribute them to their sales force. The salesmen, directed by the lead forms, in turn contact prospective students to solicit enrollments for the institution.

Enrollment applications received from the sales force are manually screened for completeness and adequacy of information. The data is then transposed to forms designed to facilitate key-punching operations. Subsequently, the enrollment data is converted to punched cards prior to being processed and placed in random access storage. Mailing labels and daily shipping lists for dispatching of course materials are prepared manually. After the shipment of materials the shipping list is used to update the active student file.

All lesson exercises of the courses offered are individually graded by instructors. The results of graded manuscripts are converted to punched cards and the cards are then used as input to update the master student record file. When the computer posts a

lesson grade to a student's record it also checks the total number of exercises submitted. If an individual has two or three volumes left to complete the system triggers form letter action requesting the student to give the name and address of a proctor who is eligible to administer the final examination. The posting of the last lesson grade to a student's record initiates the dispatching of a course examination to the predesignated proctor and a letter informing the enrollee to contact the proctor for the time and date of the tests.

The data processing system is also used to screen records and indicate which students are to receive progress reminders. A maximum of five letters are sent to individuals who remain inactive. The first two reminders consist of form letters and the others are generated by MTST's. If a student fails to submit a lesson for grading thirty days after enrollment, he is notified of his inactivity. An enrollee receives four more letters once every sixty days if he continues to remain passive. When an individual neglects to forward a manuscript for sixty days from the time a previous volume was submitted, he is also sent a progress reminder. As is the case with the non-start, a student having accomplished some work also receives four additional follow-up notices if he does not begin to submit lessons for grading.

After successfully completing a home study program an individual has the option of attending a one or two week intensive resident training course covered by the tuition. If an enrollee

attends a resident terminal training program he is awarded a Certificate of Proficiency. A person choosing not to participate in terminal instruction receives a Certificate of Completion.

The school also provides placement opportunities for students who satisfactorily complete all course requirements. Periodically the organization sends out queries to prospective employers requesting information on job opportunities. The responses from employers are matched with names of the institution's graduates and the appropriate individuals are then notified of the positions and locations where employment is available.

Almost all of the inquiries received from the active students are prepared by MTST's. Approximately seventy per cent of the replies are composed from paragraphs stored on tape. Most other letters are dictated and then submitted to the MTST operators for typing. When counselors or correspondents select applicable MTST paragraphs in response to an inquiry they also use the same form to specify any changes to the student's computer record if necessary.

As stated earlier, student records can be queried in real-time with the CRT terminals, avoiding delays caused by printout requests. The on-line system of the school is also being used to limit the need for maintaining large manual correspondence files. When a student's inquiry is answered his computer record is coded to indicate which MTST paragraphs or form letters were used to reply to the query. If the enrollee contacts the school again correspondents are able to respond promptly to the problem using the

CRT terminals without having to screen manual correspondence files to avoid duplicating efforts.

The data processing department of School 4 generates well organized and comprehensive management reports, both on a continuous basis and by request. The summaries include course analysis, sales, advertising, accounting, personnel, and numerous other reports related to management decision-making. Only inventory control data is not maintained by the computer system. Of interest are the regional statistical reports and budget statements by location. A weekly printout indicates by territory how many leads were sent to specific districts and the number of these leads which resulted in enrollments in particular courses. The report also shows which advertising media stimulated prospective student inquiries in the region and how many of the queries produced course applications. Another weekly report supplements the regional summary, showing by individual sales representative the same information as presented by the territorial survey.

Monthly budget statements are produced for each location affiliated with the school throughout the United States. These reports indicate by resource the budgeted amounts, actual expenditures, and variances from the estimates. The summary presents comparisons for the current month, cumulative months, and annual projections.

Case 5

The activities of approximately 12,000 students enrolled

in sixty-four courses are continuously monitored by Correspondence School 5. The entire program of the Federally supported instructional system is administered by twelve people supported by a shared data processing center and subject matter specialists from an associated residential school. Although the institution has been in existence since 1955, it did not utilize punched card equipment prior to computerizing its program in 1969.

One of the most unique features of the organization is the fact that it shares the computer system with two other Federally affiliated correspondence instruction systems. Further, the shared computer facility does not function primarily for the support of the three correspondence study systems. It also supports other residential and nation-wide operations. The main hardware of the data processing center consists of an IBM 360/70-40 computer, an IBM 1401 processor, a Control Data Corporation 915 optical character recognition (OCR) unit, and an IBM 1232 OMR unit.

Inactive student records are stored in a manual card file. All other files related to correspondence instruction and administration are maintained on magnetic tape.

The school's computer input, with the exception of lesson and examination answer sheets, must be transformed to OCR readable font prior to processing. This is accomplished by re-typing all input documents. Source data conversion and file maintenance is performed biweekly at the shared computer center.

Since active student records are stored on tape queries to

the file can only be made twice a week by using OCR readable input. To facilitate the continuous need to reference the active enrollment file, the school maintains alphabetical computer listings of all the records on tape. The listings are printed each month and supplements are generated each processing cycle.

The enrollment application forms are designed to facilitate data conversion to punched cards. The reason for this is that until recently all input, with the exception of test answer sheets, had to be transformed into cards. The forms are still adequate in enhancing data conversion to OCR readable font.

When an application is received by the school it is screened for completeness and eligibility of the applicant. The bottom portion of the accepted form is detached and forwarded to the course materials storage area where it is used as a mailing label to send the initial study items of a course to the student. The other half of the application form is taken to the computer center for data conversion and processing. After processing the school receives a printout of all new enrollments and a punched card for each student who has been sent a non-expendable training kit as part of his course materials. The computer system prints a monthly listing of kits due to be returned. Names from the listing are cleared by submitting the punched cards originally generated during enrollment processing.

All lesson exercises and final examinations of the institution are graded by computer. Every student receives mark-sense answer sheets with his course materials. As an individual indi-

cates his responses on the answer sheet, he also annotates in mark-sense form his social security number and the lesson or examination variation number. This procedure assures that the test is scored by the appropriate test key and that the grade is posted to the proper student record.

When lesson and examination answer sheets are received by School 5 they are visually screened for completeness and mutilations which could prevent the forms from being properly scanned. The answer sheets are then forwarded to the computer facility with all other cycle input for processing. The answer sheets are scanned and converted into punched cards by the IBM 1232 OMR unit. The cards are then used as input to either the•360/70-40 or 1401 computer, depending on the availability of the systems.

During the course of each processing cycle the computer performs eight primary functions depending on the activities of individual enrollees. First, tests are scored and then posted to applicable student records. At the same time the test item analysis file is updated and a summary is printed if requested. Mailing labels are also printed for the next set of lesson materials to be dispatched to individuals whose exercises were scored during the processing cycle.

Grade reports are generated next in letter format. The feedback shows the score attained, states whether the student has passed or failed the test, and asks the individual to study the references for the questions missed. For each incorrect item the report indicates what response the enrollee selected, what the

correct choice is, and follows that with a brief written explanation. As an example, the statement for a missed question reads:

> IT PERHAPS IS IMPOSSIBLE FOR THE TASKS FOR EACH PERSON TO BE EXACTLY COMMENSURATE WITH HIS ABILITIES, BUT THE SUPERVISOR SHOULD HELP EMPLOYEES FIND JOBS FOR WHICH THEY ARE QUALIFIED.
> REF PAR 2.6

All records are also screened for the date a lesson was last submitted for grading. Based on the check, the data processing system prints three types of reminder letters dependent on the length of a student's inactivity. If an individual has not mailed in a lesson for scoring for two months the first letter encourages him to do so as soon as possible. After failing to participate in a program for five months a person is cautioned that policy dictates the cancellation of enrollments exceeding six months of inactivity. The last letter informs a student that his enrollment has been withdrawn and that he must re-enroll if he desires to pursue the course further.

Further, an examination mailing list is prepared. If the lesson grade being posted to a student's record is for the last lesson of a course the system automatically includes the individual's name on the examination listing. The tests are dispatched to proctors predesignated by the student's initial application data.

Finally, the computer system prints course completion certificates and training records for students who have successfully completed all course requirements during the processing cycle. If a student was sent a non-expendable training kit and has not

returned it by the time his examination is graded he is automatically notified that a course completion certificate will not be forwarded until he has returned the kit. All computer generated feedback, except course completion certificates, are folded and inserted into window envelopes by machine.

The primary management reports produced by the data processing system are:

1. Test item analysis
2. Course activity
3. Pass-fail analysis
4. Lesson and examination data availability
5. Statistical analyses
6. Examination and book follow-up.

The test item analysis summary indicates the frequency with which individual responses are selected for each test item. The report also depicts the difficulty index, discrimination index, and maximum discrimination index for each item and for the lesson. The analysis is generated by request.

The quarterly course activity summary is a comprehensive review of all courses. It shows by course the current enrollments, active enrollments (lessons being submitted), new enrollments, and completions.

Every course and its associated lessons are identified by the pass-fail report printed quarterly. It gives the total number of individuals passing or failing and the mean score attained in a lesson and course.

The lesson and examination data availability summary is designed to indicate on a monthly basis file accumulations of needed data. It is used to ascertain if sufficient numbers of a specified type of data is available for valid statistical sampling and analysis. The determination as to if and when to request periodic statistical reports is based on this summary.

Non-expendable items, other than training kits, that are outstanding are identified by the monthly lesson and book follow-up report. This includes final examinations which have not been accounted for by proctors and textual materials required to be returned to the school.

Administrative inquiries received from students are generally prepared and typed manually. Some correspondence is responded to by means of form letters. Queries from individuals desiring instructional assistance are forwarded to the appropriate resident subject matter specialists for clarification.

APPENDIX III

SAMPLE SURVEY

COMPUTER APPLICATIONS IN CORRESPONDENCE

STUDY ADMINISTRATION

I. Administrative Data

A. Name of correspondence school or department_____

_____

B. Name and telephone number of individual to contact in case of additional questions:

_____

_____

C. Average number of active students enrolled at all times:

_____

D. Number of courses offered:_____

E. Is a computer system used to some extent in the administration of your correspondence school?

Yes_____ No_____

If no, do you have definite plans for using one in the future?

Yes_____ No_____

NOTE: If your school or department is not using a computer system/s, please disregard the remainder of questionnaire and return the survey.

II. Computer Application Data

A. Do you own, lease, or share a computer system with one or more schools or departments in your area?

1. Own:_____
2. Lease:_____
3. Share:_____
4. Other (Please specify):_____

_____

B. If you share a computer system with one or more institutions or departments, how do you gain access to the system?

1. Own in-house keypunch equipment with processing accomplished at the shared computer center:_____

2. Keypunching of input or output and processing accomplished at the shared computer center:_____

3. Own in-house terminal/s tied into the shared computer center for remote input or output:_____

4. Other (Please specify):_____

C. What type of storage media is used for the active student record file?

1. Manual file cards:_____
2. Punched cards:_____
3. Magnetic tape:_____
4. Disk (random access):_____
5. Other (Please specify):_____

D. What type of storage media is used for the transcript or inactive student record file?

1. Manual file cards:_____
2. Punched cards:_____
3. Magnetic tape:_____
4. Disk:_____
5. Microfilm:_____
6. Other (Please specify):_____

E. How often are your files updated or processed by the computer system?

1. Daily:_____
2. Every other day:_____
3. Weekly:_____
4. Other (Please specify):_____

F. Are punched cards the primary means of enrollment data input to the computer system to update the active student computer file?

Yes_____ No_____

If no, please specify the means of source document conversion utilized: _____

_____

G. When new enrollments are processed, are mailing labels for lesson or course materials automatically printed by the computer system?

Yes_____ No_____

If no, is a portion of the application form used as a mailing label for the lesson or course materials?

Yes_____ No_____

If no, please specify method used to address lesson or course materials: _____

_____

H. What means is used to query or obtain printouts of individual records from the active student computer record file?

1. Punched cards:_____
2. On-line terminal keyboard:_____
   a. CRT-display:_____
   b. Teletype output:_____
3. Other (Please specify): _____

_____

I. Are answers to <u>all</u> inquiries manually typed?

Yes_____ No_____

If no, indicate below what other means are used.

1. Form letters:_____
2. Magnetic tape selectric typewriters (with canned paragraphs or letters):_____
3. Computer printed letters or post cards:_____
4. Other (Please specify): _____

_____

J. What type of storage media is used for the inventory control record file?

1. Manual file cards:_____
2. Punched cards:_____
3. Magnetic tape:_____
4. Disk:_____
5. Other (Please specify): _____

_____

K. If you maintain your inventory records in a computer accessible file, in which of the following ways do you use your computer system for course materials inventory control and management?

1. Used to automatically reduce each applicable line item of course materials in stock by each new enrollment processed:_____

2. Used to identify status of course materials, (e.g., being written, being printed, in storage, etc.):_____

3. Used to indicate when items need to be reordered and in what quantities:_____

4. Used to calculate up-to-date cost data for budgeting purposes:_____

5. Other (Please specify):_____

L. Does your computer system automatically print student reminder notices for students who have not submitted lessons for a given period of time?

Yes_____ No_____

If yes, what is the maximum number of such notices that your system will print to a student who remains inactive?_____

M. Are cancellation notifications automatically printed by the computer system when a student fails to complete a course in a specified length of time or fails to submit lessons for a given period of time?

Yes_____ No_____

N. Does your computer system automatically print delinquent account notices to applicable students?

Yes_____ No_____

If yes, how many such notices are sent to the student before he is disenrolled?_____

O. Is the computer system used to grade lesson tests and examinations?

1. All lesson tests and examinations:_____
2. Most lesson tests and examinations:_____
3. Some lesson tests and examinations:_____
4. No lesson tests or examinations:_____

P. If the computer system is used to grade lesson tests and/or examinations to any degree, are test results automatically printed by the system for student feedback?

Yes_____ No_____

If yes, does the computer printed feedback card or letter also include specific corrective comments or indicate areas to be restudied by the student?

Yes_____ No_____

Q. When lesson tests and examinations are received for instructor grading, is the date of receipt posted before the tests are forwarded to the appropriate department and/or instructor?

Yes_____ No_____

If yes, what means is used for input?

1. Keypunching a card for each test received: _____

2. Student submits a prepunched card with each lesson and/or examination:_____

3. Other (Please specify):_____

R. How are the results of instructor graded lessons and examinations posted to student records?

1. Keypunched card as a result of notification received from instructor:_____

2. Prepunched card (instructor punches out applicable score positions on a card) as direct input to the system:_____

3. Optical character recognition equipment reads instructor input:_____

4. Optical mark reading equipment reads instructor input:_____

5. Other (Please specify):_____

S. Is your computer system programmed to provide lesson and test analysis on each test and test item, (e.g., per cent failure on a given test, which items are missed most frequently, difficulty index, discrimination index, etc.) on a periodic basis or by request?

Yes_____ No_____

If yes, is the test and test item file updated each processing cycle?

Yes_____ No_____

T. Does your computer system provide periodic data depicting the number of enrollments, completions, non-starts, etc., by course?

Yes_____ No_____

U. Please list any other periodic statistical data provided by your computer system, (e.g., demographic data, regional sales or enrollment data, etc.).

1. No other statistical data is provided:_____

2. _____

_____

3. _____

_____

4. _____

_____

III. Additional Data

In this section you may include any other related data not covered by the survey questions which would be helpful in depicting the degree to which your correspondence school or department is using computer systems to help administer its programs.