Present and Proposed Computer Uses in Colleges and Universities.

Ephraim Edward Davidson
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DAVIDSON, Ephraim Edward, 1923—
PRESENT AND PROPOSED COMPUTER USES
IN COLLEGES AND UNIVERSITIES.

Louisiana State University, Ph.D., 1966
Economics, commerce—business

University Microfilms, Inc., Ann Arbor, Michigan
PRESENT AND PROPOSED COMPUTER USES
IN COLLEGES AND UNIVERSITIES

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Accountancy

by
Ephraim Edward Davidson
B.B.A., University of Mississippi, 1954
M.B.A., University of Mississippi, 1955
January, 1966
ACKNOWLEDGMENT

A note of appreciation is extended to the dissertation director, Dr. Fritz A. McCameron, and other members of the committee, Dr. Lloyd F. Morrison, Dr. William D. Ross, Dr. Herbert G. Hicks, Dr. Donald E. Vaughn, and Dr. Robert S. Felton, for their patience, understanding, encouragement, and assistance.
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PRESENT AND PROPOSED COMPUTER USES
IN COLLEGES AND UNIVERSITIES

Advisor: Fritz A. McCameron

Purpose of the Study

It was the purpose of this dissertation to survey the present data processing methods employed in colleges and universities in the areas of financial and student record keeping and to propose a total information systems approach to the data processing problems of colleges and universities through the use of a time-shared computer with appropriately located satellite terminals. The proposed system would utilize the time-shared computer complex for financial records, student records, teaching and research, and information retrieval.

Procedure

Two questionnaires were developed in connection with this study. One questionnaire was designed to determine how administrators in educational institutions made the decision to install a computer, planned the installation, selected the equipment, prepared the applications, and developed the accounting systems. The second questionnaire was designed to determine how registrars in educational institutions utilized
computer equipment in admitting students, reporting grades, maintaining permanent records, and similar student record-keeping functions. In order to acquire the necessary information, the author conducted personal interviews at eleven institutions of higher learning.

Information obtained from this survey was supplemented with materials from textbooks, magazine articles, bulletins, pamphlets, and memoranda dealing with university accounting, electronic data processing, and systems and procedures. Financial reports of seventeen institutions of higher learning were examined to determine current reporting practices. The author also examined a feasibility study prepared by a management consulting firm for an electronic data processing system at one educational institution.

Summary and Conclusions

The survey revealed a trend toward establishing two computer centers, one to serve the administrative functions and the other to serve the academic functions. The equipment was utilized in the financial records area to accomplish accounting functions, financial reporting, and similar work. In the student records area, the equipment was utilized to handle admissions, grade reporting, permanent records, and statistical work.

Teaching and research personnel made extensive use of the computer. The teaching did not involve programmed
instruction, but concerned the computer and ways to utilize the
equipment fully. Personnel engaged in research found this
equipment to be an excellent research tool.

The author concluded that in the near future the fur­
ther development of the computer will make an on-line real-time
total information system feasible. Such a system would consist
of a central processing unit with tremendous bulk memory capacity
and satellite terminals located throughout the institution. A
total information system approach will be advisable in order to
avoid duplication of effort. Time-sharing will make available
to many users the data stored in memory banks.

Four major subsystems of such an arrangement would be
financial records, student records, teaching and research, and
library information retrieval. Each of these major subsystems
would be divided into smaller modules and programming would take
full advantage of information already available in the system.
This approach would avoid duplication of much input information,
reduce errors created by information transfer, increase effi­
ciency by locating points of data input near the place of data
origination, and achieve a reduction in the number of decisions
required of administrators. Library information retrieval
systems would aid students in their study and research and make
available the current work in various fields. New and more
meaningful current reports and projections of institutional
needs would be available to the university administration.
CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS

Since the development of the electronic computer for commercial applications, numbers of institutions of higher learning have found that the computer, with its capability of solving complex problems and processing business data, is of significant value as a useful tool in higher education. Early installations of electronic computers in colleges and universities were utilized on scientific and mathematical problems in connection with research studies. The computer's ability to solve problems and the amazing speed with which it operated led to its application to business problems.

Scientific computers were designed for high speed internal processing with low input and output speeds. Typical scientific problems require a limited amount of input data to feed the problem into the computer and a limited amount of output data. Internal processing is quite a different matter requiring many calculations and long periods of time for processing. Business applications are distinctly different from scientific ones in that business problems usually involve the processing of large quantities of data with relatively
little internal processing and calculation. High output is
generally required on business problems; therefore, in order to
adapt the computer to the efficient processing of business data,
computer manufacturers developed high-speed input and output
devices.

Because of the magnitude of business data processing
problems in medium-sized and large colleges and universities,
use of the computer and related peripheral equipment became a
practical solution to this explosive problem of handling business
data. The fact that in 1963 322 colleges and universities had
ordered or already installed computers suggests the ability of
the computer to handle scientific, administrative, accounting,
and statistical problems.¹ Computers other than the basic
International Business Machines 1620 and 1401 (which are con­
sidered basics in this study) then installed at institutions of
higher learning were as follows:²

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<th>Computer</th>
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<td>Burroughs Computer</td>
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²Ibid., pp. 33-46.
General Electric Computer 6 installations
Remington Rand Computer 23 installations
Other type computers 76 installations

These statistics indicate that the computer currently enjoys widespread use in colleges and universities.

Statement of the Problem

The purpose of this study is two-fold: to survey the present data processing methods employed in colleges and universities in the areas of financial record keeping, analysis, and control, as well as in the area of student records; and to propose a total systems approach to the data processing problems of colleges and universities through the use of equipment with on-line real-time capabilities. The total systems approach to be formulated will include the areas of financial records, students records, teaching and research, and information retrieval.

Importance of the Study

While a large number of institutions of higher learning have installed electronic data processing equipment to handle their business, accounting, and registrar's work, the decisions to acquire the equipment appear to have been made in most instances without a thorough investigation of all its possible applications. It appears that the organizational structure of the computer centers in the institutions surveyed was not
carefully considered. A logical, step-by-step pre-installation plan is certainly desirable and almost a necessity; in some cases, however, this matter had not been fully explored. Although a complete understanding of the computer, its capabilities and its limitations, is requisite to a well-developed installation, this important item has not been given adequate consideration in certain institutions. Finally, as equipment capabilities are increased, future requirements should be considered.

One possible reason for the apparent neglect of certain important areas in the establishment of a well-developed computer operation may be that while there is much literature dealing with segments of the major considerations of a successful university installation, there is no complete presentation on the subject. A study that considers the total scope of the electronic data processing center and treats the areas outlined as problems in this study might be used by college or university presidents and/or chief business officers as a guide to developing total systems appropriate to requirements of the centers. The presentation need not be detailed in order to be useful in the areas of accounting and financing, students' records, or teaching and research, since the details of input and output vary greatly from one institution to another. This study is designed to meet the very pressing need for an overall survey of computer operations in colleges and universities.
Approximately half of this study related to problems of the accounting and financial systems in institutions of higher learning. The remainder concerns problems encountered in student record keeping and in teaching and research areas.

**Approach to the Study**

The approach to the problem of developing the total systems concept with on-line real-time equipment for use in the areas of accounting and financing and student record keeping was as follows: The author developed a questionnaire designed to determine how eleven universities made the decision to install a computer,\(^3\) planned the installation, selected the equipment, prepared the applications, and developed the accounting system for computer mechanization. The length of the questionnaire and the detailed information needed concerning the accounting systems made it imperative that the author personally visit the eleven institutions included in the study. In most of the institutions it was necessary to interview several persons in order to achieve the breadth and depth required for the study.

A second questionnaire was developed to elicit from university registrars information such as the student records required, equipment in use, and reports required.\(^4\) The author

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\(^3\) The complete questionnaire is included in Appendix I.

\(^4\) The questionnaire used for the student records area is shown in Appendix II.
discussed these problems with registrars in five institutions.

Information obtained from these surveys has been supplemented by textbooks, magazine articles, pamphlets, bulletins, and memoranda dealing with the subjects of university accounting and financial record keeping, student record keeping, and electronic data processing.

An examination of the financial statements of seventeen institutions of higher learning was conducted to obtain a clear picture of current practices of institutional reporting. These institutions are listed in the bibliography.

The author visited the following institutions in the course of this study: Ball State Teachers College, Florida State University, Indiana University, Louisiana State University, Mississippi State University, Southern Illinois University, University of Florida, University of Kentucky, University of Southern Mississippi, University of South Florida, and University of Texas. In addition to these eleven institutions, the University of Mississippi is included in the study because the business office is planning an electronic data processing installation. Data obtained from a feasibility study conducted by a firm of consultants for the University of Mississippi is also incorporated in this dissertation.\(^5\)

Limitations of the Study

The study is not concerned with details of financial systems or student record keeping systems; it does, however, present ideas for improved systems and procedures, more informative reports, more effective control techniques, and improved forecasting.

No attempt is made to determine the most appropriate equipment to be used for data processing problems in universities. Likewise, while cost factors are considered, the discussion does not involve cost from the standpoint of feasibility for any given institution. Rather, the purpose is to present the idea of the on-line real-time total information system and to leave individual cost considerations to each institution.

It should also be recognized that the satellite terminals to be connected with the computer central processing unit and the associated peripheral equipment proposed in this paper may not yet be sufficiently developed to be practical. These machine limitations do not deter discussion of such a system. In addition, while equipment or transmission lines may limit the practicability of the proposed system at the present date, it is expected that these technological problems will be solved in the near future. Equipment limitations, therefore, are largely ignored.
Organization of the Study

The topic first considered is data processing methods currently used in universities to cope with accounting and financial record keeping and reporting. Student record keeping requirements, the current data processing procedures for maintaining student records, and the required reporting practices are then investigated. Finally, a concept is presented for a total systems approach to accounting and financial problems as well as student record keeping problems on data processing equipment with on-line real-time capabilities.

Specifically, Chapter II is a survey of financial data processing methods. The organization of electronic data processing centers, pre-installation planning, the university fund system of accounting, and financial reporting requirements are discussed. Chapter III is an investigation of educational institutional requirements and current practices with respect to admission procedures; registration systems; reporting needs; maintenance of permanent records; and scheduling of course offerings, classrooms, and laboratories. Chapter IV is an introduction to the total information systems concept presenting the capabilities of on-line real-time computer systems, problems of centralization of equipment, and the organizational structure required for such a system. The requirements for locations of satellite terminals and their respective uses are also examined. Chapter V presents a proposal for the use of on-line real-time computer
systems for processing accounting and financial data, maintaining required records, and generating desired reports. The possibilities for new financial information and improved control techniques under this kind of system are also pursued. Chapter VI examines a system of on-line real-time data processing for handling student records by centralization of student transcript records. Controlling course offerings and curriculum and the possibility of forecasting course offerings, classrooms, and laboratory requirements are also examined. The availability of data on both students and programs is critically examined.

Chapter VII is a discussion of teaching and research as they may be affected by the total systems approach. The possibilities opened to the library through use of this on-line real-time system are also considered. Chapter VIII is a summary of the important points presented in preceding chapters.

**Definition of Terms Used**

The development of the electronic computer produced an array of new terms which have now become more or less standardized. Although it is assumed that the reader will be familiar with these terms, they are listed, with appropriate definitions, in Appendix III. Definitions of other terms used in the study are given below:

Administration. The administration of a college or university is generally considered to include the institution's
president and the top administrative officials who report directly to him. Included in this group are the chief academic officer, the chief business officer, and the head of the student personnel area.

**Chief business officer or business manager.** The head administrative official who is charged with the responsibility of administering the business affairs of the institution may be known by various titles. Some titles currently in use are vice president for business, business manager, chief business officer, comptroller, and treasurer. The titles business manager and chief business officer are used interchangeably in this study.

**Business office.** All business functions are channeled through the business office headed by the chief business officer. Certain business transactions may be handled by the chief business officer himself or delegated to other officers. Such delegation to other offices may permit occasional business transactions to be handled elsewhere.

**Budget officer.** For every budget account there must be an officer responsible for the expenditure of, and accounting for, allotted funds. This person, referred to as the budget officer, may be a department chairman, dean, or other official of the institution.

**Legislative budget.** State supported institutions are required to submit to the legislature a request for support funds from state sources. This request is presented in the form
of a budget for a one-year or two-year period and is the basis for state appropriations for the institution.

**Institutional operating budget.** After the funds have been provided by the state legislators and other sources, an operating budget is prepared as the financial plan of operation for the forthcoming year's operation.

**Central cashier.** The central cashier receives all incoming cash, accounts for it, and subsequently deposits it. This person may also be called the bursar or treasurer in some institutions. Other responsibilities may also be assigned to the central cashier's office.

**Real-time computer system.** A computer system which permits several users to have access to the computer without forcing anyone to remove his program and data is referred to as a real-time system. Since the input equipment is connected directly to the computer, thus on-line, this system is called an on-line real-time system.
CHAPTER II

SURVEY OF FINANCIAL DATA PROCESSING METHODS

The decision to install an electronic data processing system entails the expenditure of substantial sums of money. In addition to the cost of renting or purchasing the computer and the required peripheral equipment, there are commitments for establishing and staffing an organization, one-time charges for physical site preparation and certain items of furniture and equipment, as well as the initial stock of operating supplies. The administrative officials should ascertain that the equipment to be acquired is actually needed and that it is carefully selected. The administrators must also determine the estimated cost of the initial installation as well as the annual rental, salaries, wages, and other items of expense associated with its operation. Further, the administration is interested in all the possible uses of the computer and its related equipment. The equipment may be utilized for teaching, research, and administrative purposes such as accounting and student record keeping.

If a computer installation requires major changes in the accounting system, the registrar's record keeping system,
or other systems currently in use at the institution, then the administration certainly will be interested to know exactly what these modifications will be, how long it will take to achieve them, and what kind of results may be expected after the computer is actually installed. An investigation into all these details of an EDP system should be conducted prior to the commitment of funds for such an installation.

The purpose of this chapter is (1) to review the studies which have been made in this connection by institutions of higher learning, (2) to analyze the kind of organization required for the EDP center, (3) to examine the pre-installation planning required before the changeover to a computer system, and (4) to examine modifications necessary to the accounting system and the financial reporting in order to utilize the computer.

In order to develop solutions to these problems, the author visited eleven institutions of higher learning and discussed with administrative officials details along the lines mentioned above. Complete data was gathered on modifications to the accounting system and financial reporting currently being practiced in institutions of higher learning. The information presented on the following pages is a result of these conferences and the questionnaires answered by officials of the institutions visited.
Feasibility Study

In order to resolve the major problems which an institution faces in converting a conventional accounting system to an electronic data processing system, it was considered essential that a study be conducted in depth. The conferences with the business officers of the institutions visited revealed that many of them had not conducted a feasibility study designed to provide specific solutions to major problems in connection with computer systems. In ten of the eleven institutions visited the decision to install a computer system was an administrative one.

While a feasibility study may have been conducted by some groups on the campus, this was not done in any depth. The decision was generally based upon the administrator's knowledge of computer systems being used at other institutions and the belief that similar equipment could be readily adapted to his own institution.

There are several reasons why a decision on an important function and expensive equipment might have been made without the benefit of a lengthy study. First, a number of institutions already had a teaching and research center in operation. In such cases, computer center personnel were able to provide answers to questions concerning rental costs, staffing costs, space requirements, peripheral equipment, programming time, conversion time, and similar problems. Second, several of the institutions were changing from punch card accounting and had
a general knowledge of conversion requirements. Third, business officers attended annual conventions where they obtained information concerning the equipment currently being used for similar work at other institutions. Thus, university administrative personnel did have certain information on which to base an appropriate decision prior to the installation of the electronic data processing equipment.

One institution had an outside consultant firm conduct a full scale feasibility study.¹ The basic objective of this study was to determine the economic desirability and technical feasibility of placing business, administrative, research, and teaching functions on a computer or computers. Specifically, it covered the following areas: (1) business and administrative systems which should be placed on the computer, (2) the economic implication of changing these systems to computer systems, (3) the computer time required for both scientific and non-scientific applications, (4) the length of time required to convert the systems initially selected for change, (5) personnel qualifications and the number of persons required to design the new system and perform the conversion, (6) proper layout of physical site, (7) selection of appropriate equipment, and (8) the organizational structure for the electronic data processing center and the number of persons required to operate it.

¹Cresap, McCormick and Paget, op. cit.
Thus, while a full scale feasibility study is highly desirable, most institutions were not conducting such a study; they simply relied on administrative judgment to make the decisions with respect to installation of an EDP system.

Organizational Structure of the EDP Center

There were generally two schools of thought in connection with the organizational structure of EDP installations. One group believed that one central center should handle all data processing. A separate organization was created and in some cases the head of the unit reported directly to the president; in one or two cases, he reported directly to the chief business officer, and in at least one instance he reported to the chief academic officer. Another school of thought held that there should be two centers, since the functions of teaching and research are distinctly different from administrative data processing. This group believed that one EDP center should function as a teaching and research center only and be directly responsible to the chief academic officer. A second computer center would be established for administrative uses, i.e., for accounting and business systems use as well as the student records and financial aids use; and this center would be organized so that the head of the unit reports directly to the chief business officer.

The belief that two computer centers should be organized
for the two distinctly different functions appeared to be the prevailing attitude, and most of the institutions visited either had two centers in operation or planned to have two in the near future. The directors of these centers reported to the chief educational officer and the chief business officer respectively.

The major problems in connection with a central center were as follows: First, the authority for processing all data was centralized in one office, and this authority cuts across natural divisions, disrupts established lines of authority, and seriously damages the organization of the institution. Second, the problem of priority of work was a major obstacle. It was felt that some major user would always suffer because he could not utilize the computer at the time desired and receive the results without doing serious damage to his own operation. Third, the possibility of loss or misplacement of important data or programs led many persons to feel that two separate centers were essential. While these arguments may be valid at the present time, there is the possibility of a central center with on-line real-time capabilities that should solve the problems which have previously necessitated development of two separate centers.

In the eleven educational institutions visited, seven had developed two separate centers, one of which served the teaching and research function and the other, the administrative
data processing function. In two of the institutions having a central center, the director reported to the chief business officer. In two others, one director reported directly to the president, the other to the chief academic officer. In one institution with a central installation, the business office made little use of the computer center.

**Pre-installation Planning**

Once the decision to install electronic data processing equipment has been made, the institution involved must prepare detailed plans for the installation. This detailed pre-installation planning is vital to a smooth and successful installation and encompasses the following major areas: (1) a determination of the initial applications to be placed on the equipment; (2) establishment of the timetable schedule; (3) establishment of the organization; (4) initial education of the employees; (5) definition of the problems, programming, and testing of each application; (6) planning the changeover or conversion; (7) education and training of staff for the center; (8) planning of physical installation; (9) exacting equipment requirements and final delivery date.

These problems can be handled adequately only if a high level administrative officer is assigned full responsibility for the pre-installation phase and charged with the responsibility of following up each phase of the operation.
In the institutions examined, the initial accounting applications were determined by the head of the accounting office, who could be expected to begin with payroll and the physical plant labor distribution, accounts receivable, purchasing and accounts payable, general ledger accounting, budget preparation and control, and cash receipts system. The registrar normally determined the applications to be placed on the computer in the student records area, including registration, grade reporting, permanent student records, class rolls, and class scheduling. Other administrative applications involved alumni office records, scholarships, student loans, other institutional financial aid programs, and personnel records. These applications were initiated by the office responsible for each operation.

The pre-installation activities dictate that target dates be established for the major activities in the overall program. A number of forms have been developed for the guidance of administrative officials responsible for the installation of the data processing system. One of these forms suggested by the International Business Machines Corporation is reproduced as Exhibit 2.1.²

Once the general schedule of the pre-installation activities has been completed, the most important part of the

# IBM Data Processing System Preinstallation Schedule

<table>
<thead>
<tr>
<th>DELIVERY DATE</th>
<th>SYSTEM NO.</th>
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<table>
<thead>
<tr>
<th>1. ESTABLISHMENT OF ORGANIZATION</th>
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<tbody>
<tr>
<td><strong>ESTABLISHMENT OF ORGANIZATION</strong></td>
</tr>
<tr>
<td><strong>INCLUDES:</strong></td>
</tr>
<tr>
<td>A. APPOINTMENT OF DATA PROCESSING MANAGER</td>
</tr>
<tr>
<td>B. SELECTION OF PLANNING AND PROGRAMMING STAFF</td>
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<tr>
<th>2. INITIAL EDUCATIONAL PROGRAM</th>
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<tr>
<td><strong>INITIAL EDUCATIONAL PROGRAM</strong></td>
</tr>
<tr>
<td><strong>INCLUDES:</strong></td>
</tr>
<tr>
<td>A. EXECUTIVE SEMINAR</td>
</tr>
<tr>
<td>B. PROGRAMMING CLIFF FOR DATA PROCESSING MANAGER AND PROGRAMMING STAFF</td>
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</tbody>
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<tr>
<th>3. GENERAL SYSTEMS DESIGN</th>
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<tbody>
<tr>
<td><strong>GENERAL SYSTEMS DESIGN</strong></td>
</tr>
<tr>
<td>IN PLANNING FOR THIS PHASE CONSIDERATION MUST BE GIVEN TO MANY REQUIREMENTS INCLUDING THE PERTINENT ITEMS INDICATED BELOW.</td>
</tr>
<tr>
<td>A. ESTABLISHMENT OF PREINSTALLATION SCHEDULE OF EVENTS (BAR CHARTS)</td>
</tr>
<tr>
<td>B. APPLICATION DEFINITION BASED PRINCIPALLY ON THE FOLLOWING ITEMS:</td>
</tr>
<tr>
<td>1. REVIEW OF SOURCE DOCUMENTS</td>
</tr>
<tr>
<td>2. ANALYSIS OF FILE REQUIREMENTS</td>
</tr>
<tr>
<td>3. DETERMINATION OF REPORT REQUIREMENTS</td>
</tr>
<tr>
<td>4. ESTABLISHMENT OF OUT-IN AND DUPOUT SCHEDULES</td>
</tr>
<tr>
<td>5. DEFINITION OF PROCEDURES WITH RESPECT TO WORK FLOW</td>
</tr>
<tr>
<td>6. DEFINITION OF ORGANIZATIONAL CHANGES REQUIRED</td>
</tr>
<tr>
<td>7. DETERMINATION OF REQUIREMENTS FOR OPERATING PERSONNEL</td>
</tr>
<tr>
<td>C. GENERAL FLOW-CHARTS</td>
</tr>
<tr>
<td>D. BLOCK DIAGRAMS</td>
</tr>
<tr>
<td>E. ALL BASIC CHANGES TO EXISTING SYSTEM DETERMINED AND AGREED TO AND A PLAN IN OPERATION TO AFFECT THEM</td>
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<tr>
<th>4. REVIEW OF PHYSICAL INSTALLATION PLANS</th>
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<tbody>
<tr>
<td><strong>REVIEW OF PHYSICAL INSTALLATION PLANS</strong></td>
</tr>
<tr>
<td>THIS MUST BE ACCOMPLISHED IN A MEETING WITH THE IBM SALES ENGINEERING REPRESENTATIVE, AND MUST CONSIDER THE FOLLOWING MAJOR ITEMS:</td>
</tr>
<tr>
<td>A. SPACE</td>
</tr>
<tr>
<td>B. POWER</td>
</tr>
<tr>
<td>C. AIR CONDITIONING</td>
</tr>
<tr>
<td>D. ROOM CONSTRUCTION</td>
</tr>
<tr>
<td>E. CABLE REQUIREMENTS</td>
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<tr>
<th>5. DETAILED SYSTEM DESIGN</th>
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<tbody>
<tr>
<td><strong>DETAILED SYSTEM DESIGN</strong></td>
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<tr>
<td>IN ESTABLISHING THE SCHEDULE FOR THIS ITEM CONSIDERATION SHOULD BE GIVEN TO THE FOLLOWING PERTINENT SUBJECTS:</td>
</tr>
<tr>
<td>A. DETAILED FLOW CHARTS</td>
</tr>
<tr>
<td>B. DETAILED BLOCK DIAGRAM OF MAJOR APPLICATION</td>
</tr>
<tr>
<td>C. CODING SCHEMATA</td>
</tr>
<tr>
<td>D. DETERMINATION OF DETAILED EQUIPMENT SPECIFICATIONS</td>
</tr>
<tr>
<td>E. REVIEW OF SAVINGS AND COST ANALYSIS</td>
</tr>
<tr>
<td>F. REVIEW OF DETAILED PREINSTALLATION SCHEDULE OF EVENTS (CODING TESTING, ROOM CONSTRUCTION, ETC.)</td>
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<tr>
<th>6. FIRST TEST SESSION COMPLETED</th>
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<tr>
<td><strong>FIRST TEST SESSION COMPLETED</strong></td>
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<tr>
<th>7. ESTABLISHMENT OF CONVERSION PROCEDURES</th>
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<tbody>
<tr>
<td><strong>ESTABLISHMENT OF CONVERSION PROCEDURES</strong></td>
</tr>
<tr>
<td>CONSIDERATION TO BE GIVEN TO:</td>
</tr>
<tr>
<td>A. TIME SCHEDULE</td>
</tr>
<tr>
<td>B. EQUIPMENT REQUIREMENTS</td>
</tr>
<tr>
<td>C. PERSONNEL REQUIREMENTS</td>
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<tr>
<td>D. PROCEDURES AND CONTROLS</td>
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<tr>
<th>8. ESTABLISHMENT OF FIRM DELIVERY DATE METHOD OF DELIVERY, SPECIAL HANDLING REQUIREMENTS</th>
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<tr>
<th>9. MACHINE ROOM LAYOUT AND CABLE ORDER APPROVED</th>
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<tr>
<th>10. SELECTION AND TRAINING OF OPERATING PERSONNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. CONSOLE OPERATORS</td>
</tr>
<tr>
<td>B. TAPE HANDLERS AND EQUIPMENT OPERATORS</td>
</tr>
<tr>
<td>C. LIBRARIANS</td>
</tr>
<tr>
<td>D. OTHERS</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>11. CONVERSION AND MAJOR APPLICATION PROGRAMS TESTED AND READY FOR VOLUME OR PARALLEL PILOT RUNS</th>
</tr>
</thead>
</table>

**EXHIBIT 2.1**
installation is that of building a really competent organization to develop the complete installation, make the changeover, and finally operate the center. Institutional business officers emphasized the fact that the success of the EDP center depends on the quality of the personnel operating it. Conway also strongly emphasizes this point in his presentation regarding the successful operation of an EDP center.3

The institutional business officers agreed that the director of the center must be a very capable individual and that the systems personnel and the efficiency with which they design the system are of extreme importance to the success of the center. In order further to assure the success of an EDP center, the administrator usually acquainted all the employees with the decision to install EDP equipment and assured them that their jobs would continue, although there might be modifications to their workloads and complete changes in responsibilities.

It was considered advisable to begin the preparation of the programming approximately two years in advance of computer installation so that 75 to 90 percent of the total applications could be programmed, tested, and debugged prior to the arrival of the computer and related equipment. The actual conversion from the old system to the new required several weeks. One or

two institutions made the shift without any conversion time, being fully confident after thoroughly testing the programs that they would run satisfactorily on the new computer. It was generally considered appropriate, however, to run a parallel operation for approximately 30 to 60 days.

The education and training of the staff was not a major problem in most institutions since operators and keypunch personnel can be trained in a very short time. The director and systems personnel were most important and had to be carefully selected. Generally, the systems personnel were selected from within the institution and trained in computer techniques, rather than bringing in computer experts and teaching them the accounting systems.

The actual physical installation for computers in current production does not require expensive air conditioning or heat controls and may be accomplished by the modification of a room to meet the electrical requirements of the computer. In most cases the computer manufacturer furnished the electric requirements, and the institution's physical plant department modified the space so that the installation could be made without any difficulty.

Fund Accounting System

It is not at all uncommon for institutions of higher learning to spend forty to fifty million dollars annually on
their educational and general programs. Add to this figure the sums expended from restricted sources, operation of auxiliary enterprises, capital outlay programs, endowment funds, loan funds, and agency funds, and the figures for total institutional expenditures can double. Accounting for expenditures in complex institutions is, therefore, a monumental task.

In order to account properly for their monies, educational institutions have developed their charts of accounts around the fund system. This system utilizes the following fund groups with subdivisions as indicated:

I. Current Fund
   A. General Current
   B. Restricted Current
   C. Auxiliary Current

II. Loan Fund

III. Endowment Funds and Funds Functioning as Endowments
   A. Endowments
   B. Annuity

IV. Plant Funds
   A. Unexpended Plant Funds
   B. Retirement of Indebtedness Funds
   C. Invested in Plant Funds

V. Agency Funds

VI. Revolving Funds

The American Council on Education recommended the above fund structure. According to Morey:

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5National Committee on the Preparation of a Manual on College and University Business Administration, College and
The accounts of a university or college . . . should be segregated and classified by funds. Accounts of funds, in the broad sense, include not only the accounts of cash relating to them, but also all other accounts necessary to reflect their condition and operation from the time they were first established. . . . Every fund or fund group is a separate accounting unit, and its accounts must balance and may be exhibited in balance sheet form.6

The fund accounting system amounts to a separate grouping of self-balancing accounts similar in many respects to governmental accounting systems. The general current funds are those available for the ordinary and necessary operation of the educational program of the institution which includes general administration and general services, the instructional program, organized research, operation of the library, and operation of the physical plant. These funds are normally expended without restriction. Restricted current funds may be available for current operation; these funds, however, are subject to certain conditions which restrict their use. Federal and state research contracts and grants, donations for scholarships and fellowships are examples of funds which have provisions restricting their use. Auxiliary current funds include accounts of self-supporting activities of the institution such as the housing system, cafeteria, the bookstore, and other activities of a similar nature.


Basically, loan funds are those available for loans to students of the institution. The principal of endowment funds must remain inviolate; the income, however, may be used for purposes specified by the donor. Annuity funds, according to the National Committee on Standard Reports, are those funds obtained under annuity agreements. That is, funds received are subject to the condition that the institution pay to a designated individual or individuals stipulated sums of money.\(^7\)

Plant funds are divided into three balanced groups. The unexpended plant funds are those set aside for renovation, major repairs, and new construction of physical facilities for the institution. Retirement of indebtedness funds are assets reserved for debt retirement. The invested in plant funds group accounts for assets which have been invested in institutional property.

Funds over which the institution has custody, but over which it can exercise little or no control, are called agency funds; they are not, in fact, owned by the institution at all.

Revolving funds include resources derived from self-supporting activities and interdepartmental services.\(^8\) Educational institutions must account for monies in separate


\(^8\)Morey, *op. cit.*, p. 29.
categories, and these funds must be handled in such a way that they meet all the requirements of donors, trustees, and other interested groups.

It has been necessary for many institutions, particularly the larger ones, to change their systems to electronic data processing in order to cope with their expanding activities and to account properly for the institutional funds. The following discussion of accounting systems is based upon a survey designed to determine the accounting practices and procedures used at the eleven institutions examined.

**Chart of accounts.** The chart of accounts produces the key to an efficient accounting system on electronic data processing equipment. Each digit of the accounting code should be significant in order to avoid needless punching of extra digits in codes. Extra digits take up space, cause extra punching, use of computer memory, and waste both time and machine capacity. It is highly desirable to create a chart of accounts code sufficiently flexible to allow for expansion and at the same time to avoid the use of extra digits which have no significance. Most of the institutional officials consulted found that they did have to recode completely their charts of accounts in order to modify their systems to an electronic data unit. The major modification generally developed not from a reorganization of the chart of accounts, but simply from changing it to a numerical sequence coding method. It is necessary in
many cases to summarize accounts in different fund groups. For example, the cash account may be summarized by properly coding the accounts so that a sort through the computer, or through sorting equipment, may be made on one or two digits of the cash accounts, thereby permitting a summary of the cash accounts into one total cash-in-bank account.

The recoding of charts of accounts varied considerably from one institution to another, but one of the simplest and most logical coding systems appeared to be the one which follows. The first digit of this code indicates the fund group; the second digit, the breakdown within that fund group. For example, under the current fund group there is a general current fund, the restricted current fund, and the auxiliary current fund. The next two digits indicate the major accounts within each fund group. A final breakdown, using one or two digits under each major account in the fund group, completes the coding outline of the general ledger.

The subsidiary income ledger followed a similar coding pattern with the first digit indicating campus location, the next digit designating major categories of income, the third and fourth digits showing the college or major unit receiving the income, the fifth and sixth digits indicating the departments within the college or major unit, the seventh digit indicating source of funds, and the final digit indicating the sequence of accounts.
The subsidiary expenditure ledger was coded as follows: The first digit indicates campus location; the second and third digits, college or major unit; the fourth and fifth digits, the department within the college; the sixth digit, source of funds; the seventh digit, the function; the eighth and ninth digits numerical sequence. Object coding for salaries, wages, supplies and expense, and equipment accounts requires three digits to give the desired flexibility in these accounts.

In summary, then, the major modification required in developing a chart of accounts for institutions of higher learning changing from conventional accounting methods to electronic data processing methods was to recode the chart of accounts so that the required reports could be generated effectively from the system. At the time of the survey, most institutions were using College and University Business Administration, Volume I, as a guide for this recoding.9

Budget preparation and control. Preparation of legislative and operating budgets has been successfully automated on electronic data processing equipment. The first step in changing to an automated budget preparation system is to have data cards punched for every line item of income and expenditure which is proposed for the current year's operation. This provides a starting point for the preparation of estimates for

9National Committee on the Preparation of a Manual on College and University Business Administration, op. cit.
the next year's budget.

After preparation of the data cards punched from the current year's income and expenditure budget estimates, a computer run generates the necessary copies. Income estimates are sent to the chief business officer to be used in the preparation of new estimates for the next year's income. The expenditure sections are sent to the respective department heads so that they may indicate employees' salary rates for the new year, new wage rates, requests for new salary and wage positions, and additional amounts required for supply and expense and equipment. Appropriate justification for each of these increases is required. Subsequent to approval of the department heads' recommendations, data cards are again prepared indicating new figures for each of the respective accounts budgeted. These cards are sorted to code sequence and processed through the computer to provide printouts of the budget. This can be done on accounting equipment rather than computers, but when computers are utilized certain percentage calculations can be derived to indicate percentage increases in respective budget positions and/or the percentage increase in total budgets. In the process of running the budget, other statistical data and/or calculations can be derived which may prove helpful to the chief business officer and the administration of the institution. This additional statistical information was not provided in the institutions surveyed.
Once the formal budget has been prepared, approved by the board of trustees, and put into operation, the accounting office is expected to control the expenditures in each budget category to prevent an over-expenditure of funds. This control is generally exercised in accordance with the following outline:

1. The budget is recorded in detail in the accounting records.

2. All purchasing is done by the business office upon the requisition of the department head.

3. Prior to issuance of the purchase order, the accounting office approves the requisition as to the availability of funds.

4. When issued, the purchase order is entered as a charge or encumbrance against the appropriate departmental budget, thus effecting a reduction in the available balance.

5. The accounting office prepares monthly statements for each budgetary unit showing the exact status of its particular budget.

6. Adjustments of budgets for unanticipated needs are properly approved and formally entered into the accounts.10

Thus, control over most supply and expense items and equipment items is effected through the purchasing system. Control over salaries and wages of personnel is established when the budget is being prepared, and any budget revisions required for increases or decreases in salary, changes in status, and the

like, must be accompanied by the necessary personnel papers.

Institutions that had automated the control over items purchased added a step in the purchasing process to permit the extraction of the necessary information from the purchase orders for transfer to data cards. The punched cards are a source document for purchase order information to be entered into the system of accounts, which then reflect the encumbrance as well as the updated, unexpended, unencumbered balance.

Budget revisions to increase or decrease account balances are handled in the same manner as approval of the original budget document. The budget revision form becomes the source document for the preparation of a punched card used to update the system in much the same way as a purchase order. Personnel papers are used as a source document from which data cards are punched to place personnel names in vacant positions or to modify the status of personnel records in positions already established in the budget.

Reports to department heads in the majority of the institutions surveyed amounted to a distribution of budget statements to the department heads concerned. Monthly statements for wages, supply and expense, and equipment showing the expenditures, encumbrances, and unexpended balances are normally used for reporting. These statements are prepared as the budget is updated from transactions previously punched into cards. As this transaction deck is processed against the budget
ledger deck of cards, all records are updated. Some institutions transferred the information to tape and thereby speeded the updating process. Few of the institutions were producing reports which they had not made previously under other systems utilizing punch cards or other machine accounting methods.

**Income and receipting systems.** Educational institutions typically receive their income from six major sources: student fees, gifts and grants, governmental appropriations, endowment income, sales and services of educational departments, and other income sources. The educational institutions examined had centralized the receiving of income in one office, referred to as the central cashier or bursar. The systems were automated through the following procedures. Funds are received from auxiliary enterprises, departments, and individuals, and a receipt is prepared indicating the code receiving the funds, the amount, the date, and any other pertinent data. This information from the receipt is then punched into data cards which are processed on the computer to distribute the income to the proper budgetary accounts which have already been established.

Departments and auxiliary enterprises bringing funds to the central cashier are expected to prepare a detailed cash report supporting the funds turned in. One receipt covering the entire department's deposit is then issued; the receipt is converted to a punched card, which is used to update all budgetary accounts affected by the receipt of income. Generally, the
budgetary accounts are expected to reflect the income estimate, the amount received, and the unrealized balance. This information is generated readily as cards are processed on the computer with the appropriate program. Other data can be obtained as a by-product of the account updating process; for example, the percentage of each budget estimate realized to date might be useful.

Payroll system. The payrolls of the institutions are divided into two major categories—the salary payroll and the wage payroll. Salary payrolls are placed on the computer through the use of the budget document which provides complete details within the salary section. The name and rank of each individual to be paid, the number of months' pay owed him, and his salary level for that period of time are indicated. As changes occur in various positions budget revisions must be processed in order to reflect the revision in an individual's status. The source document for such changes is the personnel form which is usually designed to be compatible with data cards. That is to say, the information on the personnel form is organized in such a way that a keypunch operator can readily extract this data from the personnel form and transfer it to a data card, which is then used to update the budget document in the salaries category.

The salary budget deck of data cards is used to prepare the paycheck for each individual since it shows his name, rank,
number of months, and total salary. A program to pay the individual a part of his total salary each month permits the computer to calculate the amount, print out the check indicating the individual's name, and the amount of his pay, deducting all of the necessary amounts based on the basic information included in a master card for each individual. In most institutions the basic information about the individual, such as social security number, the number of dependents, sundry deductions information, and the like is recorded on a master card. This card is merged with payroll information in the budget to determine the individual's pay for a particular period. Several printouts in addition to pay checks are prepared from the computer, setting out the required accounting information which is desired with each payroll run.

Wage payrolls also require a master card giving details about the individual. In order to complete the payroll for wage personnel (those on an hourly basis), it is necessary to know the number of hours each employee worked during the payroll period. The institutions obtained from previous payrolls all information required for the new payroll except the number of hours which the individuals worked. The computer printouts are then forwarded to the departments that hire personnel on an hourly basis for the department head to insert the number of hours worked, the number of days, and any other required information; affix his signature to certify that the work has been
performed; and return the printouts to the computer center for processing of the payroll. The center then has available the person's name, number of hours worked, rate per hour, and all other information required to process the wage payroll.

As the payroll is processed, new computer printouts are prepared to be sent to the departments for completion at the end of the next pay period. When employment is terminated, employees' names are deleted from the payroll and new persons are added when they are employed. Permanent records are prepared for the master card data in the personnel office.

As a by-product of the payroll run, many subsidiary records which are most valuable to the institution are prepared by the computer. For example, the total earnings to date, social security withheld to date, state retirement withheld to date, group life insurance payments, income tax withheld, savings bonds information, and the other sundry deductions information is compiled as a result of processing on the computer. It is also possible to update the budget document to reflect salary and wage expenditures as well as unexpended salary and wage balances.

**Expenditures, purchasing, and disbursements.** Educational expenditures in addition to payrolls are for supply and expense and equipment. Certain institutions also have funds available for capital expenditures, renovations, major repairs, and the like. In order to account for these expenditures properly and
to exercise effective control over them, a system of centralized purchasing and control and a system of encumbering are required. This centralized purchasing system requires that prior to the issuance of the purchase order, funds be encumbered against the accounts involved. This encumbrance can be automated through the preparation of data cards to which information is transferred directly from the purchase order. Thus, the account is checked to determine if funds are available before an order is issued. If funds are available, the account is encumbered for the amount; the unexpended, unencumbered balance is updated; and the purchase order is released to the vendor. When materials are received, a receiving report is prepared, the invoice obtained from the vendor, and these two documents are matched with the purchase order. Data cards are punched from a remittance advice to permit removal of the encumbrance and at the same time charge the expenditure to the budgetary account and update the unexpended, unencumbered balance in the budget document and accounting records. In most cases, the institutions surveyed had automated their systems by adding to the process the step of preparing a data card from the remittance advice. This data card is used in updating the accounting records and in preparing the payment check for the vendor.

Most institutions require that equipment purchased be capitalized and carried in the invested in plant account. A numbering system designed to record the various items of
equipment owned by the institution is also required to fix responsibility on the department receiving the equipment. Data cards are prepared for each item of equipment, giving the facts which serve as the basis for permanent records. These data cards are then used to prepare printouts of equipment assigned to each department, and these lists are periodically forwarded to the departmental chairman for certification that the equipment is still in the possession of the department. Capital expenditures are normally incurred through contracts with construction firms. Contracts and construction payments serve as a basis for the preparation of data cards which are used to establish accounting records and to capitalize the amount of funds expended for major items of construction. A similar procedure is utilized in connection with renovations and major repairs. Some institutions wait until the projects are completed and then punch cards for the total expenditures for entry into the accounting system.

**Plant funds.** Funds in the unexpended plant fund account are expended for new construction, renovations, and for major repairs, and in some cases for minor repairs which can be made by the physical plant department. Because these transactions are limited in number, the data cards are prepared at the time the construction work is completed. They are then used to update accounts in the system along with other transaction cards as the general ledger accounts are updated on a monthly basis. When
the physical plant department performs some of the actual renova-
tions or repairs, the physical plant cost accounting system is
used to collect the information and subsequently to charge the
expenditure to an appropriate plant account. If the item is of
such nature that it is to be capitalized at the end of the ac-
counting period, additional data cards are prepared to transfer
the information from the unexpended plant fund account to the
invested in plant fund account and capitalize these items and
expense.

The retirement of indebtedness account was established
to receive funds designated to retire outstanding bonds or
other indebtedness incurred through operation of the institu-
tion. Funds are set aside from auxiliary enterprises or other
sources to retire the bonds of the institution. Because of the
relatively limited number of transactions in the retirement of
indebtedness account, several of the institutions did not auto-
mate these transactions. The accounting office prepares
journal vouchers which subsequently serve as a source docu-
ment for punching data cards which are then used in the updating
process.

Various reports are prepared from the information avail-
able in the plant fund group; the major ones are those on out-
standing bonds and a printout of invested in plant items. The
invested in plant report for buildings consists of a list of
buildings, showing the initial amount, additions and deletions
to each building during the year, and a total for each building. A similar report is prepared for equipment.

**Loan, agency, and endowment funds.** The loan funds of institutions have increased considerably in the last several years because of the National Defense Education Act passed by the 1958 legislature. The institutions that have been using computers, however, had done only a limited amount of work in automating the loan funds. As the magnitude of these funds increases, however, it is expected that many institutions will process their loans on the computer. The computer can greatly assist in collection by indicating due dates of loans, amount of individual loans, amount of interest due, and other pertinent data about the loan. The computer also has the capability of deciding what students should receive loans and in what amount, if it is properly programmed. Not one of the institutions examined, however, was using the computer for this purpose.

The director of financial aids or other officers of the institution were responsible for making the decision concerning loan funds. Some institutions were using the computer to keep their loan records, to calculate the interest charges, and to advise when notices should be sent; but this was the extent to which the computer was being used for the loan fund group.

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Agency funds were computerized to a limited extent under the purchasing system since agency funds come within the same system. Similar documents were prepared to expend from loan funds. Payrolls were prepared to pay personnel where this was necessary. In most cases, however, the agency funds were not used for the payment of salaries and wages but rather for purchasing items of a supply and expense nature and items of equipment.

At the institutions examined, the endowment funds had not been placed on the computer. It should be observed, however, that this is an excellent use for computers: first, to keep track of the investments themselves; and second, to provide comparative and analytical data about the growth of the endowments and earnings from the endowment funds. Moreover, premium amortization and discount amortization can be effectively handled through the use of the computer.

Financial Reporting

The twenty-six reports listed below have been recommended for colleges and universities by the American Council on Education.\textsuperscript{12} The institutions surveyed were preparing all of these reports. Although not all of them were prepared monthly, the majority of them were prepared at least annually.

\textsuperscript{12}National Committee on the Preparation of a Manual on College and University Business Administration, \textit{op. cit.}, pp. 77, 79, 101.
1. Balance Sheet  
2. Summary of Changes in Surplus  
3. Summary of Current Income and Expenses  
4. Summary of Changes in Current Restricted Fund Balances  
5. Summary of Changes in Loan Funds Balance  
6. Summary of Changes in Principal of Endowment and Other Non-Expendable Funds  
7. Summary of Changes in Annuity Fund Balances  
8. Summary of Changes in Unexpended Plant Fund Balances  
9. Summary of Changes of Funds for Retirement of Indebtedness  
10. Summary of Changes in Net Investment in Plant  
11. Summary of Changes in Agency Fund Balances  
12. Statement of Current Income (Detail)  
13. Statement of Current Expense (Detail)  
14. Statement of Current Restricted Funds  
15. Intercollegiate Athletics, Statement of Income and Expense  
16. Residence Halls, Statement of Income and Expense  
17. Cafeteria, Statement of Income and Expense  
18. Student Union, Statement of Income and Expense  
19. College Bookstore, Statement of Income and Expense  
20. Statement of Loan Funds  
21. Statement of Endowment and Other Non-Expendable Funds  
22. Statement of Annuity Funds  
23. Statement of Unexpended Plant Funds  
24. Statement of Funds for the Retirement of Indebtedness
25. Statement of Net Investment in Plant

26. Summary of Investment by Fund Group

Few of the institutions were utilizing the computer to prepare special reports other than those indicated above. The computer's capabilities for preparing many financial reports other than those suggested above, as well as analytical reports which are meaningful for management purposes, should not be overlooked. These possibilities will be explored more fully in a later chapter.

Observations Relative to Accounting Systems

Accounting systems are converted from punched card accounting or from other machine accounting methods to EDP systems by the process of transferring information from original source documents to data cards, then programming the computer to generate the desired output. In most of the institutions surveyed, the card information entered into the computer in the early stages of implementation of the new system was first transferred to an information slip to enable the keypunch operator to transfer the data more quickly. Later, after source documents were modified to make them compatible with the data card format, the information was transferred directly to the data cards.

It appears that a better plan would be to modify source documents first, and make the change without the extra step of the information slip. Possible errors caused by the extra
transfer of data as well as the extra time required for filling in the information slip might thus be eliminated. The decision-making ability of the computers was used only to a limited extent in the accounting systems surveyed. For example, although several institutions kept accounts receivable on the EDP system, none had programmed to have the computer indicate that past-due notices should be mailed and prepare these notices for mailing. Likewise, in the area of student loans receivable, the computer could be used to generate all collection data and send out collection letters, past-due notices, and follow-up notices to management that action other than correspondence is needed.

There was considerable duplication of data in many of the computer applications. Information on personnel may be assembled in a budget deck of cards; almost duplicate information may be used for payroll as well as personnel records. In addition, when employees are also students, the student records office has similar information. The above example is only one of many.

Accounting applications were programmed generally as separate entities without regard to how each application constituted part of a much bigger, overall system. In other words, a total systems approach, which might have reduced duplication of effort and overlapping of data and at the same time increased the efficiency of the system, was not used.
Summary

While it would seem reasonable to expect administrative officials of institutions of higher learning to conduct a full-scale feasibility study prior to the acquisition of expensive EDP equipment, this step was not taken in the majority of institutions surveyed. The decisions to purchase were administrative decisions based on the officials' knowledge of the equipment.

Administrative personnel at the institutions examined did not believe that one central computer system could meet the requirements for administrative uses as well as teaching and research functions. Consequently, the majority of the institutions had two separate centers in operation—one for each function. The heads of these units reported to their respective division heads; that is to say, the administrative computer center director reported to the chief business officer, while the academic computer center director reported to the chief academic officer.

Two years of planning were required to get most business systems programmed and ready to operate. This time was used to recruit, train, and educate personnel; to prepare the physical site; to install the equipment; and to accomplish the conversion. The accounting system required a recoding of the chart of accounts to make it compatible with the computer system, and some documents needed changes to make them compatible with data cards.
The applications had to be programmed, tested, and debugged before the conversion of any application could be completed. These steps were a major undertaking in most accounting applications.

In several institutions the required reports were generated on the computer, but the majority of the institutions were assembling the financial reports by hand from computer-generated data. It is the writer's opinion that the computer systems could be used to generate new, more useful reports than are currently being produced.
CHAPTER III
SURVEY OF STUDENT RECORDS DATA PROCESSING METHODS

Shortly after the development of electronic computers, college and university registrars, grappling with the problems of processing data and maintaining both current and historical records on increasing numbers of students, realized that the use of such equipment could help solve their problems. In numbers of institutions, the registrars decided to convert to electronic computers long before business officers determined that the same kind of equipment might also solve some of their business data processing problems.

Registrars are pressured to produce grade reports almost immediately after the final date for examinations, so that the graduation lists may be verified, faculty and students may plan work for the next semester, and decisions may be reached concerning scholarships, fellowships, and loans which are tied to grade point averages.

Increasing student enrollments in colleges and universities create the need for expanded housing and food facilities, additional sections of classes, and increased faculties and instructional facilities. These requirements, in turn,
increase pressures during registration. Utilization of electronic computers has helped to alleviate at least some of the problems created by larger enrollments and has greatly aided the registration procedure. Computerized scheduling of course offerings, classrooms, and laboratories has solved certain problems in these areas, speeded the registration process, and made it more orderly. Student admissions records and reports which indicate the status of all students applying for admission to the institution can be rapidly prepared by computers.

The above statements provide a brief overview of the student records problems confronting registrars in educational institutions. The author visited five institutions to survey the student records data processing methods in current use. A discussion of the findings from this survey is presented below.

**Student Admissions Procedure**

The details of admission requirements for educational institutions may vary considerably from one institution to another; the pattern with respect to the kind of information required, however, is essentially the same. The application for admission generally requests information such as name, address, educational background, and physical handicaps of the prospective student. Information about the student's parents, such as names and addresses, occupations, and ages, may be
required. In the case of a married applicant, similar information on the student's husband or wife may also be requested. The applicant is required to indicate the program he plans to undertake, to submit his high school or college transcript, and, if he is a freshman, to pass an entrance examination with an acceptable score. While specific details may vary, the essential information establishes a pattern.

Two of the five institutions surveyed had developed master data on each student by punching data cards directly from the student applications. The application form and data card were designed to be complementary. A section at the bottom of the application form was used to synthesize data, and the punch operator utilized the application as an original source document. Admission information vital to the institution, as well as other data needed for registration procedures, permanent records and the like, is collected. Only one institution was actually producing an admission status report on applicants for admission. The status report did not indicate whether a student had been admitted, but only what requirements he had fulfilled. None of the institutions had yet programmed computers to make the admissions decisions which they logically could make after the punching of certain data and proper programming.

To determine educational eligibility one needs a high school transcript showing class standing, completion of twelve grades or the equivalent, and courses of instruction which meet
standards set by the college. Also required of freshmen are entrance examination scores of a pre-determined level.

Information relative to student's age, marital status, address, parents' address, and high school attended is required to determine resident status. This data is revealed in the application and can be partially confirmed by the high school transcript.

Data used to determine admissions can be punched into cards and processed on the computer. Admissions certificates are then prepared. Where admissions data is incomplete, status reports can be prepared. Depending on institutional policy, the registrar can advise students not meeting admission standards of their failure to meet requirements, or of their admission on a probationary basis.

Registration Systems

Three of the institutions surveyed were using IBM 1620 computer systems in the registration process; the other two used an IBM 1401 and a 1410, respectively. Only one institution was already using a pre-registration system, but one other planned to begin such a system during the 1965 fall term.

In a pre-registration system the students list the courses for which they wish to enroll during the forthcoming semester (new students file this data when taking entrance examinations) and secure their dean's approval of their programs. Subsequently, this data is punched into data cards and used to
project course offerings, staffing requirements, classroom and laboratory requirements, as well as pre-registration data for individual students. With advance information, the billing of fees can be handled easily. Information concerning the students' living requirements for dormitory rooms or apartments can be included on the forms filled in for courses, and the billing for housing can be rendered along with billing for registration fees. Receipt of a check in payment of all fees completes registration and the student is permitted to attend classes when he arrives on the campus. Class rolls and other data needed for internal use are prepared from completed registration forms.

The other four institutions were not utilizing a pre-registration system but were employing more conventional methods. Punched cards for courses offered were prepared in sufficient quantities to enroll the number of students who could be seated in each classroom. A master card for each student admitted, or already enrolled, was prepared prior to registration and was available at registration. This card, along with other required data cards, was distributed at registration. The student listed the courses in which he wished to enroll and secured the dean's approval of his schedule. Subsequently, he received data cards for each of his courses and added these to his packet. A housing card, indicating dormitory room assignment, was added if he needed housing; other cards for supplementary items such as religious preference were also added. Fees were noted on a
fee card to be used as a source document for punching fee data, or cards with pre-punched data were added to the packet. The student presented his packet at the end of the registration process and paid his fees. The registration system explained above is used in numbers of institutions today.

Subsequently, the information on the master cards is gang-punched into course cards, fee cards, religion cards, and housing cards for use in preparing reports. The usual reports prepared are class lists giving student's name, number, classification, sex, and other required information; fee distribution reports; housing lists indicating dormitory, floor, and room; religious preference lists; and statistical data of enrollments by schools, departments, and classification. Depending upon the data punched into the master card and subsequent cards used in registration, it is possible to generate other reports which are useful to registrars and administrators. These are discussed in the paragraph on sundry reports.

**Grade Reporting Requirements**

Parents of freshmen are interested in the progress their sons and daughters are achieving in college. To supply this information, many institutions prepare mid-semester grades for freshmen, and in some instances for all enrolled students. This process is facilitated by duplicating and sending to the instructors copies of the course cards used at registration. The instructors indicate on these cards grades for each student enrolled.
The cards are returned to data processing where the grades are punched and grade reports prepared. Cards are sorted by student numbers to get all of a student's courses together, and the master information on addresses is added so that grade reports indicate name, address, courses, and grades. At the end of each semester, final grade reports are prepared in a similar manner. The number of credit hours earned, the quality points, and the grade point average are generally included.

Preparation and Control of Records of Earned Credit

The main purpose for recording grades and credits earned is to indicate the progress of each student as he or she fulfills the requirements for a degree. The dean of the college in which the degree is being sought must be satisfied that the requirements of the institution have been fulfilled prior to the awarding of a degree; therefore, a permanent record of all credits earned must be maintained for each student. This record also supplies information required to determine scholarship awards and eligibility for loans, to transfer credit to other institutions, and to facilitate job interviews.

In grade reporting one records credits earned and grade point averages—information which must also appear on the
permanent record. This data can be transferred to the permanent record card of each student in different ways. One institution used a heat transfer process\(^2\) which is simple, accurate, and efficient since the grade report computer-run copy serves as a source document for the transfer. Two institutions used computer-prepared labels which could be pasted directly to the permanent records.

Regardless of the method used, a permanent record of credits and grades of each student must be maintained for an indefinite period because registrars are often called on to supply records of students previously enrolled at the institution. Many persons decide to return to college after retirement, or after having worked for a number of years, in order to further their education. The maintenance of permanent records of credits earned in large institutions can be a monumental task. Unless the older records are reduced to microfilm the space and file cabinets required for the records become a major item of expense in the student records area. Several of the institutions surveyed are microfilming records to conserve space and time and reproduce transcripts from the microfilm.

The registrar controls transcripts. Before a transcript is official, it will usually bear the seal of the institution and the signature of the registrar. Transcripts are released only for students in good standing at the institution.

\(^2\)The registrar at Louisiana State University uses this process.
In many institutions the scheduling of courses, classrooms, and laboratories is performed by the deans of the various schools. Although heads of the respective academic departments usually desire to have all classes scheduled in the building where their offices are located, many are finding it increasingly difficult to arrange such scheduling. Mounting enrollments and pressure for more effective utilization of facilities force scheduling of classes to make optimum use of classrooms and laboratories. Several institutions in large cities are currently scheduling classes on a twenty-four hour basis.\(^3\) Many other institutions find it essential to schedule classes through ten o'clock in the evening. Space utilization is only one reason for such scheduling, with convenience for students being another.

In the institutions studied, each department head prepares a schedule of courses to be offered indicating classroom and laboratory desired, names of the instructors, and hours at which the courses are to be taught. These schedules are then checked by the dean of the school and all schedules are consolidated. The dean makes any modifications necessary to balance morning and afternoon work loads, resolves conflicts in schedules,

\(^3\)New York University has been scheduling on a twenty-four-hour basis for a number of years.
and checks for compliance with teaching load requirements. He then sends the schedule to the chief academic officer who consolidates all schedules prepared by deans of the various schools in the institution. The complete schedule is sent to the registrar to be used in preparing the correct number of data cards for capacity seating in each classroom where a course is scheduled. The one institution using an advance registration system knows in advance courses needed by students and thus does not need to determine courses to be offered.

In all except one of the institutions visited this scheduling is still being prepared without the aid of a computer. The registrars in all institutions surveyed were using computers, but utilization had not advanced to the stage where the optimum schedule of courses was being determined by the computer. If this work were accomplished on the computer, it would be logical to go a few steps further and determine rooms to be assigned based on projected size, institutional load for teaching faculty, laboratory requirements and schedules, and the like. A master schedule of all courses offered, students' schedules, and teaching schedules, with optimum use of classroom facilities, could then be generated by the computers.

At least two of the institutions are working toward an advance registration system which may ultimately result in programming as suggested above. Under such a system students

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4 University of Kentucky and the University of Southern Mississippi are planning advance registration systems.
currently enrolled will indicate the courses for which they desire to enroll the next semester. They may also indicate preferences for hours of classes, laboratory schedules, and housing. The students' requests, after approval by the deans concerned, can be prepared for computer print-out. Processing with a computer program designed to prepare the optimum schedule furnishes the chief academic dean with a solid basis for selection of courses to be offered during the semester.

New students are included in this system by signing up for courses at the time they take entrance examinations, send in applications, or any other appropriate time designated by officials of the institutions.

Sundry Reports

In addition to the reports generated in connection with the major areas of computer applications mentioned above, other reports which are generally required of the registrar are as follows:

(1) Enrollment of Students. This report indicates classification, sex, and school or college.

(2) Distribution of Students. This report indicates the number of students from each county of the state. Numbers of students from other states are given by state of residence.

(3) Report of Students Graduating. This report gives student's name, address, and college, as well as indication of excellence in achievement.


(5) Report on Withdrawals.
(6) Grade Point Averages for Students Holding Scholarships and Fellowships.

(7) Reports on New Admissions and Transfers.

(8) Enrollment Projections. This report may be a five, ten, or twenty year enrollment projection.

The above list is not all-inclusive, but does reveal some of the major reports currently being prepared by registrars in the institutions examined. In several institutions these reports are prepared through the use of E.D.P. equipment. The reports on enrollment and distribution of students are prepared by the computer from admissions advice. The report on dismissals for academic reasons is prepared as a by-product of grade reporting. The new admissions and transfers report is also prepared from admissions advice. Other reports are currently being hand-prepared.

If the total information about each student were available in disk pack or on magnetic tape, it would not be a difficult task for the computer to prepare the other reports if the information were properly programmed. For example, the list of graduating seniors could be prepared by computer examination of the earned credits compared to the requirements for the degree sought. A print-out of students' names, degree programs, courses, and grades of work accomplished could readily be generated for review by the respective deans before a final determination of students to be graduated. Students who had not completely satisfied all requirements for graduation could then
be deleted by the deans. Similar data could be prepared for other reports where total information on each student is accessible via computer programs.

**Summary**

As educational institutions experience increasing enrollments, the necessity for tools designed to prepare and process data extremely fast has been strongly felt. Application of the computer to the data processing needs of the registrar has been extremely helpful in solving many problems.

Computers are currently being programmed to make admissions decisions on individuals who meet the admissions standards of the institutions and to prepare admission status reports on individuals applying for admission. The computer can be programmed to make the necessary decisions and print-out admission certificates or rejection notices for mailing. Currently, university registration systems are not taking full advantage of the capabilities of the computers for preparing the best schedules for students, for calculating fees, and for producing printouts of all required data. If this system were used, the course schedules for students would be prepared prior to actual registration, at which time the students would be given their schedules and admitted to classes.

Grade reporting and record keeping of earned credits are well mechanized. In most student records systems the computer prints the grades for mailing to the students, and the
recording of earned credits is a by-product of this operation.

Advance registrations are being tried in two of the institutions studied and should develop into a system for determining courses to be offered, classrooms and laboratories to be used for each section, instructor assignments, determination of instructional personnel required, and similar data.

Of the many reports required of registrars, a large number are being generated through effective utilization of the E.D.P. equipment. In the institutions surveyed, much work remains to be done before all the required reports can be successfully generated by computers.
CHAPTER IV
INTRODUCTION TO TOTAL SYSTEMS CONCEPT
USING ON-LINE REAL-TIME EQUIPMENT

In the preceding chapters the automation of the various subsystems within the institution's total information system has been considered one application at a time. Each application comprising the accounting system has been programmed, tested, and placed on the computer without attempting to utilize data already available to the system through other programmed applications. This system results in duplication of certain data as applications of the respective subsystems are added.

The same duplication can also be observed in student records keeping. For example, when grade reports are prepared, all necessary data are punched into cards, although at least part of the information may have been readily available from other subsystems. Duplication of efforts results in the preparation of required data. Each application in the accounting and financial records area is a minor subsystem. When all these subsystems are combined they form the major subsystem for financial activities. Likewise, all of the applications in the student records area are minor subsystems which combine to form the major subsystem for student records. The areas of teaching and research
may be considered as two major subsystems; for purposes of this paper, however, they will be treated as one major subsystem. The library information retrieval system will also be considered as a major subsystem.

In educational institutions the above major subsystems comprise the total information system. Certain of these major subsystems are dependent on one another for part of the data required for completion of a major subsystem. For example, a student cannot be assessed registration charges until the records reveal the course load, name of student, and other information. Certain of the major subsystems, such as the research area, are relatively independent. The total information system must be designed to achieve efficiency and to serve the administrative, teaching, and research needs of the institution.

The administrative officials expect from the total information system timely, accurate, and meaningful information on which to base decisions regarding the operation and management of the institution. The computer is a major tool for processing data to provide the information necessary for the administrators.

The idea governing the total information systems approach is to provide greater control over the increasing flow of information, to avoid the duplication of information, to prevent the necessity of combining data from several external
files to prepare reports, and to save time and effort in changing individual files. The approach emphasizes thinking, working, and planning for the total system rather than individual subsystems. When a system is correctly planned, master data already available in the system can be used when needed for the respective subsystems.

The total information systems approach is not necessarily new or startling, but has not been undertaken in the institutions surveyed because of a limitation on data capacity. The expense currently associated with the data capacity necessary for a total systems approach is generally considered prohibitive for small institutions. Scientific breakthroughs and advancing technology in the computer field are likely to solve these cost problems in the near future.

The total information systems approach with on-line equipment having a real-time access to a central processing unit with massive data capacity presents exciting possibilities for the future. Details of the general concept for an OLRT total information system and its potential utilization in colleges and universities are considered in this and following chapters. Although all equipment for this system may not be currently available, advancing technology can be expected to provide it in the near future; and, in the meantime, an overall view is presented of computer systems expected to be available in the next five to ten years.
Elements of an On-Line Real-Time Computer System

The concept of the on-line real-time total information system is to provide more than one user of the computer virtually immediate access to the full capabilities of the computer and peripheral equipment. This time-sharing of a centrally located computer is achieved through the use of satellite input-output terminals located at points of use throughout the campus. The time sharing techniques now available make it possible for several independent users at remote locations to interact with a computer almost simultaneously.¹

The essential characteristics of such a system are:

1. An almost unlimited data capacity.²

2. The work of each user may be dependent on data already in data storage or completely independent.

3. Each user should have almost immediate response to data entered into the system.³

4. Utilization of the equipment for any work that might be accomplished on a computer not equipped for time sharing.

The total systems approach using on-line real-time equipment permits individuals to utilize the equipment in ways not


²International Business Machines Corporation, College and University Administrative Applications (New York: n.d.), p. 3.

heretofore possible. For example, any user may, within prescribed limits, have access to data stored in the memory banks, thereby avoiding duplication of data. The various satellite terminal capabilities will be determined by the uses required of the equipment. Users of such a system may expect the same kind of service they would receive from a system with direct physical access to the computer, peripheral equipment, programs, and the like.

Service Requirements of Satellite Users

The satellite user will expect immediate access to the system and certain data available in storage; he will expect service on a continuing basis; and he will expect a rapid response to his programs and data. These three factors merit further consideration.

Access to the computer system. In the on-line real-time computer configuration, remote users must have access to the complete system. A sophisticated user, knowledgeable about data in storage, may want to develop programs employing data already available. Such usage, of course, is basic to a total systems approach. In order to utilize data stored in the memory banks of the system, the user would have to ascertain if the desired data were in storage, if the material were available for his use, and the procedure for obtaining access to these data. The

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4 Schwartz, op. cit., p. 3.
system must be arranged to produce this information upon request from a user.

Certain users will need to store data for subsequent common use. There must be programmed some method for determining who may use the stored data, as well as a system for screening requests to store data. Obviously, certain data will not be made available to all users, and the protection of data through programmed security is a basic requirement of a "time-shared total information system."

Access naturally includes the use of any needed equipment in the computer system, such as the disk and tapes, memory, and printers which normally would be available in any non-time-shared complex.

**Continuing service.** Since each user will expect that service will continue for so long as he needs the computer, the equipment must not only be free from breakdown, but also contain circuits which isolate errors for appropriate action. The possibility of loss or destruction of the program code and data must also be eliminated. Personnel trained to provide prompt technical servicing of equipment should be available, and stand-by equipment may also be essential.

The problem of errors and possible loss or destruction of programs seem to be more important to continuity of service than machine breakdown. The experiences of chief business

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officers concerning breakdown of equipment indicate that the computers currently being manufactured are highly reliable.

The problem of errors can be solved by using error checking circuits and programs designed to respond to computer errors. Such programs should analyze the problem, make the corrections possible, and notify the user.

**Computer responsiveness.** The users desiring access to the computer systems will range from those doing production work (such as payrolls or grade reports) to those requiring fast and sporadic short term access (such as an inquiry about a student grade). If a quick response to an inquiry is given during a production run, there must be a means of interrupting the production run or the machinery must be capable of handling several transactions simultaneously.

Production satellite terminals will require an extremely high input-output ability. It is necessary to move the required program into memory almost instantaneously, feed in the production data, and receive an immediate response. To improve responsiveness on currently available equipment an externally generated priority should be established to determine user priority.\(^6\) For optimum sequencing one must consider program size, running time, and input-output requirements.

Even with the abilities of extremely high input-output and computer processing speeds, it still may be necessary to

\(^6\)Swartz, *op. cit.*, p. 11.
interrupt a long production run. Thus, a mechanism that interrupts after an established time interval and equipment capable of handling several program codes in memory will be necessary to achieve the responsiveness required.

Problems of Centralization of Computer Equipment

In Chapter II the study of the organizational structure of data processing centers showed a trend toward two computer systems because of the difference in functions performed. In considering an on-line real-time computer system utilizing the total systems approach one needs to re-examine the problems presented earlier to determine if all of the arguments against centralization can be overcome.

In the system being considered here, the computer's central processing unit, memory modules, tape drives, disk pack, and necessary auxiliary equipment would all be centralized in one location. Remote users would thus be able to take advantage of more powerful equipment than might be available in separate systems.

The remote users would then operate and maintain equipment designed to fit their particular needs which may vary considerably depending on user requirement. These needs will be considered further in later paragraphs and subsequent chapters. There may be numbers of remote terminals, of course, depending on where actual needs exist. Under such a system individual users have, in effect, their own private computer
The fact that diverse users will have their own systems and can run their programs at will would seem to negate any argument that users could not get their data processed on schedule. The externally generated priority system would assign priorities to assure certain users processing of their programs within a given pre-determined time.

With this system it would make little difference where the computer central processing unit, memory units, tape, and disk drives, and auxiliary equipment are located since each user has immediate access. Although the possibility of loss or misplacement of data is still present and must be guarded against, this problem is now handled by the computer through programming and computer design, rather than by individuals.

Specially trained personnel required for each remote user would be employed at the remote terminal levels. Personnel in the central E.D.P. center would specialize in the areas concerning them, such as throughput, error detection and correction, information security, memory protection, memory bulk storage, programming, and other problems relating to the time sharing system. Thus, it would seem that the arguments for separate computer systems do not hold under an on-line real-time system.

**Organization of the Central Computer Center**

From the examination of centralized computer centers,
no pattern emerged which appeared to be the best organizational structure. Centralized computer center directors reported to the president, to the chief academic officer, or to the chief business officer, depending on institutional preferences. It is the author's conviction that an OLRT center, organized with the director reporting to any one of the three persons named, would function satisfactorily. When reduced to its lowest level, the computer center is nothing more than another tool to assist the institution's personnel in performing services. Viewed as a service operation, much as other pieces of equipment, the computer might logically be the responsibility of the chief business officer. If it is viewed as a teaching and research tool, strong arguments can be made for organizing it under the chief academic officer.

When the OLRT center is placed in proper perspective as a service unit to assist faculty, staff, and students, there is little argument for suggesting that the director report to the institution's president. Following a survey of twenty-seven industries, John T. Garrity reports that highly successful installations in nine companies were only two levels below the chief executive, and that in two-thirds of the remaining companies the centers were reporting at this same level.

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while the remaining group reported three levels below the president. Since none of the industries surveyed by Garrity was organized with computer center directors reporting to the president, and since few colleges and universities are so organized, it is concluded that the central computer center director should report to the chief business officer or to the chief academic officer. The author believes that the former plan would be preferable with the OLRT center.

Since the OLRT center will provide computer services to the college community of faculty, staff, and students, the center should be staffed with systems analysts, programmers, computer operators, key punch and verifier operators, librarians, and other specialists required to provide the desired level of service. Major users, such as the registrar and business office, may also require several employees at their satellite terminals. For example, the business office (accounting) may need a programmer, systems analyst, and punch operator in order to assure the success of its operation; therefore each satellite user should employ the staff required for its location. Such personnel would be employees of the satellite user rather than the central unit.

**Concept of Satellite Terminals**

One can visualize a central OLRT computer system with satellite input-output terminals in locations where they are accessible to users desiring service. These users may be
identified according to major functions: administration, research, teaching, and service. The concept of satellite input-output devices to service these functions is discussed below.

**Administrative terminals.** The administrative uses of the computer are greatest in the registrar's office, accounting office, personnel office, financial aids area, purchasing office, and central cashier's office. The users in these offices need equipment designed for high speed input and output with special requirements in input and output format. Other administrative users could be served through inquiry terminals designed to respond to specific questions relative to data in storage. Such users are the president, chief academic officer, chief business officer, academic deans, and auditor.

**Research terminals.** Research personnel will require terminals designed for limited input and output. This unit may be simply a card input device with typewriter output, which would enable a researcher to use the computer to assist him. The satellite terminal may be located in an individual faculty member's office or laboratory. One can envision future computer systems where every faculty member would have his own input-output device giving him access to a computer. Such a device may become as essential as a typewriter or telephone is today.

**Teaching terminals.** The teaching of courses about computers and computer systems has been increasing over the past several years. A recent survey indicates over one thousand
courses were being offered in 1963, compared to one hundred ninety-five courses counted in an earlier survey.

Computers have also been successfully used to assist in teaching. Several organizations in different parts of the country are currently using computers experimentally for this purpose. The computer has been used to control the sequence of lesson material presented to each student based on the student's performance in the lesson, to record and evaluate the student's responses, and to control the feed-back information about correct answers and errors, and to assist the student in correcting errors. Several laboratories, similar to language laboratories, might be set up with computer stations for each student, so that the students could work individually. Thus, in the area of teaching, satellite terminals may be on the order of scanner input with a visual response through use of a cathode ray tube. These terminals may be set up as required for instructional purposes.

Service terminals. For purposes of this study, various university operations which serve the interests of the

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institutions but do not come under the three major areas mentioned above may be called service centers. These service centers can use the computer and provide certain data for other agencies under a total information system.

Such uses include ticket distribution by the athletic department; maintenance of alumni records by the alumni department and student records and health programs by the student health service department; maintenance of specialized and general accounting systems by auxiliary enterprises and cost accounting by the physical plant department; information retrieval in libraries; recording information on student behavior by campus security. The terminals may vary in requirements since certain ones require production runs (auxiliary enterprise accounting) while others may add to existing data or inquire into data already in the system (for example, a campus security terminal could add to student records).

The above discussion of the concept of satellite terminals which may one day be used on college and university campuses is not intended to be exhaustive or all inclusive. General ideas for location, use, and differences in load requirement are suggested. This system could be linked to a total information system with OLRT equipment at the governing board level for use of the board members and all institutions under their control. A more detailed treatment of satellite terminal tie-in and use is presented in the chapters which follow.
Cost Considerations

A total information system for educational institutions using on-line real-time equipment is a highly sophisticated system. At the present level of computer rentals and selling prices, such a system would be economically impractical for most institutions. A computer having 1000K memory and the capabilities for on-line real-time use in a medium size institution and without the satellite terminals would presently rent for $63,000 per month. The cost increases at least $100 per month for each I/O terminal with low speed capabilities. Visual display units currently available rent for $350 per month each. Since more powerful I/O terminals for production runs are not presently available their cost cannot be estimated.

A currently available system for time sharing made up from IBM equipment has the monthly rental rates (without discounts) shown below.

1 - IBM System 360 Model 67 time-sharing computer equipped with three channels to accommodate 192 I/O units $24,000

1 - 1,000 X Memory Storage Unit 31,000

1 - Direct Access Storage Facility with eight modules of disk storage of 25 million bytes 5,250

1 - Data Cell with 400 million 8-bit bytes of storage 2,800

4 - High-speed Printers @ $900 3,600

4 - Model II 2250 Visual Display 1,400
160 - Typewriter I/O Units $16,000
2 - Optical Scanners @ $3,500 7,000
Miscellaneous punch units, verifiers, collators, etc. 1,000
Total system per month $92,040

In spite of the present expense of these systems, it is the writer's conviction that advancing technology will continue to decrease costs and at the same time improve the efficiency and capabilities of the equipment. As transmission lines improve and computers become less expensive, and as satellite terminal capabilities improve, the possibilities increase for the OLRT computer system being utilized by an entire campus for the uses mentioned above and many others. Through using the modular approach to the total information system, minor subsystems and terminals can be added to improve the system.

Summary

An on-line real-time total information system utilizing a central processing computer with large bulk storage capabilities and satellite terminals located throughout the institution presents exciting possibilities for educational institutions. These possibilities include, but are not limited to, satellite input-output terminals used for financial activities, student records, and library information retrieval. Other possibilities include inquiry terminals for use of administrative offices, research I/O terminals for use of research personnel, and teaching
aids for remedial purposes as well as for routine instruction.

Satellite terminals could be located wherever personnel require access to a computer and/or the information in storage at the central unit. Certain problems, such as security of certain data in storage, are encountered; but presumably these problems can be solved effectively. In today's computer market the cost for such a system may be prohibitive, but future technological advancements are certain to decrease costs to a practical point.
CHAPTER V
TOTAL SYSTEMS PROPOSAL FOR FINANCIAL DATA PROCESSING

The Systems Development Corporation has demonstrated that a time-sharing computer system is workable in practice,\(^1\) and the idea of a total information system has been well established as the ideal approach to effective utilization of computer capabilities.\(^2\) Since the OLRT total information system will be provided with massive memory capability, it is feasible to store data relative to the financial activities of the institution in the memory banks of the system. The financial activities, encompassing the accounting system and related financial records, are considered one of the major subsystems. Financial information will be fed to the central processing units through satellite terminals located in offices concerned with finance and accounting. This chapter will be devoted to a discussion of the financial activities on this kind of system,

\(^1\)Schwartz, op. cit., p. 1.

with consideration given to its operation and accomplishments.

Concept of Financial Data Processing with OLRT Equipment

Chapter II outlined the fund accounting system employed in institutions of higher learning. The essentials of the system consist of six self-balancing funds with most activities of the institutions categorized in the general fund group. Various funds groups are subdivided by function and then further subdivided into object classifications.

Financial information that is to be stored in the memory banks of the OLRT system may be classified in the following major categories:

a) Budgetary data. These data include a summary as well as detailed information comprising the institutional budget and give names, ranks, and salaries of personnel employed. The supply and expense and equipment budgets will show appropriate budgetary details.

b) Employee records. Included in employee records are details such as number of dependents, sundry deduction information, social security facts, and similar information required for pay purposes.

c) General financial. The general ledger accounts, income ledger accounts, and expenditure accounts are included.

d) Income and expenditure detail. Detailed information is required for many accounts controlled by the general ledger, income ledger, and expenditure ledger.

e) Inventories. Details on inventory items must be recorded so that inventory control and reports may be effected readily. Details such as inventory number, quantity, and cost are required.

Financial transactions are recorded as they occur from information introduced into the system from satellite terminals.
in the financial accounting area. Although information pertaining to financial data processing originates in different offices of the institution, the preparation of the various reports required for the management of the institutions requires the consolidation of these data. A number of satellite terminals will be established to achieve the necessary input to the system and the required feedback from the system. Through the use of satellite terminals, data input will originate close to the source of such data, achieving certain economies and making the system more efficient since duplication of data and multiple handling will be eliminated.

Financial information will be processed through the satellite terminals making available to satellite users certain data already stored in the memory banks. Accurate and efficient record keeping will require appropriate staffs and proper equipment at each satellite location.

Centralization of Financial Records

The centralization of the financial information in the memory banks opens new and interesting possibilities for improvement in the financial record keeping area. New and different financial reports and statistical data (considered below) are easily prepared through proper programming over satellite terminals. With the basic financial records stored in the memory banks of the central computer system, the input over the satellite terminals becomes merely an updating of the
accounts and financial records. Since the basic records are available to satellite users, modifying or updating of records can be accomplished closer to the source of data origination. Placing input at the source of data origination eliminates the problems of routing, duplicate handling, and errors created through paper work modification. The centralization of financial records permits modification of the records to be made within the computer complex, thereby reducing errors to those which are computer made.

Because the system is a total information system, by careful programming, one can obtain the desired information organized in a format most suitable to his needs. This means that financial and statistical information can be generated without regard to conventional statements, and numerous summary studies of detailed income and expenditure accounts can be produced.

**New Financial Information via Programming**

Institutions of higher learning make extensive use of financial information which permits a comparison of the financial activities. Financial activities during the most recent accounting period may be compared with a similar period of time during the preceding year. Likewise, the financial position at a given date may be compared with the position a year earlier. Thus, it may be concluded that financial transactions covering at least two years must be maintained in the memory banks of
the OLRT system. The storing of this basic financial information creates opportunities for the preparation of financial reports and statistical data by simply writing computer programs and processing them through one of the high speed satellite terminals which is equipped with printer output.

Chapter II presented a listing of the usual financial reports prepared for institutions of higher learning at the end of the fiscal year. These reports should be programmed for routine preparation on a monthly, quarterly, or annual basis. Moreover, certain details could be deleted from the monthly report if desired. The financial report would be prepared in the desired format so that when printed out it would be ready for binding and distribution.

Cost accounting for colleges and universities has been neglected largely because of two basic problems. First, bringing together in an organized manner the vast quantity of data necessary for cost analysis is an almost insurmountable task. Perhaps a more difficult problem is that of establishing an appropriate basis on which to determine cost. The first problem is easily solved since a computer program can require the computer to recast the stored basic information in any desired form. The second problem is more complex since it is difficult to make a strict identification of the final product. Several interesting possibilities for cost work are presented.

An analysis and comparison of the per-student cost in
the bachelor's, master's and doctoral programs may be prepared through programming. This information would be useful to the administration of the institution and its governing board. An analysis and comparison of the per-credit-hour cost for courses of instruction in various departments and schools at various levels of instruction would prove useful for identification of high cost areas.

Comparison of salaries in various departments at the professor, associate professor, assistant professor, and instructor levels becomes practical and easy through use of computer programs. These studies can be helpful to administrative officials in keeping salary levels within schools and departments on a comparable basis. Similar studies are also practical in the wages area.

Supply and expense items in the colleges and universities surveyed were charged to the supply and expense account of the respective departments. Although many institutions did not classify and code these expenses so that summaries of various classifications were possible, it is now practical to assign an account code to the respective categories, and enable the extraction of data on any classification via programs. For example, the following summaries may be useful:

1) Summary of travel by departments, school, and divisions.
2) Summary of telephone expenses by department and school.
3) Summary of expenditures for service contracts on
typewriters, adding machines, etc. (This information would be useful in determining at what point it is feasible for the institution to undertake its own service work.)

4) Summary and detail studies on cost of operating vehicles.

5) Summary analysis of instructional supplies.

6) Summary of postage expenditure by departments.

This list includes only a few of the special financial reports and summaries both possible and practical through the use of written programs designed to compile the data.

**Financial Activities Center**

Although various offices originate financial transactions and related information, they send this material to the accounting office for processing and recording. Thus, the accounting office becomes the hub of the institution's financial transactions and is considered the financial activities center.

Under the OLRT system the accounting office will still be the financial activities center but much of the information which has been traditionally sent to the accounting office will be fed into the computer memory banks. The accounting office will then extract data as needed from the memory banks. In most institutions, the following offices provide information for the accounting office: purchasing, personnel, physical plant, auxiliary enterprises, and the central cashier. All academic departments send to the accounting office data for budget preparation. The accounting office will be a major
user of the system and will require an appropriate terminal; other offices will require terminals to feed data into the system and receive the necessary feedback. The satellite terminals (with an input and feedback for the system) to be used by the offices listed above and certain administrative officials are discussed below.

**Accounting office satellite.** The accounting office is responsible for maintaining a system of general and budgetary accounting which will adequately and permanently record all financial transactions so as to provide information necessary for financial statements for the chief business officer, the president, and the governing board. In keeping with this responsibility, the accounting office must maintain a satellite terminal designed to handle production input and output. The input data may be broadly classified as budgetary data and general financial. Budgetary input will consist of account name, number, and amount of budgeted income and expenditures. Detailed salary accounts will be established which will show account number, individual's name, rank, department, pay basis, and rate of pay for each person employed on a permanent basis. Wage amounts budgeted for each department provide a code number and amount of wages funds. Supply and expense budgets will show amounts budgeted for the respective categories, and equipment

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budgets will indicate appropriate code numbers for each category.

The computer feedback will be in the form of completed budgets, monthly budget statements of salaries, wages, supply and expense, and equipment for each department, and reports on adjustments to budgets. Feedback will also consist of budget analysis, projection of income and expense, and summary comparisons of budget data.

The general financial input for the accounting office terminal will record income received and the expenditures incurred in all accounts in the entire system of fund accounting. Charges to accounts for salaries and wages actually paid, payments for supply and expense items and equipment actually received will be recorded in proper classifications. Income received and interdepartmental transfers will also be recorded. Feedback will consist of the printout of financial reports listed in Chapter II, expenditure summaries mentioned above, and departmental expenditure reports.

Under the OLRT system, budgetary accounts should be merged with the accounting system as is the convention practice so that printouts will reflect budget amounts as well as actual amounts for both income and expense accounts.

Personnel information considered basic for pay purposes will be fed to the memory bank through the personnel office terminal. Information for encumbering the accounts
will be fed into the memory banks through the purchasing office terminal. Other offices will likewise feed in required data. Thus a number of terminals will be providing input data on which the accounting office will draw in processing payrolls, payments to vendors, interdepartmental transfers, reimbursements of expenses, and similar transactions.

The accounting office terminal should be equipped for high speed optical read-in and high speed printout. Optical readers are currently available which will accurately read 1,200 characters per second and recognize 110 type fonts. Improvement in the speed of this equipment certainly can be expected in the near future.

Under the OLRT system the accounting office will read in budget changes, as they occur in the orderly process of business, to update the budget held in the computer memory banks. Personnel information for filling positions at a given rate of pay will also be optically read in to memory. The preparation of monthly payrolls is then reduced to programming the computer for a monthly printout of check register and pay checks. Hourly wage payrolls would be handled in similar fashion except that the number of hours worked, dates covered, and employee identification number would be read in before the wage payroll program was activated.

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Supply and expense and equipment items procured would require matching with purchase order, receiving report, and vendor invoice. Optical read-in of vendor invoice and activation of an appropriate computer program would initiate preparation of checks for mailing to vendors. Accounts would be charged, encumbrances liquidated, and balances updated at the same time. Travel reimbursement requests could be optically read by the computer, audited for compliance with institutional policy, and reimbursement checks prepared in a one-step operation through the accounting office satellite. Other accounting documents would be similarly handled.

**Purchasing office satellite.** After receiving bids or quotations for supplies, services, and equipment needed by the institution, the purchasing office is responsible for the issuance of purchase orders. Prior to releasing purchase orders, the purchasing office must check with the accounting office to be certain that funds are available in the account to be charged for the purchase.

Before issuing purchase orders, purchasing offices in state supported institutions are generally required to receive bids or quotations on specifications and accept the lowest and best bid. Closed specifications cannot be used because this procedure would exclude manufacturers of comparable equipment or supplies. Because of these limitations the purchasing office cannot effectively utilize the computer until the
purchase order is written. At this point, the entire purchase order, or simply the accounting information essential for encumbering the accounts, can be placed into the memory banks. In the latter event, a typewriter terminal with a special character which the typist would press before typing the accounting details should be used. As typing is completed the computer would be programmed to inquire about available funds and then print the updated balance on the order.

Terminal telephone connection (or other cable connection) to the computer could provide the communications hook-up. One line at the bottom of a continuous purchase order form could be used to record the code charged, purchase order number, date, and amount of order. The computer might respond with an updated account balance on the same line before the typist proceeds to the next order.

Equipment inventories are required for all items classified as equipment under institutional policy. Generally considered as equipment are items which cost more than fifty dollars and have an average life of more than three years. If items of equipment are listed on purchase orders separate from supply and expense items, it would be easy for the accounting office to place in the computer via optical reader details on all items of equipment and to assign an inventory item number while the invoice, purchase order, and receiving report are being pre-audited. Equipment files should be random access in order to
permit printouts by departments, schools, and divisions. Equipment item runs beginning with numbers on untagged equipment could be printed out by computer programs at any time since the beginning and ending assigned numbers would be known. This list would be employed by the institution's property officer to tag the equipment. In many institutions, the purchasing department is responsible for property control and physically tags the equipment.

**Personnel office satellite.** The major activities of the personnel office in institutions of higher learning are divided among the areas of recruitment, maintenance of personnel records, job analysis and position classification, employee benefits, in-service training, and student employment. While the personnel office does not recruit faculty, it maintains records on faculty members and administers the faculty benefits program. To fulfill this responsibility the personnel office will collect details such as name, address, number of dependents, insurance desired, retirement data, beneficiary, and similar information about every employee. These data are required for pay purposes, statistical information, reports to governing boards, and proper administration of employee benefits.

To aid in creating an information file on each employee, the personnel office will need an input-output terminal designed to introduce the information collected directly to the memory
bank (personnel file). This device might be a typewriter terminal or similar configuration. Input would include information on persons employed and those applying for employment, changes in status of employees, job analysis of positions classified, data on student employees, test results on current and prospective employees, and details on employee benefits.

Feedback from the central computer complex would be reports of persons available for employment properly classified with qualification details; lists with names, addresses, and telephone numbers for institutional directories; statistical reports; change of status reports; and reports of sick leave and vacation time taken by each employee.

**Physical plant office satellite.** The physical plant department expends educational and general budgeted funds for operation and maintenance of the plant. In addition, it expends funds for new construction, renovation, and repairs; performs cost accounting services for these projects; and accounts for supporting facilities operated as auxiliary enterprises. These supporting operations, such as garage, furniture shop, and physical plant storerooms add to the plant department's accounting burden. In accounting for its many functions, the plant department may prepare and process its own wage payrolls, keep track of inventories, keep accounting records for several auxiliaries, and prepare job cost records.

Input for the above accounting records may be achieved
by an optical reader in the plant office. The plant office could then pay its own hourly personnel (salary payroll is handled automatically in the accounting office). Input for the job cost system would be the distribution of labor charges, charges for materials used, and the application of overhead cost. Inventories would be updated as a by-product of charging materials to jobs. Materials used in regular operation and maintenance would be charged to plant budgets with appropriate credits to inventories. Accounting records for auxiliaries would be maintained in a manner similar to salary, wage, supply and expense, and equipment charges already considered.

Feedback by a high speed printer would consist of work-in-process and completed job reports, printouts of updated inventories, payrolls with labor distribution, monthly statements of auxiliary income and expenses, and reports of budget balances.

Auxiliary enterprises satellite. The auxiliary enterprise salaries, wages, supplies and expense, and equipment expenditures can be accounted for under the system already described. The income accounting can be effectively handled through the central cashier stations to be discussed below. It would seem advisable, however, for large auxiliary enterprises to have access to the central computer via a typewritter terminal, which would permit cost studies of their operation, inquiry about accounts, and limited output.
Central cashier office satellite. The central cashier office in educational institutions is responsible for receiving and recording the institution's income and receipts. That office makes an original record of incoming cash and checks, indicating the accounts to be credited as well as source of funds, amount of funds received, and other necessary details. This office is responsible for collecting accounts and notes receivable, and under certain systems may prepare and distribute checks to vendors, employees, and others. In the system being considered here, however, the checks are prepared and distributed by the accounting office. It would be an ideal arrangement if the central cashier's terminal configurations were planned so that each cashier could put accounting data directly into the system as income and process receipts. Since this arrangement is somewhat more complex that it might appear, further consideration of the input-output requirement is justified.

The central cashier will receive student fees, governmental appropriations, gifts and grants, endowments, and other income. There will be payments on accounts for students, faculty, and staff, as well as payments on notes by students. If small auxiliary enterprises are not equipped with terminals, the income from these sources must also be processed in the central office. It would appear that the terminals should permit the cashier to credit immediately an income, expense, or individual's account (as the case may be) as funds are received.
Since other departments initiate charges to accounts receivable, the central cashier terminals must have the capability to process this kind of transaction. Since any given institution may have numerous cashiers recording transactions simultaneously, the input problems become quite complex. Responses to individuals calling for detailed analyses of their accounts will require an inquiry device with the ability to printout individual accounts in detail.

Fulfillment of the requirements set out above and reconciliation of cash and checks against the accounting record generated by the respective cashiers will require an input-output configuration which can quickly modify data received and feed information to the computer system as this modification occurs. It would seem that a terminal with a typewriter keyboard for both input and output which generated a receipt for all income and receipts processed would be the most appropriate device for the cashier to use. The output format should also permit the printout of individual and organization accounts upon inquiry. Thus, each individual cashier in the central cashier's office should be equipped with an I/O configuration which permits input of accounting information directly to the central processing unit. This configuration should permit daily reconciliation for receipts and should generate a written receipt for incoming items. Further, the ability to inquire into the system for certain accounts and loans receivable data
is a necessity for the appropriate operation of the central cashier's office.

**Administrative inquiry satellites.** The president, chief academic officer, and chief business officer need and expect the total information system to generate timely and accurate reports on which to base their decisions. The usual institutional reports in many instances will not be sufficiently detailed to answer questions which arise in the course of operations. For example, a student's parent may telephone the president to find out why his son or daughter was dismissed from school. An immediate visual presentation of the student's complete record is essential to give the president the information he needs. In another instance, the president or chief business officer may be asked about a student's account, and in order to respond he needs a visual record of the account. A means of obtaining quick responses from information in the memory banks is essential for these administrative officials.

There are currently available inquiry devices which can direct the computer to bring programs into core storage which in turn triggers the computer to extract from memory banks the complete details of a student's record, an account, or other data. This device is a visual display unit which has a keyboard for indicating student number or account number in order to obtain visual displays of the information desired. To become available later are voice-activated devices into which
one may speak and request the data on any individual by giving the person's name or number.

**Other possible satellite terminals.** Several other offices handling financial problems should be mentioned since these offices may have a sufficient volume of work to justify a satellite terminal. The institution's internal auditor certainly will want to have reports prepared that enable him to assure management of the proprietary and accuracy of the financial information being prepared by the computer system. The auditor will be able to study records without having to procure them from various offices, since the information will be in the memory banks, and his position should permit him access to any and all institutional records. Inasmuch as his terminal may require limited input with massive output, a card or typewriter input with a high speed printer for output may best serve his needs.

The financial aids office is responsible for processing scholarships, fellowships, loan applications, work study programs, and similar financial aids to students. This office may need a terminal designed to handle the flow of paperwork processed through the office. Work study programs, loan applications, and scholarship awards present decision-making opportunities which can and should be placed on the OLRT system.

The alumni office may also effectively use a satellite terminal. The students enrolled in the institution today are
the alumni of tomorrow. Utilization of student records information (discussed in Chapter VI) stored in memory banks should be available to the alumni office as soon as the students leave the student category. Since the student records contain basic information on all students, they are tremendously valuable to the alumni office.

Deans of the respective colleges or schools will find inquiry terminals in the form of typewriter terminals or more sophisticated visual display units extremely useful in their administrative work.

The various uses of satellite terminals discussed in this chapter should be adequate to show how the OLRT system could operate in the business area and in certain administrative offices. Any given institution may have more or less satellite terminals than discussed above. The idea here is to illustrate the working arrangement of this concept.

**Budget Preparation and Control with the OLRT System**

Budget preparation and control are simplified through the use of centralized financial information since the entire budget can be introduced into the system by the use of the optical reader in the accounting office. Adjustments to the budget require administrative approval, and then the approved document may be used to update the budget through the use of optical readers. When authority is received to fill vacant budget positions this information can be recorded by optical
read-in of the approved name, rank, and other necessary details.

The preparation of a new budget requires first a printout of the adjusted current budget to be used as a basis for revision of the figures. The chief business officer then enters the new figures for income estimates in the appropriate column on the budget copy. The computer can greatly assist with income estimates since basic data are in memory banks and projections of income categories merely require writing a program and subsequent processing. Budget sections are then distributed to department chairmen, deans, and division heads for their recommendations. The approved changes are typed on a complete budget copy and read-in to the computer by the optical reader. Totals are prepared by the computer and the amount the budget is out of balance can be determined. This procedure may have to be repeated to bring the proposed expenditures into agreement with estimated income.

Budget control under the OLRT total system will be somewhat different from the conventional systems. Budget changes should still require administrative approval. The budget change document sent to the administrative officials authorized to recommend budget changes should be designed to permit optical read-in and budget adjustment. In this manner, a properly approved budget change document becomes the source document for the input of budget changes. Control of the total funds to be appropriated is thus still in the hands of the administrative
officials of the institution. Budget control over approved expenditures for the object classifications is exercised by the computer via programs in storage. The salary control would be exercised by the computer through programs that reject appointments to positions which do not carry sufficient funds, thereby forcing an approved budget change before the position can be filled. Wages in any given budget would be controlled by programs which reject payrolls that exceed the funds available in the account. Modifications to this plan are possible so that budgets could be exceeded by a nominal figure and the proper officials advised that funds were exhausted. Controls over the supply and expense, and equipment expenditures are exercised through the encumbrance system discussed under purchasing. The typing of a purchase order will, through the purchasing office terminal, encumber the account in the amount of the purchase order, update the account balance, advise if the account is overexpended, and give the amount by which the purchase order exceeded available funds. Where funds in departmental budgets were exceeded, a request for budget adjustments should be initiated and, if approved, would then serve to increase appropriated funds in the proper budget. Budgetary studies are simplified in this system since the total budget will be placed in the memory banks and a written program will direct the computer in the recasting of budget data.
Modification of the Existing Financial System

The financial record keeping system must undergo certain modifications in order to keep data input as close as possible to the point of origin and to make all financial records immediately accessible to certain computer users. These modifications which may normally be expected in changing from a conventional data processing system to the OLRT total information system utilizing satellite terminals may be grouped in the major categories listed below. The accounting system will require a coding structure of sufficient size and flexibility to permit the generation of financial reports, cost studies, and inquiry data. A very efficient coding system is required to reorganize data in a number of different ways and to avoid excessive use of memory capability. Since quick access to financial data will be expected, a numerical coding of individual and organization accounts will probably be required. Numerical coding of most basic data is essential to achieve retrieval of the data.

In order to prepare data input for the computer at the point of data origination, the original documents will require a careful organization to be compatible with the format of data to be placed in memory banks for later use as well as compatible with computer programs which may be processing the data as they originate. Computer capabilities must, therefore, be considered in data origination and the input format in order
to achieve a compatible and efficient system.

The ability of optical readers currently available is limited to approximately 110 type fonts. While the equipment of the future may overcome these limitations, the institutions will find that at present careful planning can reduce the type fonts input at certain satellite stations to a small number and thereby achieve better results. Economies may be realized through the use of equipment designed to read only a limited number of type fonts. It should be remembered, however, that the accounting office optical reader will be handling a variety of invoices from many different vendors and type fonts for this particular input terminal cannot be controlled without either retyping the invoice or specifying the type font which vendors must use.

Perhaps the most important systems modification is the construction concept of the total information system. One must think and plan in terms of the total information concept. The relationships between the respective parts of the total system must be carefully considered and combined to achieve a minimum of duplication. One must think in terms of placing basic information in the memory banks and then adding the various subsystems as modules to the total system. Since input to the system may come from more than one terminal, the systems personnel must be familiar with the data in storage as well as the input that relates to the respective subsystem being added.

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5Leitch and Fineman, op. cit., p. 185.
Systems design will be complex in the total information system because of modular additions which depend on data, some of which may be in memory banks and some of which may be introduced at the time of processing.

The above discussion is intended to touch briefly on the major modifications in existing financial systems which must be considered in changing to an OLRT total information system. Certainly many detailed questions and problems will arise which cannot be anticipated prior to beginning systems design and conversion.

Advantages and Disadvantages of the OLRT System

The advantages of the OLRT total information system are numerous, and some of these are obvious from the preceding discussion. It may be worthwhile at this point, however, to summarize the distinct major advantages of the system.

1. In effect, each satellite user has at his fingertips the full capabilities of a powerful computer complex. Although he is sharing with other users, the net effect is like having his own individual computer.

2. The centralization of information in memory banks makes possible the reduction of input and multiple use of stored data.

3. Many financial, statistical, and information reports may be generated by the system from stored data via written programs.
4. The fact that storage capabilities enable placement of basic information in memory banks suggests that the computer can be used for decision-making at levels normally considered too high or too difficult for the computer to achieve satisfactorily.

5. A central center requires the development of only one very highly trained staff rather than two staffs as were required in the colleges and universities reviewed.

6. Input from satellite terminals permits preparation of data for computer consumption as they originate, thereby eliminating duplication and errors.

Although the above items summarize the major advantages of such a system, it would be grossly unfair not to point out the major disadvantages which are as follows:

1. At present the cost of such a computer complex is generally prohibitive except for major institutions of higher learning.

2. Certain equipment discussed in this paper is not currently available or yet developed to the point of accuracy and dependability. This disadvantage, of course, will be overcome as technology solves these problems.

3. Currently, such a system would require many hours of programming and a large staff to perform a conversion quickly and efficiently.

It is the author's conviction that this kind of system
will be feasible in the near future and that administrative officials of educational institutions contemplating either a computer installation or the upgrading of their systems should carefully consider an eventual change to an OLRT total information system.

Summary

The OLRT total information system utilizing numerous satellite terminals for financial data processing presents exciting possibilities for improved and expanded services from the business office of the institution. The massive memory banks which would permit storage of basic financial information for immediate access open the door to rapid preparation of the regularly scheduled financial reports as well as numerous special reports. These special reports are limited only by the imaginations of the personnel who might want financial data recast in different forms. Cost accounting now becomes an area in which one may develop numerous cost studies through the processing of cost programs.

The moving of input information closer to the source of data origination enables one to eliminate errors created by information transfer and to avoid duplication of data.

The opportunity for decision-making by the computer is greatly enhanced by the basic financial information in memory banks. The computer may efficiently handle decisions on
student loans, scholarships, and other similar activities.

The remote terminals in the president's office, business office, chief academic office, and deans' offices make it possible for these officers to query the system and receive immediate answers.

This OLRT system aids in improving the quantity and quality of financial information for which business offices are responsible. Budget control and other methods of financial control are also elevated to higher levels.
CHAPTER VI
TOTAL SYSTEMS PROPOSAL FOR STUDENT RECORDS

The student record keeping function may be classified as an academic task within the province of academic administration. In certain educational institutions, however, responsibility for students when they are not in the classroom rests with a separate division, such as the "Division of Student Personnel." In this kind of organization, the academic division is responsible for matters relating to students' academic programs and progress. Having recognized the distinction between academic progress and the problems of student behavior, the author places the student record keeping problems in the academic area and proceeds on the assumption that results are essentially the same.

The two preceding chapters have established the background for extension of the OLRT total information system to the student record keeping area. In the institutions surveyed this function was performed in the registrar's office where the opportunities to use the total systems approach to good effect are quite numerous and exciting. The student records area is that phase of administration responsible for recording the
relationship between the student and the institution from the time of his initial application until his status as an alumnus.\(^1\) Student records encompass admissions, testing and counseling, registration, and student services. Alumni records are sometimes included in the student records area but in this study have been discussed in Chapter V under the business area.

Since determination of course offerings and scheduling of classrooms and laboratories are academic functions closely connected with the student records area, it is logical to consider those problems in this chapter.

Construction and Centralization of Master Data

The student is the main factor to be considered in an educational institution, because the basic purpose for its existence is to educate the student and, in effect, all activities revolve about him. It has been suggested that two informational prerequisites are vital for the greatest effectiveness and efficiency of a total information system.\(^2\) A unique identifying number must be assigned for each student so that he is always positively identified by this number from his original application to the time he becomes an alumnus. Secondly, master data about each student must be located in only one

\(^1\)International Business Machines Corporation, College and University Administrative Applications (New York, n.d.), p. 10.

\(^2\)Ibid.
place and must be available to the various subsystems for processing.

Under the OLRT total information system, the registrar would have access to the central computer via a satellite terminal in his office. The idea of creating master data on each student to be available to other users opens the same kind of opportunities for creative uses of the system as were considered in Chapter V.

When a student applies for admission to an institution he is immediately assigned a unique number, and the data from his application and supporting documents are immediately read into the computer memory banks. This process begins construction of the student records which is to be maintained in memory banks for so long as the student remains in school. Read-in over an optical reader permits rapid entry of pertinent data into the system, but also requires that the application form be especially designed to be used as the source document. It may be essential to standardize the transcripts from high schools and/or colleges to permit optical read-in of basic information which is required for admission.

As the student progresses through school, his record of courses taken, credit hours earned, grades, grade point average, honors, and disciplinary action are added to the master data. These additions may be viewed as modules or separate subsystems. As changes occur, deletions and modifications are
also recorded on the master record so that an up-to-date status report on any student is immediately available.

With properly programmed instructions, the computer system could prepare and print-out letters to prospective students advising them of admission status at the same time the application for admission was being processed. Three basic letters might be used: one to advise students who fulfilled the requirements for admission that they had been admitted; another to reject applicants who were ineligible for admission; and a third to request additional information from those whose applications were incomplete.

A daily, weekly, or monthly admission status report should be simple to prepare since it requires only the preparation of a program of instruction for the OLRT system designed to have the computer send the report over the appropriate satellite terminal. From the basic application information the computer can prepare the following reports:

1) Student status report showing students accepted or rejected, and those whose admissions are pending.

2) Student statistical analyses, showing number of applicants accepted, rejected, and pending. These data may be listed by college and department within each college.

3) Prediction reports on each student if intelligence tests are required for admission.

4) Enrollment projection reports, since data on students already enrolled will be stored in memory banks.
5) Statistical reports on in-state and out-of-state students, with details about locations from which they come.

By activating appropriate programs, the above reports can be prepared and printed out over the registrar's satellite terminal at any time after the data have been placed into memory banks. Additional reports could be prepared from the master data which are also available to the student housing office, the counseling and testing office, alumni records office, the business office, and others.

**Housing Office Satellite**

When a student applies for admission to the institution, he will very likely also apply for some form of housing. In many institutions a student housing office administers, maintains, and operates the housing system. That office assigns students rooms or apartments, permits moves from one room to another, maintains a certain degree of discipline, checks students in and out of rooms, and handles any other problems arising in the housing area.

Room assignments would be easily handled by feeding into the computer memory data on available housing and programming the computer to assign rooms as applications are received and processed. To say that this job could be handled by the registrar as a by-product of admissions, however, oversimplifies a complex problem. Students already enrolled may desire to keep the same rooms and roommates. Ideally, freshmen
should not be housed with upperclassmen, and graduate students prefer to be with other graduate students. These complexities of housing, however, can also be processed through proper computer programming.

Housing assignments and problems should be handled in the housing office, and a satellite terminal should be available in that office. Master data are available from the applications processed by the registrar, and testing data may be obtained from the counseling and testing office. Depending upon the tests administered by the counseling and testing office, it may be possible to match students' personalities, intelligence levels, religious preferences, educational levels, and other criteria in making room assignments. Thus the number of room changes normally expected because of incompatible roommates might be reduced. The parameters for the behavior comparisons may be a part of the computer program and the rooms available may be in memory; thus, the OLRT system can select the students and assign rooms.

A housing report showing the names and addresses of persons assigned rooms in each building may be prepared at any time. Moreover, the printout may list vacant rooms in each building and summarize the number of vacancies.

**Counseling and Testing Office Satellite**

Counseling and testing of student applicants as well as students in residence are of growing importance in the educational
program. These tests and counseling help determine a student's potential, help him select a suitable major field, and assist in placing him in class sections appropriate to his abilities. Personal counseling and guidance are generally available to the student during his entire college career.

As various tests are completed, results can be fed into the memory banks of the computer by an input-output terminal located in the counseling and testing office. The information from testing adds to data from the application which is already in the memory bank. As the student progresses through school his grades are reported to the registrar and then become available to the counseling and testing office through the total information system. Interest and abilities reports can now be formulated for comparison with later interest and abilities test scores. Predictions of success in college level work can be computer-processed and compared with actual results. Readily available to the counselor via the OLRT system are grades, grade analyses, course requirements completed and not completed, and extracurricular activities information.

Other Student Services

In addition to registration, housing, and counseling and testing, certain other services, including financial aids and alumni records, are generally considered in the student records.
area. Both of these services have been mentioned in Chapter V and need not be considered further.

**Control Over Course Offerings and Curriculum**

Determination of the courses of instruction to be offered during each semester or term is the responsibility of the academic division. With the use of the OLRT system it becomes practical to change to an advance registration system such as that discussed in Chapter III. One advantage of the new system, for example, is the possibility of preparing a firm list of courses to be offered from an evaluation of the advance registrations, student records, and degree requirements. Counselors would assist students to determine the courses for which they should enroll during subsequent semesters. Students should be registered for the courses requested with the possible exception of those courses desired by only a few students. The computer would determine if the courses in which an inadequate number of students had enrolled are actually needed by the students in that particular semester in order to fulfill requirements for graduation. If not, these courses could be rescheduled for a later semester.

Optimum schedules permitting better utilization of faculty time and facilities would be possible because the OLRT total system would be capable of keeping the entire schedule of course offerings in the memory banks along with previous courses taken, degrees being pursued, degree requirements,
data on facilities available for classrooms and laboratories, and similar data. Teaching load limits and other required parameters can be written into the programs which the registrar's office would process on its satellite terminal to print out the registration lists.

Sections would be balanced, and faculty members would be assigned equivalent teaching loads with the computer system doing the necessary checking and comparing to assure equity. More effective control over courses, teaching assignments, and student schedules becomes possible under this kind of system. Moreover, there is an attendant saving of administrative time since many decisions will be made by the computer.

Forecasting of Course Offerings, Classroom and Laboratory Requirements

Forecasting the courses to be offered in succeeding semesters and predicting classroom and laboratory needs become feasible on the OLRT system. Once the system contains courses taken by currently enrolled students, classroom sizes, laboratory sizes, number of sections, degree requirements, and similar data, it can make projections based on these data. An enrollment projection will be required, of course, but this too can be computer-prepared since the historical data on which to base such projects are available.

These forecasts can be prepared so that the courses to be offered as well as classroom and laboratory needs can be
established for each college and for the departments within each college. The forecast on courses to be offered would indicate new instructors and office space required. The computer can prepare data on teaching positions to show the dollar value of the various positions. If the number of administrative and clerical positions required in relation to the number of teaching positions is projected, an estimate can be made of the cost for added enrollment. Classroom, laboratory, and office space needs would provide a basis for the projection of new construction requirements. After construction requirements have been projected, the cost of future operation and maintenance of physical facilities can be readily determined. Library requirements, based on student enrollment, can be estimated as a percentage of the total educational and general budget. This basic information needed for expenditure projections would normally be prepared by the business office, but is mentioned here because compilation of information on new expenditures is occasioned by increasing enrollments.

Simplification of Registration Procedures

An advance registration system such as that envisioned in Chapter III permits current students, after consulting with their deans or counselors, to register prior to the beginning of the next semester. The advance registration document may include such things as requirements for housing, meals, and other items typically included at registration. After proper approval,
the registration documents would be sent to the registrar for processing. New students would register at the time they fulfill admission requirements. This registration could be arranged while they were taking tests in the counseling and testing phase of admission. The registrar will process advance registration documents by means of his satellite terminal to advise a student of his course schedule, room assignment, and registration fees due prior to the beginning of the semester. The student mails payment for his fees and receives a receipt from the central cashier. The student may then attend classes when he arrives on the campus.

This system permits the registrar to charge the student's account and his payment to the central cashier is the basis for crediting his account and listing his name on the proper class rolls. Names of students who had not paid the necessary fees would not appear on class rolls, and they could not receive credit for course work. If the registrar is permitted access to the student accounts receivable, the printout of fees for registration could also indicate any unpaid balance from prior semesters.

Using this simplified registration procedure, the computer would prepare these usual registration reports:

1) Class lists giving students' names, numbers, classifications, and sex.

2) Housing list by dormitory, floor, and room.
3) Religious preference lists.
4) Statistical data by college and department.
5) Enrollment reports.

Using the OLRT system, the student would be required to provide basic personal information only once, and many reports could be prepared from the stored data.

**Grade Reporting Methods**

Utilizing the OLRT system proposed in this study would make a big change in grade reporting methods. Under the current systems, faculty members in the institutions surveyed placed grades on a data card or class roll which was then processed by the registrar. This method is still available to institutions if they choose to continue using it. Under the new system, however, each faculty member would have at his disposal a typewriter input-output terminal. Simple programs could be prepared to ask the computer to print out an alphabetical listing of all students enrolled in each course taught by the individual faculty member. All details except final grades would be typed automatically on the professor's I/O terminal, and the program would be prepared to stop the I/O terminal so that the faculty member could insert a final grade for each student on the roll. The final grades would be fed directly to the computer and the memory banks. Mid-term or final grade reports could be prepared by the registrar's terminal after the final date for reporting all grades.
If all grades are not completed by the final date, grade reports may be delayed or incomplete reports mailed to students enrolled in courses for which the instructor has failed to report grades by the scheduled deadline. The computer system should be programmed to print out over an inquiry terminal in the office of the chief academic officer, the names of those faculty members responsible for late grades so that prompt administrative action may be taken.

**Permanent Records Control**

At the time of registration, information concerning the courses for which each student enrolls would be stored in the memory banks of the system. As final grades are reported for each student, the course number, name, date, grade, and semester hours credit earned can be transferred to another section of memory storage and added to the student’s previous record of credits earned. At this point, new semester averages, cumulative averages, total hours credit earned, and total quality points acquired could be calculated and stored. A printout of these data would give all the information generally required on credits earned, and a student grade transcript could easily be computer-prepared. Since the student’s name, name and address of the institution, dates of attendance, and the record of courses and grades would be printed on the terminal in the registrar’s office, only the registrar’s signature and the official seal of the institution would be required before
the transcript could be mailed. Although only the registrar should have access to complete student records, the issuing of transcripts is further controlled since the institution's seal and handwritten signature of the registrar are required.

**Availability to Other Users of Data on Students**

The OLRT system provides for the memory storage of information on high school or previous college record, test scores and other information from counseling and testing, housing, accounts receivable, college program, and courses taken for each student. These data may be placed in the memory banks in a modular fashion so that access to certain parts of the data is granted to specified users only. Obviously, the student accounts receivable (a business office function) should be available to certain users for information only. Basic data such as name, number, address, parents' address, and similar information taken from the application form could be made available to all users. Data prepared from counseling and testing should be restricted to those users actually needing such information. Security can be effected by programs that restrict access to certain satellite terminals.

Certain side benefits of the OLRT system become apparent when one considers the information in memory banks. For example, in institutions where student charge accounts are permitted, the business office would find it extremely useful to know which students are making poor grades and are likely to become academic
failures. Pressure to collect these accounts could be exerted early. Similar benefits may be available to other users. The important point to remember is that basic information on all students is available in memory banks.

From the foregoing discussion, it is evident that the complete history of a student's progress at the institution can be computer-maintained. Naturally, there must be programs for removing data from the memory banks when the information is no longer useful. Permanent records of students' academic credits must be maintained for many years, and they should be transferred to microfilm or other methods used for permanent storage. The memory banks should be used to store only current, useful information.

The president, chief academic officer, chief business officer, and other administrative officials will find these kinds of data extremely useful in handling the day-to-day problems which arise concerning individual students. Deans will find the availability of student records useful in job placement, assisting students nearing academic failure, and in responding to inquiries about the college records of students. This type of information can be made available to each of these officers over a visual display unit in their respective offices.

Summary

Collection and maintenance of appropriate records
relative to the student's background and his progress at the educational institution are major undertakings. The OLRT total information system, through the use of satellite terminals, presents real opportunities to reduce the workload and complexity of this task.

The centralization of master data through a satellite terminal in the registrar's office permits the creation of student records available to other users of the system. Careful construction of this master data will reduce the necessity for certain other users to duplicate much of this basic information. Further, the large memory storage capability of the equipment makes it possible to utilize the system for making decisions.

Housing assignments processed by this kind of system can take into account certain tests which show students' personalities, intelligence levels, religious preferences, and educational backgrounds.

Counseling and testing data will be analyzed by the computer as the information on the tests is fed into the system over the I/O terminal in the counseling and testing office. Prediction of the student's success in college, comparative interest and abilities reports, and similar data will be readily prepared.

Under the OLRT system, advance registration procedures will achieve a high degree of efficiency. In addition, the system has the ability to project the number of courses and
sections to be offered, the faculty needed, space required, and cost. This projection will be based on enrollment trends, records of student distribution and its trend, and information on degrees being pursued. Budgetary projections of institutional needs can be readily prepared also.

Basic data on each student is available to numerous users of the system. The college president, chief academic officer, and chief business officer will find that almost immediate access to this data will be most useful.

Grade reporting is considerably simplified since each faculty member will report grades over his own I/O terminal by keying in the grade for each student.

Effective control over current records of credits earned is maintained by storing this information in the computer memory bank and restricting access to certain users. Moreover, printouts for transcript purposes are controlled by requiring the registrar to sign and seal each transcript.
CHAPTER VII
TOTAL SYSTEMS PROPOSAL FOR TEACHING, RESEARCH, AND LIBRARY

Although the survey of the institutions covered in this study was concerned primarily with the financial and student records areas, it was impossible completely to eliminate the teaching and research functions. Since this study is concerned with a total systems approach to data processing problems, it is desirable to include these two areas, and in the interest of completeness, the library is also considered. The investigations made in these three areas were not as detailed as in the areas of finance and student records.

Teaching Via Satellite Terminals

Instruction concerning computers, the associated peripheral equipment, programming, and similar items has been included in the course offerings of many educational institutions for a number of years. Courses of this kind have been designed to help the student understand the capabilities and utilization of the computer. To accomplish this purpose, it has been necessary to expose the student to the equipment and permit him to use it in mastering certain courses. Computer programming
is one course that is learned through use of the machine.

The use of computers for instructional purposes is a recent development and has not yet been widely applied. Several organizations in different parts of the country are presently experimenting with using computers for teaching purposes. The main application of computer systems for teaching purposes has been in programmed instruction which is sometimes referred to as "automated teaching" and must not be confused with computer programs which instruct the computer. In programmed instruction, the computer controls the sequence of course material offered each student, based on his performance in the lesson. The computer system evaluates the student's responses to questions contained in the course material and controls the feedback information concerning correct responses, errors, and further information on the nature of errors.

Experimental work in programmed instruction has been conducted in stenotype, German, and statistics by International Business Machines Corporation. The University of Illinois has completed studies in computer programming, mathematics, and

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1Coulson, op. cit., p. 93.
2Ibid.
electrical engineering. These studies and others of a similar nature indicate that programmed instruction will very likely be expanded in colleges and universities in the near future. Further experimentation will be required before widespread adoption of computers as an instructional force comes into full-scale use.

The OLRT total information system under consideration in this survey should include satellite terminals for programmed instruction. These terminals could be set up in classrooms similar to language laboratories, and a student would work at a speed limited only by his own abilities. The student would initiate the programmed instruction by keying in a code from his terminal. The satellite terminals should be designed to give each student a visual presentation of problems, responses, and feedback aids that assist instruction. Typewriter keyboards may be used for input of students' responses, but the noise level must be kept low since numbers of students are in close proximity. It would be appropriate also to have these satellite terminals designed so that the library information system might be accessible. If a student needed further background material in a particular course he could call upon library resources (discussed below) for this purpose.

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In Chapter IV it was suggested that OLRT centers be staffed with personnel sufficient to provide the institutions with the desired level of service. Because programmed instruction is likely to be complex and highly specialized, it is advisable that this work be accomplished by the staff in the central center with the assistance of faculty members specializing in each particular subject. As courses of instruction are prepared for the computer system, they would be introduced into the system from the OLRT central center. A staff of specialists could then coordinate and maintain the programmed instruction operation.

Research via Satellite Terminals

Research in educational institutions is conducted by members of the faculty, graduate students, and certain staff personnel. The bulk of the research is performed by the faculty, and they must be provided with the essential tools. It became apparent early in the development of the computer that its potential for research purposes was tremendous. Institutions began installing computers for research purposes long before general applications to business problems, information retrieval systems, and student record keeping were considered.

The full potential of the OLRT system is made available to each faculty member for the conduct of his research by equipping his office with an appropriate satellite terminal. This terminal may be a typewriter input-output configuration
or a more sophisticated piece of equipment with visual display. Since each faculty member needs a typewriter for his office, a device which could double as an input-output configuration would be an economical way of providing the computer capability. This device would be used to record grades, inquire about information in the system, and other purposes. The faculty member could have full use of the system for research as well as many other purposes.

Research on a given subject will be facilitated by the satellite terminal's access to the library information system. Using this capability an individual would be able to call forth information available in the library on any given subject.

Library Information Retrieval System

The library of the college or university has traditionally been one of the major facilities for organizing and storing the recorded memory of civilization. Educational institutions are the instruments for preparing students to cope with the demands of modern civilization and in order to educate the leaders of tomorrow must find ways to handle the explosion of recorded knowledge. In some manner, the institution must find the means to make available on a dynamic basis the recorded knowledge.

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knowledge of mankind.

An information retrieval system has been defined as a man-machine system combining human intelligence and electronic equipment for gathering, classifying, and sorting factual and textual material and for retrieving and disseminating this information upon demand. Certain work has already been accomplished in the design of computer hardware systems which automate many of the human functions associated with information retrieval. It is expected that much more work will be accomplished before the computerized information retrieval system comes into full-scale use in colleges and universities. Nevertheless, it is appropriate to consider the elements of such a system utilizing the OLRT total information system.

The kind of information retrieval system that will be available to colleges and universities of the future will likely be originated by a national or regional information center. A national center, which will acquire all books, magazines, patents, doctoral dissertations, and similar documented materials as they become available, will be assumed for this discussion. The center will be staffed with subject matter specialists who will select the information for indexing, abstracting, and coding into a magnetic tape file. Entire publications will be copied into the file and coded so that they will be readily

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6Borko and Bushnell, *op. cit.*, p. 53.
accessible. Copies of these files will periodically be made available to college and university libraries for use on their computer-based information retrieval system. Students desiring to use the information retrieval system will go to a satellite terminal in the library (or perhaps in a classroom) and key in the code to obtain access to the system. He may then key in the subject matter area in order to scan over a visual display unit the titles of the publications in the subject matter area. Each publication will carry an abstract code which when keyed in by the student would permit him to read the abstract from the visual display unit. The satellite terminal should be designed so that the speed of the material displayed on the unit could be set to his level of comprehension. Should the abstract indicate a need for the student to read the entire book, publication, or pamphlet, the textual material can be made available by keying in another code. This kind of system will require periodic purging to keep current the information available by this means. Other materials might be retained in the index for a time so that the student could have knowledge of such material and could refer to the particular publication in the library.

It was suggested that this system be on magnetic tape only because material can be quickly copied on magnetic tape. This system requires a storage media to permit quick transfer of information and substantial reduction in the storage media
itself. Microfilm would permit a tremendous reduction, but the author believes that it must be improved to achieve the kind of information retrieval system that is to be the ultimate answer.

As tape materials are prepared by the national center and distributed to college and university libraries, the material will be added to the OLRT system memory banks by staff personnel in the central center. It will be the responsibility of the staff to enter new library information into the system promptly to keep the information retrieval system current.

Each institution will order from the national center only those materials which will be useful to its students, faculty, and staff. A liberal arts college would have little use for medical information and would not order it. Nevertheless, there will be occasions when certain information not subscribed to by an institution is needed. A data transmission line might link the institution to the national center to make other library material available to personnel of the institution.

This kind of information retrieval system can be expected to achieve the results set out below. The problem of maintaining effective control over library materials is reduced, since the student can always obtain access to the system from a satellite terminal. Fewer books and publications will be maintained in the library stacks and reading rooms. Fewer library personnel will be required since the students will be provided materials on a self-service basis. Libraries would
not need to enlarge as often because the knowledge is stored in memory banks of the OLRT system. The hours the library is open may be substantially reduced since students can utilize the library material over a classroom teaching terminal.

Satellite terminals will be located in the library and may be arranged similar to the classrooms considered earlier. Each graduate carrel and study room should be equipped with such terminals. The terminals should be equipped with a visual display device as well as keyboard for keying in requests for information.

The evidence to support the projection of a national center to acquire, select, index, abstract, and code material into magnetic tape files for subsequent distribution to remote school systems may be shown from the current trend toward such information centers as the Armed Service Technical Information Agency and the Scientific and Technical Information Facility. These two facilities deal exclusively with space and aeronautical sciences. Twelve universities have recently been designated to process, annotate, and convert to machineable form all the research reports sponsored through government contracts. It is clear that there is a trend toward information centers to prepare and disseminate information.

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Summary

In the near future, colleges and universities will adapt certain courses of instruction to computer systems. Teaching courses with computer equipment is called programmed instruction. The OLRT total information system lends itself to this kind of automated teaching. Classrooms will be equipped to provide access to programmed instruction over satellite terminals arranged in modular fashion. In such programs, a student will receive instruction and respond to this instruction at his individual intellectual level. The instructional materials introduced into the system will be prepared by specialists in the OLRT center with the assistance of faculty members competent in the respective fields. These materials will be maintained in memory banks of the system.

Research by faculty, staff, and graduate students can be accomplished under the time-shared system through the use of satellite terminals located in their respective offices. These satellite terminals permit each researcher to have access to the full capabilities of the OLRT system.

Libraries will receive their materials for introduction into the information retrieval system from a national information center which will collect information in all subject matter fields and select the information for indexing, abstracting, and coding into machine-processable form. The information will then be distributed to institutions of higher learning based on
their requirements for educational information. This system would reduce textbooks, magazines, technical publications, patents, doctoral dissertations, and similar information to magnetic tape which can be placed on the OLRT system for immediate use.
CHAPTER VIII
SUMMARY AND CONCLUSIONS

In the past several years increasing numbers of educational institutions have installed electronic data processing equipment to solve their problems of mass data processing. This change from conventional to electronic data processing equipment has been brought about for several reasons. Sheer increases in the volume of data to be processed have forced institutions to find some means of handling this increasing volume in order to meet time schedules for processing the work. Electronic data processing equipment has now been developed to handle efficiently business data and make business-type decisions.

In a recent study, varying degrees of success were observed in eleven institutions of higher learning which have installed electronic data processing equipment to handle the processing of financial data, aid in student record keeping, and facilitate teaching and research work. Some of the institutions are well advanced in the use of EDP equipment with virtually all of their accounting and business data processing being handled by the equipment. Most of the registrars'
student record keeping systems and registration procedures were likewise being processed by the equipment. Several institutions reviewed had only a few of the high volume operations currently programmed. Many of the institutions had not fully harnessed the decision-making capabilities of the equipment, and none of the institutions had taken the total systems approach to its data processing problems.

The following summary presents highlights of the survey of eleven educational institutions and presents a concept for an on-line, real-time total information system which utilizes its equipment in financial activities, student record keeping, teaching and research, and information retrieval.

**Summary**

**Survey of financial data processing methods.** Although it would seem reasonable to expect administrators in institutions of higher learning to conduct a full-scale feasibility study prior to the acquisition of expensive EDP equipment, the majority of institutions surveyed did not conduct such a study. In many instances, the decision to purchase or lease expensive data processing equipment has been an administrative decision based on an individual administrator's knowledge of the equipment and its capabilities. The administrators were not convinced that one central computer system could meet the requirements for administrative uses as well as teaching and research functions; consequently, the majority of the institutions had
two separate centers in operation, with one center for each function. The heads of the units reported to their respective division heads; thus, the administrative computer center director reported to the chief business officer while the academic computer center director reported to the chief academic officer.

Two years of planning were required to get most business systems programmed and ready for operation. This period of time was used to recruit, train, and educate personnel; to prepare the physical site; to install the equipment; and to make the conversion. The accounting system required a re-coding of the chart of accounts to make it compatible with the computer system, and changes were required in some documents to make them compatible with data cards. The applications had to be programmed, tested, and de-bugged before the conversion of any application could be completed. Although the required reports were generated on the computer at several institutions, the author observed that most of the institutions were assembling the financial reports by hand from computer-generated data. The computer systems could have been used to generate new and more meaningful reports and the decision-making capability of the computer could have been utilized to a greater extent.

**Survey of student records data processing methods.** Since institutions of higher learning have experienced increasing enrollments, they have felt keenly the necessity for tools designed to prepare and process data extremely rapidly.
Application of the computer to data processing needs of the registrar has been extremely helpful in solving many problems.

In the area of admissions, computers are currently being programmed to determine which individuals meet the admission standards and to prepare status reports on individuals applying for admission. It is possible for the computer to make the necessary admissions decisions and print out admission certificates and rejection notices for mailing.

Registration systems are not currently taking full advantage of the capabilities of the computer since few institutions have the computer prepare students' best schedules, calculate fees, and produce printouts of all required data. If these functions were being computer-accomplished prior to the time of registration students could enter classes without further registration procedures.

Grade reporting and record keeping of credits earned are well mechanized. The computer prints grades for mailing in most student records systems, and earned credits are recorded as a by-product of this work.

Advanced registration procedures are being tried in two of the institutions surveyed and should be developed into a system to determine courses to be offered, classrooms and laboratories to be used for each section, assignment of instructors, number of instructional personnel required, and similar information.
Large numbers of the reports required of the registrar are generated in some institutions through effective utilization of the EDP equipment. In the institutions surveyed, however, there is much work to be done before all of the required reports can be successfully generated by computers. The registrars in these institutions do not seem to be making full use of the decision-making capabilities of the equipment.

**Introduction to total systems concept using on-line real-time equipment.** An on-line, real-time total information system utilizing a central processing computer with large bulk storage capacity and satellite terminals located throughout the institution presents exciting possibilities for production users in the areas of financial activities, student records, and library information retrieval. Other uses include inquiry terminals for administrative officers, research terminals, and teaching aids for remedial purposes, as well as for routine instruction. Satellite terminals could be located in any office where personnel require access to the computer and/or the information in storage at the central unit. Although certain problems are inherent in this kind of system (for example, certain data must be restricted for the use of specified personnel and programs of production users must be interrupted on occasion for other users), the author believes that they can be effectively solved. In today's computer market the cost of such a system may be prohibitive for many institutions,
but future technological advancements will reduce costs to a practical point.

**Total systems proposal for financial data processing.**
The on-line, real-time total information system utilizing numerous satellite terminals for financial data processing presents opportunities for improving and expanding business office services. The massive memory banks permit storage of basic financial information for immediate access; therefore, regularly scheduled financial reports as well as numerous special reports can be prepared rapidly. These special reports are limited only by the imaginations of the personnel who might want financial data recast in various forms. Numerous cost studies may be developed through the processing of cost programs.

Moving input information close to the source of data origination eliminates errors created by information transfer and avoids the duplication of data. The possibility for computer-made decisions is greatly enhanced by the store of basic information stored in memory banks. It is quite reasonable to expect the computer to make decisions regarding student loans, scholarships, and similar matters.

Remote terminals in the offices of the president, business officer, chief academic dean, and other deans will permit these administrative officials to query the system and receive an immediate response. This on-line, real-time system serves the financial area by improving the quantity and quality of
financial information for which business officers are responsible. In addition, methods of financial control are also improved.

**Total systems proposal for student records.** The collection and maintenance of appropriate records concerning the student's background and his progress at the educational institution are major undertakings. The on-line, real-time total information system, through the use of satellite terminals, reduces the workload and complexity of these tasks. The centralization of mass data fed to the system through a satellite terminal in the registrar's office permits the creation of student records which can be made available to other users of the system. Careful construction of master data will reduce the necessity for certain other users to duplicate these data. The large memory storage capacity of the equipment makes it possible to utilize the system for decision-making.

Under this system, the housing office can take advantage of certain tests administered to the students. Students assigned as roommates can be matched on the basis of personalities, intelligence levels, religious preferences, educational backgrounds, and similar traits. Tests administered by counseling and testing personnel will be analyzed by the computer as the information from these tests is fed into the system over the satellite terminal in the counseling and testing office. Comparative interest and ability reports and similar data will be prepared and readily analyzed, and a student's
future success in college can be predicted by the computer.

Advanced registrations processed on an on-line, real-time system could achieve a high degree of efficiency in this area. The system has the ability to project the number of courses and sections to be offered, faculty and space requirements, and costs. These projections will be based on enrollment trends, student distribution records and trends, and information concerning degrees being pursued.

Budgetary projections and institutional needs can also be readily prepared. Basic data on each student is available to many users of the system. The college president, chief academic officer, chief business officer, and deans would find most useful the almost immediate availability of this information.

Grade reporting is considerably simplified since each faculty member would report grades on his own satellite terminal by keying in the grade of each student. Effective control over current records of credits earned is easily maintained by restricting access to this information to specified users. Printouts for transcript purposes would be controlled by requiring the registrar to sign the transcripts and affix the university seal.

Total systems proposal for teaching, research, and library. Colleges and universities of the future will adapt certain courses of instruction to computers. The on-line,
real-time total information system lends itself to automated teaching referred to as programmed instruction. Classrooms will be equipped to provide access to the programmed instruction over satellite terminals arranged in modular fashion. Using such programs, students will receive instruction and respond at their own individual intellectual levels. The instructional materials will be prepared by specialists of the on-line, real-time center with the assistance of faculty members competent in various fields and will then be introduced into the memory banks of the system.

Research conducted by the faculty, staff, and graduate students can be accomplished under the time-shared system through the use of satellite terminals located in their respective offices. These satellite terminals permit each researcher to have access to the full capabilities of the system.

Libraries will receive materials for introduction into the information retrieval system from a national information center which collects data in all subject matter fields, selects the items for indexing, abstracting, and coding into machine-processable form. The information will then be distributed to institutions of higher learning based on their requirements for educational purposes. The system would reduce textbooks, magazines, technical publications, patents, doctoral dissertations, and similar information to magnetic tape which can be placed on the on-line, real-time system for immediate use.
Conclusion

A number of conclusions relative to installations of electronic data processing equipment in institutions of higher learning have been drawn from this study.

(1) In a number of institutions, administrative officers based their decisions to install EDP equipment on their knowledge of the equipment being used at other institutions. The author believes that a feasibility study of the institution's proposed uses for such equipment would insure a more efficient installation. Such a study can be conducted by the institution's own personnel or by an outside consulting firm. When the institution had had no experience with EDP equipment, an outside management consulting firm should be employed to make a feasibility study of sufficient depth and breadth to provide the administrative officials with complete data on which to base their decisions regarding an EDP center.

(2) The current trend in educational institutions is to establish two EDP centers, one for the teaching and research function, the other for the administrative data processing function. At present, this arrangement appears to be justified because of the conflict of functions and limited capabilities of the equipment available. In future installations, full consideration should be given to an on-line, real-time computer center complex. It is believed that such a complex, equipped with a time-sharing computer and satellite input and
output terminals, would effectively handle the problems currently being processed by two separate computer centers. This time-shared computer would permit all personnel to have access to the full capabilities of the computer and the data stored in the system.

(3) Preinstallation planning usually requires two years of careful work and coordination of all activities associated with the installation of an EDP center. In practice it has been observed that this period cannot be appreciably shortened. In order to obtain reasonably efficient initial performance, at least 75% of all applications should be programmed, tested, debugged, and ready for operation by the time the computer is delivered and installed. Institutions anticipating a computer center should plan for a two-year period of preinstallation work to achieve a minimum goal of 75% of applications ready for activation at the time the equipment is installed.

(4) Most institutions found it necessary to modify the coding system for their chart of accounts in order to generate by computer the detailed and summary accounting reports required by the administration. Sufficient thought must be given to each institution's individual accounting system to devise a chart of accounts containing no more digits than are actually required. Reports should be prepared in accordance with accepted practices for college and university accounting. Special reports which may be required by the administration
can be readily developed through appropriate programming on
the time-shared equipment.

(5) In programming the accounting and financial
applications for the time-shared computer complex, the pro-
grammers must be keenly aware of and have full access to the
information already available in the memory banks of the system.

(6) Although many of the institutions visited did not
yet have all of their accounting systems programmed, most of
them were planning such action. There seem to be no major
problems to prevent utilization of EDP equipment for all ac-
counting applications. The use of a time-shared computer com-
plex with satellite terminals located throughout the campus
makes it imperative that all financial data be placed into
memory banks in the computer so that reports can be generated
as required, decision-making capabilities of the computer com-
plex can be fully realized, and the input data required from
each subsystem can be reduced to a minimum.

(7) Registrars in many institutions have made excel-
lent use of the computer in the area of student records. When
a time-shared complex is available, it is imperative that the
registrar utilize the computer to its fullest extent. Much of
the registrar's information, such as historical data on the
students enrolled, is required by other users of the computer
complex. Making this information available to other users
through the time-shared complex will help achieve a high degree
of overall efficiency. Decisions concerning which applicants should be rejected or accepted by the institution and which students have fulfilled the requirements for degrees can be readily made by the computer. To relieve administrative personnel of the details of such routine matters, the computer should decide as many of these problems as possible.

(8) The teaching and research functions and library information retrieval may be thought of as separate systems or as subsystems of the total information system. While the teaching and research functions may be performed to a certain degree without using other information available in the system, it seems appropriate that they be included as parts of the total information system. In pursuing programmed instruction courses, students may require information retrieval from the library system to provide the necessary background material for the course.

Faculty members, graduate students, and staff personnel engaged in research projects will require access to the information retrieval system and possibly to other data stored in the memory banks of the system. Library information retrieval must be available to students requiring use of library materials for their course work.

Since all subsystems are interconnected in use, it is difficult to think of each one as separate from the total information system. Educational institutions should give particular attention to these vital areas in connection with the
installation of the time-shared computer complex. It is the author's opinion that an on-line, real-time total information computer complex having a central computer with time-sharing capabilities and certain peripheral equipment harnessed by cable to satellite input and output terminals will eventually provide to major users computer capabilities similar to those which would be realized if each user had his individual computer center. At that time computer capabilities can be fully exploited for financial records, the registrar system, teaching, research, and library information retrieval.
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University of Kentucky, year ended June 30, 1963.
University of Kansas, year ended June 30, 1960.
University of Louisville, year ended June 30, 1964.
University of Maryland, year ended June 30, 1960.
University of Mississippi, year ended June 30, 1964.
University of Missouri, year ended June 30, 1962.
University of New Mexico, year ended June 30, 1963.
University of Oklahoma, year ended June 30, 1963.
University of Tennessee, year ended June 30, 1963.
University of Texas, month ended August 31, 1964.
Vanderbilt University, year ended June 30, 1957.
APPENDIX I
SURVEY QUESTIONNAIRE

1. Institution ___________________________ Date ________

2. Location ______________________________

3. Name of person answering questionnaire ____________________

4. Title of person __________________________

5. Enrollment of institution __________________________

6. Is Medical Center included? __________________________

7. Does institution have a computer installation? ________

8. If yes, is the computer centralized (i.e., are research, teaching, registrar, and business office operations all using a central installation or are there two or more installations)? ______________________________

9. If decentralized, give the number of computer locations ________________ and the functions of each ______

10. Approximate square footage of space required for the installation(s) __________________________

11. What is the total dollar volume of business transactions on the computer? __________________________

12. In reaching decisions on the acquisition of a computer:

A. Did you have a committee of faculty members to study the problems? __________________________
B. Was a consultant of any kind used other than the manufacturer's representatives?  

C. Was the decision simply an administrative one?  

D. Did the study group or person base his decision on:  
   (1) Economics of operation  
   (2) Better reporting  
   (3) Greater speed in processing data or research problems  
   (4) Type of equipment  
   (5) Other factors  

E. Please describe in detail the kind of study made in deciding to acquire the computer.  

F. Did committee decide on the organization of the computer center?  

G. Please describe the organization.  Show with chart if easier.  

Were departmental work flow charts prepared?  
Was present system examined to see if improvements could be made?  
Was there adequate discussion with department heads to assure cooperation in the E.D.P. installation?
H. Give duties of each position in the organization:

I. Did committee or individual administrator of study decide on salary levels of employees?

If so, give schedule __________________________

________________________________________

13. Machine applications. List applications:

A. Registrar's Records __________________________

B. Accounting System __________________________

C. Alumni Office ______________________________

D. Purchasing _________________________________

E. Physical Plant ______________________________

F. Inventory and Equipment Control ________________________

G. Other Application __________________________

14. In the accounting system--

A. Was a revision of the chart of accounts required?

____________________________. Describe _______________________

B. How are the various funds or accounts listed below processed on the computer?

(1) Cash receipts

(2) Accounts and notes receivable

(3) Inventories
(4) Equipment, Land and Building Accounts

(5) Accounts Payable

(6) Reserve Accounts

(7) Payrolls

(8) Loans and Scholarships

(9) Investments

(10) Plant Activities

(11) Income and Expenditures

(12) Income Accounts

(13) Other Expenditure Accounts

(14) Interdepartmental Operation Charges and Expenses

15. In the accounting system, was source data changed in accounting office to key punch for computer?

_______________________________. If no, was source data changed at original source? ___________. Somewhere in between? ______________________________
16. Did installation eliminate any employees in the accounting office? _______ If yes, how many employees were used before? _______ and after installation in accounting office? ________________________________

17. Recruiting and Training Personnel

A. Who recruited person for Computer Center? ____________________________

B. How was training accomplished? ____________________________

C. How long did training period last for programmer? ______
   Operator? _______ Key Punch Supervisor? ______
   Key Punch Personnel? _______ Systems Personnel?____

D. Was this coordinated with machine installation? ______

E. Were programs written, de-bugged and ready to use when machine was installed? ____________________________
   If no, how long after the computer was installed before the programs were ready? ____________________________

F. Was progress of training program checked frequently? ____________________________

G. In another installation would you follow a similar schedule? ____________________________.
   If no, what changes would you suggest? ____________________________
18. Programming the work to be done before computer arrived.

A. How long was the training program for employees scheduled prior to machine arrival? _______________________

B. What was the time element for the preparation of physical facilities? _______________________
   Cost of preparation of physical facilities? ______
   Space requirements in square feet? ________________
   Other problems:

C. Was responsibility fixed for the preparation of the entire installation? _______________________
   If yes, was this one individual or a committee? ______
   ________________  __________ Title

D. What applications were actually prepared and ready to be used at the time the machine was installed? ______

E. Was it necessary to change existing forms? __________
   Were procedures changed? _______________________
   Which procedures were changed and to what extent?______
19. Installation and operation of equipment.

A. For strictly business office work, how many of the following employees are needed?

(1) Key Punch Operators?
(2) Verifier Operators?
(3) Programmers?
(4) Systems Personnel?
(5) Key Punch Supervisor?
(6) Console or Machine Operators?
(7) E. D. P. Manager?

B. In the change over from punched card or other system accounting to E.D.P., how long was a parallel operation carried on?

What were major problems in the change over?

C. How many accounting office personnel were absorbed in the E.D.P. unit?

D. In program de-bugging and revision, was this a difficult problem? Was extensive work required? If so, what was the nature of this problem?

E. What controls were established over input data to assure accuracy?
F. What controls were established over output of the data?

G. What was the conversion cost? _____________________________

20. Auditing the E.D.P. System.

A. Describe the audit program in effect at your institution.

B. Is there a significant difference between audit programs before and after E.D.P.? _____________________________
   If so, what are the major changes? _____________________________


A. Are charges made to other user departments within the university? _____________________________
   If so, what is the hourly rate? _____________________________

B. What charges are made against research grants from outside sponsors? _____________________________

C. What rates are charged for outside work from business firms? _____________________________

D. Were formal operating policies written? __________
   If yes, attach copy.

22. Evaluation of the System.

Describe in a paragraph your evaluation of the system as compared with your prior system from the standpoint of economics, speed, volume, personnel, additional information, and the like.
APPENDIX II
STUDENT RECORDS SURVEY QUESTIONNAIRE

1. Name of institution ___________________________ Date ___
2. Address ___________________________________________
3. Name of person answering questionnaire ______________
4. Title of person _____________________________________
5. Enrollment ________
6. What kind of computer equipment does the institution have?
   ____________________________________________________
7. What is the computer center organization? ______________
8. What functions are on the computer? ____________________
9. In what areas does the registrar make use of the computer?
   ____________________________________________________
10. In admissions, is the computer used to determine who will be admitted? _______________ Rejected? _______________
11. Are student notices of admissions computer-prepared for mailing? ______________ Rejections? ______________
12. Are cards punched directly from the application form? _____
    If not, how? ______________
13. What is generally required for admission? ______________
14. Is a computer used for registration? _______ Describe in detail the system in use. ____________________________

15. Have you considered an advance registration system? _______ Describe the system in detail. ____________________________
When will this system go into operation? __________________

16. Describe in detail the reports generated from registration. ____________________________

17. Do you prepare grade reports on computer? _________
   Mid-term? ________ Semester? ________________

18. How are late grades handled? ____________________________
   Is this a major problem? ____________________________

19. When are grade reports generally mailed? ________________
   Number of days after final examinations __________________

20. Are student schedules computer prepared? ________________
   If so, describe system in detail. __________________________

   Do you plan to start a computer scheduling system? ________

21. Do you prepare permanent records by the computer? _______
   Transcripts? ________ If yes, describe system in detail. __________________________

22. What kind of control do you exercise over transcripts?
23. Does either your office or the business office distribute fees on the computer? ________ If yes, describe the system in detail. ____________________________________________

24. Are student housing assignments made by computer? ________ If so, describe the system in detail. ________________________________

25. Does the student counseling office use the computer for testing? ________ Test analysis? ________ Other? ________

26. Is the computer used for assignment of faculty work load?____ If yes, discuss in detail. ________________________________

27. Describe how the schedule of course offerings is compiled.

28. List the various reports generally required of the registrar.

29. Discuss uses which you could make of the computer that you do not make at present. ________________________________

30. Do you plan to implement these new uses? ________ When? __

31. Do you see much duplication of effort in certain applications? ________ Where are the duplications? ________________

How could these be eliminated? __________________________
32. What decisions does the computer make for your office? 

Are there others that could be made? 

What are these decisions? 

How could the computer be programmed to make such decisions?

33. Do you think the decision-making ability of the computer should be utilized fully? Discuss in detail.
APPENDIX III

DEFINITION OF TERMS

Access Time - The time required to condition a storage unit or device to receive or transmit data after the instruction to do so is given.

Accuracy - Correctness or freedom from error (as contrasted with precision).

Activity - A term to indicate that a record in a master file is used, altered, or referred to.

Algorithm - A fixed step-by-step procedure for accomplishing results; usually a simplified procedure for accomplishing a complex result.

Analysis - The investigation of a problem by a consistent method, and its separation into related units for further detailed study.

Analyst - One who analyzes and defines a problem.

Arithmetic Operation - Any of the fundamental operations of arithmetic, e.g., the binary operations of addition, subtraction, multiplication, and division, and the unary operations of negation and absolute value.
Arithmetic Unit - That component of computer hardware where arithmetic and logical operations are performed.

Automatic Coding - A technique by which a machine translates a routine written in a synthetic language into coded machine instructions, e.g., assembling is automatic coding.

Automatic Programming - A technique by which a machine converts the definition of the solution of a problem into a series of ordered procedures and operations which can be automatically coded.

Automation - Production by devices or machines which are self-acting with respect to predetermined processes, e.g., making automatic the process of moving work from one machine to the next.

Auxiliary Equipment - Equipment not under direct control of the central processing unit.

Auxiliary Storage - Storage which supplements the primary storage.

Available Machine Time - The elapsed time when a computer is in operating condition.

Batch Processing - A systems approach to processing where a number of similar input items are grouped for processing during the same machine run.

Bit - 1. The abbreviation for binary digit.
          2. A basic unit of information.

Bit Density - A measure of the number of bits recorded per unit of length of area.
Bit Pattern - A combination of \(-N\)- binary digits to represent \(-2\) to the \(N\) - possible choices, e.g., a 3-bit pattern represents 8 possible combinations.

Byte - A generic term to indicate an easily manipulated portion of consecutive binary digits, e.g. an 8-bit or 6-bit byte.

Card - 1. A machine-processable information-storage medium of special-quality paper stock, generally 7 3/8 x 3 1/4 inches.

2. An internal pluggable unit for printed circuits wiring, and components.

Card Code - The combinations of punched holes which represent characters (letters, digits, etc.) in a punched card.

Card Column - One of the vertical lines of punching positions on a punched card.

Card Face - The printed side of a punched card. If both sides are printed, the side of major importance is the face.

Card Feed - A mechanism which moves cards into a machine one at a time.

Card Field - A fixed number of consecutive card columns assigned to data of a specific nature, e.g. card columns 15-20 can be assigned to identification.

Card Hopper - A mechanism which holds cards preparatory to feeding.

Card Punch - A device to record information in cards
by punching holes in the cards to represent letters, digits, and special characters.

**Card Reader** - A device which senses and translates into internal form the holes in punched cards.

**Card-to-Tape** - Pertaining to equipment which transfers information directly from punched cards to punched or magnetic tape.

**Cathode Ray Tube** - A vacuum tube used as a storage or a visual display device.

**Central Processing Unit** - That component of a computing system which contains the arithmetic, logical and control circuits of the basic system.

**Channel** - 1. A device which connects input-output units to the main part of the computer or to each other.

2. See **Track**.

3. A path for electrical transmission between two or more stations.

**Character** - A primitive informational element used to form symbols in printing and recording, e.g., letters, digits, etc.

**Character Density** - A measure of the number of characters recorded per unit of length or area.

**Character Emitter** - An electromechanical device which emits a timed pulse or group of pulses in some code.

**Character Printer** - A printer in which only a single character is composed and determined within the device prior to printing.
**Character Reader** - An input device which reads printed characters directly from a document.

**Character Recognition** - The act of reading, identifying, and encoding a printed character by optical or other means.

**Check** - To examine or test for accuracy or for precision.

**Check Bit** - A redundant bit carried with a group of bits in such a way that an inaccurate retrieval of that group of bits is detected.

**Check Digit** - A redundant digit carried with a group of digits in such a way that an inaccurate retrieval of that group of digits is detected.

**Checkout** - The application of diagnostic or testing procedures to a routine or to equipment.

**Checkpoint** - A point in a routine at which sufficient information can be stored to permit restarting the computation from that point.

**Checkpoint Routine** - A routine which stores information for a checkpoint.

**Circuit** - A physical, conducting connection between two points.

**Classify** - To arrange into classes of information according to a system or method.

**Coaxial Cable** - A cable with at least one transmission line consisting of two conductors concentric with and insulated from each other.
**Code** - 1. (n.) The assignment of meaning to a character or group of characters, e.g., an alphabet.

2. (n.) A label to identify a routine, location, operator, operand, name, etc.

3. (v.) To translate and write information in an abbreviated or shorthand form, e.g., to write machine instructions, symbolic notation, etc. from a statement of the problem.

**Collate** - To compare and/or merge two or more similarly ordered sets of items into one ordered set.

**Collating Sequence** - The relative ranking of permissible graphic symbols or their representations.

**Collator** - A device designed to compare data from two decks of punched cards and to sequence-check them, merge them, and/or select cards from them based on this data.

**Communication** - The process of transferring information from one point, person, or equipment to another.

**Comparator** - A device for making a comparison.

**Comparing Unit** - An electromechanical device which compares two groups of timed pulses and signals either identity or nonidentity.

**Comparison** - The examination of the relationship between two similar items or data. Usually followed by a decision.

**Computer** - An electronic device capable of accepting information, performing mathematical and logical operations on it, and reporting the results—all under control of a stored program.
**Computing** - A generic term for all mathematical and logical operations carried out according to precise rules of procedure.

**Console** - A panel which contains lights, keys, switches, and related circuits for man-machine communication.

**Control Card** - A card which contains input data or parameters for a specific application of a general routine.

**Control Data** - One or more items of data used as control to identify, select, execute, or modify another routine, record, file, operation, data value, etc.

**Core Storage** - A form of high speed storage using magnetic cores.

**Data** - A collection of facts, numbers, letters, symbols, etc., which can be processed or produced by a computer, i.e., a representation of information.

**Data Collection** - The act of bringing data from one or more points to a central point.

**Data Communication** - The transmission of the representation of information from one point to another.

**Data Conversion** - The process of changing data from one form of representation to another.

**Data Origination** - The translation of information from its original form into a machine-sensible form.

**Data Processing** - Manipulating data to achieve desired results.
**Data Processing System** - A network of machine components capable of accepting information, processing it according to plan, and producing the desired results.

**Data Transmission** - The sending of data from one part of a system to another part.

**Data-Phone** - A word used by A.T. & T. to designate any of a family of devices used to permit data communications over telephone channels.

**Debug** - To examine or test a procedure, routine or equipment for the purpose of detecting and correcting errors.

**Decision** - The process of determining further action based upon the relationship of two similar items of data, e.g., characters, words, choices, etc. Decision is usually preceded by comparison.

**Delete** - To remove or eliminate, e.g., to remove a record from a master file.

**Device** - 1. That which is devised, invented or formed by design.

2. A mechanical contrivance or appliance.

**Digital Computer** - A computer which processes information represented by combinations of discrete or discontinuous data as compared with analog computer for continuous data.

**Disk** - A physical element of disk storage.

**Disk Storage** - A storage device which uses magnetic recording on flat rotating disks.
**Display Unit** - A device which provides a visual representation of data.

**Document** - A medium containing a representation of stored information, such as a sheet of paper, a punched card, etc.

**Documentation** - The process of collecting, organizing storing, citing, and dispensing documents or the information contained in documents.

**Error-Correcting Code** - A code containing redundant information which can restore to the original form certain classes of detected errors.

**Error-Detecting Code** - A code containing redundant information which can be used to indicate the presence of certain classes of unintentional alterations of data.

**File** - An organized collection of information directed toward some purpose.

**File Maintenance** - The processing of a file to effect changes in the file, e.g., updating a master file.

**Format** - A predetermined arrangement of characters, fields, lines, punctuation, page numbers, etc.

**Hard Copy** - A printed copy of machine output in a visually readable form, e.g., printed reports, listings, documents, summaries, etc.

**Hardware** - The mechanical, magnetic, electrical and electronic devices or components of a computer.

**Identify** - To attach a unique code or code name to a unit of information.
**Input-Output** - 1. Commonly called I/O. A general term for the equipment used to communicate with a computer.

2. The data involved in such communication.

3. The media carrying the data for input-output.

**Inquiry** - A request for information from storage, e.g., a request for the number of available airline seats or a machine statement to initiate a search of library documents.

**Inquiry Station** - The device from which any inquiry is made.

**Instruction** - A set of identifying characters designed to cause a computer to perform certain operations. A machine instruction consists of one or more operators, operands, tags, etc.

**Interrupt** - 1. (n.) A break in the normal flow of a system or routine such that the flow can be resumed from that point at a later time. An interrupt is usually caused by a signal from an external source.

2. (v.) To cause an interrupt.

**Keypunch** - See Card Punch.

**Language** - 1. A defined set of characters which are used to form symbols, words, etc., and the rules for combining these into meaningful communications, e.g., English, French, algol, fortran, cobol, etc.

2. A combination of a vocabulary and rules of syntax.
**Library** - 1. A collection of documents for study or reference.


**Line Printer** - A printer in which an entire line of characters is composed and determined within the device prior to printing.

**Machine Operator** - The person who manually controls a machine.

**Machine Run** - The execution of one or several machine routines which are linked to form one operating unit.

**Machine-Sensible Information** - Information in a form which can be read by a specific machine.

**Magnetic Core** - A small doughnut-shaped ferrite designed and constructed for on-off magnetization and used to store information in the computer.

**Magnetic Tape** - A continuous flexible recording medium whose material is impregnated or coated with a magnetic sensitive material ready to accept data in the form of magnetically polarized spots.

**Main Frame** - The main part of the computer, i.e., the arithmetic or logic unit. The central processing unit.

**Mass Storage** (on-line) - The storage of a large amount of data which is also readily accessible to the central processing unit of a computer.
**Off-Line** - Pertaining to the operation of input-output devices under direct control of the central processing unit.

**Optical Scanning** - A technique for machine recognition of characters by their images.

**Optimize** - To arrange the instructions or data in storage so that a minimum amount of machine time is spent for access when an instruction or data is called out.

**Output** - Information transferred from internal storage to external storage or to an on-line output device.

**Output Area** - The area of internal storage from which data is transferred to external storage.

**Peripheral Equipment** - See Auxiliary Equipment.

**Primary Storage** - The main internal storage.

**Printer** - A device which expresses coded characters as hard copy.

**Program** - 1. (n.) The plan for the solution of a problem including data gathering, processing, and reporting.

2. (v.) To plan the method of attack for a defined problem.

**Programmer** - One who prepares programs for a computer.

**Programming** - The art of reducing the plan for the solution of a problem to machine sensible instruction.

**Punched Card** - A card which may be punched with holes to represent letters, digits, or characters.

**Random Access Storage** - 1. Storage in which the time required to obtain information is statistically independent of
the location of the information most recently obtained.

2. A type of storage in which access can be made directly to any storage location regardless of its position, either absolute or relative to the previously referenced information.

**Reader** - A device which converts information in one form of storage to information in another form of storage.

**Real-Time Operation** - Concurrent operations for data processing (computing) and physical processing in such a way that the results of the computing operations are available whenever needed by the physical processing operations, and vice versa.

**Report Generator** - A special machine routine designed to prepare an object routine that, when later run on a computer, will produce the desired report.

**Reproduce** - To prepare a duplicate of stored information, especially for punched cards, punched paper tape, or magnetic tape.

**Retrieval** - 1. The recovery of something searched for.

2. The act of finding again.

**Scan** - To examine stored information for a specific purpose, i.e., for content, arrangement, etc.

**Search** - 1. (n.) A systematic examination of the available information in a specific field of interest.

2. (v.) To scan available stored information.
Sort - To break down or distribute into groups according to a given set of rules, usually to make a numerical, alphabetic, or alphanumeric sort.

Sorter - A device to sort cards.

Storage - A general term for any device capable of retaining information.

System - 1. A Collection of consecutive operations and procedures required to accomplish a specific objective.

2. An assembly of objects united to form a functional unit.

Systems Analysis - The analysis of a business activity to determine precisely what must be accomplished and how to accomplish it.

Tag - A specific identifier such as a label, an index, etc.

Tape - A linear medium for storing information which can be used as input or output to a computer, e.g., magnetic tape.

Terminal - A point at which information can enter or leave a communication network.

Track - A single path, e.g., as on paper or magnetic tape.

Update - To modify a master file with current information according to a specified procedure.

Verifier - A device similar to a card punch, to check the inscribing of data by rekeying.

Verify - To check the transcription of data.
EXAMINATION AND THESIS REPORT

Candidate: Ephraim Edward Davidson

Major Field: Accounting

Title of Thesis: Present and Proposed Computer Uses in Colleges and Universities

Approved:

[Signatures and titles]

EXAMINING COMMITTEE:

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Date of Examination:

January 12, 1966