# A COMPUTERIZED INFORMATION SYSTEM MODEL FOR DECISION MAKING FOR THE OKLAHOMA STATE DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

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# CHAPTER I

## INTRODUCTION

Design and utilization of computers for logistics and operations research procedures was effected during World War II. Rapid adaptation of computer technology to non-military decision-making processes was realized in the engineering, petroleum, automobile manufacturing, and other industrial fields. In comparison, the current state of the art for computerized systems in education is far less advanced as stated by Goodlad:[1]

> Nonetheless, the applications of computer technology in education have lagged far behind those in business, science and government. The computer sciences have so far had only a limited impact on education, and automated information systems are still the exception rather than the rule.

In 1966, approximately twenty years after the end of World War II, when the potential of computer technology was realized by many segments of the economy, surveys indicated only fourteen percent of the 2,100 colleges and universities and one percent of the public school districts in the U.S. utilized electronic accounting machine equipment and computing equipment.[2] A survey of public schools in 1970 indicated approximately 34 percent of the schools had access to computing facilities.[3] By 1971, the majority of colleges and universities had access to some type computing facility for educational needs.[4] Surveys did not specifically differentiate between instructional and administrative applications within the educational systems; however, indications are that instructional applications take precedence over administrative applications.

Reasons for the relatively slow rate of computer adaptation to the field of education include:[5]

1. An inherent fear of automation;
2. Implied dehumanization of the very humanizing and personal processes termed "education";
3. Economic constraints more pervasive in education than fields of business, science and government; and
4. Significant deficiency in educators' awareness of computer potential for educational problem solving.

These impediments to computer adaptation are undergoing forced re-evaluation due to increased paper work associated with expanded enrollments and the increased emphasis on accountability by the total educational system.

As the realization of computer potential occurs, the total information needs of the educational system must be analyzed in aggregate terms. Marker and McGraw[6] state:

> A good information system must serve all of the units in the educational structure. Local information is needed in more and more detail at the state level. And it is no longer practicable merely to summarize local statistics into a state report at the end of the fiscal year.

Advantages indicated by those educational systems utilizing some form of integrated computerized information systems include convenience, economy and a high level of report validity. The possibilities for computer simulation of processes become readily apparent as the data base within an information system expands. It is axiomatic that computer processing of data is an integrating process. This integrating effect is expressed by Caffrey[7] as follows:

> But as computers become faster, as time-sharing systems become practical, as intercomputer system integration makes it possible to have a separate satellite that is all one's own part of the time and a feeder to a very large monster another part of the time, and as executive programs provide reliable scheduling and multi-program processing so that both payroll and grade reports can be handled at the same time, the movement is toward the design of centrally planned and managed systems that meet the needs of research, instruction, and administration.

The integrated system concept provides an open-end potential for optimizing information processing in a dynamic management decision-making environment.

An information system design should satisfy more than one level of decision making. The multiplicity of decisions required of the decision maker can be classified generally into three categories as suggested by Burch and Strater.[8] These categories are strategical, tactical, and technical.

The strategical decisions are those which must be made with a significant degree of uncertainty and which affect future conditions. These types of decisions will affect the total organization through the establishment of long-range policies and selection of various strategies for achieving stated goals. The strategical decisions are classified primarily as planning activities exemplified by capital expenditure planning and establishment of new schools.

The tactical decisions are characterized by a combination of planning and controlling activities. The applicable time frame is short range with major emphasis on resource allocation to achieve given objectives. Tactical decisions impact on personnel problems, budgeting, and school plant layout.

The technical decisions are those characterized primarily by a control function. The focus of technical decision making is explicit specification of activities assuring optimum achievement of immediate goals. Technical decisions affect assignment of personnel, scheduling of classes and other similar activities.

The information system model must satisfy all three categories of decision making (i.e., strategical, tactical and technical). The degree of satisfaction will vary but, generally stated, the technical decisions can be facilitated by the information system output alone. The tactical and strategical decisions will utilize the information system data base as an input to various management science techniques (e.g., simulation models, queuing theory models and linear programming models). The information in Table I indicates the relationship between the categories of decision making and various information classifications. The classification of information includes information source and information time-frame designations.

The methods or approaches utilized in designing information systems models are classified according to Burch and Strater[9] as (1) the management science method utilizing models for determination of optimum outcomes, (2) the filtering method utilizing a predetermined select criteria for producing information, (3) the interrogative method utilizing specific system inquiry/response interaction by the user, (4) the exception method utilizing the concept of reporting only deviations from predetermined norms, and (5) the external method utilizing extra-organizational sources for information gathering and dissemination. These methods are not mutually exclusive and the mix of methods used in the information system design will vary depending on the organizational

TABLE I

CLASSIFICATION OF INFORMATION WHICH MEETS THE REQUIREMENTS OF THE THREE CATEGORIES OF DECISION MAKING

| Classification of Information | Categories of Decision Making | | |
| --- | --- | --- | --- |
| | Technical | Tactical | Strategical |
| Dependence on External Information | Very Low | Moderate | Very High |
| Dependence on Internal Information | Very High | High | Moderate |
| Information Online | Very High | High | Moderate |
| Information in Real Time | Very High | Very High | Very High |
| Information Reported Periodically | Very High | Very High | Very High |
| Information that is Descriptive-Historical in Nature | High | High | Low |
| Information that is Performance-Current in Nature | Very High | High | Moderate |
| Information that is Predictive-Future in Nature | Low | High | Very High |
| Information that is Simulated-What If in Nature | Low | High | Very High |

SOURCE: John G. Burch and Felix R. Strater, "Tailoring the Information System," Journal of Systems Management, Vol. 24, No. 2, (February, 1973), p. 37.

decision making environment. The increasingly complex administrative problems caused by accountability, reduced government spending efforts, and arbitration emphasize the need for supplementing the decision-making process with the mass data manipulation capabilities of computer systems.

## Need for the Study

The Oklahoma State Department of Vocational and Technical Education is not currently utilizing the full potential available from a computerized information system based on an integrated system concept. The fragmented approach currently in use can result in multiple regeneration of already existing information. The periodic non-availability of information from this fragmented approach can have a negative impact on the management decision-making process. The need for the study is emphasized by the magnitude of the elements impinging on the decision-making process within the Oklahoma State Department of Vocational and Technical Education.

Approximately 108,000 students are enrolled each year in vocational and technical education courses instructed by 1,900 teachers in the state of Oklahoma. Courses are offered in 435 high schools, 11 junior colleges, 15 area vocational-technical schools and 5 skill centers.[10] Supervision of these courses is achieved through a district and state supervisor hierarchy divided into districts with headquarters in Stillwater, Oklahoma. The annual operating budget of $27,569,000[11] is utilized by the seven training divisions plus Administration, Research, Finance and support functions (Curriculum Development, Purchasing, and Special Services) with a combined staff of 245. In addition to the reporting system for on-going department operation, special reporting requirements must be fulfilled for state offices and the U.S. Office of Education.

## Purpose of the Study

The purpose of the study was to develop a computerized information system model for decision making for the Oklahoma State Department of Vocational and Technical Education. The model was developed from the analysis of current information requirements for managerial decision making, a review of literature and personal interviews with critical decision-making levels of management. The information system model more effectively and efficiently meets both the current and projected information requirements for managerial decision making within the State Department. The model provides a capability for packaging data in various combinations to realize minimum management reaction time for critical decision making.

## Scope of the Study

The current Oklahoma State Department of Vocational and Technical Education information system was analyzed with special emphasis on managerial decision-making information. Managerial decision-making information as defined within the context of this study is that information utilized by top administrators (e.g., Director, Deputy Director, Division Heads) having final authority for personnel changes, budget modifications, and capital expenditures for planning, organizing, and controlling the activities of the respective organizational elements. Information requirements for internal departmental planning and control and for external state and federal agency needs were analyzed. Current operating computer systems were analyzed for determination of intersystem compatibility and information processing capabilities. Information requirements for both current and projected managerial decision making were included. This study develops the model parameters and is not concerned with operation or detail specification of system elements (e.g., field sizes, report formats).

## Assumptions

The following assumptions are applicable to this study:

1. Managers within the current decision-making framework of the State Department of Vocational and Technical Education are aware of current information needs and can project short-range modifications which may result from a changing decision-making environment.
2. The decision-making processes of the Oklahoma State Department of Vocational and Technical Education are similar to corresponding activities in other states and other educational systems.
3. A common data base can be determined which will facilitate decision making at various managerial levels within a formal organization.

## Methodology

A review of literature was completed to provide a background of current and planned efforts in the area of computerized information systems for management decision making. Personal interviews were conducted with State Department managerial personnel to determine existing information needs and to project future information needs. (See Appendix for interview schedule.) The computerized information system model was developed from a composite analysis of the management interviews plus literature reviews and the researcher's background and personal experience in computer systems design.

## Objectives

Objectives for the study will be to:

1. Identify present and projected information requirements of the various departmental components within the Oklahoma State Department of Vocational and Technical Education.
2. Design a computerized information system model utilizing an integrated systems concept which will efficiently and effectively satisfy current and projected information requirements. The model will not be operationalized or totally specified within the scope of this study.
3. Incorporate a flexibility into the design which will reasonably assure changes in the decision-making criteria can be accommodated with minimum dysfunctional impact to the on-going system.

## Glossary

Batch--An aggregation of data in the form of vouchers, load-sheets, etc. that represents the activity for a given time frame (e.g., day, week, month).

Boolean Logic--A symbolic method of stating a problem in terms of logical and, or and not decisions (e.g., find all records with N in Field A and R in Field B or with X in Field C and Y in Field D).

Core--Central or immediate access storage of a computer system. (Core size is variable, contingent on cost and application constraints.)

Debugging--A series of activities completed by a programmer to assure a written computer program will execute instructions to yield a specified result.

General Purpose File Management System--A software package designed for the purpose of accessing and modifying computer processed information with minimum user orientation. This type system reflects minimum emphasis on hardware efficiency and maximum emphasis on user and information effectiveness variables.

Gross Value Entry--A transaction which reflects the total original value of an item.

Hardware--Physical units of computing equipment.

Implementing--A process of incorporating a new system or procedure into the on-going operation. The implementation phase of a project requires extensive coordination between systems design personnel, programmers and actual users of the system or procedure.

K--A computer short-form notation for one-thousand character positions of computer storage.

Locator File Process--A computer process utilizing key information in the transaction entering the system to locate additional descriptive coding maintained within the system. The additional coding is inserted into an expanded transaction record which facilitates reporting flexibility with minimum resource commitment.

Model--A structural representation of an actual or theoretical process or processes to be used for analysis, design or explanation.

Net-Out Entry--A transaction which reflects the difference between the total original value of an item and the current value to be reflected in the State Department of Vocational and Technical Education records for operating purposes.

Program--A set of instructions written for execution of computer processes for specified data.

Software--All instruction oriented communications media usable within the computer hardware (e.g., COBOL, FORTRAN, MARK IV).

Source Document--Any document which is used as an origin for data entering the system.

Storage--Any device with a retention capability for computer oriented activity (e.g., core, tape, disk).

Subsystem--A logically delineated subdivision of a larger system. Subsystems of a larger system will reflect some degree of commonality in data processed.

System--A network or series of programs and/or processes directly related to the logical execution of a recognized organizational activity.

Voucher--An aggregation of source documents identified by a common number for all items and a unique page number for each document within the aggregation.

## Organization of the Report

This beginning framework establishes the modus operandi for the study of information systems, vocational and technical education decision-making processes and computer technology assistance to vocational and technical education decision making. Chapter II, Review of Literature, provides a profile of contemporary concepts applicable to computerized educational information systems. Chapter III, Design Approach, establishes the framework for developing the model including a synthesis of managerial decision-making rationale, recapitulation of current computerized information systems in the Oklahoma State Department of Vocational and Technical Education, and consideration of critical computer oriented data processing techniques. Chapter IV formulates the computerized information system model via integration of completed research. The conclusions reflected in Chapter V are the result of observations and research conducted during the study.

FOOTNOTES

[1]John I. Goodlad, et al., *Computers and Information Systems in Education* (Saddle Brook, New Jersey, 1966), p. 27.

[2]Ibid., pp. 27-28.

[3]Arthur L. Korotkin, et al., *A Survey of Computing Activities in Secondary Schools* (Silver Springs, Maryland, 1970), ED 047 500.

[4]American Data Processing, Inc., *Computers in Education--Their Use and Cost* (Detroit, Michigan, 1970).

[5]John I. Goodlad, pp. 28-29.

[6]Robert W. Marker and Peter P. McGraw, "Gaps in Educational Information Systems," *The Computer in American Education*, eds. Don D. Bushnell and Dwight W. Allen (New York, 1967), p. 198.

[7]John Caffrey, "Computer in Higher Education," *The Computer in American Education*, eds. Don D. Bushnell and Dwight W. Allen (New York, 1967), p. 219.

[8]John R. Burch and Felix R. Strater, "Tailoring the Information System," *Journal of Systems Management*, Vol. 24, No. 2 (February, 1973), pp. 34-38.

[9]Ibid., pp. 35-38.

[10]*Annual Descriptive Report, 1971-72*, (Stillwater, Oklahoma, 1972).

[11]*OE Form 3131*, (Stillwater, Oklahoma, 1972).

## CHAPTER II

## REVIEW OF LITERATURE

The literature applicable to educational decision-making, information systems and computerized information systems is extensive. This literature review is a representative sampling of contemporary philosophy categorized into major concentration areas including Systems Analysis Implications for Decision Making, Modeling Techniques for Decision Making, Student Services Systems, General Purpose File Management Systems, and Evaluation of Computer System Components.

### Systems Analysis Implications for Decision Making

A generalized organization theory has been derived from Thompson[1] to establish a genesis for problem approach. The subject of organization theory is evaluated by Thompson through the use of a framework which integrates several independent approaches into an interdisciplinary model. The concepts impinging on the study of complex organizations are analyzed in propositional form. Open system theory of organizations is the primary assumption of the Thompson text as the author evaluates the technical, managerial, and institutional levels of responsibility and control. Technical and organizational norms of rationality are investigated as well as the behavioral characteristics of organization members. Some universal characteristics of organizations are recognized as (1) generalized uncertainty, (2) contingency, and (3) interdependence of components. Thompson's primary objectives are to encourage study of organizations "in total" utilizing open system theory and the certainty/uncertainty dimension.

A general overview of the existing status of computerized information systems in education by James S. Coleman and Nancy Karweit[2] indicates current systems are primarily concerned with scheduling, attendance reporting, grade reporting, standardized testing and career and college counseling and master file maintenance. The authors suggest these types of data can provide a basis for implementing an information system for multi-level decisions via a model similar to Figure 1. The major problems Coleman and Karweit address with this model are:[3]

1. Problems of location, arising from differences between the locus at which data are generated, the locus at which the file is maintained, and the locus at which information is needed for decisions.
2. Problems of control of and access to the information.
3. Problems of comparability of data from different schools or different school districts.
4. Problems of incomplete information: data not ordinarily obtained or filed for administration purposes, but necessary for decisions of various types.
5. Problems of information aggregation, analysis, and presentation.

The basic concept of the system is that files are interactive with controlled access in certain cases and updating completed by the system at the point of original data entry. Types of information include: (1) student performance data, (2) teacher information, (3) curriculum, (4) class size, (5) equipment available, and (6) expenditure data.

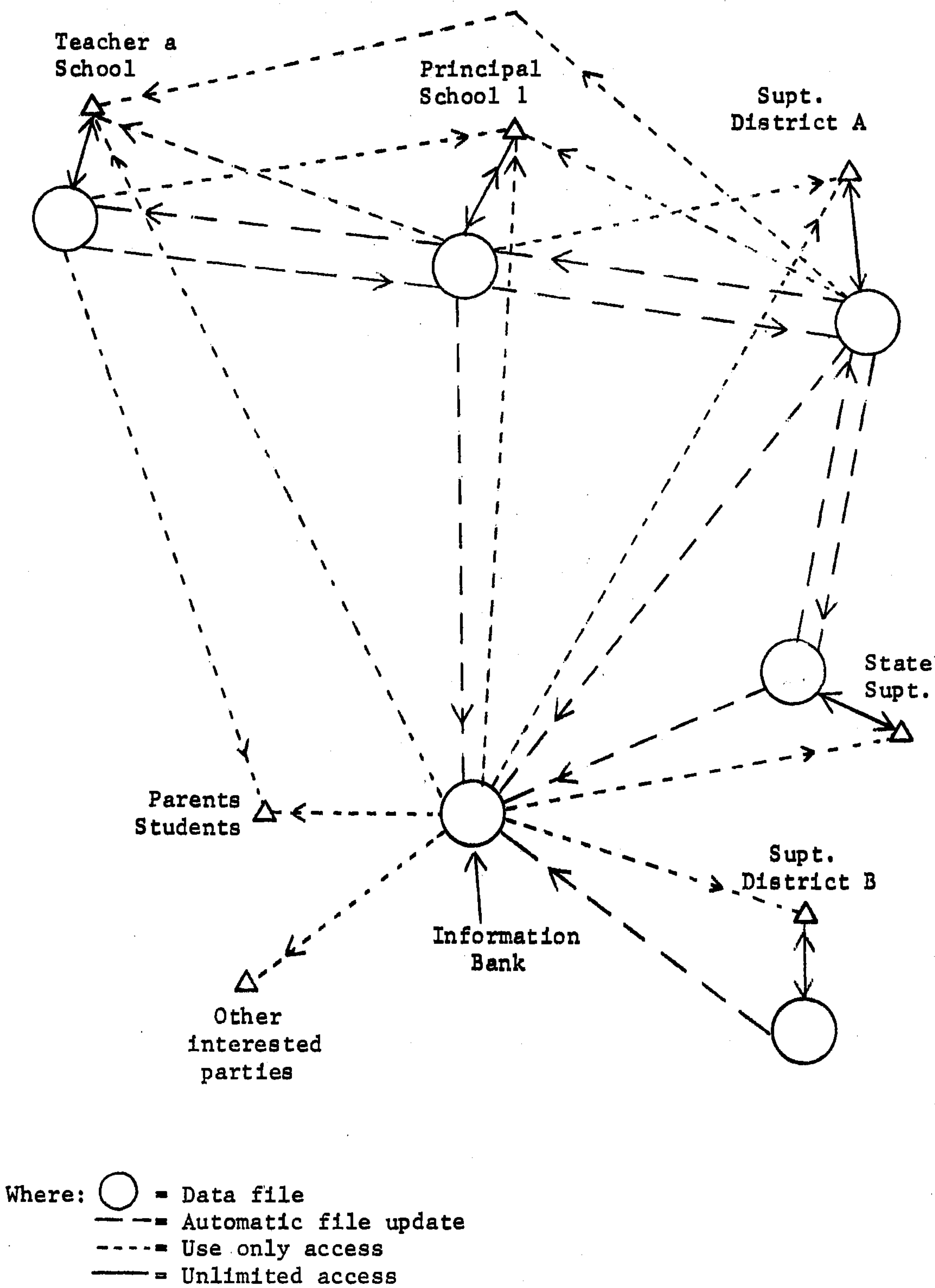



Figure 1. Communication Flow

The function of "Educational Information-Banker" as proposed by Coleman and Karweit would be to:[4]

1. Create the design for an information system which receives information from various sources, processes the information in appropriate ways, and provides output information to interested parties.
2. Assist in the design of any satellite data systems, as in individual school districts or even schools, to insure compatibility with, and automatic inputs to, the information bank.
3. Monitor inputs to the information bank from each source, to insure quality and quantity of information.
4. Maintain necessary information bank or files, with security against illegitimate access.
5. Provide to each of the interested parties that information to which it has legitimate access, after processing to make it relevant to the decisions of that party.

The authors have emphasized two essential elements in computerized information systems design as:[5]

1. Data on each variable must be maintained at levels of disaggregation far below the level to which aggregation is desired, often at the level of the individual student, whose performance and educational environment are recorded; and
2. Aggregation must be carried out by joint use of more than one variable.

The design of rational information systems is reviewed by David J. Werner[6] with a proposal for using a combined decision-oriented approach for designing management information systems and systems analysis methodology for actual design effort. In addition to identification of relevant variables impinging on the decision-making process, Werner[7] suggests additional attributes of information for decision making include (1) a time dimension comprised of when decisions are made and elapsed time for actually making the decision, (2) a location specification identifying the point or points at which information must be available for decision-making, and (3) a specificity dimension indicating the degree of information exactness needed for decision making (e.g., normal or abnormal may be adequate rather than a percentage calculation calculated to six decimals of accuracy). A design effort utilizing a composite decision-oriented-systems analysis approach will improve the potential for designing a rational and effective information system.

Some writers in the field of education have been critical of the efforts made to utilize electronic data processing for educational information needs. Some of these writers, Goodlad, O'Toole and Tyler,[8] indicate there is no need for further research into the potential for utilizing automated procedures in educational information processing because the applicability is well established. Another conclusion is that the field of education is still primitive in its use of EDP for large volume common processing applications (e.g., personnel, budgeting, and general accounting) which have been successfully implemented by business, industry and the military. A third conclusion refers to the most formidable block to progress of EDP adaptation as the understanding of relationships between interactive variables within the educational environment. This problem can be resolved to some extent by a concentrated effort to develop a comprehensive body of knowledge which will permit users to capitalize on other efforts in specific application areas. A recognized problem stated by Goodlad, et al. which must be addressed is the communication gap between educators and EDP professionals. The authors state some fears exist in the education community that anonymity and dehumanization existing in other areas of society may become prevalent in the field of education as a side effect of the automation process. This publication suggests the high potential areas for research and development of automation in education processes include standardizing nomenclature and definitions, providing system and subsystem compatibility, resolving differences between educational and technological processes and developing models for effecting instructional change.

The systems design activity for a computerized information system should be an integral part of the total organization planning activity and should be concerned with (1) reporting past performance, (2) providing information to satisfy the decision making requirements for daily operations, and (3) providing information to be used in the planning process.[9] Items one and two are normally considered when designing the information system, however, provision for planning information is minimized in most systems design efforts. Planning has been excluded from past information systems design efforts as Clarke states:[10]

> ...the planning process has not been considered an integral part of data base design. In the past this type of system has been classified as an operations research function completely separate from the data processing function. However, many of the O. R. techniques to be effective require an analysis of past data to determine trends, relationships, etc. Lack of this information reduces the impact that modeling can have on planning and problem solving.

In an attempt to answer questions concerning which theories, methods, and processes of decision-making impinge on the success of managers, Greenwood[11] concluded: (1) systems analysis and systems models are basic elements in all decision processes; (2) the primary input to the decision-making process is information and, therefore, there is an inherent need for information systems; (3) environmental and behavioral decision analysis of intermediate decisions is an integral part of the problem solving process; (4) heuristic, symbolic, and syllogistic logic is an integral part of management decision theory; and (5) middle management staff specialists are primarily responsible for designing and implementing computer oriented mathematical models. These conclusions emphasize the need to systematically determine those elements which facilitate the decision-making process of the organization and the need to optimally integrate critical theoretical and pragmatic characteristics into the design of the computerized information system.

The effective application of the systems approach to management systems in education is based on five basic assumptions indicated by Monroe[12] as (1) the purpose of the educational system is to develop the individual's attitudinal, intellectual, emotional, interpersonal, and physical dimensions; (2) all educational systems are amenable to improvement; (3) local and state educational programs are extremely complex activities, (4) current local, state and regional programs operate in a nonsystematic mode; and (5) investment in systems analysis within the educational system would yield a guaranteed return. Monroe[13] states the basis for these assumptions includes (1) an estimated 600 million dollars is lost in personal income and gross national product due to lost earning power of three-quarter million dropouts; (2) none of the 500 education projects attempting to utilize systems analysis and or operations research techniques during a two-year period ending November, 1969, have approached the problem in a comprehensive, wide-scale thorough manner for an entire educational endeavor; (3) educational administration operates too often in a "fire-fighting" mode and in many cases over-reaction to a multiplicity of public pressures rather than developing long-range, comprehensive strategies. The elements of a system design approach suggested by Monroe[14] include system definition, need assessment, need selection, program analysis, program development, program implementation, and program evaluation.

The development of a computerized information system for decision making should utilize a systems approach which is primarily dependent on the systems analysis technique. The subject of systems analysis in education is discussed by Cook, who defines a system as:[15]

> ...a series of interrelated and interdependent parts designed to accomplish a goal or objective. ...A system once identified, can be broken out through a process of disassembly into a series of subsystems or a process of noting the variables making up the system. Once disassembled, we can study the interaction of the various variables through a process of assembly.

These "systems analysis" processes are executed to evaluate component parts and reorganize the system to more effectively achieve specified goals and objectives. One major problem proposed by Cook in the design of education computer systems is the difficulty of quantifying many elements of the educational environment. A positive expression toward the potential for educational computer systems is reflected in his comment:[16]

> The concept of management information systems in business and industry has progressed much further than that in education but we can learn from their experience as we begin to develop and implement such systems.

A concluding salient comment by Cook is:[17]

> ....the input of systems concepts is going to require some adjustment or modification of the training of educational administrators....to gain acceptance of these ideas, it will be important for us to keep in mind the various factors related to resistance in the change process....

The concensus of educational writers concerning computerized information systems is that systems analysis techniques for problem identification and solution design should be utilized.

## Modeling Techniques for Decision Making

The decision making process as it impinges on the evaluation activity of vocational and technical education has been effectively prescribed in a Coster and Morgan publication.[18] Their model utilizing the analysis technique defines the major elements within the evaluation process as individual attributes, society's needs, goals, objectives, operating procedures, resources, and outcomes. The decision maker is responsible for evaluating societal needs and values, individual attributes and values and various regulatory agencies' goals for the purpose of deriving objectives of the evaluation activity. A second major decision making process occurs when the desired objectives are converted into allocation of given operating procedures and resources for optimally realizing desired outcomes. The evaluation activity determines the degree of correlation between stated objectives and actual outcomes. Coster's model[19] emphasizes the need for examining activities for relative contribution to goals and objectives attainment and maintaining flexibility for modifying objectives or reallocating resources and procedures to optimize the input-output mix. The author suggests the application of quantitative analysis to optimize the utility and probability functions for maximizing effectiveness of programs and the decision making process. Recognition of the intangible character of some objectives is incorporated into the calculation of optimum mix. Coster[20] discusses at length the alternative courses of action which will be taken by the "risk taker" and the "non-risk taker" (e.g., low probability of success/high utility if successful and high probability of success/low utility if successful). This basic model has application for the majority of decision making/evaluation processes.

An expanding interest in the modeling technique is becoming apparent in many areas of education. As models are developed the outputs tend to become prescriptive as well as descriptive. This tendency must be recognized and a continuing effort exerted to re-evaluate the factors operable within the model. A model's effectiveness can be evaluated by determination of certain characteristics which LeBaron classifies as:[21]

1. Completeness of the model is essential to avoid lack of relationship of the model to the total system. The model must effectively interface with the man-model elements of the universe if the results are to be applicable to the decision-making process.
2. The model should reflect an operational reality which recognizes the actual variables impinging on the decision-making process and minimizes or ignores non-existent idealistic criteria.
3. The model should be understandable by fully clarifying the inter-relationships between the model and the next larger universe.
4. The model should encourage analysis through questioning basic purposes rather than attempting self-improvement based on traditional assumptions.

5. The model should encourage feedback by responding to information from the operation of the model and from the environment to adjust the model operation for improved goal attainment.

The presence of these characteristics assists in assuring a viable model will result from a systems design effort.

The feasibility of developing heuristic simulation models has been confirmed by various efforts, including models discussed by Dr. Hugh J. Watson[22] involving (1) student applicant screening for the University of Georgia Law School and (2) simulated human decision-making model for processing checks written against insufficient funds. The author concludes:[23]

> ...There are many decision making situations that can, and should be computerized. Many have not been because they are frequently thought to be too loaded with subjective considerations to allow quantification.... Whether the decision maker realizes it or not, he is usually employing a model of some type.

Decisions concerning development of these types of models will obviously be affected by time and economic constraints.

Some operational principles present for successful implementation of a computerized information system should, according to a South Carolina State Department of Education publication,[24] include:

1. Master file storage and maintenance should be strategically located for optimum updating capability.
2. Procedures for data transmission must be incorporated to assure maximum access by decision makers.
3. Diminishing detail should be integral, which refers to the need for increasing levels of summation as higher levels of decision making are exercised.

4. Economy of data collection should be maximally exerted to minimize data capture overlap or duplication.
5. Compatibility efforts should be maximized requiring a uniformity of terminology, definitions, concepts, etc. to facilitate comparisons.
6. Data item selection will be a priority item requiring each data element to have a critical information signficance for educational activity in one or more of the following categories:
   (a) Provide a basis for decision making related to the management and direction of the education enterprise.
   (b) Assist in the performance of regulatory, legislative, and congressional functions;
   (c) Aid in the evaluation of the effectiveness of educational programs;
   (d) Be useful in the teaching-learning process; and/or
   (e) Help inform the public about education.
7. Commitment to the information system at the top administrative levels which is essential for optimum efficiency and effectiveness.
8. Confidentiality of information.

These principles should be operative within the constraints imposed by organizational goals and resource allocations.

## Student Services Systems

Problems which should be considered when designing student oriented information systems are designated by Havens[25] as (1) point of decision for inclusion/exclusion of student data in the data base, (2) validation of information for detection of errors resulting from incorrect information or machine error; and (3) maintaining current status of information in the data base. Havens suggests a "panel of experts" or staff team establish parameters for the student data base and that a yearly check for accuracy of each file be included as part of the on-going operation. Significant benefits have been realized in scheduling, records systems, retrieval, research and simulation of student oriented information, according to Havens, and he indicates the wide range of applications and rapid expansion of computer oriented systems extend highly desirable opportunities to educators.

The advantages of computer assisted counseling have been explored by various projects including The Total Guidance Information Support System (TGISS) at the Bartlesville Public Schools,[26] The Man-Machine Counseling System[27] and The Newton Information System for Vocational Decisions.[28] The Man-Machine Counseling System was concerned with developing an interaction system which would provide information retrieval capabilities concerning health and attendance records, grades, test scores, and teacher comments. Elementary statistical manipulation of data includes frequency counts, means, and variances. A monitoring capability is incorporated to identify students failing to meet requirements; students reflecting changes in achievement pattern, and students who do not take advantage of electives which would provide career exploration. The Cogswell computer model generates various automated reports including report cards, progress reports, and atheletes failing classes. A predictive dimension is included which provides the counselor an option on sample size and dependent and independent variables for purposes of analyzing student success probabilities. This dimension of the system is designed to be an assistance device and not a decision making device per se. Additional features include an automatic reminder capability, follow-up on students who have exited the system and various vocational gaming programs. Gaming programs provide the student an opportunity to interact with the system, via a typewriter console, for guidance concerning vocational information, college planning and special problems (e.g., probability of success in specific courses).

In addition to direct student assistance, research and evaluation information is incorporated into some guidance and counseling models to be used by administrators for planning new programs or modifying existing programs. Types of information for research and evaluation purposes available in the Computerized Vocational Information System discussed by Harris include:[29]

1. Number of times a student makes different decisions about level of education and interest area during his high school career.
2. Number of minor and major discrepency messages given (i.e., degree of congruence between self evaluation and computer determined evaluation of performance capabilities)
3. The result of these messages, i.e., do they cause students to move toward more realistic goals?
4. The last 10 occupations explored in depth by each student. This can be compared with results of 1 and 5 year follow-up studies to see to what degree the system is helping students to choose an occupation.
5. The number of times each occupation is explored by students.
6. The number of times each student uses the system.

This type of information will be supplemented by extra-computer inputs including student and counselor reaction questionnaires, student interviews and short and long-term follow-up studies. A computerized student guidance and counseling system should address not only on-going operation needs of students and counselors, but also provide substantial input to the decision-making process for general administration.

## General Purpose File Management Systems

Inclusion of a file management system as an integral part of the computerized information system is essential for optimum utilization of data, hardware and design and programming staffs. The general purpose file management concept stated by Harvison and Radford[30] should assure "...the applications programs are made independent of the file structures which support them, so that the files can be changed without the necessity of an accompanying change in the systems design."

The resulting subsystem file independence provides a greater flexibility in developing a common data base which will support new types of decision making information. The general purpose file management system can be considered the linkage between operational subsystems and the common data base. Writers Harvison and Radford suggest an evolutionary approach to common data base development with individual subsystems optimumly designed in lieu of total redesign of all subsystems to accommodate a new common data base. The rationale is that total requirement prescription for the common data base design is highly improbable and, therefore, redesign is not feasible.

The increasing interest in general purpose software or general purpose file management systems has been stimulated by a shortage of qualified programmers and the complex architecture of third generation hardware. The concern for compressing the programming time frame is expressed by Sundeen.[31] The majority of computer users are becoming increasingly disturbed by the "programming bottleneck," realizing that the elapsed time to implement a new application by conventional methods is going to be--at best--poor. Such lengthy implementation periods have been a fact of life faced by most users to this point in time, independent of whether the programming language employed was machine language or a high order language. A file management system execution series will include:[32]

A. System control parameters
   1. Processing function (e.g., "UPDATE," "RETRIEVAL")
   2. Dictionary name of file to be processed
   3. Global parameters and housekeeping information
B. The applicable processor is loaded and begins execution, which is usually comprised of three functional phases:
   Phase 1 - Reads the processor dependent parameters (i.e., language statements from the input device, satisfies the dictionary references applicable to the data referenced; validates the input; prints a list of the input including error messages for all invalid inputs.
   Phase 2 - Predicated on valid input, this phase compiles the object program for the function to be performed. The object program compiled is usually of the following types:
      a. Compressed parameter tables
      b. Pure machine language instructions
      c. Subroutine linkage
      d. Source language code to be input to another processor
   Phase 3 - Performs the actual processing of the given data file by:
      a. Table driven interpreters generating the applicable execution
      b. Executing the compiled machine language instructions.

This brief outline provides an orientation to the mechanics and philosophy of general purpose file management systems.

## Evaluation of Computer System Components

An evaluation procedure for the types of computer hardware/ software combinations is outlined by Harold J. Podell.[33] The determination of an optimum computer configuration should be based on present and projected data base size/structure and input/processing/output requirements. General trends noted by Podell indicate:[34]

1. Hardware/Software Control
   (a) lower cost mass storage, peripherals and hardware/ software control
   (b) improved multiprocessing, timesharing, and communication hardware/software capability
2. User Software
   (a) standardized summary software to support off-line processing, e.g., MARK IV and RAPS
   (b) interactive on-line summary languages to support hardware/software communication capability
      (1) standardized off-the-shelf summary software e.g. MARK IV/2 (projected)
      (2) custom summary software

These future trends suggest lower unit costs for processing more data. This situation can result in an increased economy of technological scale for the management information system function. The implicit requirement upon data base design is to prepare now for the anticipated growth and innovation.

Although data base design and hardware/software configuration should be optimum, these elements must be subjected to the constraints imposed by the information system requirements for an optimum decision making environment. Maintenance of perspective is indicated by Podell's statement:[35]

> Within the realities of executive performance measures, data base design for growth must be subordinated to the requirements for effective decision making. The impact of this design criteria is that it is entirely feasible to design for sub-optimum performance at the data base level so that the optimum can be achieved for the overall management information process.

The need for an expanded effort in utilizing objective inputs to decision making is amplified by a survey of thirty vocational and technical local administrators from five states. A stratified random sampling technique completed by David McCracken and Wilma Gillespie[36] concluded, in part, that local administrators generally perceived little need for information for use in problem resolution; that most decision making was completed in the absence of an information search, and that respondents (administrators) first attempted to resolve problems through personal contacts (consultations, visits, and interviews). The major criterion for utilization of print materials was the familiarity or degree of experience the administrator had with the materials and the content quality.

The implications for information dissemination agencies derived by the authors of the study were:[37]

1. In-service education programs need to be provided for local administrators concerning the value of information in problem resolution and the use of information dissemination systems.
2. There is a need for information specialists to act as personal contacts to link information dissemination agencies with practitioners.
3. Information needs to be packaged in a form easily applicable to problem resolution.
4. Information needs to be provided local administrators on their major problems (student and personnel services, curriculum, quality and supply of personnel, program planning, decision-making, community and human relations and facilities).
5. Information needs to be known about, easily used, and trusted by local administrators.

Additional implications from the study for the State Department include:[38]

1. Local administrators rely upon their state department of education for resolution of finance-related problems.
2. States might maintain a list of consultants and their fields of expertise so local administrators might systematically select personal sources of information.

3. States could enhance information utilization by developing linkages of information dissemination systems and practitioners.

The conclusions and implications of the McCracken-Gillespie survey assist the validation of need for a comprehensive information system with which the Oklahoma State Department of Vocational and Technical Education can react to the multiplicity of information needs of both state and local administrators.

## Significance of Literature Review

The literature review has provided additional insights into problems and potential solutions in developing a computerized information system for decision making. Conceptualizations derived from this review will be integrated with additional research discussed in Chapter III to evolve a viable information system model for assistance to decision making in the Oklahoma State Department of Vocational and Technical Education.

## FOOTNOTES

[1]James D. Thompson, Organizations in Action (New York, 1967).

[2]James S. Coleman and Nancy L. Karweit, Information Systems and Performance Measures in Schools (Englewood Cliffs, 1972), p. 67.

[3]Ibid., p. 32.

[4]Ibid., p. 40.

[5]Ibid., p. 50.

[6]David J. Werner, et al., "Designing Rational Systems," Journal of Systems Management (January, 1973), pp. 34-39.

[7]Ibid., p. 39.

[8]John I. Goodlad, John F. O'Toole, Jr. and Louise L. Tyler, Computers and Information Systems in Education (New York, 1966).

[9]Lawrence J. Clarke, "Why Plan for Systems Development?" Journal of Systems Management (June, 1971), pp. 8-11.

[10]Ibid., p. 11.

[11]William T. Greenwood, Decision Theory and Information Systems (Cincinnati, 1969).

[12]Bruce Monroe, Modifying Existing Management Systems for Use in Educational Agencies or How to Eat an Elephant (Seal Beach, California, 1969), ED 035 994.

[13]Ibid., pp. 2-3.

[14]Ibid., p. 9.

[15]Desmond L. Cook, The Impact of Systems Analysis on Education (Columbus, 1968), p. 243.

[16]Ibid., p. 7.

[17]Ibid., p. 15.

[18]John K. Coster and Robert L. Morgan, The Role of Evaluation in the Decision Making Process (Raleigh, 1969).

[19]John K. Coster and Robert L. Morgan, p. 12.

[20]Ibid., pp. 15-20.

[21]Walt LeBaron, Techniques for Development of an Elementary Teacher Education Model. A Short Review of Models, Systems Analysis, and Learning Systems (Falls Church, Virginia, 1969).

[22]Hugh H. Watson, "Simulating Human Decision-Making," Journal of Systems Management (May, 1973), pp. 24-27.

[23]Ibid., p. 27.

[24]South Carolina State Department of Education, Planning Design for Basic Educational Data Systems (Columbia, 1969).

[25]Robert I. Havens, Computer Applications in Guidance and Counseling (Oshkosh, Wisconsin, 1969).

[26]Tommy L. Roberts, et al., The Bartlesville System: Total Guidance Information Support System, (Washington, D.C., 1970).

[27]J. F. Cogswell and Others, Exploratory Study of Information-Processing Procedures and Computer Based Technology in Vocational Counseling. Final Report (Santa Monica, 1967).

[28]Ibid., p. 13.

[29]Jo Ann Harris, Summary of a Project for Computerized Vocational Information Being Developed at Willowbrook High School (Villa Park, Illinois, 1970).

[30]C. W. Harvison and K. J. Radford, "Creating a Common Data Base," Journal of Systems Management (June, 1972), p. 10.

[31]Donald H. Sundeen, "General Purpose Software," Datamation (January, 1968), p. 22.

[32]Ibid., pp. 24-25.

[33]Harold J. Podell, Developing the Common Data Base for Management Information Systems, VI, Designing a Data Base for Growth (Bethesda, Maryland, 1969).

[34]Ibid., pp. F4-F5.

[35]Ibid., p. F3.

[36]David McCracken and Wilma Gillespie, Information Needs of Local Administrators of Vocational Education (Columbus, 1973), pp. 53-54.

[37]Ibid., p. 55.

[38]Ibid., p. 55.

# CHAPTER III

# DESIGN APPROACH

## Introduction

This chapter analyzes the critical elements impinging on the design of the information system model. A significant element in the design approach is an analysis of the current computerized information systems operating within the State Department of Vocational and Technical Education to determine the extent current information needs are being satisfied. The methods of system information access are evaluated to assure an optimum user/information system interface. The subsystems of the information system are reviewed in this chapter to establish the rationale for Chapter IV.

The design approach is concerned with utilization of locator files for transaction coding expansion. In some cases the location of a school indicates the applicable economic region, state congressional district, and U.S. congressional district. These types of supplemental coding can be added to the system files by computer, minimizing data entry efforts and error potential.

An effective information system design approach must include three basic elements according to Churchill.[1]

> In examining the differences between apparently successful and unsuccessful approaches to these more advanced systems, three requirements were isolated:
> a. A good information system or information base upon which to build a data base.

b. A system staff that understands the management aspects of the problems being studied and an involved management that understands something of the computer and the systems approach--a management base.
c. Sufficient highly placed executive support to help cross organizational boundaries, to restructure activities where needed, and to overcome natural resistance to change--top-level management support.

The information system or information base requires at least a minimum configuration of computer hardware, software and experience with applications which will comprise the base for developing the information system. The personnel involved must have an appreciation of integrated systems and the need for good data collection systems and also some first hand knowledge of the Departmental operation.

The management base is comprised of two interacting groups: (1) computer trained personnel who have some knowledge about management processes, decision making, information needs of management and the ability of the computer to facilitate these functions; and (2) management personnel who have some knowledge of computer capabilities and can effectively work with computer trained personnel and systems concepts. This combination of personnel characteristics will minimize the communication gap between the computer processes and the users of computer processes.

The top-level management support base is essential for the following reasons: (1) secondary level managers are naturally less interested in activities that do not have the interest or support of superiors, (2) the resources involved in computer efforts are of a high order of magnitude and, therefore, require top management consideration, and (3) top level support is necessary to effectively develop integrated systems which cross existing organizational boundaries. Effective systems design cannot take place in a managerial vacuum.

The State Department of Vocational and Technical Education utilizes more than one source of computing hardware, software, and systems design and programming support (Figure 2), including access to "owned" computing equipment located in Oklahoma City and a programming support staff located at the Stillwater Complex. Additional programming support can be arranged through the Data Center at Oklahoma City or by contract with individuals working at Oklahoma State University. Computer time is also available at Oklahoma State University on a "rate per hour" basis. The information system currently in operation within the State Department of Vocational and Technical Education utilizes computer application for selected processes. The systems now operating and their inter-relationships are shown in Figure 3.

## Current Systems

A brief discussion of each system or subsystem follows.

### Finance Division

Claims Subsystem. The subsystem validates claim and encumbrance data. Processes include: (1) preparation of the monthly claim register, (2) preparation of the monthly division ledger, (3) update of the master file of claims paid for each fiscal year, and (4) preparation of the yearly division ledger. Output of this subsystem is used as input to the encumbrance subsystem.

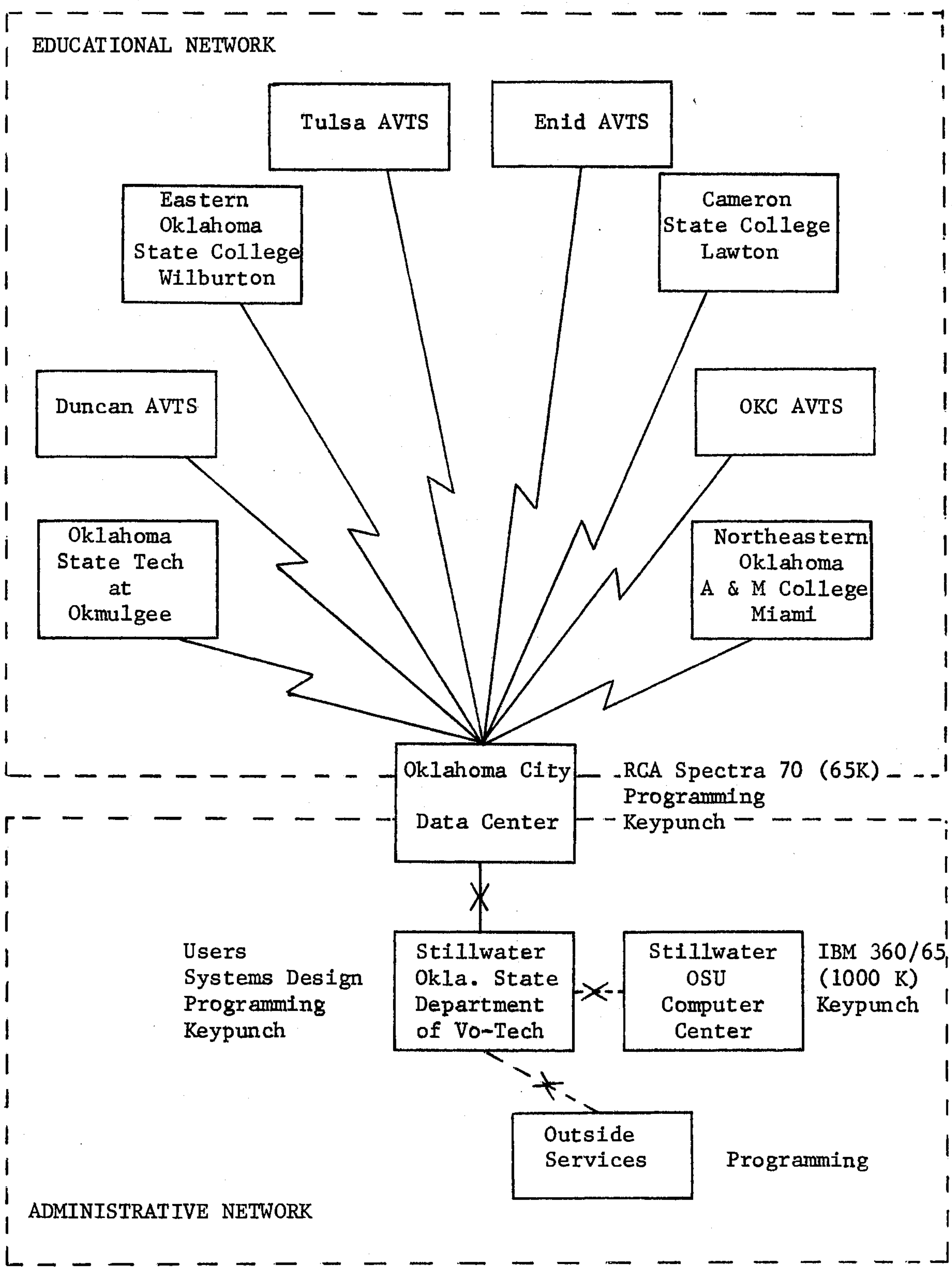



Figure 2. Computer Facilities and Services

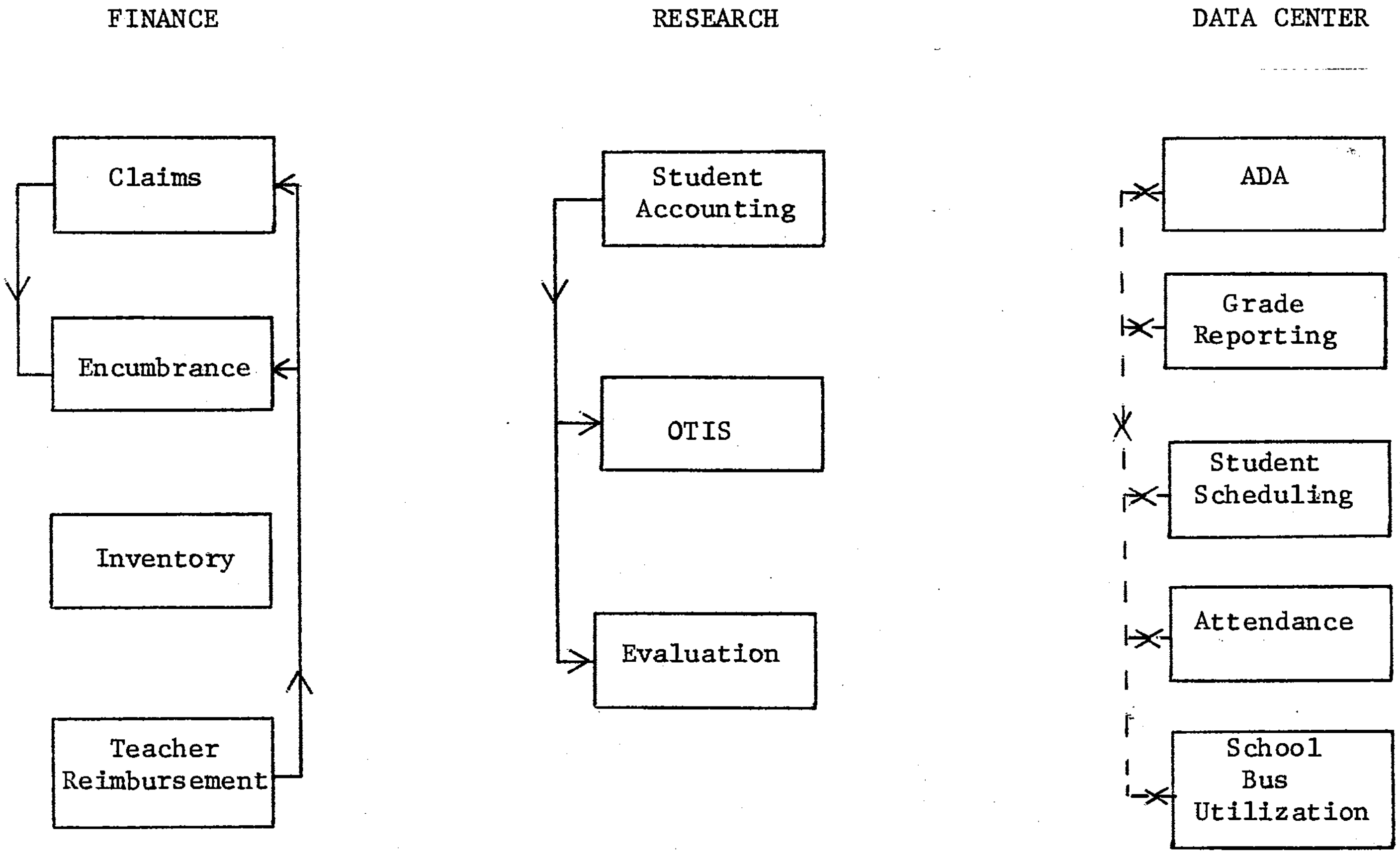



Figure 3. Current Systems and Applications

Encumbrance Subsystem. The subsystem utilizes budget data, claims data, and encumbrance data to report the amount of funds not yet obligated. The claim and encumbrance data are validated and processed for the monthly encumbrance register. The encumbrance data are processed to update the various fiscal year claim master files and encumbrance master files. Checks are made for duplicate purchase order records and duplicates are combined. The outstanding encumbrance register is printed and budget fund totals are accumulated for preparation of the encumbrance register. The budget summary for both fiscal years is prepared as the final report of this system.

Teacher Reimbursement System. This system calculates funds for teacher reimbursement using a weighted system approach. A weighted index for manpower needs, dropout and disadvantaged needs, and the ability to pay are then calculated to determine the percentage of Federal and state funds to be paid each school. Payments are then validated and reimbursement information is presented in school, division, and county report formats. The "Claims for Teacher's Salary Reimbursement," used for Federal reimbursement and state reimbursement is prepared as the final report of this system.

Inventory Application. This application provides a listing of all equipment owned and/or being purchased by the State Department of Vocational and Technical Education. An inventory list is also provided by school and by program. Equipment totals by course, division, and school site are produced.

Research Division

OTIS--Occupational Training Information System. The system utilizes information from the student accounting system and outside sources (private schools, MDTA, Employment Security Commission, etc.) to produce detailed net manpower needs reports by occupational clusters on a regional and statewide basis.

Student Accounting System. The system creates the data base used for student oriented reporting and decision making within the State Department of Vocational and Technical Education and student reporting to outside agencies. Types of information in the data base include: (1) name, (2) social security number, (3) occupational objective, (4) class, (5) school, (6) sex, (7) age, (8) grade level, (9) race, (10) economic disadvantage, (11) other disadvantage, (12) course completion, and (13) one-, two-, and three-year follow-up. Information is provided by the student and by the instructor via enrollment forms, completion reports, and follow-up reports.

Evaluation System. The system processes data gathered from multiple sources including evaluation team on-site visits, teachers, administrators, and student follow-up from the Student Accounting System. Generated reports include comparisons of individual programs and student objectives with similar school categories and statewide accumulations. Teacher/program retention calculations and product index calculations reflecting program impact on students are significant elements of the system.

Data Center

These systems are designed to provide information support services for high schools and junior high schools throughout the state and provide information for the Oklahoma State Department of Education.

ADA (Average Daily Attendance) Subsystem. The subsystem produces statistics for the individual school and the State Department of Education on average daily attendance.

Grade Reporting Subsystem. The subsystem generates nine weeks semester grade reports for the student, permanent school records, canceled records, and permanent transcript labels.

Student Scheduling Subsystem. The subsystem produces student semester schedules, class roles, enrollment cards, room utilization, and teacher utilization reports.

Attendance Subsystem. The subsystem provides an attendance register for each class in a particular school. A complete analysis of attendance records is provided each week, each nine weeks, and each semester.

School Bus Utilization Subsystem. The subsystem utilizes data from the attendance subsystem to identify student location and facilitate transportation efficiency.

## Systems Information Access Methods

A computerized information system design effort must consider optimum system information access methods. Two general methods of information access and manipulation are (1) specific programming for specific system processes and (2) general purpose file management with high level flexibility. Each method fulfills a specific requirement when optimally applied. "Specific programming" is more efficient from an operation cost standpoint if processes are highly complex and repetitive in nature (e.g., daily, weekly, monthly processes). The "specific programming" method of system information access and manipulation involves a high relative one-time cost for programming, debugging, and implementing; however, lower relative operating costs will provide for acceptable recovery of investment rates.

Management decision making may require manipulation of data in the information system on a non-recurring basis. Cost, time, and/or manpower constraints associated with the "specific program" method may restrict response to "one-shot" type information requests. Therefore, in addition to "specific programmed" outputs and file manipulation capability, an access provision should be incorporated into the system design for general purpose file management which will facilitate non-programmer trained personnel to interact with the system for inquiry and maintenance purposes. This type file management capability must be adaptable to the needs and orientation of clerical, administrative, and management personnel.

An effective general purpose file management system should include the following capabilities.[2]

1. Extract selected items of data from multiple files utilizing Boolean logic.
2. Resequence extracted data.
3. Compute subtotals, totals, averages and perform other data manipulations.
4. Generate reports of high utility.
5. Generate new files for the system.

6. Modify existing files in the system.

The general purpose file management system must be capable of processing files generated by COBOL (the programming language used to produce the current information system in the State Department of Vocational and Technical Education) and should have capacity to search both sequential tape or disk files and random (direct addressing) disk files. Files created by the general purpose file management system must have process compatibility with "specific programs" (e.g., COBOL written programs). This flexibility assures system access compatibility between the two access methods.

Examples of general purpose file management systems with the prescribed characteristics are Informatics Inc. MARK IV and IBM IMS/360. Manufacturers estimate that training time of non-programmer personnel will be approximately three days. This estimate compares with three to six months minimum training for a COBOL programmer.

The general purpose file management systems require between 32K and 64K bytes of memory, which would necessitate utilization of a relatively large computer system for processing.

The advantages of reduced programming time and minimum training required to use this general purpose system is highly significant for the Oklahoma State Department of Vocational and Technical Education which has a relatively high level of one-time information requests and a very limited programming staff.

## Conclusions Derived From Interviews With Decision Makers

A personal interview technique was used to determine information needs of top decision makers within the Oklahoma State Department of Vocational and Technical Education (See Appendix). The results of these interviews indicate a definite need for exception reporting capabilities with flexibility for "one-time" information requests. The interview results have been synthesized by major area as follows.

### Financial Data

In addition to "normal" control type information represented by cash status, budget comparisons, expediture accumulations, claims summaries, and encumbrance summaries, additional decision-making information could be provided by:

1. Reporting on an exception basis the status of various fund accounts and indicating critical lead time to assure non-loss of funds due to mandatory expiration dates.
2. Reporting on an exception basis any major deviations from predetermined fund flow profiles (e.g., notation of a fund totally expended in two months with a projected profile of uniform expenditure over a 12 month period).
3. Determining the impact of appropriation changes on various classifications of expenses. This option should have the capability to specify total change in dollars or percent and percentage mix between classifications.

4. Reporting on an exception basis those items of equipment requiring replacement based on budget and lead-time constraints.
5. Special request reporting through utilization of a general purpose file management system (e.g., how many lathes are located in area schools and what is replacement rate anticipated?).
6. Preparation of an overhead and operating expense report by line item (e.g., salaries, office supplies, telephone) by month for a six-month period and cumulative year-to-date expenses.
7. Reporting of aged accounts receivable for sale of curriculum material and excess property transportation and storage costs.

Student Data

A substantial student data base exists within the State Department of Vocational and Technical Education concerning enrollment, completion, followup and economic and academic disadvantaged information. The primary interest expressed concerned faster access to "one-time" information requests. A general purpose file management system would effectively address this problem.

Various methods are currently used to isolate shifts in student placement, performance, etc. An exception report which would isolate specific shifts in enrollment from period to period could be used by decision makers to direct efforts for program modification or other corrective action.

A training cost per student calculation capability should be provided for various aggregations. This particular option could be accommodated by the general purpose file management system.

Personnel Data

Administration of Education Professions Development Act (EPDA) programs and general personnel administration are concerned with maintaining a high level of professional competency. A reporting capability to reflect upgrading efforts for teachers would assist in planning additional training activities or modifying existing training programs.

Budgetary constraints would require an analytical capability for evaluating alternative courses of action impinging on salary adjustments. Evaluation of "hire/don't hire" options contingent on normal attrition rates and specific age distributions of personnel would assist decision making by optimizing staffing and related costs.

## Summary

The design approach for development of the computerized information system model reflects a pragmatic application of systems analysis to the current and projected information needs of the Oklahoma State Department of Vocational and Technical Education decision makers. The need assessment was derived from personal interviews with decision makers, a comprehensive review of on-going information systems within the State Department of Vocational and Technical Education and trends in information processing techniques derived from a literature review. The researcher combined determined information needs with computer technology and actual experience with computer systems to derive a viable information system model for decision making. The computerized information system model components resulting from this study are introduced in Chapter IV.

# FOOTNOTES

[1]Lawrence J. Clarke, "Why Plan for Systems Development?" Journal of Systems Management (June, 1971), pp. 8-11.

[2]Systems Design Division, "Working Papers," Central Computer Department (Ponca City, Oklahoma, 1968).

## CHAPTER IV

## THE COMPUTERIZED INFORMATION SYSTEM MODEL

### Introduction

A computerized management information system for decision making in the Oklahoma State Department of Vocational and Technical Education must be responsive to the multiplicity of constraints imposed by available resources, governmental regulations, society demands, administrative requirements and student needs. Information needs for the three levels of decision making (i.e., strategical, tactical, and technical) to interface with the designated constraints are identified by the Computerized Information System Model (Figure 4). The model recognizes the necessity for satellite systems or subsystems for major departmental activities (e.g., student data, financial data, and personnel data). These major functional areas will be designed for optimum "stand alone" and subsystem interactive operation.

The "stand alone" capability will be primarily applicable to technical and tactical types of decision making. Special purpose subsystems (e.g., linear programming and evaluation) will be implemented on an "as required" basis and will utilize the common data base or the subsystem data bases via the general purpose file management access method. Those data having utility in multiple subsystems will be maintained in the common data base through which individual subsystem file updating

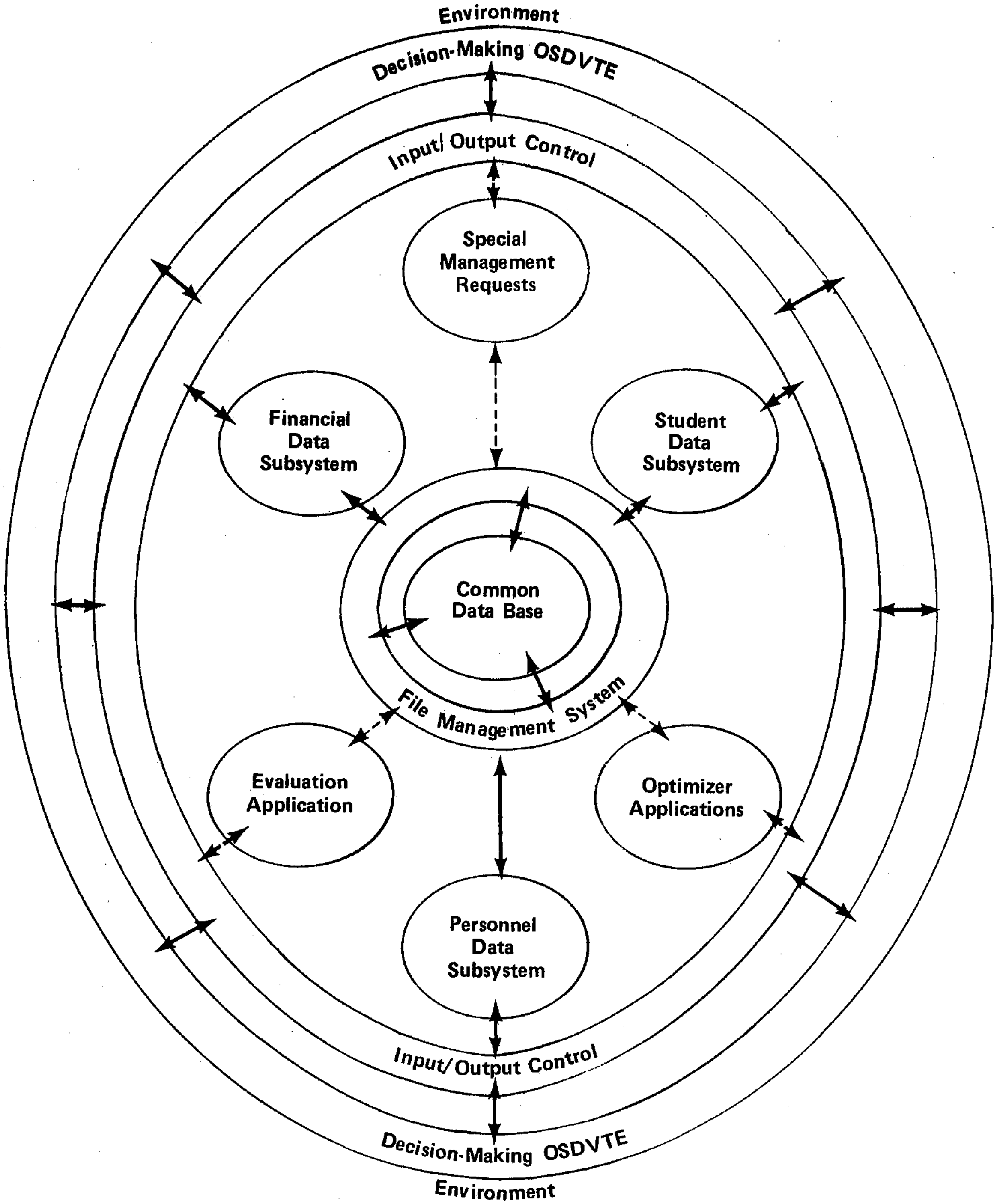



Figure 4. The Computerized Information System Model

will be completed. The personnel data subsystem exemplifies the strategical decision making capabilities of computer simulation.

Within the common data base update procedure a logic provision will be incorporated for utilizing locator files for coding expansion to minimize data capture effort (e.g., a school code identification will automatically determine economic region, U.S. congressional district, and Oklahoma congressional district with the appropriate coding entered into an expanded record by computer processing).

The Computerized Information System Model major components include the Financial Data Subsystem, Student Data Subsystem and the Personnel Data and Behavioral Forecasting Subsystem. These subsystems and other model components will be addressed in this chapter.

## Financial Data Subsystem

### General Accounting

An evaluation of the current accounting system at the State Department of Vocational and Technical Education, interviews with State Department decision-makers and study of other organizations' accounting procedures indicate major modifications in manual and computer processing can yield a significant benefit to decision-making, reporting and control procedures. An annualized magnitude of operation derived from Finance Division records indicates:

| | |
|---|---|
| Claims processed | 14,400 |
| Accounting entries | 24,000 |
| Equipment items purchased | 6,000 |
| Encumbrances | 12,000 |

| | |
|---|---|
| Budget categories | 2,000 |
| Computer print lines-reports | 500,000 |

Currently the Finance Division utilizes a manual single entry accounting system supplemented by computer processing for post closing control. A single entry system has inherent control problems and restricts the capability for efficiently and effectively preparing a trial balance, balance sheet and other management control statements. Processing and reporting flexibility loss results partially from utilization of computer facilities at a remote location. A daily processing of financial data is not feasible within current cost constraints (i.e., (1) daily transportation and wait time between Oklahoma City and Stillwater, (2) feasibility of telecommunication service between Oklahoma City and Stillwater).

The document flow within a revised double entry accounting system for each of the three major processing activities, (1) general accounting, (2) excess property, and (3) purchased equipment (100% and joint) is presented in Figures 5, 6, and 7. Implementing a double-entry computerized accounting system as a module of the Computerized Information System Model requires modification in the Finance section handling of all transactions reflecting value changes. Revenue activity (as exemplified by Letter of Credit approval, any cash pool changes) for computer processing should be submitted to the system through debit/credit entries in miscellaneous vouchers. These types of entries to the system will provide a necessary audit control function for revenue accounting and will also provide a basis for reacting to special management requests for revenue flow information, fund status, exception reports for time frame analysis, and unexpended

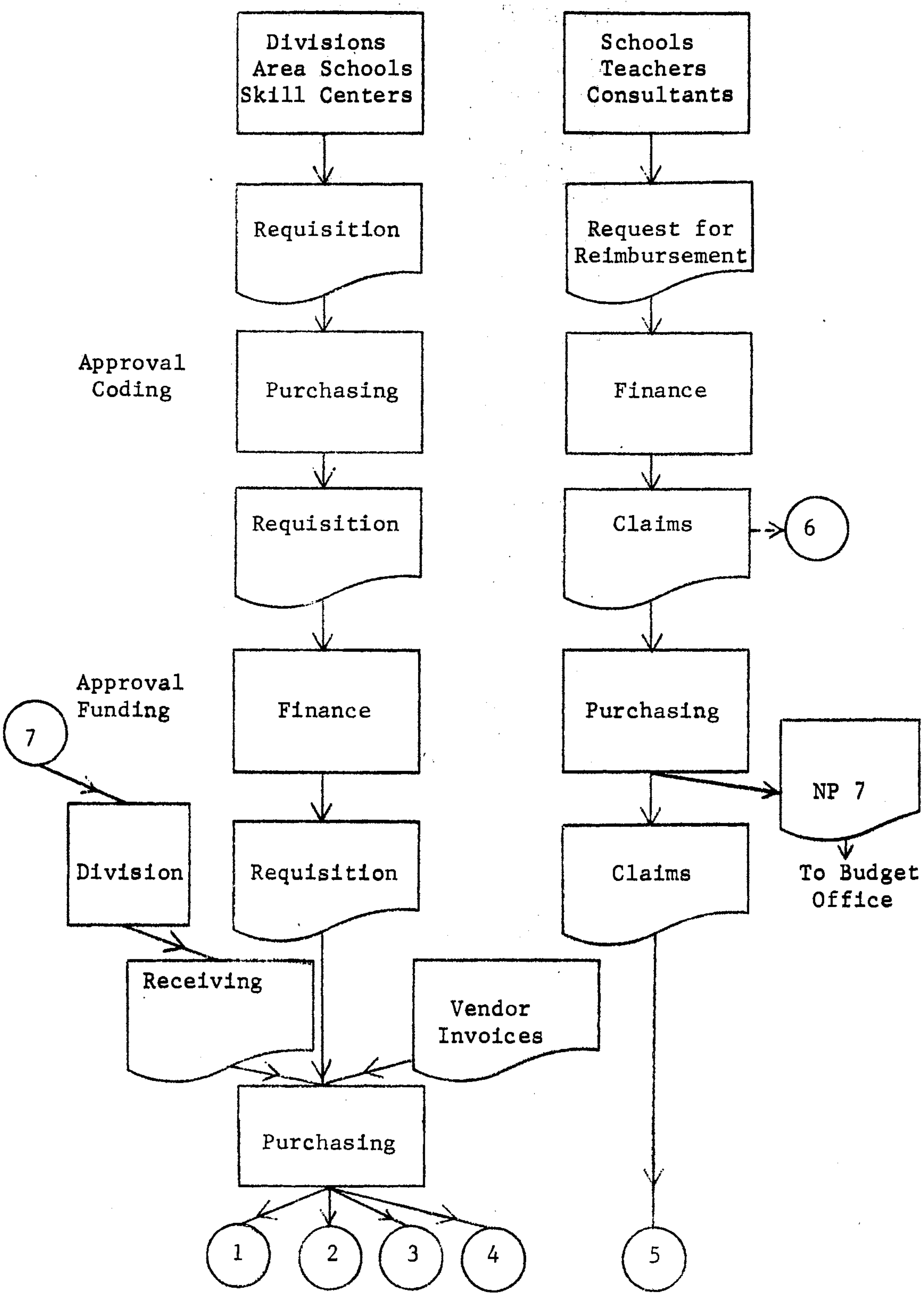



Figure 5. General Accounting Procedural Flow Chart

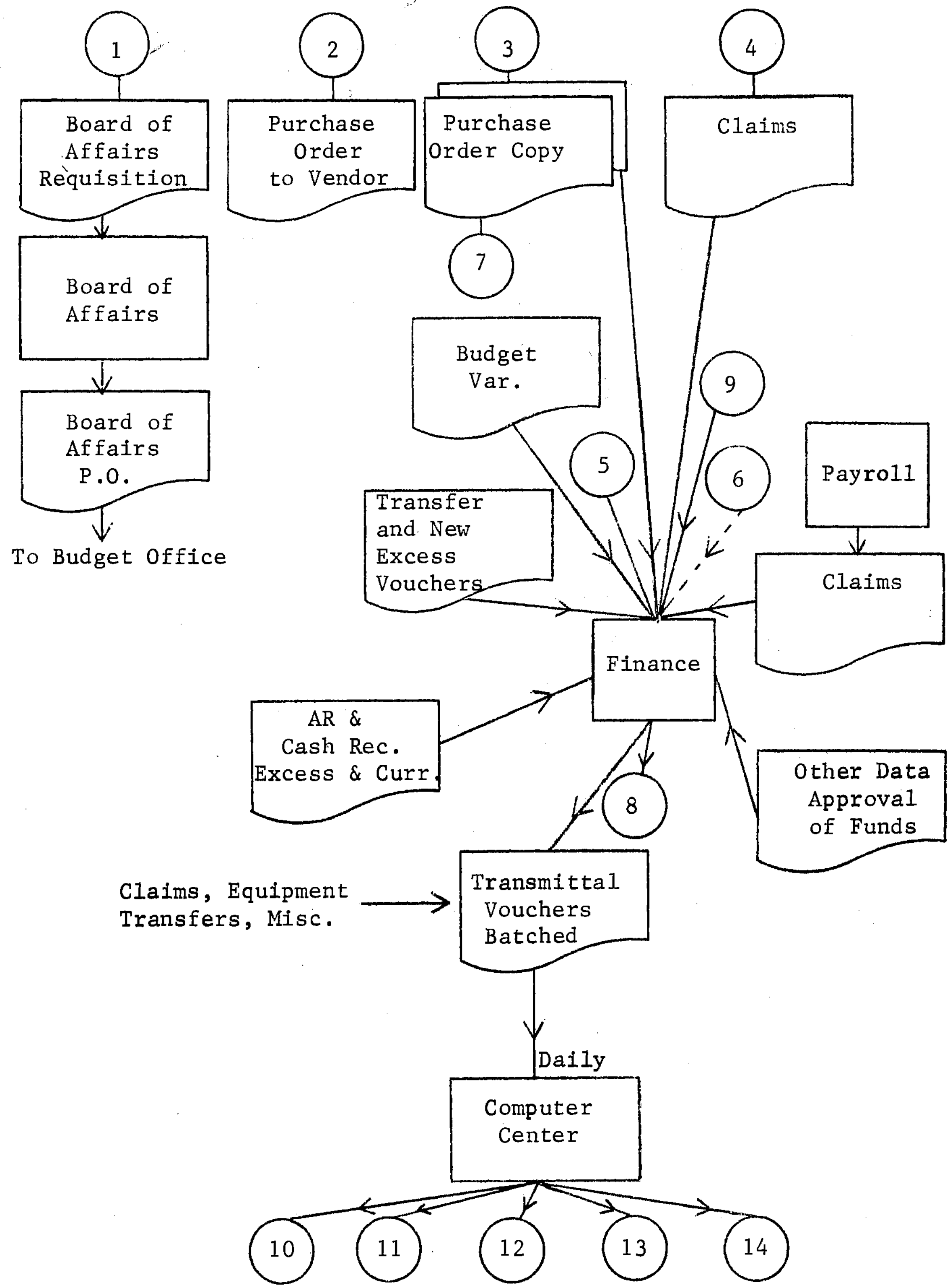
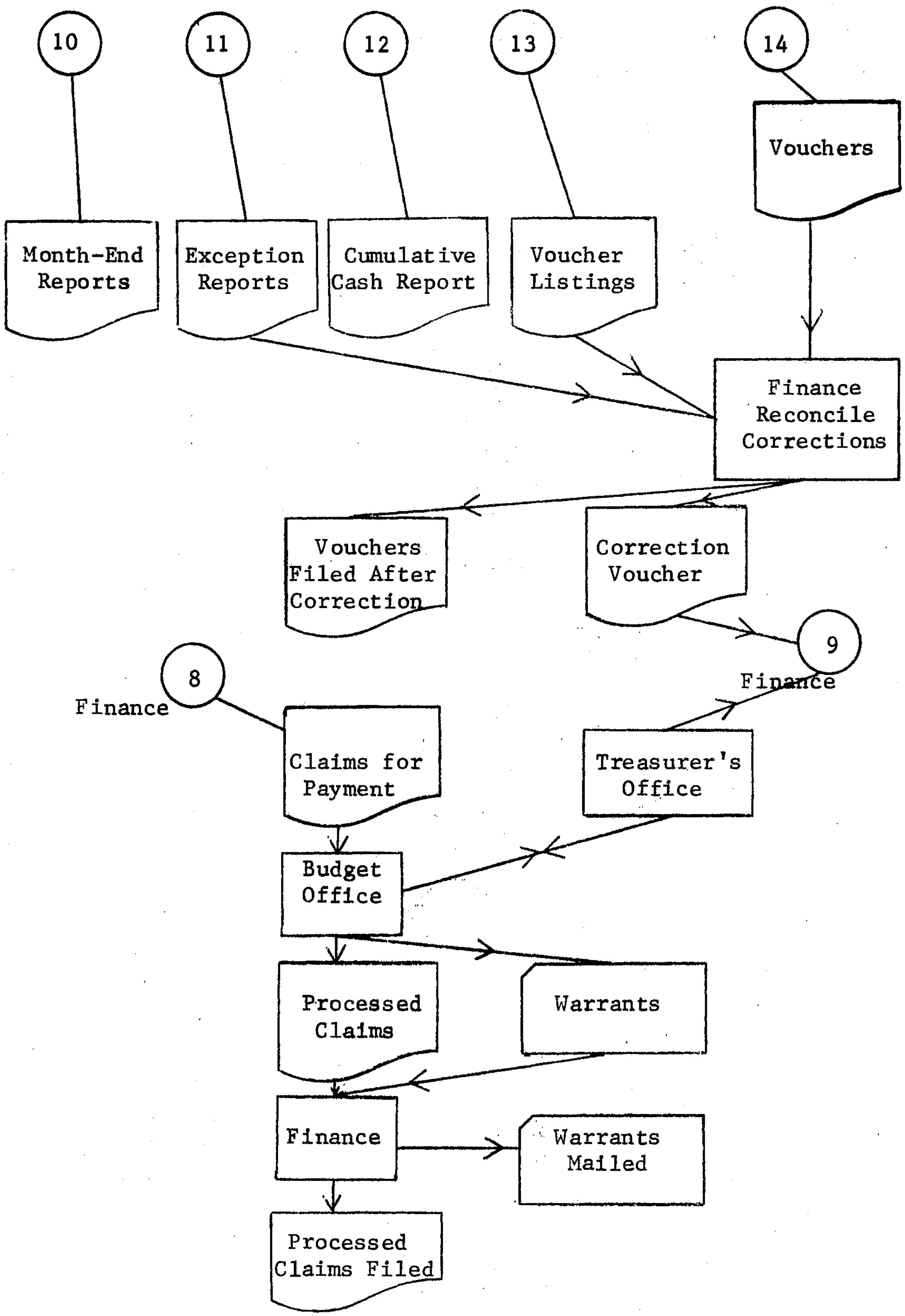



Figure 5. (Continued)

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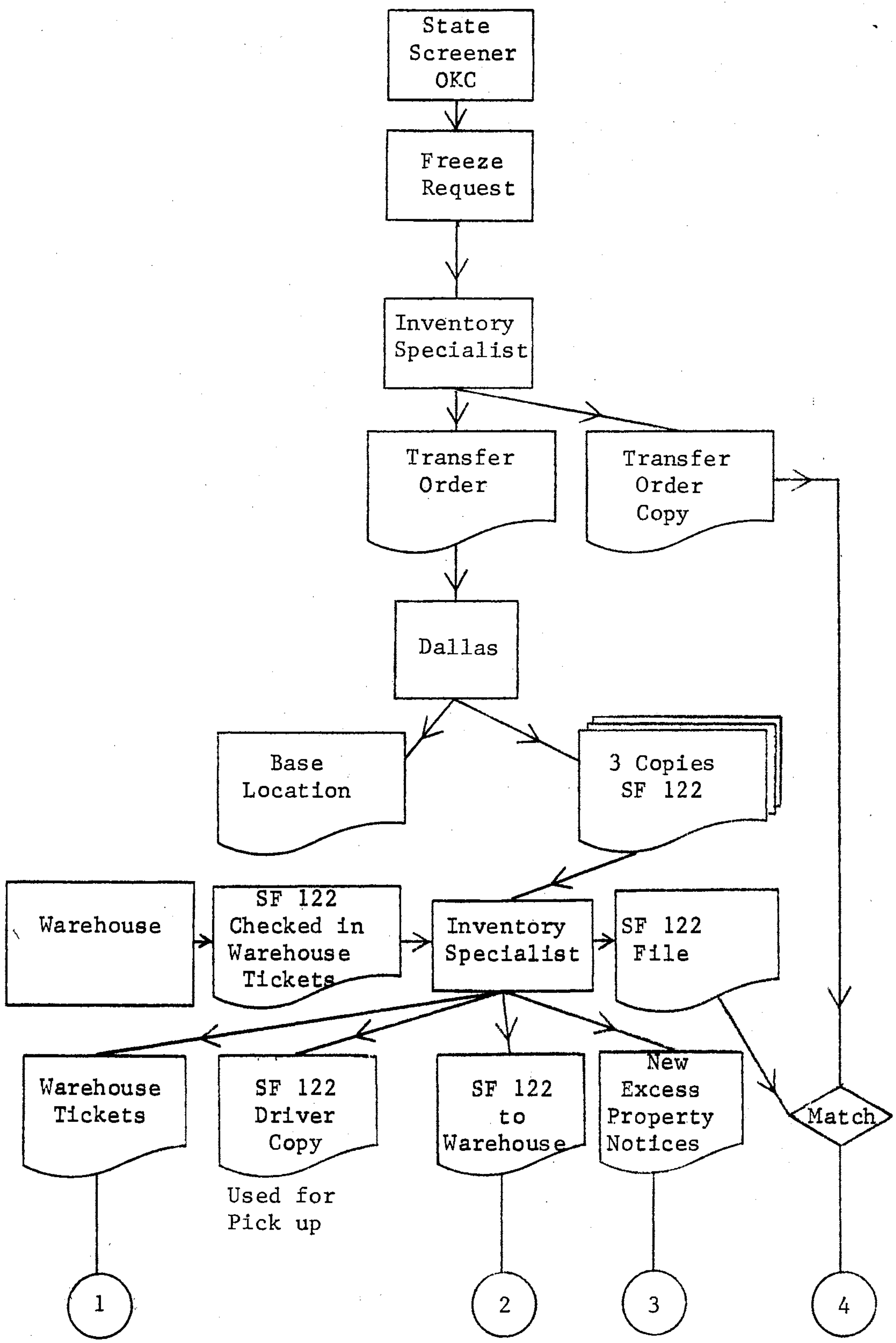


Figure 6. Equipment Investment Excess Property Procedural Flow Chart

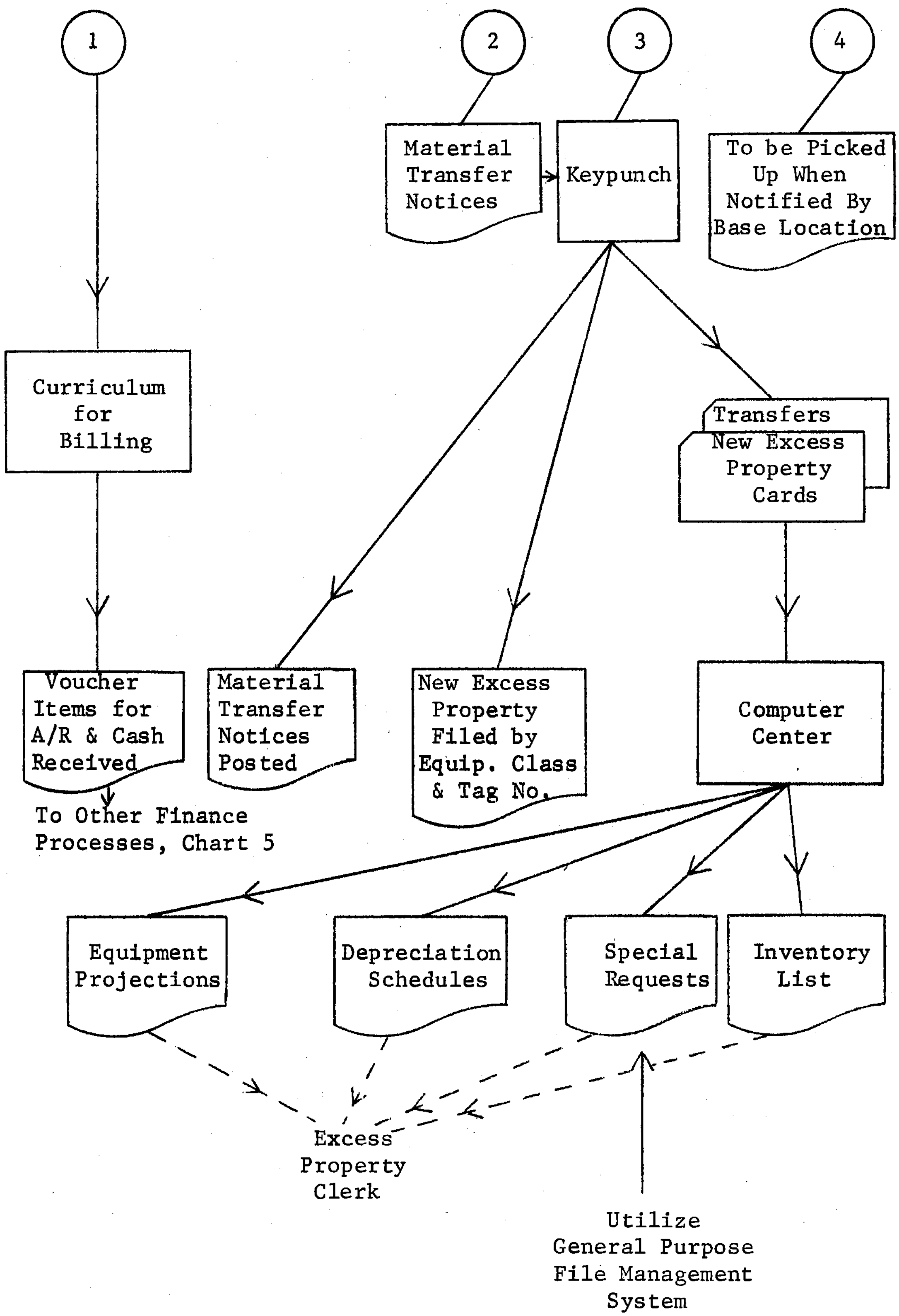


Figure 6. (Continued)

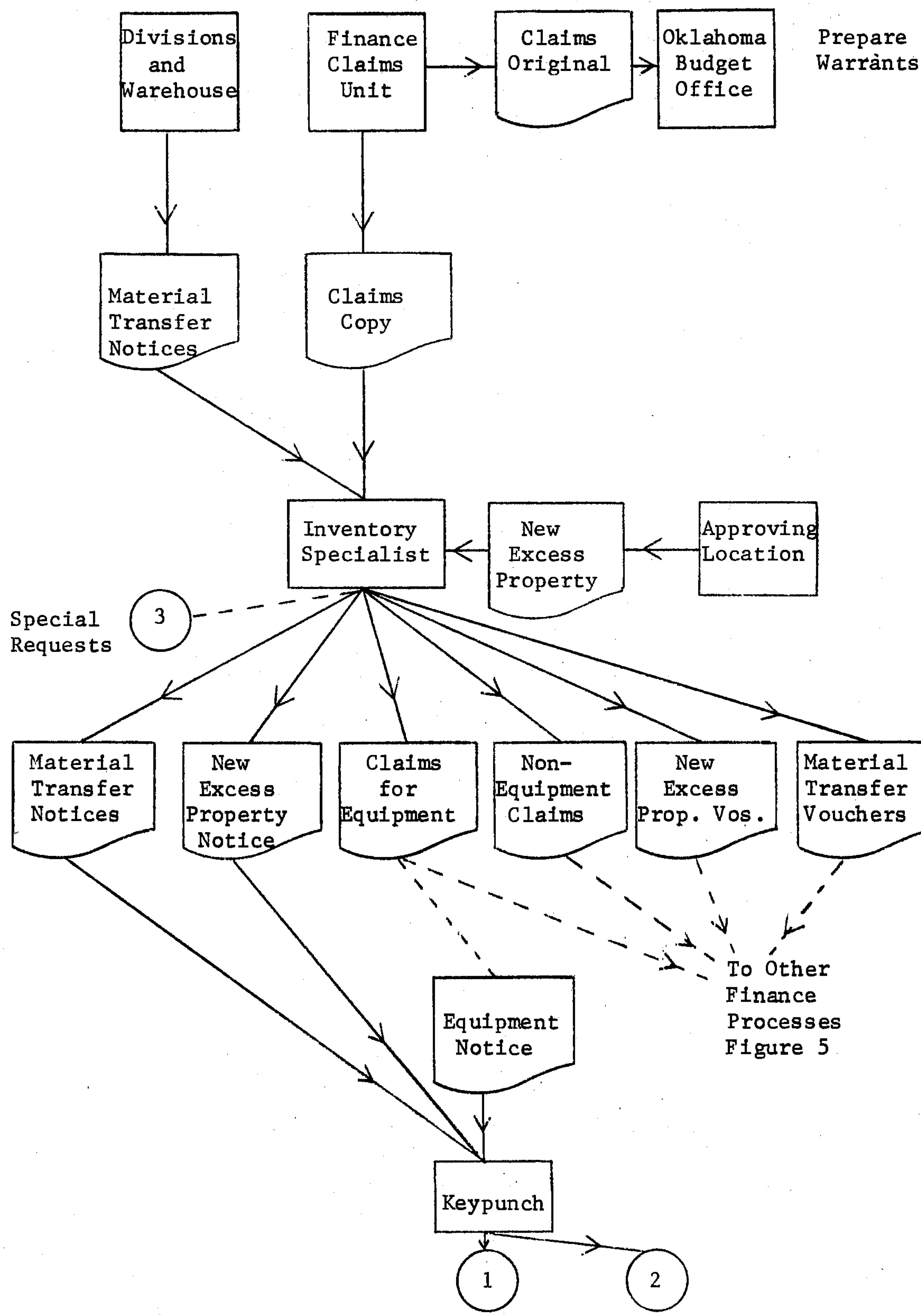


Figure 7. Equipment Investment Purchased Equipment--Procedural Flow Chart

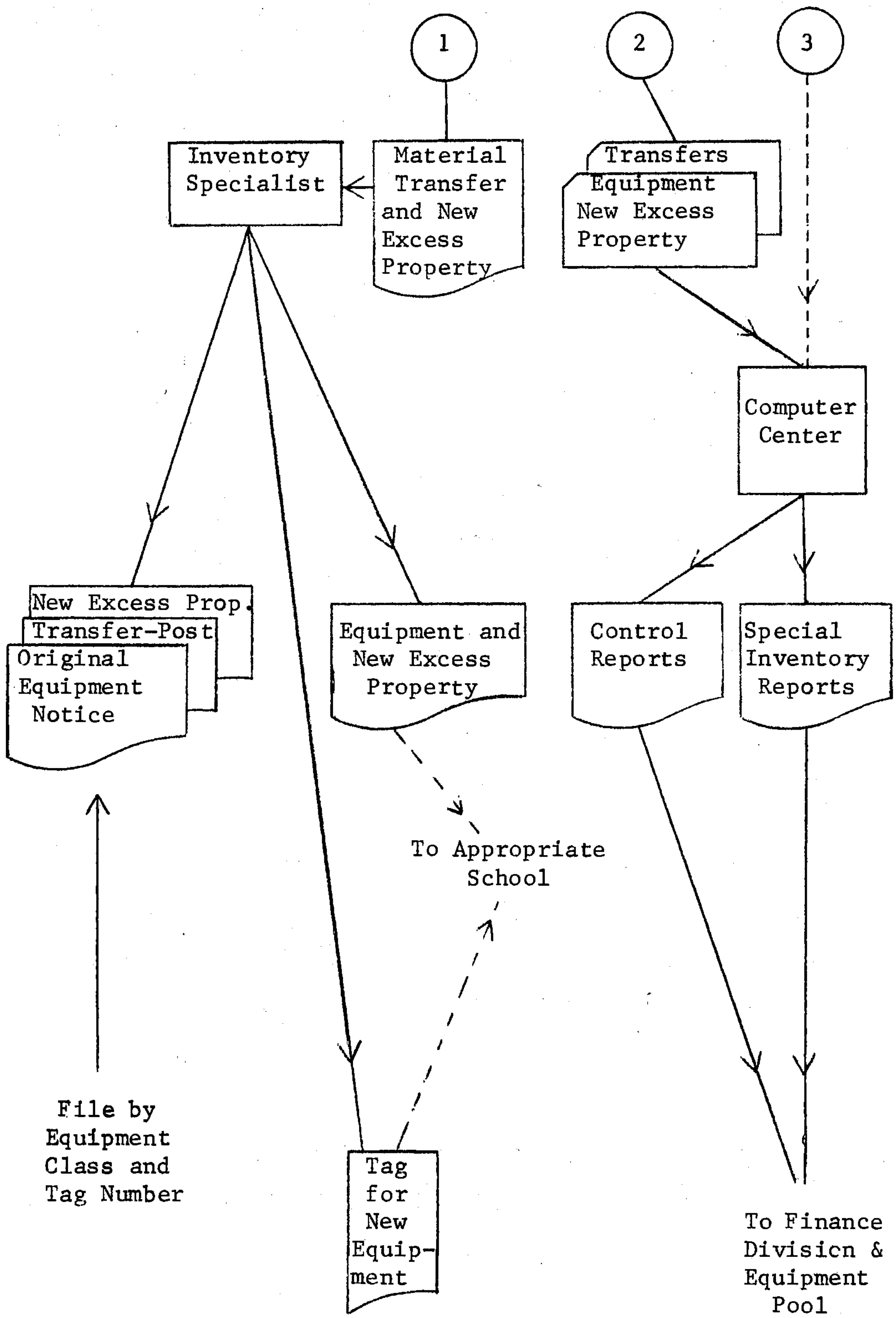


Figure 7. (Continued)

balances determination. This information will be of use in both on-going operations and assistance in planning and budgeting for subsequent periods.

Materials transferred from one location to another should reflect accounting entries for value changes and depreciation adjustments. These voucher entries will be completed by an inventory specialist and submitted to the Finance section for inclusion in the batch of vouchers to be processed for the current accounting period.

New excess property will be vouchered into the system with both gross and "net out" entries for each transaction which will provide the capability for producing Federal reports reflecting gross amounts and net reports for Departmental accounting. Depreciation calculation provisions will be discussed in the Equipment Investment Section.

The cash receipts and accounts receivable voucher entries will be prepared by the curriculum division and will reflect changes in those accounts for additional sales made for curriculum material and delivery charges for excess property picked up at the warehouse. Payment of vendor invoices will be vouchered via the claims form and each claim will reflect the expense ledger account to be charged and the asset/liability ledger accounts to be credited.

The double entry voucher system for data entry will minimize the need for lengthy "tie-in" or reconciling processes as each voucher will be "in-balance" before it is released for addition to the data base. The debit/credit offset requirement reasonably assures all entries have been processed and that individuals actually completing the coding on the source documents have designated all necessary coding.

The financial subsystem will require budgetary data for comparison purposes to evaluate performance effectively at the designated cost control centers. The data are prepared annually by the Finance Division from data supplied by the various organizational units. Budget adjustments are provided on a continuing basis. The organizational channels for approving budgets and submitting budget changes are established by operating procedures within the Oklahoma State Department of Vocational and Technical Education and external agency guidelines.

A critical feature to be incorporated into the computer processing will be a transaction audit capability. The purpose of this audit is to reasonably assure coding is correct as established by client determined parameters. These parameters will include actual valid code lists, ranges of acceptable codes, ranges of acceptable values and valid code combinations. The results of these validity tests will be reflected on audit error reports to be used by Finance section personnel as a reference for correcting data. Corrected data and new data are then combined for the subsequent batch process. The Exception reports, audit error reports, voucher listings and cash report will comprise the daily "working" output from the system (Figure 8).

The cash report will be prepared each day with accumulative detail transactions reflected for the month. A computer logic check will be included to assure adequate balances of funds exist before claims are processed into the system data base. Rejected transactions will be noted on the exception report and those transactions will be removed from subsequent processing. The exception report plus the

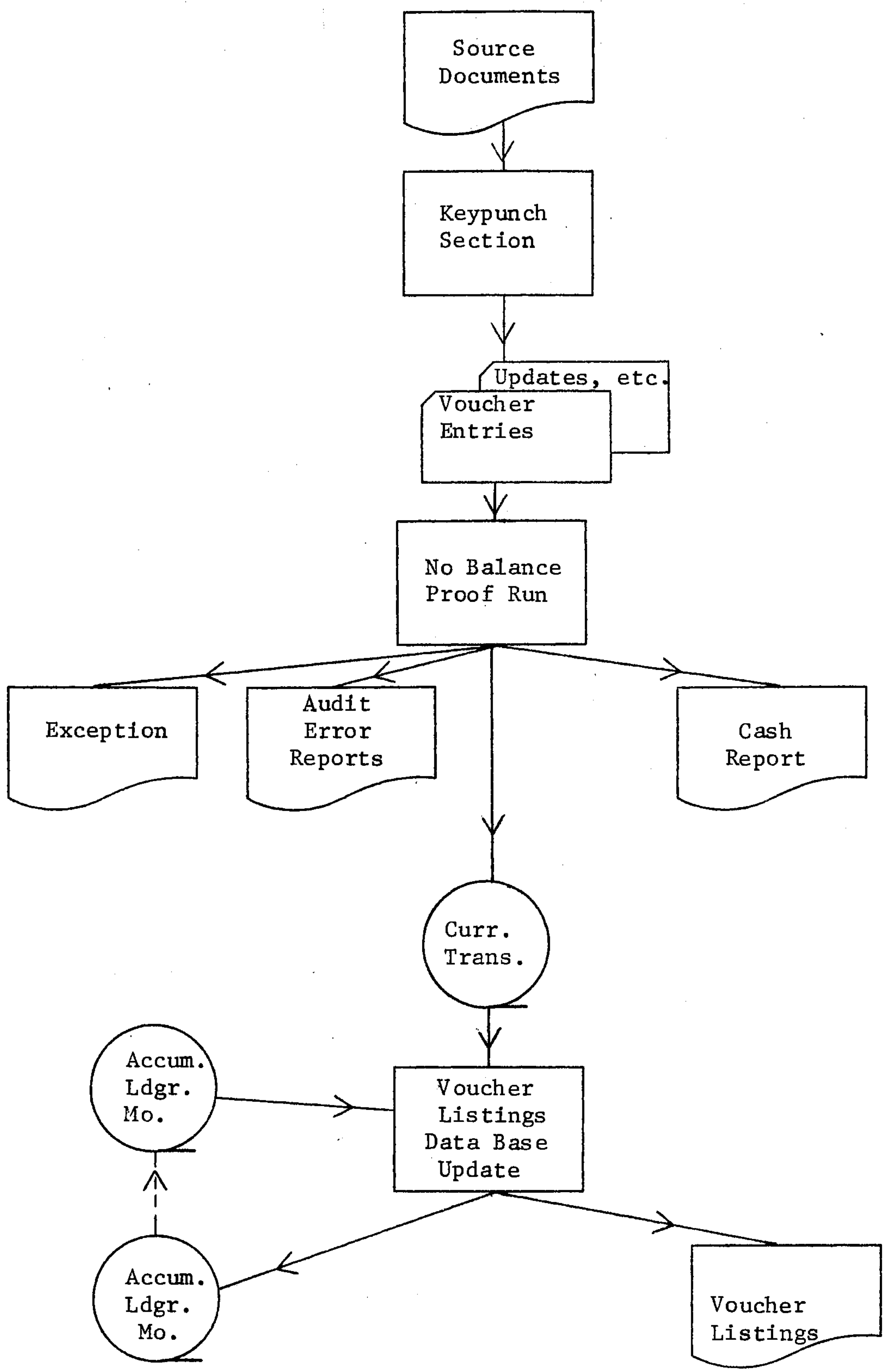


Figure 8. General Accounting--Daily Computer Processing

vouchers will be used by the Finance section to determine corrective action (i.e., adjust fund balances, charge other funds, reprocess through organizational unit responsible for expenditure, etc.). The transaction or claim should be resubmitted in a subsequent voucher if payment is to be made after necessary adjustments. A reconciling function will be executed to balance those entries going to the computerized information system with those claims submitted to the Oklahoma State Budget Office for warrant preparation.

Prepared vouchers will be batched and routed to the Keypunch section at 8:00 each morning. The keypunched data and all information requests will be processed at 1:00 each day with output available by 2:30 for Finance Division processing. This time frame is within the Oklahoma State University Computer Center and Oklahoma State Department of Vocational and Technical Education constraints.

The Finance Division will release claims for warrants corresponding to the claims voucher entries by 4:00 p.m. for those transactions satisfactorily processed. Vouchered claims rejected by the system for insufficient funds or erroneous coding will require holding claims for warrants in suspense until corrections are made.

Month-end processing will be a phase and type operation (Figure 9) utilizing a combination of current and cumulative data to produce the trial balance, accumulative ledgers, overhead and operating expense statements and encumbrance reports. Month-end reports will be prepared within one day after close of the current month's accounting.

The month end process concludes the general accounting activity cycle except for special year end reports or special requests which will be processed using the general purpose file management system.

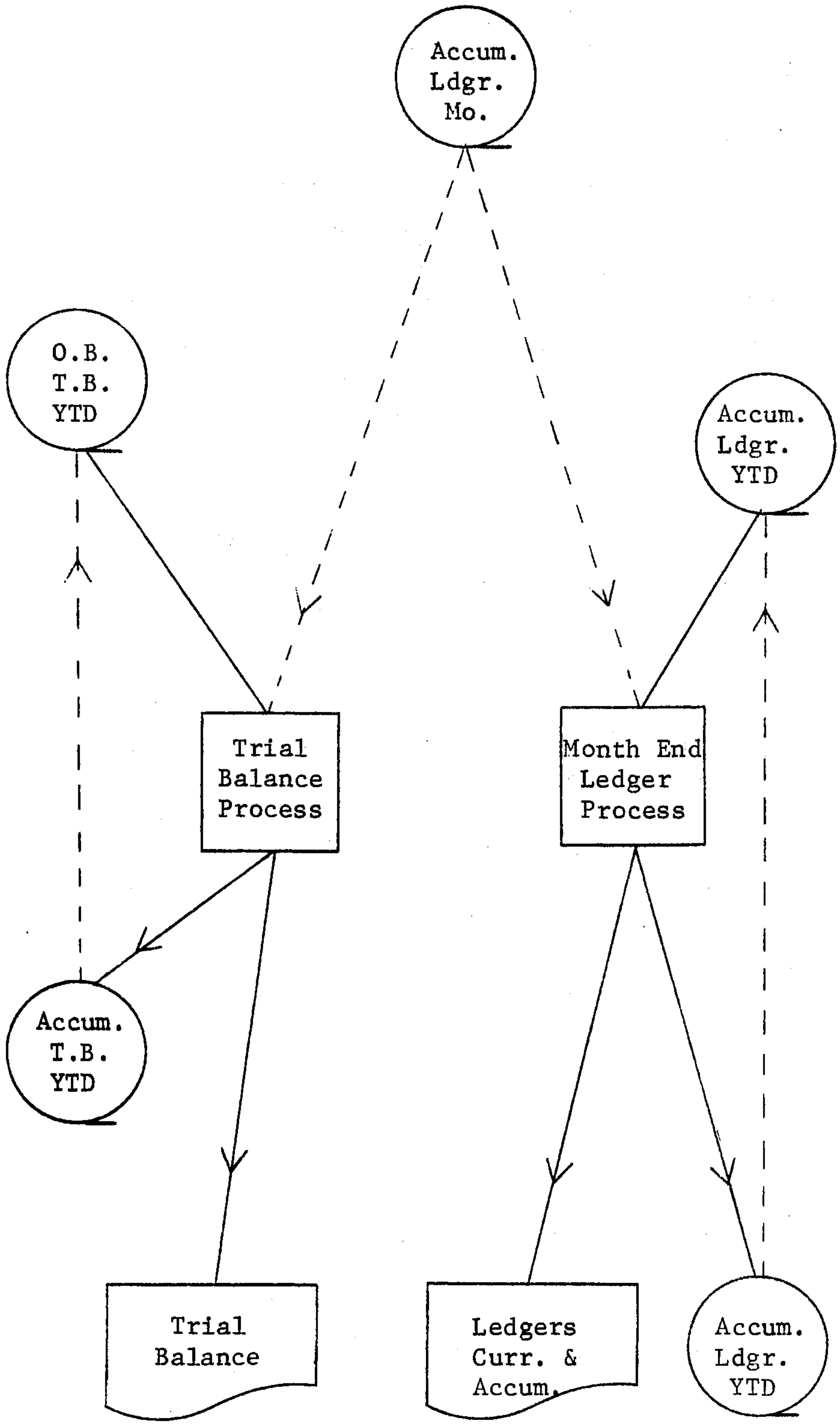


Figure 9. General Accounting--Month End Computer Processing

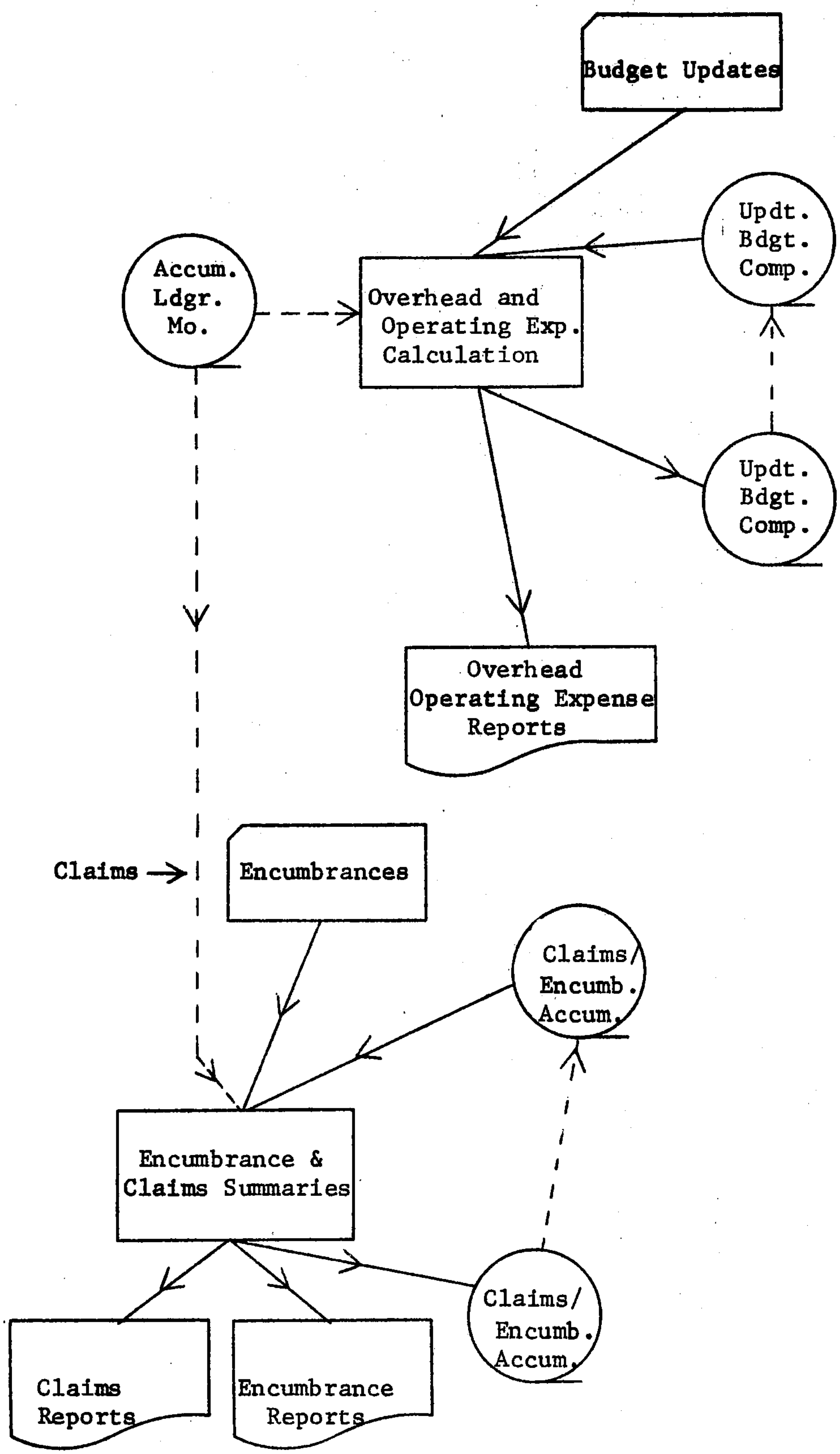


Figure 9. (Continued)

The next element within the Financial Data Subsystem is the Equipment Investment.

Equipment Investment

The State Department of Vocational and Technical Education is responsible for a continual expanding equipment investment inventory. At the completion of the 1973 data capture for all equipment, approximately 3,500 units of excess property and 56,000 units of one hundred percent and joint purchased equipment will be included in the inventory records.

Excess property information processing is indicated in Figure 6. All transactions affecting excess property will require entry to the information system. Each item entered into the system will require sufficient identification to maintain the inventory files and also reflect those changes critical to financial accounting. These types of identification do not overlap in all cases. For example, the general ledger number is not critical to an inventory system and original acquisition date is not directly critical to financial accounting reports. The system will provide for depreciation calculation capabilities. Data captured for each item must include depreciable life, original acquisition date, and reference number, in addition to control fields. The methods for updating file information will be a loadsheet completed by the inventory unit for location change, addition or deletion. The primary source document for data capture is the SF 122 form prepared by the Oklahoma State Department of Vocational and Technical Education and approved by the United States Office of Education, Department of Health, Education, and Welfare, in

Dallas, Texas. A secondary source is the material transfer notices reflecting relocations of equipment.

Purchased equipment transactions require analysis of claims by an inventory specialist to determine those items to be included in the equipment inventory file. The data captured will include identification of fund, source, division, object, depreciable life, etc. Transfer vouchers will be used to reflect adjustments in values and depreciation and location changes as equipment is transferred from warehouse locations to field locations and vice versa.

Equipment investment output reports prepared on a routine basis will include a complete quarterly listing by school with additions only each month and a complete semi-annual listing by equipment class with additions only each month. Depreciation schedules for vouchering purposes will be generated for inclusion in the following month's accounting process. These types of reports and schedules will provide the working output of the equipment investment procedure. Utilization of the general purpose file management system can generate special reports on an "as needed" basis with minimum lag time. A decision-making type output from the system would be "equipment needs" projections based on depreciable life, budget constraints, estimated delivery dates, etc. Equipment needs projections will be used for planning and budgeting purposes.

In addition to providing a substantial data base for financial decision-making, this module of the Computerized Information System Model will reduce manual intervention in report processing or special data gathering with a resultant compression in response time.

Various manual posting procedures will be eliminated in addition to some "in case" types of data compilation.

## Student Data Subsystem

The student data subsystem (Figure 10) reflects enrollment, completion, followup, achievement, and personal characteristics information for students enrolled in vocational and technical education programs. The information is utilized by decision makers for action steps concerning program emphasis, compliance with regulatory agency guidelines, evaluation of teacher and student performance, continuation or discontinuation of programs, and student guidance and counseling. The subsystem data file will include various demographic data to be used for special reporting purposes.

Three processing concepts will be used in this subsystem, including an auditor, locator file and general purpose file management system. Incorporation of these concepts will impact significantly on the accuracy, flexibility and accessibility of student information for decision making.

The basic input documents for this subsystem include enrollment forms, completion reports, followup reports and supplemental information reports. Enrollment forms are prepared each period by the teacher and submitted to the system to reflect basic student data (e.g., name, social security number, occupational objective, school code, program code, class code, sex, grade level, etc.). This basic information is supplemented by additional information provided by the school on a request form prepared from the system. The additional data will include (1) overall grade point average for each

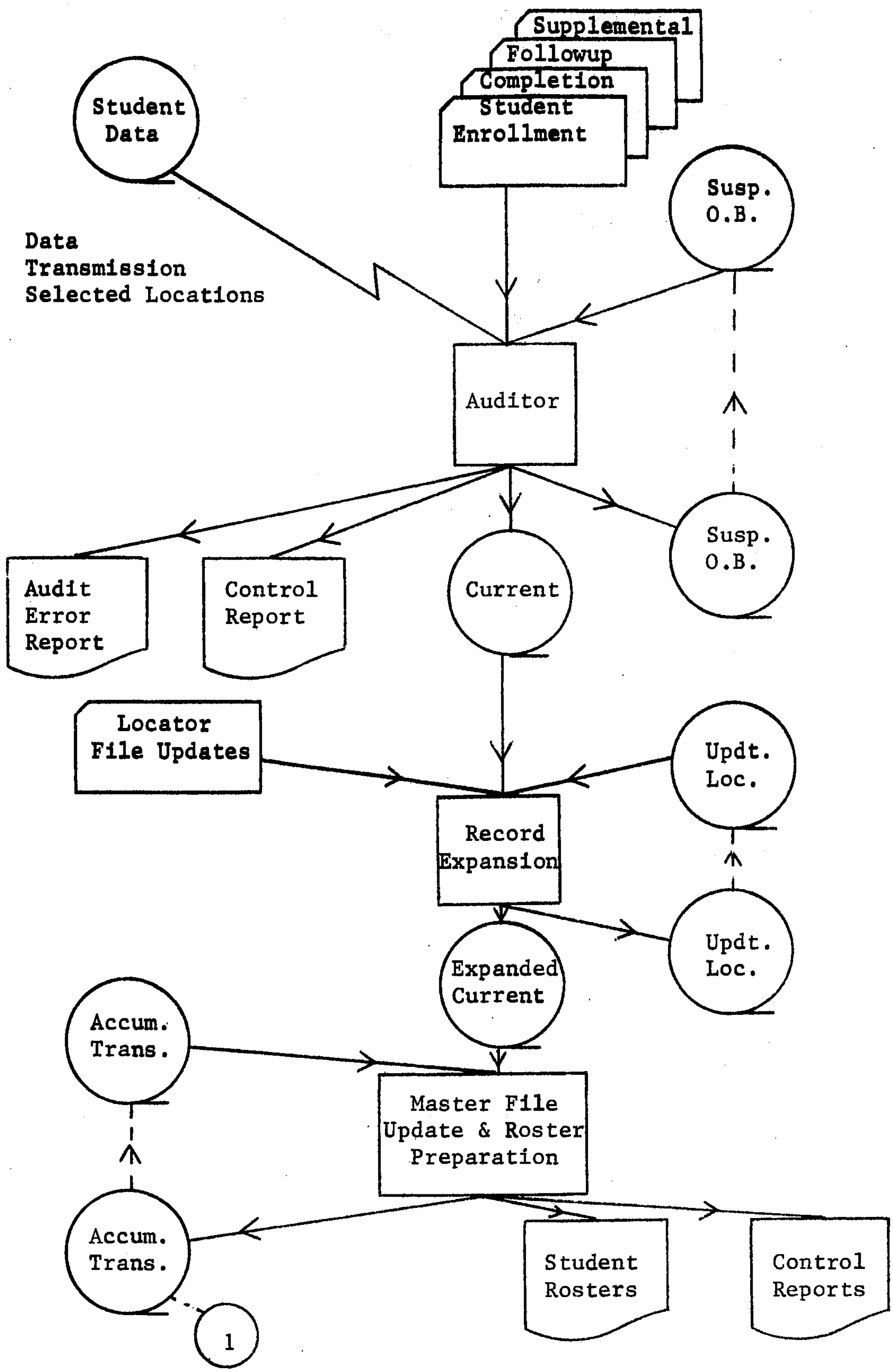


Figure 10. Student Data Subsystem--Computer Processing

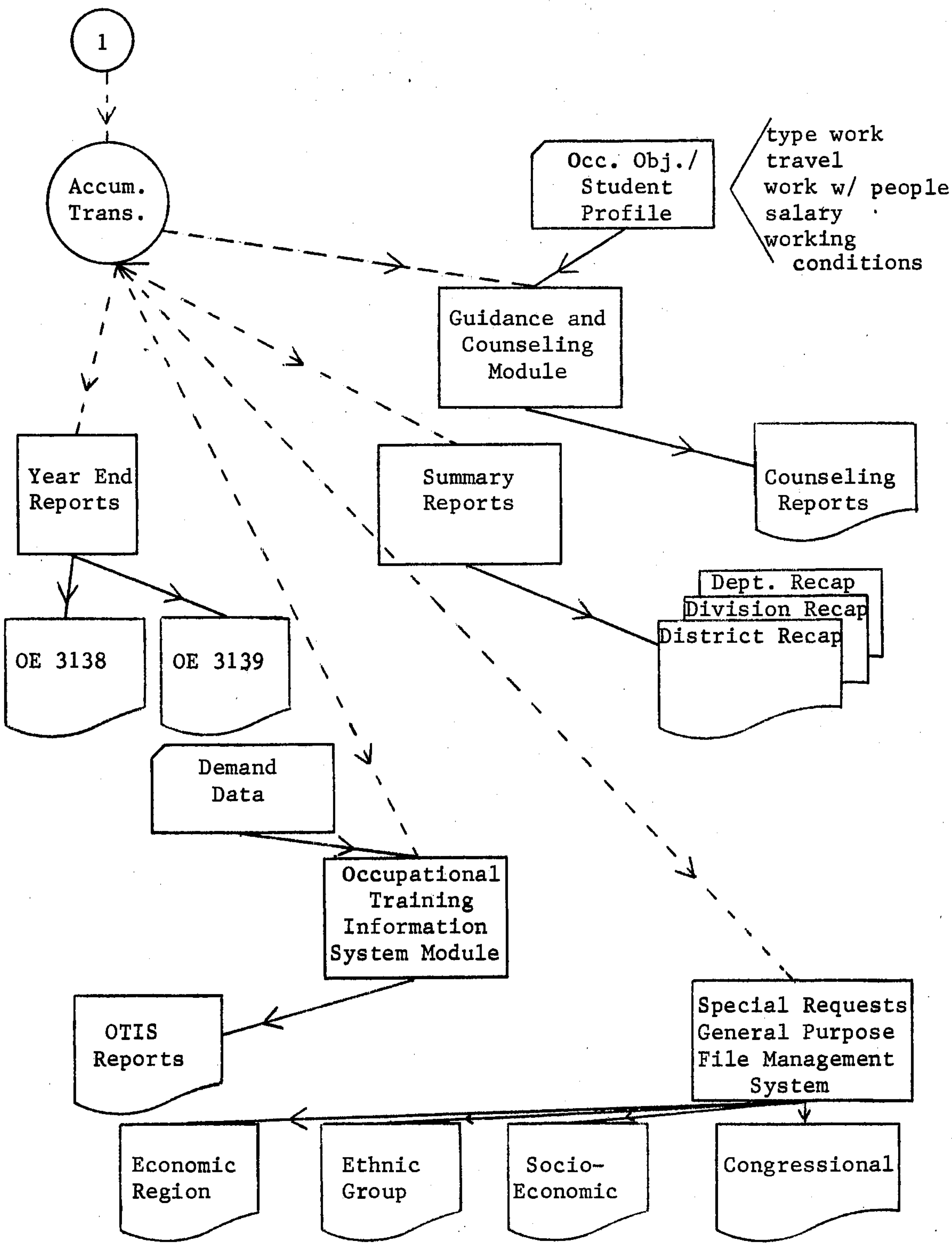


Figure 10. (Continued)

semester from grades 7-12, (2) number of absences by semester, (3) health profile (e.g., condition 1 = good, 2 = average, 3 = poor; categories include eyes, ears, teeth, heart, feet, growth and respiration), and (4) standardized test scores (e.g., GATB, Khulman, SRA, etc.). These additional data will be used in modeling applications and the guidance and counseling module of the student data subsystem.

A suspense procedure will be implemented to hold all current transactions entering the subsystem for a school/program if errors are detected in the audit phase of the processing.

The auditor function will be utilized to assure that transactions entering the system are valid. Validity will be checked for school code/program code combinations, program code/occupational code combinations, missing coding, value ranges of fields and coding configuration (e.g., alphabetic/numeric). The audit function is essential to an effective computerized information system. Reports are more accurate and delay time for error correction in reporting is minimized by batch validating data each time the data base is updated. The primary reports prepared during the audit process are control reports for maintaining current status of student/school/program data entry to the subsystem and the audit error report indicating transactions in error and type error detected.

The record expansion program will utilize a locator file to expand the basic transaction. Information added will include U.S. congressional district, state congressional district, economic region, etc. This facility will expand the flexibility of the student data base to include information for decision making which may not be required on a routine basis. Computerized expansion of data can be achieved within economic constraints not amenable to manual procedures.

A guidance and counseling module will facilitate assessment of student program selection congruence with student capabilities, interests, and limitations. Physical, academic and behavioral characteristics provided through school personnel to the student data subsystem will be correlated with personal preferences and self perception indicated by the student (e.g., type work, travel, desire to work with people, salary expected, working conditions desired, etc.). These data will be used to produce a counseling report which will indicate to decision makers the degree of correspondence between student perceptions and student capabilities. This type information can be used to modify counseling programs and program emphasis and to impact on placement rates, student performance, and teacher performance.

The accumulative transactions file will be used for a multiplicity of special reports including year end USOE reports, summary reports to divisions, reports by economic region, ethnic groups, socioeconomic groups, congressional districts, etc. The method for accessing the student data special reports will be the general purpose file management system which incorporates flexibility, compressed response time and minimum programming costs.

The student data file and demand data from external agencies (e.g., Oklahoma Employment Security Commission, MDTA, etc.) will provide the basic input to the Occupational Training Information System module. This module produces vocational student supply/demand data for decision making concerning program emphasis and vocational counseling and placement efforts.

## Personnel Data and Behavioral Forecasting Subsystem

Application of simulation to educational decision making is in a formative stage. The Personnel Data and Behavioral Forecasting Subsystem emphasizing simulation will facilitate future oriented strategical decision making; however, the state of the art requires specification in conceptual rather than totally prescribed terms.

The effective use of manpower is a primary concern of most organizations. Behavioral problems confronting administration are as significant as any other organizational problem confronting administration. Major technological advances, affluence, increased mobility, and high levels of education all contribute to the need for more comprehensive and forward looking programs to anticipate behavioral response to organizational change. Computer simulation can assist vocational-technical education administration in evaluating probable impact of various changes before any change is actually effected.

Traditionally behavior has been regarded as a cost function which requires control in the form of standards, rules, and reports. This approach to behavioral monitoring represents only one strategy for assuring effectiveness and efficiency of organization members. An equally important strategy is represented as a "value-added" strategy.[1] A requirement of a value-added strategy includes anticipation of the consequences of changes in administration's behavior on the behavior of organization members. Another requirement is administrative distinction between those motivating influences which are not susceptible to effective control and those which can be controlled.

A strategy for encouraging value-adding behavior consists of replacing cost control behavior through participative administrative styles; programs for employee advancement, job enrichment, and improved two-way communications. The value-adding approach will yield minimum success in areas of highly routinized jobs staffed by less educated groups. The value-adding approach focuses on eliminating the causal factors contributing to carelessness, turnover, slowdowns, separations, and formation of dysfunctional coalitions. The approach seeks to subtly accomplish cost control through increasing the organization members' sense of responsibility and feeling of accomplishment.

The more advanced behavioral theory, termed "value-added," requires a reappraisal of administration's own attitude toward behavioral monitoring. Traditional administrative theory may be stated as exercising the cost control behavioral strategy which is exemplified by placing primary emphasis on assuring that organization members act in a prescribed manner. The major thrust of administrative training under traditional administration may be preparation for conflict resolution rather than stimulation of employee creativity, innovation, and improved self concept. This behavioral strategy approach is reflected in various negative responses including (1) an adversary environment between administrator and staff, (2) loss of valuable professionals to other organizations, and (3) vocal dissension of mediocre performers resulting in formation of suborganization coalitions.

The exercise of classical cost control behavior strategy has necessitated shifting to the more perceptual form of behavioral monitoring which is accommodated by computerized modeling techniques. The process of modeling requires an explicit interpretation of critical variables and their purposes in an understandable form for analysis. If variables are explicit an empirical identification of operational factors can be effected which will yield a systematized rather than fragmented treatment of organizational activities. A systematized or wholistic approach to individual and group behavior emphasizes the interaction of key variables and provides a framework for evaluating the impact of alternative courses of action. The systematized approach also encourages a continuous flow function rather than a series of loosely related lesser models addressing specific areas of the problem of anticipating behavior.

A systems approach demanded by the computer simulation technique requires formulation specification in a form which permits effective conceptualization of alternative strategies to achieve the perceived optimum organizational structure. Models developed in the simulation mode also produce analytical "spin offs" which yield additional insight into the complexities of organizational dynamics. It should be emphasized that the analytical capabilities of computer simulation models are not designed to pre-empt the administrative decision making activity but rather to support that activity with a multi-dimensional behavioral evaluation capability.

Behavioral model building is classified by Mason Haire, Massachusetts Institute of Technology,[2] as either descriptive or prescriptive. Descriptive models emphasize a projection over a given period of time yielding some diagnostic implications. The prescriptive models reflect behavioral responses based on feedback and constraints introduced into the system on an "as required" basis.

Framework for Development

Classical and contemporary theories of organization consider specific physiological and psychological constraints as critical to each particular theory.[3] The constraints applicable in either theory are subject to delayed feedback reaction in the real world which can result in decision making based on reaction rather than action. A computerized behavioral forecasting model should anticipate reactions of employees to the organizational environment and provide a basis for minimizing dysfunctional behavior.

The degree of assistance to management from a model of this type is a function of the input parameters and can be modularized to any degree of complexity. One criterion of the model will be a turnover ratio by organizational unit. The data for this element will be derived from employment, transfer and termination records within the personnel data system. The ratio will be compared with local, regional and national ratios for similar activities. The value of reducing excessive turnover can be quantified by applying the excess turnover rate to hiring costs (including transportation, moving, etc.), training costs, etc. This value reflects the direct tangible costs of high turnover; however, it does not quantify the potential deteriorating effect on morale and related losses in productivity. These intangibles are a very real part of the turnover impact.

The application of the behavioral model to the education system should be restricted to those having sufficient elements to incur economies of scale with reference to data manipulation and number of variables.

C. A. Meyers emphasizes the importance of behavioral monitoring stating,[4]

> If top management has given attention, with the help of staff specialists in personnel administration, to the organizational conditions which foster self renewal, to the training methods which develop greater sensitivity to interpersonal behavior, to managerial styles which integrate concern for production and people, to ways of helping an organization to change through the participation of people in charge (including the introduction of EDP) then it is a reasonable expectation that management's relations with employees (and their unions) will be more constructive.

The proposed modeling technique could have application to various organizational sensitivity analyses involving interaction of multivariate constraints. The tangible and intangible costs associated with suboptimum behavior of group members encourages developing tools for management to detect problems in this area at the earliest possible time. Lower management personnel administration deficiencies can be detected through a computer assisted monitoring system which will evaluate critical points of the personnel administration framework for divergencies from predetermined norms.

The computer model will be used to evaluate the interaction of behavioral variables impinging on organizational efficiency and effectiveness. The General Model of Adaptive Motivated Behavior, Figure 11, proposed by March and Simon[5] will be used as the theoretical framework for developing the behavioral model proposed in this study. The Adaptive Motivated Behavior model describes the interactions of stimulus/response as follows:

1. As an individual realizes lower levels of satisfaction he will engage in increasing levels of search for alternative methods of achieving satisfaction.

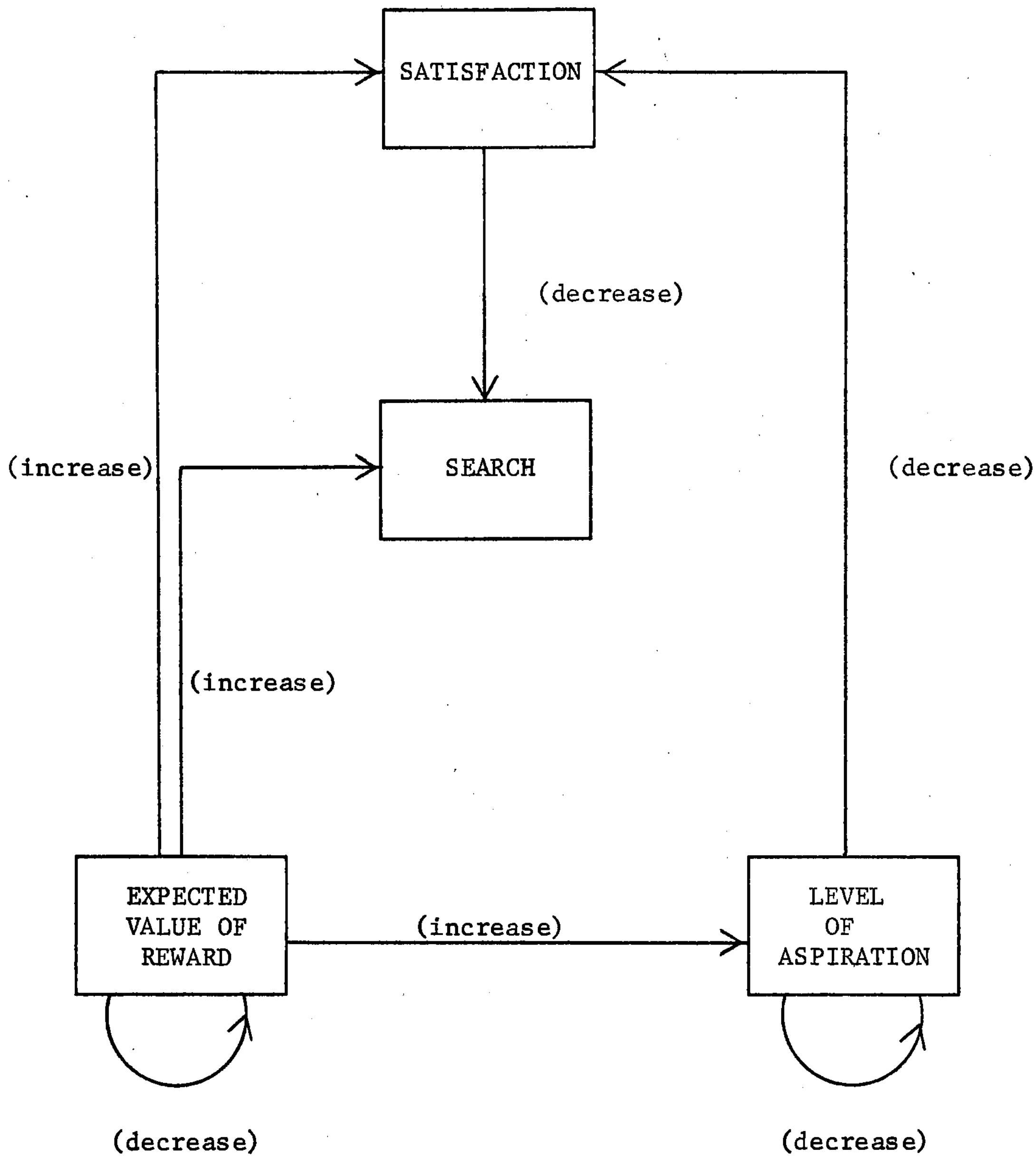


Figure 11. General Model of Adaptive Motivated Behavior

2. The expected value of reward will increase with increased search.
3. As the expected value of reward increases, satisfaction also increases.
4. As the expected value of reward increases, the level of aspiration also increases.
5. As the level of aspiration increases, satisfaction decreases.

Based on this model the individual who may become dissatisfied has various alternatives available. He may elect to leave the organization, he may decide to conform to the organization norms or he may decide to remain with the organization but identify with other than organizational norms. The proposed computer model will be concerned with optimizing the possibility of organization member dissatisfaction which would result in termination or identifying with suborganizational groups. If the individual elects to conform to norms, it is assumed his dissatisfaction level is not dysfunctional. Optimizing in this case recognizes some level of turnover is desirable for maintenance of a dynamic organization.

Computer simulation of a multi-variate behavior model should be an effective method for evaluating the behavioral impact of multi-dimensional organizational modifications. Validation of this hypothesis will indicate that administrators can use the simulator model to approximate organization member reaction to various organization changes. This additional administrative tool can yield significant improvements by permitting pre-planning for expected behavioral responses which will increase work satisfaction, reduce dysfunctional coalition formation, reduce non-planned turnover, reduce absenteeism and reduce loss due to intergroup and intragroup conflict.

Independent variables will be classified as those conditions which are submitted to the model in the form of impact requests (e.g, what is the impact of reducing the salaries of a group of employees with certain demographic characteristics?). Dependent variables will be classified as the response to the impact request (e.g., estimated two will terminate, ten will ask for transfers to other jobs in the current area, morale and productivity loss will be one percent for a period beginning with announced location change until six months after relocation is completed). The distinction between the two types of variables could be made as follows: independent variables represent simulator inquiries and the dependent variables represent the simulator responses.

## Design of the Behavioral Forecasting Subsystem

The Behavioral Forecasting Subsystem will be designed to assist administration in evaluating the impact of various structural and functional changes conditioned by policy changes and staff profiles. The methodology used will be computer simulation. A similar approach is recommended by J. R. Miller,[6] Stanford University, which he terms micro-simulation. Micro-simulation refers to computer models focusing on individuals or groups rather than organizations. This approach is advocated due to the current state of the art, which has not developed adequate knowledge in the area of complete organizations. In addition, the small group is more responsive to organizational change and therefore will be effective as a vehicle for evaluating alternative courses of action. The model is using the most sensitive reactor element in the educational system. A simulator can be modified readily and effectively to monitor behavioral impact actions resulting from the various stimuli impinging on the organizational unit. Lower informational requirements and fewer data collection problems are the primary justification for utilizing micro-simulation rather than macro-simulation.

Detail descriptive inputs to the model, Figure 12, are:

1. Structural elements including communication channels, group size, and authority delegations.
2. Functional elements including work performed, input/output relationships, and process flows.
3. Policies applicable to the organization including promotion, reward, and institution.
4. Personnel profiles including aspirations, skills, and work history.

The Behavioral Forecasting Subsystem will be designed to provide administration oriented output which will be of assistance in the task of anticipating impact of organizational change on individual and group behavior. The model must incorporate the following characteristics to assure a viable result:

1. Data collection procedures must be developed which are validated as operationally functional.
2. A feedback mechanism must be included which will monitor the interaction between performance, reward, appraisal, learning, and motivation.

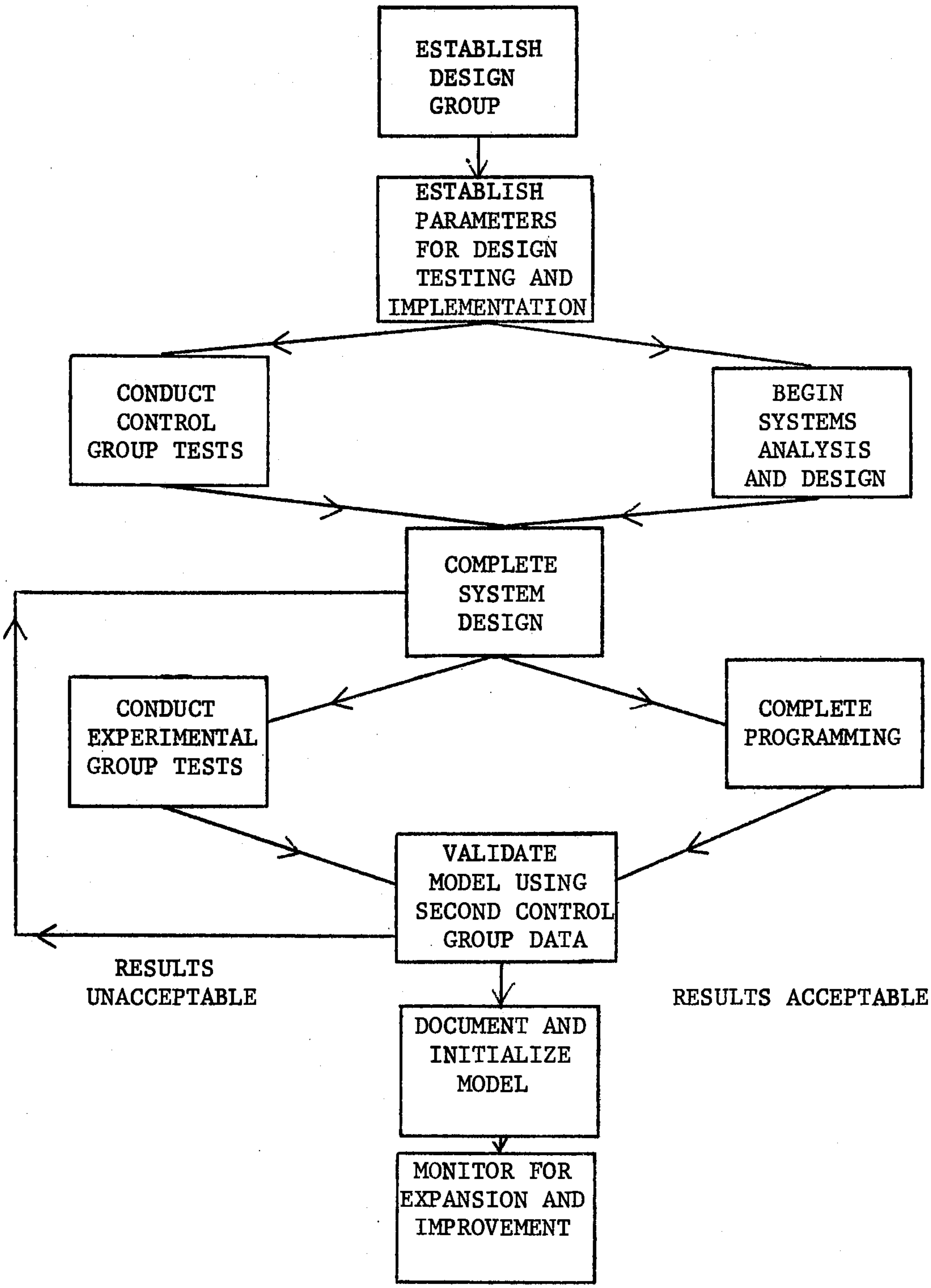


Figure 12. A Procedural Flowchart for Designing a Behavioral Forecasting Model

3. A capability must be included which will permit sensitivity testing of active variables.
4. Only concepts which can be validated through empirical testing should be utilized. The testing should follow specified research procedures.
5. The model should be developed as an integral part of the total education planning framework.
6. The model should be designed to provide incorporation of additional constraints if they become critical. The model must be in a dynamic environment.

The model will be modular in concept and hierarchical in structure to allow multi-group evaluation with minimum effort or model alteration. It will be designed to operate in an educational environment for the purpose of evaluating the impact of organizational change on the behavior of organization members.

The design group should consist of a management scientist, a behavioral scientist, an administration representative, and a systems analyst. All critical areas for developing a viable behavioral model should be represented by this proposed design team. The members should have ready access to all personnel information and expertise in the educational system impinging on the organizational members whose behavior will be simulated by the model. The information from these sources plus professional expertise in the various disciplines represented, plus consultations with outside sources should provide a working knowledge to effectively develop a behavioral reaction test instrument. This test instrument can be administered to control and experimental groups for design and verification of behavioral reactions to various organizational changes.

The test instrument will be administered to anticipate reactions to real world conditions and will require anticipation of reactions by test participants. Consideration must be given to possible biased answers to influence results (e.g., a test participant may be asked what his reaction to a ten percent pay cut would be and he may respond that he would terminate employment; however, confronted with a similar real world condition he would possibly rationalize his position). The format of questions and the selection and conditioning of control groups to minimize biased responses require the inclusion of the behavioral scientist and possibly a psychologist in the design team. An elaboration of types of information to be collected for system design purposes is included in the Data Collection and Sampling Procedures section.

The use of a simulation technique for behavioral monitoring has been selected because the problem does not adapt to an analytic formulation comprised of a relatively small set of solvable mathematical variables. The analytic formulation prescribes specific relationships between policy variables and between a policy variable and the characteristics of the system.

Simulation is used when there are a substantial number of variables and the exact relationships of the variables and system interplay are unknown. If simulation is used, it is possible some potential savings and some detail understanding may be sacrificed. The determination of the relationship between simulated reward policy and individual performances requires a complex evaluation of the interrelationship of rewards to learning, satisfaction, motivation and appraisal.

The design effort should utilize information from outside sources, information from the designed test instrument, and in-depth interviews with organization members to provide the basis for incorporating variable interaction. The model should provide the capability for submitting requests which describe specific sets of parameters.

A sample request:

> We are planning on establishing a system of differentiated staffing with promotions and new job assignments based on the administration's evaluation of past performance.

Organization member profile information is then submitted with the request specifying all critical variables impinging on the analysis. All data will be entered in a coded format compatible with computer input requirements.

The model should be designed to analyze organizational groups of varying size and description. The descriptive characteristics of the group will be correlated with predetermined reactions developed from detailed analysis and control group evaluation. Output results will indicate the probable response of the specified population to the given sets of input parameters.

Data Collection and Sampling Procedures

The control group participants to be used for assisting in the design of the model should include a representative sampling of all significant elements of the organization (e.g., middle age, middle income, low mobility; young, low income, high mobility; and middle age, high income, high mobility).

A partial list of factors to be considered:

1. Length of service grouping (i.e., 1-2 years, 3-5 years, 6-10 years, 10-15 years, and over 15 years)
2. Income groups
3. Marital status
4. Family size
5. Work history
6. Education
7. Number of previous employers (mobility)
8. Number of intra-system location assignments
9. Promotion history
10. Personality tests

Questionnaires should be designed to ask questions concerning reactions to the following types of questions:

1. What would the reaction be to various levels of salary reduction (e.g., two percent, five percent, ten percent)? Responses may be termination, work slow down, request for transfer, acceptance, dysfunctional intragroup and intergroup activity.
2. What would the reaction be to a remote location transfer? Responses may be acceptance, termination, additional maneuvering for incentives, request for transfer, etc.

The foregoing examples are presented for type only. The actual questionnaire should be designed under the direction of a behavioral scientist and a psychologist to assure minimization of biased response and artificially induced threat to subjects.

The following methodology can be executed for reward response data collection:[7]

1. Organization members allocate their time over a set of activities applicable to their individual work environment. These activities will also be the basic input to the simulator. Certain sets of activities possess certain outcomes which are relevant to the group mission. These sets, called consequences, can either contribute to or detract from the group mission.
2. The respective administrators evaluate the activity sets and the consequences designated by the staff members and determine a subset most critical to group mission accomplishment.
3. The respective administrators assign a performance measure for each critical subset outcome possibility.
4. The respective administrators evaluate observed performance by applying an appraisal algorithm to the measured performance of each staff member. The appraisal algorithm is established through detailed interviews prior to system implementation. The appraisal algorithm utilizes as inputs the vector of performance measures generated by each staff member during the specified time frame.
5. The respective administrators distribute rewards according to a selected reward policy. The reward policy may be based on seniority, the appraisal algorithm result, or a random selection.
6. Each staff member designates a subset of the reward policies he feels gives him maximum satisfaction. In addition to the

reward policy the staff member designates other items in the work environment contributing to his satisfaction.

7. The staff member assigns descriptive reward measures to each critical reward outcome possibility.
8. The staff member evaluates his satisfaction by applying a satisfaction algorithm to the rewards received. The satisfaction algorithm is established through detailed interviews, in addition to aspiration levels, prior to system implementation. The algorithm compares rewards received with aspiration levels to derive a satisfaction number. Satisfaction numbers indicate extent to which aspirations were realized.
9. The staff member then diagnoses the administrator's appraisal algorithm and correlates his own satisfaction with the rewards received and performance from prior time frames to establish the administrator's perceived appraisal algorithm.
10. The staff member then combines his perception of his administrator's appraisal algorithm with his additional sources of satisfaction and evolves an optimum allocation of effort over various activities for the following time frame.

This process is repeated a sufficient number of times to provide a set of stable reward/behavior/response patterns for inclusion in the model. Similar type procedures must be executed for determining all constraint parameters in the model.

The time and cost required for developing this model will vary depending on the complexity of the model and the magnitude of the organization being simulated. Data collection media design and administration will require a significant effort to provide analysis data for systems design. Actual programming, testing, documentation, and initialization time requirements will also be a function of the magnitude and complexity of the systems. After the parameters are established and an initial feasibility study prepared, the information for preparation of a detailed PERT or CPM schedule will be available.

## Analysis of Results

The results of the behavioral model simulation can be analyzed in one of the three ways proposed by Milton L. Lavin.[8]

1. Determine if the output appears intuitively correct. The Turing test is used for extremely complex processes and is executed by submitting to an expert evaluation group (e.g., top administrative groups) the outputs from both the simulation model and an actual process for a stated time series. These experts are then asked to evaluate the comparability of results and determine the source of each time series.
2. Determine if the model actually simulates behavior sequences. Compute interset and intraset time series correlation comparisons for both the model and the actual systems.
3. Determine if the model contains soundness of logic. Through empirical testing determine if weighing factors for the various alternatives incorporated in the model are invoked by the users or subjects of the model. Decision making may involve utilization of varying weights over time. This condition must be checked to assure compatability between model logic and actual logic of organization members.

This model specifies the requirements and advantages of a computerized behavioral forecasting model for assisting administration in analyzing personnel policy decisions and their impact on the attitude, productivity and morale of organizational staff members. The introspection required for establishing a model of this type yields fringe benefits in the form of better understanding of ongoing operations and may provide a basis for making significant improvements in existing operations.

The area of behavioral modeling is in its genesis form and will require a significant amount of research and experimentation before models of high reliability and predictability are evolved. A significant degree of model validation must be done on a "comparison with actual" basis; however, as more research is completed in the area a catalog of standard relationships between some variables will evolve.

This dynamic simulation model is complex to formulate and implement because of variability in human responses to given stimuli. Other behavioral models more quantitative in nature which have been developed include linear programming models to maintain a steady state of people for the organization. Markov modeling has also been adapted to the problems of hiring, promotion, termination, career potential and mobility. These linear programming and Markov models utilize elements which can be quantified; transition probabilities, historical manpower movements, etc.

## Special Subsystems

Special subsystems of the computerized information system for decision making will be operationalized on an "as-needed" basis and will access the common data as a primary source of data for processing. Examples of special subsystems include evaluation, linear programming (an optimizer application), and various special administration requests not directly related to any single subsystem.

The evaluation application accesses student data from the common data base and direct application data entry to generate reports for determination of program efficiency and effectiveness. These determinations are based on comparisons of individual programs with all programs reflecting some similar characteristics (e.g., per student expenditure) and comparisons with all programs within the state. Additional evaluative criteria are computed, including a product index which is a composite representation of three critical placement variables and a retention rate which expresses the effectiveness of retaining students in the program.

The linear programming model (optimizer application) for optimizing entry level wages of students based on various criteria (e.g., demand data, program costs, GATB scores, etc.) is an example of multiple subsystem data accessing. Student data from the common data base are interfaced with various cost data from the financial subsystem and supply/demand data from the Occupational Training Information System module.

A pervasive need exists to maintain flexibility within the system for reacting to a multiplicity of non-recurring information requests. Decision makers interviewed within the State Department of Vocational and Technical Education indicated these information requests are and will continue to be an integral part of the decision-making process. Recognition and incorporation of this characteristic into the model assures a realistic dimension. An example of a special administration request may be stated as" "How many handicapped students are served by the funds expended for handicapped instruction?" This problem requires utilization of data from the common data base (e.g., student handicapped statistics) and data from the financial subsystem (e.g., various state and federal funds authorized and expended). The method for accessing the data will be the general purpose file management system for rapid access and multi-subsystem file manipulation.

## Summary

The computerized information system model submitted in this chapter is reflective of the dynamic decision making environment of the Oklahoma State Department of Vocational and Technical Education. The model recognizes the significance of major decision making influence activities (e.g., student data, financial data, and personnel data). The model provides for preparation of all levels of decision making information (e.g., technical, tactical, and strategical). The technical and tactical information is typified by the routine and special request outputs from the student data and financial data subsystems. Strategical decision making is exemplified by the personnel data and behavioral forecasting subsystem and the linear programming application for maximizing student entry level wages. The computerized information system model accommodates the information request variability factor by utilizing the general purpose file management system concept for compressing response time for multi-dimensional, non-recurring information requests. The common data base concept is utilized to assure non-repetitive data entry procedures and maximum access for special information processing activities. The auditor concept reasonably assures validity of data for information processing which is imperative for effective decision making. The locator file concept maximally utilizes computer capability for generating data classifications. The advantages of the locator file concept to data base expansion are reduced costs and minimized error potential. Special subsystems (e.g., special administration requests, evaluation, linear programming, etc.) data access is accommodated by the common data base concept and the general purpose file management concept which minimize access time to any data within the computerized information system.

The model should be implemented on a "phased-in" basis to assure continuity of on-going operation and maximum utilization of computer potential for assistance in decision-making. The conclusions and recommendations of this study are presented in Chapter V.

FOOTNOTES

[1]Saul Gellerman, "Behavioral Strategies," California Management Review (Winter, 1969), p. 45.

[2]Mason Haire, "A New Look at Human Resources," Industrial Management Review (Winter, 1970), pp. 22-23.

[3]James G. March and Herbert A. Simon, Organizations (New York, 1958), pp. 34-35.

[4]Charles A. Meyers, "Behavioral Sciences for Personnel Managers," Harvard Business Review (July/August, 1966), p. 162.

[5]James G. March and Herbert A. Simon, p. 49.

[6]James R. Miller, "Micro-Simulation as an Aid to Managing Human Resources," Industrial Management Review (Winter, 1970), pp. 24-30.

[7]Ibid., pp. 28-29.

[8]Milton L. Lavin, "Strategy in Modeling Manpower Problems," Industrial Management Review (Winter, 1970), pp. 49-50.

# CHAPTER V

# SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

## Summary

A substantial interest is indicated among decision makers within the Oklahoma State Department of Vocational and Technical Education for expanding the information base and the flexibility for accessing. This interest is indicated by the extensive response to personal interviews expressing needs for additional information for ongoing operations, projections of equipment needs, and projections of program expenditures.

The information needs as mentioned previously are multi-variant resulting in a gross inadequacy of a static or totally prescribed information system output. Therefore, the future emphasis should be directed toward recognizing and planning for a system that will react optimumly to a dynamic, low error tolerance, non-repetitive reporting option environment. The salient elements of the proposed model include:

1. A total systems approach (i.e. all information needs analyzed for interdependence, minimized data capture effort, etc.).
2. Double entry accounting to provide maximum flexibility and control.

3. Distribution audit to assure data entering the system conforms to predetermined format and coding prescriptions.
4. Locator files for expanding basic coding identifying a transaction to include additional identification elements automatically for expanded information processing options. Advantages include minimized error rate, minimized coding effort and data base expansion for increased information processing options.
5. A common data base providing minimum maintenance for updating data common to multiple subsystems. A common data base will provide a locus for accumulation of data not associated with specific subsystems and has potential for special information requests.
6. A general purpose file management system to maximize the utilitarian function of a computerized information system by minimizing information access time and minimizing accessing costs through reduced programming, debugging, and implementation costs.

## Conclusions

Implementation of a computerized information system with the capabilities and flexibility prescribed within this study would facilitate the decision-making process within the Oklahoma State Department of Vocational and Technical Education. Concepts which have special significance for decision making include the general purpose file management system with the potential for accessing and manipulating data within abbreviated time frames to satisfy unique one-time information needs.

The current manual/computer information system can not uniformly react to requests for decision making information in an efficient and timely format. Decision makers utilize a heuristic alternative when quantitative processes within the existing system are determined to be restrictive. In these cases, decisions may be made with less than optimum information.

The double entry accounting system prescribed in this study for Financial Accounting is a required effort to optimumly coordinate current decision making information needs and the environmental press for increased accountability, budget reduction and delineation of training responsibility areas.

An information system model addressing all levels of decision making must realistically interface with critical variables and provide flexibility for incorporating changes with minimum dysfunctional impact to on-going operation.

A systems approach for evaluating the total information needs of the Oklahoma State Department of Vocational and Technical Education will yield a significantly more effective decision making mechanism than a fragmented system which addresses isolated problems on an "as required" basis. Disadvantages of a fragmented approach include duplication of data capture efforts, duplication of analysis efforts, duplication of processing, increased costs for redesign as new information requests occur and minimum intra-organization awareness of information available for decision making. The computerized information system model proposed in this study, if implemented utilizing research in the recommended areas, will significantly facilitate the decision making process within the Oklahoma State Department of Vocational and Technical Education.

## Recommendations

A computerized information system derived from the model should be developed for the Oklahoma State Department of Vocational and Technical Education. This model should be used as a long range plan to be implemented on a phased basis dependent on further study of the following critical elements:

1. Expanded systems orientation for increasing the utilization of computerized systems capabilities by decision makers and decision making information sources.
2. Optimum location of computer facilities and design and development activities to effect a system with maximum utility for State Department of Vocational and Technical Education decision makers.
3. Determination of implementation phases for the computerized management information system which will minimize dysfunctional impact to the on-going information system and decision-making process.
4. Completion of cost/benefit analysis for designing and implementing the computerized information system for decision making. This analysis will include both tangible and intangible costs and benefits. Tangible costs/benefits are those specifically identifiable and quantifiable (e.g., reduced manpower requirements). Intangible costs/benefits

are those identified but not readily quantifiable (e.g., compressed response time for information requests).

## BIBLIOGRAPHY

American Data Processing, Inc. Computers in Education--Their Use and Cost. Detroit: American Data Processing, Inc., 1970.

"Annual Descriptive Report, 1971-72." Stillwater: Oklahoma State Department of Vocational and Technical Education, 1972.

Burch, John R. and Felix L. Strater. "Tailoring the Information System." Journal of Systems Management (February, 1973), pp. 34-38.

Bushnell, Don D. and Dwight W. Allen. The Computer in American Education. New York: John Wiley and Sons, Inc., 1967.

Clarke, Lawrence J. "Why Plan for Systems Development?" Journal of Systems Management (June, 1971), pp. 8-11.

Cogswell, J. F., et al. Exploratory Study of Information--Processing Procedures and Computer-Based Technology in Vocational Counseling. Final Report. Santa Monica, California: System Development Corporation, 1967.

Coleman, James S. and Nancy L. Karweit. Information Systems and Performance Measures in Schools. Englewood Cliffs, New Jersey: Educational Technology Publications, 1967.

Cook, Desmond L. The Impact of Systems Analysis on Education. Columbus: Educational Research Management Center, 1968.

Coster, John K. and Robert L. Morgan. The Role of Evaluation in the Decision Making Process. Raleigh: Center for Occupational Education, 1969.

Estavan, D. P. Implementation of Vocational Counseling System and Computer Prediction and Counselor Prediction. Final Report. Santa Monica, California: System Development Corporation, 1969.

Gellerman, Saul. "Behavioral Strategies." California Management Review (Winter, 1970), pp. 45-51.

Goodlad, John I., John F. O'Toole, Jr. and Louise L. Tyler. Computers and Information Systems in Education. Saddle Brook, New Jersey: Harcourt, Brace and World, Inc., 1966.

Greenwood, William L. Decision Theory and Information Systems. Cincinnati: South-Western Publishing Company, 1969.

Grimes, George H. A Proposed Education Information System for the State of Michigan. Lansing: State Department of Education, 1969.

Haire, Mason. "A New Look at Human Resources." Industrial Management Review (Winter, 1970), pp. 17-23.

Harris, Jo Ann. Summary of a Project for Computerized Vocational Information Being Developed at Willowbrook High School. Villa Park, Illinois: Willowbrook High School.

Harvison, C. W. and K. J. Radford. "Creating a Common Data Base." Journal of Systems Management (June, 1972), pp. 8-12.

Havens, Robert I. Computer Applications in Guidance and Counseling. Oshkosh: Wisconsin State University, 1969.

Hayes, R. M. and K. D. Reilly. The Effect of Response Time Upon Utilization of an Information Retrieval System. A Simulation. Los Angeles: Institute of Library Research, 1967.

Jones, Gail P. "An Analysis of the Student Accounting Forms Originating From the Oklahoma State Department of Vocational and Technical Education." (Unpub. M. S. thesis, Oklahoma State University, 1971).

Korfhage, R. R. and T. G. Delutis. A Basis for Time and Cost Evaluation of Information Systems. Lafayette: School of Industrial Engineering, 1969.

Korotkin, Arthur L., et al., A Survey of Computing Activities in Secondary Schools. Silver Springs, Maryland: American Institute for Research, 1970. (ED 047 500)

Kriebel, Charles H. and Richard L. Van Horn. Management Information Systems Research. Pittsburgh: Carnegie-Millon University, 1971.

Lavin, Milton L. "Strategy in Modeling Manpower Problems." Industrial Management Review (Winter, 1970), pp. 47-51.

Le Baron, Walt. Techniques for Developing an Elementary Teacher Education Model. A Short Review of Models, Systems Analysis and Learning Systems. Falls Church, Virginia: System Development Corporation, 1969.

Magisos, Joel H. Interpretation of Target Audience Needs in the Design of Information Dissemination Systems for Vocational and Technical Education. Columbus: The Center for Vocational and Technical Education, 1971.

Maley, Donald. The Implementation and Further Development of Experimental Cluster Concept Programs Through Testing and Evaluation, Including Placement and Follow-Up of Subjects. The Cluster Concept Project. Phase IV. Final Report. College Park: Maryland University, 1969.

March, James G. and Herbert A. Simon. Organizations. New York: John Wiley and Sons, Inc., 1967.

McAllister, Lois, Ed. New Developments in Information Services. Canton, New York: North County Reference and Research Resources Council, 1970.

McCracken, David and Wilma Gillespie. Information Needs of Local Administrators of Vocational Education. Columbus: The Center for Vocational and Technical Education, 1973.

Meyers, Charles A. "Behavioral Sciences for Personnel Managers." Harvard Business Review (July/August, 1966), pp. 160-175.

Miller, James R. "Micro-Simulation as an Aid to Managing Human Resources." Industrial Management Review (Winter, 1970), pp. 24-30.

Monroe, Bruce. Modifying Existing Management Systems for Use in Educational Agencies or How to Eat an Elephant. Seal Beach, California: Space Division/North American Rockwell, 1969. (ED 035 994)

Mowery, Kay A. Methodology of System Design: Definitions and Directions. Atlanta: Georgia Institute of Technology, School of Information Sciences, 1969.

OE Form 3131. Stillwater: Oklahoma State Department of Vocational and Technical Education, 1972.

Podell, Harold J. Developing the Common Data Base for Management Information Systems. VI. Designing a Data Base for Growth. Bethesda, Maryland: Leasco Systems and Research Corporation, 1969.

Postley, John F. "The Mark IV System." Datamation (January, 1968), pp. 28-30.

Reinhart, Bruce A. Toward a Vocational Student Information System. Sacramento: California State Department of Education, 1969.

Roberts, Tommy L., Wayne Richardson, Ed Forsberg, and Gene Smith. The Bartlesville System: Total Guidance Information Support System. Washington: U. S. Office of Education, 1970.

Rzonca, Chester S. and Robert M. Tomlinson. A System Model for the Collection, Processing, Summarization and Comparison of Course Cost, Enrollment and Reimbursement Data at the Community College Level. Springfield: Board of Vocational Education and Rehabilitation, 1971.

South Carolina State Department of Education. Planning for Basic Education Data Systems. Columbia: South Carolina State Department of Education, 1969.

Sparks, David E., et al. A Methodology for the Analysis of Information Systems. Final Report. Reading, Massachusetts: Information Dynamics Corporation, 1965.

Summers, J. K. and J. E. Sullivan. The State of the Art in Information Handling. Operation PEP/Executive Information Systems. Burlingame, California: San Mateo County Superintendent of Schools, 1970.

Sundeen, Donald H. "General-Purpose Software." Datamation (January, 1968), pp. 22-27.

Systems Design Division. "Working Papers." Central Computer Department. Ponca City, Oklahoma: Continental Oil Company, 1968.

Thompson, James D. Organizations in Action. New York: McGraw-Hill Book Company, 1967.

Watson, Hugh H. "Simulating Human Decision Making." Journal of Systems Management (May, 1973), pp. 24-27.

Werner, David J., et al. "Designing Rational Systems." Journal of Systems Management (January, 1973), pp. 34-39.

Wilder, Dolores J. Tennessee Information Retrieval and Dissemination System for Vocational Education. Final Report. Knoxville: Tennessee Research Coordinating Unit for Vocational Education, 1971.

Witmer, David R. The Computer as a Management Tool--Physical Facilities Inventories. Utilization and Projections. 11th Annual Machine Records Conference. Proceedings. Knoxville: University of Tennessee, 1966.

Yee, Patricia, et al. The Construction and Implementation of a Data Base Information System for Vocational Decisions. Cambridge, Massachusetts: Harvard University, Graduate School of Education, 1970.

Zwickel, I., et al. Vocational Education Information Systems State Operating Manual. Volume I. Paramus, New Jersey: Federal Electric Corporation, 1966.

________. Vocational Education Information Systems State Operating Manual. Volume II. Paramus, New Jersey: Federal Electric Corporation, 1966.

APPENDIX

OKLAHOMA STATE DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION
FRANCIS TUTTLE, DIRECTOR • 1515 WEST SIXTH AVE., • STILLWATER, OKLAHOMA 74074 • A.C. (405) 377-2000

April 5, 1973

M E M O R A N D U M

TO: Dr. Bill Stevenson

FROM: Gene Smith

SUBJECT: Interview Schedule

An integral part of my dissertation data gathering procedure includes personal interviews with key decision makers within the State Department of Vocational and Technical Education.

I request a schedule be established to provide a 30-45 minute meeting with each of the following managers.

| | Date | Time |
|---|---|---|
| Francis Tuttle | | |
| Arch Alexander | | |
| Byrle Killian | | |
| Larry Hansen | | |
| Dale Hughey | | |

These meetings will assist in determining the degree to which decision making can be facilitated by a computerized information system.

Scheduling can be flexible with the exclusion of Wednesday afternoons from 3:00-5:00 and all meetings should be completed by April 24.

## ADMINISTRATOR/INTERVIEW GUIDE FOR CONFIGURATING DECISION-MAKING INFORMATION

1. What are the major job/organizational relationships?

2. What are the goals and objectives of the administrative position?

3. What types of information input are required for achieving objectives?

4. What are the major decision-making time frame constraints (i.e., information access rates, decision response rates)?

5. What is the frequency cycle of decision-making activities?

6. Do current information configurations maximally satisfy decision-making information requirements?

7. What delay times are significant in the current decision-making process?

8. What is the variability of decisions made (i.e., what portion of State Department activity is impacted by the administrator's decision-making activities)?

OKLAHOMA STATE DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION ADMINISTRATORS INTERVIEWED FOR MODIFICATION OF DECISION-MAKING INFORMATION CONFIGURATIONS

| Name | Title |
|---|---|
| Francis Tuttle | State Director, Vocational-Technical Education |
| Arch Alexander | Deputy Director, Supportive and Administrative Services |
| Bill Stevenson | Assistant State Director, Research, Planning, and Evaluation |
| Byrle Killian | Assistant State Director, Educational Services and Special Programs |
| Larry Hansen | Assistant State Director, Business, Finance, and Purchasing |
| Fred Shultz | Assistant State Coordinator, Area Vocational-Technical Education |
| Charles Hopkins | Coordinator of Planning, Division of Research, Planning and Evaluation |
| R L Beaty | Finance Director |

2

# VITA

Hubert Gene Smith

Candidate for the Degree of

Doctor of Education

Thesis: A COMPUTERIZED INFORMATION SYSTEM MODEL FOR DECISION MAKING FOR THE OKLAHOMA STATE DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

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Education: Graduated from Ponca City Senior High School, Ponca City, Oklahoma, May, 1949; received the Bachelor of Science degree from Oklahoma State University in 1953 with a major in Business Administration; received the Master of Business Administration degree from Oklahoma State University in May, 1971; completed requirements for the Doctor of Education degree at Oklahoma State University in July, 1973.

Professional Organizations: Beta Gamma Sigma, Association for Systems Management, Delta Sigma Pi, Delta Pi Epsilon, Oklahoma Council of Local Administrators.

Professional Experience: Tabulating, Accounting, Data Control and Operation, Continental Oil Company, Ponca City, Oklahoma, 1953-1957; Methods Analyst, Continental Oil Company, Ponca City, Oklahoma, 1957-1960; Computer Analyst, Continental Oil Company, Ponca City, Oklahoma, 1960-1965; Senior Analyst, Continental Oil Company, Ponca City, Oklahoma, 1965-1969; Assistant Director, Research Project, Bartlesville School System, Bartlesville, Oklahoma, 1969-1971; Research Assistant, Division of Research, Planning, and Evaluation, Oklahoma State Department of Vocational and Technical Education, Stillwater, Oklahoma, 1971-1973.