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BY

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Norman, Oklahoma

1973

A METHODOLOGY FOR EVALUATING ALTERNATIVE TECHNICAL SERVICES SYSTEMS IN LIBRARIES

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DISSERTATION

A METHODOLOGY FOR EVALUATING ALTERNATIVE TECHNICAL SERVICES SYSTEMS IN LIBRARIES

By John Boyd Corbin

Major Professor: Dr. Raymond P. Lutz

As a result of the pressures of the information explosion, increased operating costs, inflation, and a general recognition of a need for modernization, many libraries are either contemplating or engaged in a redesign of their technical services divisions to improve and streamline existing procedures or as a prelude to the installation of completely new or computer-based operations. The library manager assigned the responsibility of planning and designing improved technical services operations must select, in advance, which of the many possible alternative systems would be best. To meet this need, a quantitative basis for comparing and evaluating alternative technical services systems would enable the manager to base his decision to accept or reject a proposed system on acceptable decision criteria rather than on experience, judgment, and intuition.

This work provides a methodology by which alternative technical services systems may be compared and evaluated and the best system selected. A theoretical framework for the methodology is first built and described, in which six phases are identified and examined in detail:

1. Performance of a systems study of each system to divide it into its component operations;
2. Establishment and validation of evaluation criteria for the component operations;
3. Construction of decision models for predicting system performance;
4. Establishment of decision criteria for determining the best system;
5. Simulation of the alternative systems;
6. Selection of the best alternative system.

After it is determined that the methodology theoretically will work, it is demonstrated by the evaluation of a hypothetical manual technical services system against a hypothetical computer-based system, using the framework developed in the six phases. The results of the computer simulations of the alternative systems are placed in a decision matrix, and the bases for determining which is the best system is discussed in detail.

CHAPTER I

INTRODUCTION

Need for Study

An accelerated growth of information accompanied the unparallelled rise of science and technology after World War II, resulting in a wealth of knowledge referred to as an "information explosion."[1] In 1963, John Senders of Bolt Beranek and Newman, Inc., conservatively estimated that there were then between 4.6×10^{14} and 4.6×10^{15} bits of recorded information in the world's libraries and growing at a rate of 3.1% per year; this is a growth rate of about 6.2×10^{13} bits per year, or, a doubling every twenty-two years (82, p. 1968).[2] In contrast, all human knowledge (in and out of libraries) was estimated by 1950 to be doubling every ten years, and by 1970, every five years (4, p. 9).

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[1]James Martin and Adrian Norman believe that "information explosion" is not a good term because "the violent growth of an explosion quickly ends--the growth of man's information has no end in prospect, only greater growth" (59, p. 25).

[2]A bit is a numerical measure of information, based upon the binary unit or bit, which is the logarithm to the base two of a number of possible, equally-likely alternatives specified (1, p. 13).

Information is rapidly becoming a central commodity to our society. Contemporary life has become so information-based, and the problems associated with the mass have become so critical, that a request has been made that information be recognized as a national and international resource, to be managed in the same manner as are our natural resources (93, p. 16).

The shift of our economy from predominantly business and product sectors to services has resulted in a corresponding shift from blue collar to white collar work in every part of society (9, pp. 5-6). From this trend has emerged a need for continuing education or retraining for a large segment of society. More students enrolled in educational institutions on all levels than ever before and more emphasis placed on research and individualized instruction have required fast access to informational materials.

A result of the proliferation of and dependence upon information is that more and more materials (books, documents, reports, and so on) must be reviewed by librarians and other persons involved in the selection of materials for inclusion in libraries, selected or rejected, and acquired and processed for use if selected (8, pp. 168-9). The types of media in which information is stored have expanded and now include microfilm, microfiche, microprint, phonodiscs, magnetic and video tapes on reels and in cassettes, films, filmstrips and filmloops, and other media unknown a decade ago (75, p. 195).

The library is faced not only with a need for fast access to an increasing amount of information in a widening range of dissimilar storage devices which adds to the complexity of library operations, but with increasing operational costs. Costs of labor, equipment, and supplies are increasing at a steady rate (8, p. 169; 10, p. 17). Operating expenditures of college and university libraries, for example, increased during 1968-69 by 15% over the previous year alone (94, p. 12). A similar pattern exists for public libraries (45, p. 146). Another pressure is the recent trend of expecting the library to eliminate wasted and duplicated efforts and to justify its existence. In many large libraries, perhaps 80% of total staff time is devoted to the acquisition and processing of materials (5, p. 30).

The technical services division is that unit of a library responsible for this work. This division also provides the basis for organization (the classification scheme and cataloging) and retrieval (the card catalog, shelf list, and identification or call numbers on materials) of materials, and thus provides the foundation--bibliographic control--for reference and information service, circulation, and other work performed in the library.

Consequently, it is evident that the quality and quantity of work performed in the technical services division of a library is important and can vitally affect the service provided by other divisions of the library to users. Maurice Tauber, a pioneer in technical services, states:

> Surveys have revealed there is a high correlation between failure in technical routines and the ability of library personnel to provide adequate readers' services (87, p. 192).

As a result of these pressures and problems and a general recognition of a need for modernization, many libraries are either contemplating or engaged in a redesign of their technical services divisions to improve and streamline existing procedures or as a prelude to the installation of completely new computer-based operations.

The problem confronting the library manager assigned the responsibility of planning and designing improved technical services operations is his need to select, in advance, which of the many possible alternative systems would be best. In addition, he will want clear answers to such questions as:

1. How many people would be required in a new system?
2. Where would they be needed?
3. Where are the potential bottlenecks?
4. How much volume could be expected from a new system?

The answers to these questions and the criteria for decisions to convert from one system to another are not readily available to the library manager, are not reported in the literature, and therefore must be presumed not to exist. The average librarian does not have the special skills and knowledge to establish a methodology by which proposed systems can be assessed, though he might have a superior knowledge of day-to-day operations in technical services. A systems engineer or other similar person might have a superior knowledge of systems, but he would not have the library background vital for the evaluation of a successful library program.

A study which would provide a quantitative basis or methodology for comparing and evaluating alternative technical services systems is needed. The library manager then could base his decision to accept or reject a proposed system on acceptable decision criteria rather than on experience, judgment, and intuition.

Objectives of the Research

Quantitative measures are needed by which alternative technical services systems in libraries can be compared and evaluated and accepted or rejected. An analysis of a technical services system in order to identify and define the problem and to break it into quantifiable elements could yield decision models which could be studied. Therefore, the objectives of this research were:

1. To define and analyze the technical services division of a library as an operating system, considering both a manual and a computer-based operating system as examples;

2. To establish quantifiable evaluation criteria for measuring the component operations of alternative technical services systems;

3. To establish decision criteria for determining which is the best alternative system;

4. To construct a decision model for forecasting or predicting the performance of alternative technical services systems.

The result of the research was a quantitative methodology by which alternative technical services systems for a library could be compared and evaluated and the best system selected. While this research concerned technical services systems of libraries, the methodology developed can be applied equally well to other divisions or systems of libraries, such as information delivery systems, or to other non-library systems which are of the job-shop or enterprise nature common in many manufacturing and business organizations.

Summary of Phases of Evaluating Alternative Technical Services Systems

A summary of the phases of evaluating alternative technical services systems for a library is as follows:

1. Performance of a systems study of the alternative technical services systems;

2. Establishment and validation of evaluation criteria for component operations of the alternative systems;

3. Construction of decision models for predicting system performance;

4. Establishment of decision criteria for determining the best alternative system;

5. Simulation of the alternative systems;

6. Selection of the best alternative system.

A detailed summary of the procedures within each of these six phases can be found in Appendix K.

CHAPTER II

A METHODOLOGY FOR EVALUATING ALTERNATIVE TECHNICAL SERVICES SYSTEMS: THEORETICAL DEVELOPMENT

The evaluation of possible alternative technical services systems for a library and the selection of one for implementation must be achieved, as much as possible, without disrupting an existing system. Past experience has shown that an existing technical services system must remain in operation and at its peak performance level until the alternative system which will replace it has been selected and is ready to be installed or implemented. Especially in the case of a computer-based system, an existing manual and the new system should operate initially in parallel to assure continuous operation of the technical services division. Direct experimentation on an existing system as a whole should be limited to activities such as a systems study, time study, sampling, job evaluations, and so on, which are necessary but only minimally disruptive. Experimentation and study for the improvement of individual and isolated operations on a continuing basis are, of course, necessary.

The library manager must compare and evaluate an existing system against one or more possible, alternative systems or against an ideal system, using one or more decision criteria established for the best system. To properly evaluate alternative systems, the library manager must have:

1. Detailed knowledge of how the systems work or will work;
2. Evaluation criteria for measuring component operations of the systems;
3. Decision criteria for determining which is the best alternative system;
4. A decision model for forecasting or predicting system performance.

The six phases for evaluating alternative technical services system (the study of the alternative systems, the establishment and validation of evaluation criteria for their component operations, the establishment of decision criteria for determining the best system, the construction of decision models for forecasting system performance, simulation of the alternative systems, and selection of the best system) will be approached sequentially, beginning with the following systems study.

The Technical Services Division of the Library as a System

A system may be defined as a set of parts or elements coordinated to accomplish a set of goals (22, p. 29). It is composed of interdependent and interacting people, materials, information, equipment, facilities, and other resources. Each element or sub-system can also be viewed separately as a distinct and complete system which contains its own set of parts or elements coordinated to accomplish a set of goals.[1] For example, the library is a dynamic system with three basic elements (administrative services, public services, and technical services) whose common goal is to provide users access to materials and information. Each of the three elements of the library can be separated further into smaller elements or sub-systems. Thus, a system can be progressively subdivided again and again until a desired level is reached or until no further division can be made.[2]

For the past several decades, the concept of library organization has been that of technical, as opposed to service, functions (86, p. 24). A common organizational pattern for a library is the reflection of these functions in "public" and "non-public" services or divisions. The public services include refer-

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[1]Society, the universe, or "the whole" is composed of a hierarchy of systems; each system is a sub-system of the next higher system (56, p. 3).

[2]The systems approach or concept implies that the elements of a system are viewed first as a series of interlocking operations, rather than as separate and unrelated parts; the interrelationships or integrity of the elements are stressed (70, p. 232).

ence, circulation, interlibrary loans, and other functions pertaining to the retrieval and distribution or dissemination of materials and information to library users in which the staff routinely meets and serves the public directly. The technical services, on the other hand, include the acquisition and processing of materials, where the staff does not ordinarily meet or serve the public directly.[1] Some other functions, such as general or overall management and administration of the library, personnel services, building maintenance, and so on, are necessary and common to both public and technical services. For this reason, a third function has been added: general administrative services. This function is not unique to libraries and is amenable to study by ordinary business and management theory.

Activities are not independently distributed among the public, technical, and general administrative functions. For example, in the circulation department, which is usually considered a public service function, there is clerical work such as filing, sorting, and other

---

[1]Other terms used to describe technical services are "technical processing," "processing services," "processing," "preparations," and so on. The word, "technical," is perhaps a bad choice, since it does not convey the true meaning of non-public services. However, for lack of a better term, librarians have continued to refer to them as "technical services," which is the most prevalent designation today (101, v. 1, p. 2).

operations which do not involve direct public service, yet which is not considered a technical services function.[1] Other examples are that both public and technical services include some administration and management of the respective functions. Also, the selection of materials for the library's collections often is divided among all three divisions of the library. Tradition, personnel, physical quarters, financial support, personalities, and the attitude of administrative officials can account for variations of organization from library to library (88, p. 4). However, most operations of a library can be placed without serious argument into one of three categories:

1. General administrative services;
2. Public services;
3. Technical services.

This more-or-less natural tricotomy of functions, which are not necessarily congruent with management lines, has served librarians fairly well in organizing and operating their libraries, particularly in those large organizations where a specialization of personnel is necessary and closely-related functions are most effectively performed together.

The technical services division of a library

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[1] Maurice Tauber does put all circulation operations in technical services (88, pp. 343-87).

is composed of a variety of activities; among them are verifying and searching; ordering; receiving, cataloging and classifying; and physically processing materials for use.[1] These have a sequential relationship and are closely interwoven and coordinated in a well-organized library (24, p. 166). The mission or goal of the technical services division is to acquire, organize, and otherwise process library materials for use in the most efficient and effective manner possible while maintaining the highest standards of quality attainable. The technical services division of a library, then, has all the qualifications of a system:[2]

1. A set of elements;
2. Coordination;
3. Goals.

Together, the elements of technical services can be viewed, not only as a system discussed above, but as an input-output mechanism or device (see Figure 1). Requests for materials to be acquired and processed are input into the system, where step-by-step acquisition and processing operations occur. Output is the

---

[1]The concept of a unit of library operations designated as "technical services" can be traced back as far as 1939. By 1948 at least 48 libraries were known to have had such units, and the trend continued in the next two decades (28, p. 202).

[2]Hereafter, technical services will be referred to as a system by itself, rather than as an element or subsystem of the library as a system.

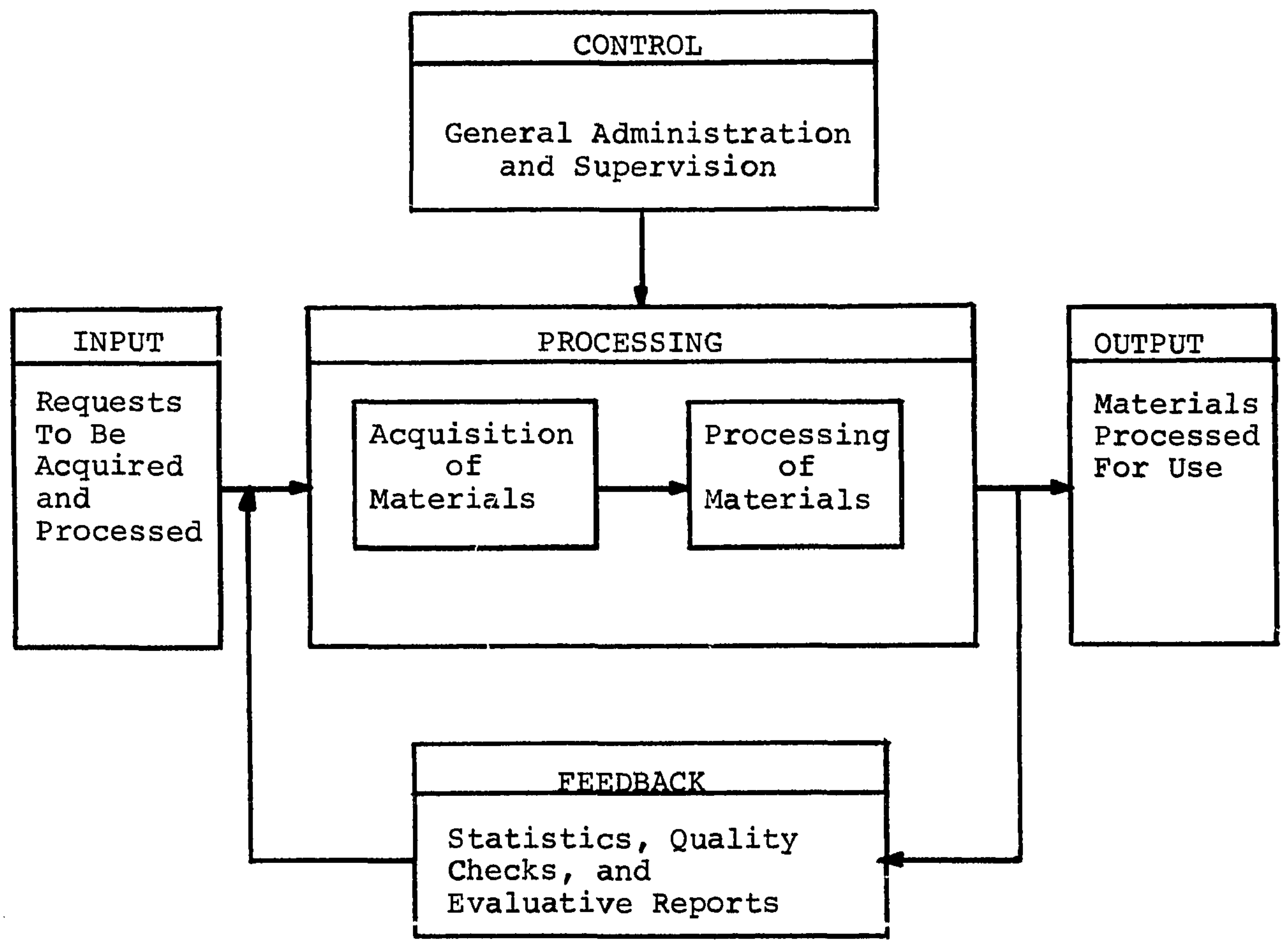

Fig. 1.--A model of technical services as an input-output mechanism or device (101, v. 1, p. 45).

materials processed for use. General administration and supervision of the system provide control of the operations to meet the goals and objectives of the system. Information such as statistics, quality checks, and evaluative reports pertaining to the quality and quantity of the operations and the final output is transmitted back to the beginning of the system, where future input can be qualitatively and/or quantitatively influenced by this feedback (81, p. 12).

The objectives of and procedures in a study of the technical services division of a library as an operating system are:

1. To identify the technical services division as an operating system and to establish its boundaries and parameters;
2. To determine the goals and objectives of the system;
3. To divide the system into its component parts;
4. To establish the work flow through the system.

Usually, the general purpose of a systems study is to learn enough about a system to design and implement a better one, if that is possible (63, p. 88). The results of a systems study of technical services could indicate that the division is meeting its goals and objectives operationally and economically and that no change should be made; or, that an existing manual system should be replaced by a computer-based one (18, p. 22).[1] In this research, the systems study was needed, not to be able to design a better technical services system, but to separate it into its component parts for complete understanding in an unambiguous manner.

Two common management science techniques which can be utilized in a systems study of technical services are:

1. Systems analysis;
2. Flowcharting.

Systems analysis is a method or procedure by which the component parts or elements of a system are studied and their relationships sought (58, p. 257).[2] In this research, the technique was used only to analyze alternative technical services systems, not to design them. However, systems analysis can provide the decision-making ingredients necessary for a conversion from one system to another, whether it be from a manual to a machine system or from an existing manual system to another

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[1]Indeed, it may well be that by far the most significant result of a study of technical services could be an improvement of the existing system resulting from the study itself (99, p. 27).

[2]Variant terms for systems analysis are "systems and procedures," "process analysis," "work design," "operations analysis," "methods study," "work simplification," "motion economy," "methods improvement," and others.

improved manual system (63, p. 88).[1] During or after the process of separating the complex procedures of the technical services system, the sequence of the component operations can be indicated by the use of flowcharts.[2]

The technical services division is first identified as a unique and distinct element of the library system and isolated from all other sub-functions. This initial step is the beginning of a series of successive partitionings performed until the technical services division has been separated into its smallest logical components essential to a study (14, p. 298). Parallel to the separation of the division into its component parts is the determination and statement of its goals and objectives.[3]

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[1]Systems analysis probably has been used by librarians more than any other management science technique, particularly since the introduction of the computer to library operations. Efforts to apply such techniques to routine procedures common to library operations frequently result in personnel cost saving opportunities ranging from 10 to 20% (10, p. 41). An overview of scientific management and its value to librarians can be found in Dougherty and Heinritz (30, pp. 13-19).

[2]The general use and application of flowcharts to library operations has been well documented by Dougherty, Gull, Hayes, and others (30, 33, 36).

[3]Determining the goals and objectives of a system can and must be done in advance if a new system is being designed. In the analysis of an existing system, this is more difficult and might be impossible until the nature of the components is known. This is true particularly if the goals for a system have never been stated or have been forgotten.

Requirements for the goals and objectives of the technical services system are that they be independent and collectively exhaustive. That is, the goals and objectives of a sub-system of technical services must not duplicate those of another sub-system, though they must be in harmony with each other lest sub-systems work at cross-purposes. Also, the goals and objectives must be broad or general enough to encompass or describe all its component operations. The over-all goals and objectives of technical services, of course, can not jeopardize those of the library itself.

Once the technical services system has been isolated, it must then be separated into its component parts for further study. Five levels are deemed necessary and sufficient for an analysis of technical services as an operating system:[1]

Level 1---System

Level 2---Sub-Systems (Components of a System)

Level 3---Activities (Components of Sub-Systems)

---

[1]Very few authors agree on terminology for the levels of a system. The terms used here are arbitrary but seem logical and are simpler than, for example, sub-sub-sub-sub-system as a designation for tasks. The results of a division of the hypothetical manual and computer-based systems used as examples in this research are in Appendices A and B, respectively. Operations are divided further into their component tasks or steps only to indicate which of the variations in performing operations are considered.

Level 4---Operations (Components of Activities)

Level 5---Tasks (Components of Operations)

These levels are shown in Figure 2 as a general model for the analysis of technical services. This method of analysis is used because it is an effective and logical means of breaking the complex technical services system into more manageable and understandable components.

The process of separating the system into its component levels is begun by determining the sub-systems (Level 2) comprising the system. Each sub-system then is subdivided, and the process is continued until an outline of the system adequate to enable studies to be undertaken emerges (66, p. 95). This pyramid concept also structures a system and enables the analyst to see relationships between the levels. The last step of the study of technical services is the establishment of work flow through the system. This is accomplished by preparing flowcharts which graphically portray the sequence in which operations are performed (19, p. 29).[1]

Once the study of technical services as a system has been completed, criteria must be established for evaluating its component operations.

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[1]Flowcharts for the hypothetical manual and computer-based technical services systems used in this research are in Appendices D and E, respectively.

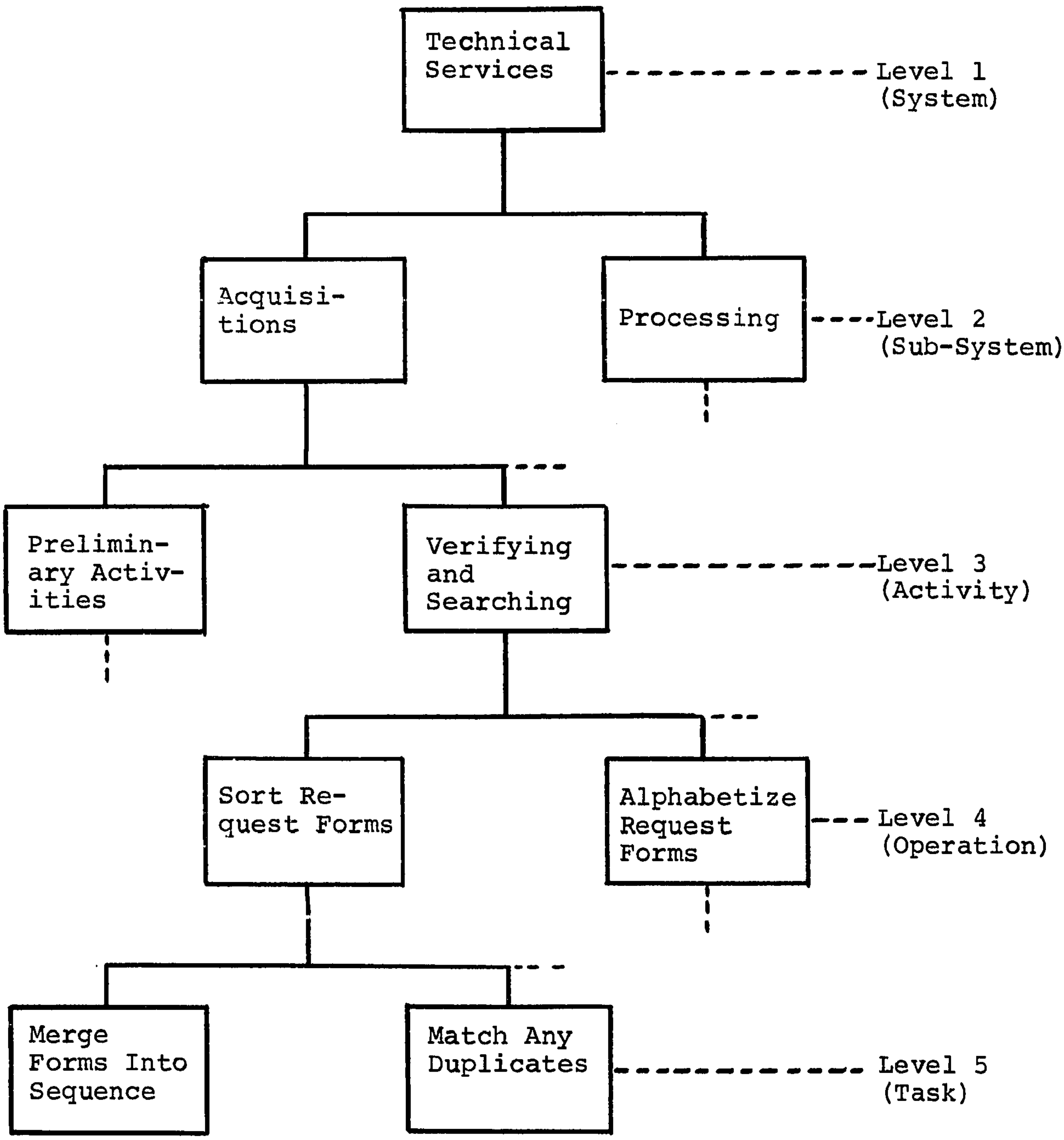

Fig. 2.--A general model for the analysis of technical services as an operating system.

Evaluation Criteria for Technical Services Operations

As seen from the study of a technical services division, that system is comprised of a number of sub-systems and activities which can be separated further into a series of operations and tasks which can be displayed graphically in sequence by flowcharts. The next phase of evaluating alternative technical services systems is to determine the times required to perform the component operations.

Evaluation criteria are defined as requirements or rules on which judgments or decisions may be based; they are the bases or standards for evaluation of that being evaluated (54, p. 26; 101, v. 2, p. 7).[1] The criteria consist of the steps or tasks of operations, which were determined in the systems study, and the standard times required to perform them. Together, these provide a means by which an existing or proposed operation can be compared and evaluated for effectiveness.

Evaluation criteria will define and delimit operations in such a manner that an analyst or performer of the operations will know precisely of what the operations consist and the times required to perform them. For example, a criterion for an operation in the acquisitions sub-system

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[1] Other terms for criteria are "policies," "standards," "rules," or "measures."

of the technical services system might be:

> A trained clerk can alphabetize an incoming request for purchase by title or main entry in nine seconds.

The characteristics of the operation in this criterion are:

1. A trained clerk should perform the operation;
2. A request can be alphabetized either by title or by main entry;
3. A request can be alphabetized in nine seconds.

Thus the evaluation criterion both describes desirable characteristics of an operation and provides a quantitative means of evaluating it.

Evaluation criteria must be relevant and reliable, if they are to be useful in evaluating existing or possible operations. If criteria are relevant, they are reasonably appropriate and sound measures of the operations in question which will produce the desired results of being able to measure those operations adequately (66, p. 751; 101, v. 3, p. 2). If criteria are reliable, they are trustworthy and dependable to be about the same if measured repeatedly under the same conditions (54, p. 30; 101, v. 3, p. 2).

There are several methods for determining the times required to perform technical services operations. Among those described by Nadler are (66, pp. 749-50):

1. The time study;
2. Elemental standard data;
3. Work sampling;
4. Informed estimation.

The time study is an analysis of operations for the purpose of determining the times that it should take qualified people, working at normal paces, to perform the operations, using definite and prescribed methods (6, p. 659). This technique provides a means for determining the preferred methods of performing work and a means for measuring it (38, p. 558). Barnes lists seven steps in the procedure for a time study (6, pp. 661-3):

1. Contact the supervisor of the performer of an operation;
2. Contact the operator to be timed; in no case should a time study be made without the operator's knowledge;
3. Check the operation for method; the supervisor should approve the method in use as being valid and complete;
4. Obtain all necessary information; the analyst should obtain and record on an observation sheet all information about the job or operation, such as operator location, materials, and tools;
5. Divide the operation into tasks; the operation should be divided into tasks as short in duration as can be accurately timed. Each task must be carefully defined and delineated;
6. Record the time; the analyst should carefully time all tasks of an operation to obtain the representative time taken for each;

7. Rate the operator's performance; due to the difference in individuals' paces, the operator being timed must be rated, for example, against a normal day-work pace index of 100 points. This is the normal time for the performance of an operation.

Rating an operator's performance perhaps is the most difficult part of the time study. This is the process of comparing the performance, speed, or tempo of an operation under observation with the observer's own concept of normal performance (6, p. 381). If the observer believes the operator is working at a normal pace, he assigns a rating factor of 100%. If the pace is thought to be above normal, a rating of more than 100% is given; if the pace is less than normal, a rating of less than 100% is given. The accuracy of rating depends almost entirely upon the skills and subjective judgment of the rater and on what appears to be fair to the employee (30, p. 110).

The normal time for the performance of an operation does not include time for:

1. Personal allowances;
2. Fatigue;
3. Delay.

Since these factors are to be expected, they must be accounted for in a time study. Therefore, the term, "standard time," is used to denote normal time plus allowances.[1] Allowances are added to normal time in the following manner:

Standard Time = Normal Time + (Normal Time x Allowances in Per Cent)

Using Barnes' method of computing standard time, the time to alphabetize a request form, for example, would be found as follows:

Selected Time = 0.15 Minutes

Rating Factor = 110%

Personal Allowances = 5%

Normal Time = $0.15 \times \frac{110}{100} = 0.17$ Minutes

Standard Time = 0.17 + (0.17 x 0.05) = 0.179 Minutes

The time study is discussed at length by Barnes and by Nadler (6, 66). Dougherty and Logsdon discuss it briefly and its applications to libraries. Other librarians have performed research on specific applications of the time study to library operations (30, 52, 61).

Elemental standard data are output information from operations collected for the purpose of establishing standard times or output predictions without making

[1]Barnes suggests a personal allowance of from 2 to 5% per day, or 10 to 24 minutes, depending upon the type of work, and states that the fatigue and delay factors usually can be either incorporated into organized rest breaks, minimized, or added into the time for personal allowances as one single computation (6, pp. 401-5).

direct measurements of the tasks (66, p. 464). Work sampling can determine the percentage of time spent by a person on an operation, based on samples (30, p. 131). Informed estimation is based on subjective estimates by qualified supervisors when operations are extremely difficult to measure (66, p. 751).[1] An example of the use of informed estimates would be the measurement of some cataloging and classification operations in technical services work. These operations are, to a great extent, intellectual in nature, and the performance times often are dependent in part upon the skills of the performer, the data and information available to him, and the complexity of the subject matter being cataloged and classified.

The performance times for technical services operations must be determined utilizing the most appropriate method possible. In all cases, the time study method is preferred because it is the most precise. Regardless of the technique used, some variability in performance times should be allowed. People psychologically will accept work standards or performance criteria more readily if they know that they are not expected to perform operations in exactly the same amounts of time each time. The standard deviation might be used as an indicator

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[1]The informed estimation is the least reliable of all the methods, but sometimes it is the only possible one which can be used.

of permissible variation. An appropriate standard deviation of ten per cent of the mean value of a performance time has been suggested as appropriate (6, p. 366; 66, p. 432).

After the alternative technical services systems have been analyzed and criteria have been established for evaluating their operations, models must be constructed by which the performance of the systems can be forecast or predicted.

A Decision Model for Predicting System Performance

A common model for determining the expected outcome of a system is one which minimizes the total times to perform all its component operations. For example, to find the time required to perform the i_{th} operation, T_i , the following model could be used:

$$T_i = \sum_{j=1}^{m} P_j t_j c_j$$

where: P_j = The j_{th} task of the i_{th} operation, $1 \leq j \leq m$;

P_j = 1 if the task is performed;

P_j = 0 if the task is not performed;

t_j = Time required for the j_{th} task, $t_j \geq 0$;

c_j = A performance constant for the j_{th} task, which might be

used as a utility or weighting factor for cost, time, quality, community service, and so on.

If the criterion for optimum system operation is to minimize the time required to perform i operations, where $1 \leq i \leq n$, then the objective function for the system would be:

$$Z_m = \sum_{i=1}^{n} T_i$$

where: Z_m = The minimum time required to perform all i operations.

Such a single-criterion optimization model is sufficient for evaluating processes in a system where the performance times of operations can be reduced to the lowest possible values. In such cases, total processing times of alternative system configurations can be minimized.

Component operations of a technical services system will, however, require different performance times when repeatedly executed because the materials being processed are unique to an extent. Intellectual decisions requiring varying time frames are incorporated into most operations; in other cases, the amount of information to be processed varies. For example, the time required to type headings on catalog cards is proportional to the length of the headings to be typed; a subject heading of three lines obviously will require more time than one of three words.

Also, the purpose of evaluating an alternative technical services system is not necessarily to determine if it offers an optimum solution, but whether or not it is acceptable, based on the information available (such as performance data for component operations) and on the decision criteria established for selecting the best system (32, p. 11).[1] Therefore, the minimization approach may not suffice in evaluating a technical services system for two reasons:

1. A technical services system is stochastic by nature; that is, because of the variables allowed in the performance times of operations, repeated applications of the same model can produce different results;

2. The evaluation of a technical services system normally is based on a combination of several decision criteria rather than on a single, minimization criterion.

In evaluating complex, alternative technical services systems which have variable performance times for their component operations and with multiple criteria for determining the best system, a computer simulation tech-

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[1] Decision criteria for selecting the best system are discussed in the next section of this chapter.

nique can be used to obtain enough trial outcomes over a period of time to obtain a sufficiently close approximation of the mean performance times of operations in such dynamic systems (15, p. 271).[1] Simulation also enables a demonstration of the effects, problems, difficulties, and relative merits of alternative systems which can be used in applying the multiple criteria for the best system (25, p. 47).

Most general purpose programming languages such as FORTRAN, COBOL, PL/1, and others can be used to prepare a computer simulation model for predicting the performances of alternative technical services systems. However, the use of a special simulation "language" such as GPSS, SIMSCRIPT, GASP, DYNAMO, and others, offers:

1. A generalized structure for designing simulation models;
2. A convenient and fast method for converting simulation models into computer programs;
3. A rapid means of making changes in models which could readily be reflected in machine programs when testing alternative methods;
4. A flexible means of obtaining useful results or outputs for analysis.

Since GPSS (General Purpose Simulation System) was designed for job shop or enterprise models used in

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[1]Simulation is defined as the process of conducting experiments on a model describing the behavior of a system over extended periods of actual time in lieu of direct experimentation with the system itself (6, p. 1).

business and industry, which the technical services system closely resembles, this simulation language is described here and was used in this research (see Chapter III). This language is relatively easy to learn and is flexible enough to be adaptable to library operations. This type of simulation has been applied to technical services work before. As reported by Stephens, the New York State Library has used GPSS II (an earlier version of GPSS) in their technical services to simulate acquisitions, cataloging, catalog maintenance, invoice production, and card production. The stated purpose of their simulation was to project the effect of personnel changes and increasing work loads into the future (84, p. 280). The advantages and disadvantages of their simulations were discussed, and samples of output were shown.

GPSS is a problem-oriented language, which means that the functional flow of items or jobs through the technical services systems can be described directly (31, p. 118). The orientation of GPSS is one of transactions moving in time through a system composed essentially of facilities, storages, and queues (60, p. 219). In order to use the language, materials or items being processed in the technical services system are viewed as units of traffic called transactions that flow through queues, storages, and facilities (7, p. 190). The models of the alternative technical services systems to be evaluated are a series of static block designs similar to those in a block diagram flowchart.[1] The diagrams become symbolic representations of the systems (40, p. 1). The block diagram models thus constructed become sets of interrelated logical and mathematical symbols which represent those aspects of the alternative systems to be evaluated which are of interest and are to be simulated (40, p. 5).[2]

The GPSS models provide the means by which the performance of the alternative technical services systems can be predicted and evaluated. The simulation programs create transactions representing materials being processed, moves them through the specified blocks in the models representing staff and machines, and executes the actions associated with the blocks. The transactions move from block to block in a manner similar to the way in which materials being processed would progress in the real technical services systems. Statistics are automatically gathered and reported as transactions move from block to block through the models. Among the statistics which can be compiled and reported to the analyst are:

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[1]The GPSS symbols used in this research are shown in Appendix F.

[2]The GPSS flowcharts of the hypothetical manual and computer-based technical services systems used as examples in this research are in Appendices G and H, respectively.

1. The number of transactions passing through each block in the models;
2. The utilization times of facilities such as staff or machines, including the number of transactions received and the average number of units of time that transactions are held for processing; these statistics can indicate to the library manager, for example, which facilities (staff or machines) are overloaded or underloaded and therefore where more or less staff or machines are needed;
3. The maximum, average, and total contents of queues in the systems where transactions must be delayed to await processing by facilities such as staff or machines; these statistics can indicate, for example, which staff or machines are bottlenecks in the work flows by causing long waiting lines for processing.

These statistics provide a means by which the analyst can be assured that (67, p. 5):

1. The models are operating as intended;
2. Accurate results can be derived concerning the behavior of the models;
3. Decisions can be made from the data generated by the simulation experiments.

After the GPSS models have been constructed, they should be tested with actual or test data (the evaluation criteria or performance data). Before the performance of each alternative system being evaluated is actually simulated on the computer, the library manager must establish decision criteria for determining the best system.

Decision Criteria for Determining the Best System

The technical services system ultimately chosen from a group of alternatives must be the one which most closely matches one or more decision criteria established in advance for what constitutes the best system. Decision criteria or decision rules are policies upon which decisions are made (80, p. 9); examples are:

> Choose the alternative system which will enable the staff to process the most items meeting all quality check requirements; or:
>
> Choose the alternative system which will minimize costs the most; or:
>
> Reject the alternative system whose unit costs exceed $10.00.

Most decision criteria which can be established for determining the best system can be placed into one of two general categories (55, p. 25):

1. Those pertaining to a system's output;
2. Those pertaining to a system's costs.

Decision criteria can reflect a need to maximize total output of a system; to use more clerical than professional staff; to use no professional staff; to minimize the total staff necessary to operate the system; to reduce total or unit costs to a minimum or not to exceed a set cost figure; and so on. These criteria, once established, are relatively easy to apply to a technical services system being evaluated because they can be measured quantitatively. Qualitative or subjective decision criteria might be easy to establish but very difficult to apply; for example, a criterion might be established to accept a system in which a maximum number of minority or unskilled workers can be incorporated; which will provide a maximum amount of prestige to the library; or which would not be conducive to the establishment of a labor union.

Decision criteria for determining the best alternative system being evaluated must be based on accurate knowledge of the real constraints or pressures upon the library (internally as well as externally) in which the alternative technical services system ultimately chosen for implementation will exist; examples of some constraints are:

1. Pressure from a governing board, users, or other groups for the technical services division to process materials in the shortest possible times regardless of costs;

2. A unit or total cost factor which can not be exceeded;

3. A lack of adequate equipment or qualified staff (such as a particular computer configuration, machine programmers, managers, and so on) to support an alternative system being considered;

4. An anticipated lack of commitment to or support of a proposed alternative system by the library's governing board, manager, staff, or other groups or individuals;

5. An abundance of clerical staff to the library but a lack of professional persons;

6. A desire to install a highly flexible system which can be expanded or altered later at minimum cost.

A decision to accept or reject an alternative technical services system being evaluated is usually based on multiple criteria. It is the belief of the researcher that the more decision criteria which are established for the best system, the better a decision will be.

Up to this point, the following steps have been accomplished in the evaluation of alternative technical services systems:

1. Each system to be evaluated has been divided into its component parts, with goals, objectives, and work flow established;

2. Evaluation criteria have been established for the component operations of each alternative system to be evaluated;

3. Decision models for predicting system performance have been constructed for each alternative system;

4. Decision criteria for determining the best system have been established.

The remaining steps in the methodology are to simulate the performance of each alternative system on the computer and to select the best system from those evaluated.

Selecting the Best Alternative System

After the performance of each alternative technical services system to be evaluated has been simulated on the computer, the expected values (the forecast of the system's performance) resulting from manipulation of data through the predictive models and from additional interpretations can serve as the quantitative basis for selecting the best system. A schematic of this decision-making process for selecting the best system is shown in Figure 3.

The values upon which the best alternative system will be selected can be placed into a decision matrix, shown in Figure 4. S_n in the matrix can represent alternative technical services systems being evaluated; DC_m can represent the decision criteria established for determining the best system; and E_{ij} can represent values in units of output, time, money, or other suitable quantitative values which are determined through the simulations of each system being evaluated (66, p. 675). Some quantitative values which can be obtained from the computer simulations of the alternative systems or from interpretations of the results for each decision criterion established for a system to be evaluated include:

1. Means or averages, which can be used as the primary basis of comparison of systems' performances;

2. Measures of variation, such as variances and standard deviations, which can be used to indicate the dispersions of values about the means;

3. Relative differences, such as percentage differences between means or averages, which can be used as simple measures of difference in systems' performances;

4. Tests of significance, which can be used to determine whether the differences between means or averages are statistically significant or whether the differences can be attributed to chance.

Decision criteria for selecting the best system should be ranked (or perhaps weighted) in the matrix in order of importance to the decision-making process. A pre-determined number of criteria should be considered so vital that any alternative system being evaluated must be significantly superior in all these categories in order to be selected clearly as the best system.

Thus, the values placed into the matrix can provide the library manager with a quantitative basis for comparing and evaluating alternative technical services systems.[1] Then, he can accept or reject an alternative on acceptable decision criteria rather than on experience, judgment, and intuition.

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[1]The use of these values is demonstrated in Chapter III.

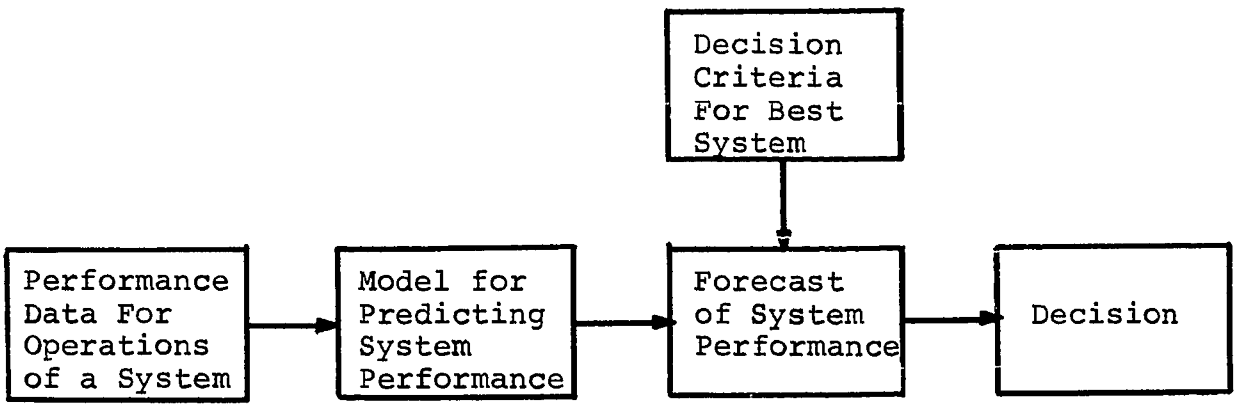

Fig. 3.--A model of the decision-making process for evaluating a technical services system.

	S_1	S_2	S_3	...	S_n
DC_1	E_{11}	E_{12}	E_{13}	...	E_{1j}
DC_2	E_{21}	E_{22}	E_{23}	...	E_{2j}
DC_3	E_{31}	E_{32}	E_{33}	...	E_{3j}
. . .	...	...	...	...	...
DC_m	E_{i1}	E_{i2}	E_{i3}	...	E_{ij}

Fig. 4.--A decision matrix for recording outcomes of system evaluations. DC_m are decision criteria established in advance for the best system; S_n are alternative systems; and E_{ij} are values by which the system will be evaluated.

CHAPTER III

DEMONSTRATING THE METHODOLOGY

In order to demonstrate the methodology of comparing and evaluating alternative technical services systems for libraries, a hypothetical manual system was evaluated against a hypothetical computer-based system. The situation could have represented any combination of alternative systems. For example, an existing manual system could have been evaluated against another existing manual system; a proposed automated system could have been evaluated against a proposed manual system; and so on. More than two alternatives could have been evaluated simultaneously, if so desired. An existing manual system could have been evaluated against, for example, any number of proposed manual systems and proposed computer-based systems. In each case, the procedures for evaluation and comparison would have been identical.

Demonstrating the methodology required six phases, as discussed in Chapter II:

1. Performance of a systems study of the alternative technical services systems;
2. Establishment and validation of evaluation criteria for component operations of the alternative systems;

3. Construction of decision models for predicting system performance;
4. Establishment of decision criteria for determining the best alternative system;
5. Simulation of the alternative systems;
6. Selection of the best alternative system.

Performance of a Systems Study of the Alternative Technical Services Systems

A systems study was performed on the alternative manual and computer-based technical services systems used as examples in this research. The procedures for this study were:

1. Identification of the two as operating systems;
2. Determination of the goals and objectives and boundaries and parameters of the systems;
3. Division of the systems into their component parts;
4. Establishment of work flows through the systems.

The library in which the two hypothetical systems could exist is a composite of many and representative of those in medium-sized college or public libraries.[1] This type of library has an average acquisitions rate under 50,000 volumes at a minimum (94). The manual technical ser-

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[1]Typically, the library using a computer is a university or special library, with an annual acquisitions rate of around 50,000 volumes. Historical accounts of the use of data processing and computers in libraries can be found in Kent and Lancour (43, v. 2, pp. 184-230) and Kilgour (46, pp. 218-29).

vices system in this application was presumed to be working properly. The library manager had been asked to design a computer-based system to replace an existing system and to determine in advance if the alternative system could:

1. Reduce processing times for acquiring and processing materials;
2. Utilize fewer staff members in technical services;
3. Have a lower staffing cost in technical services.

The conversion of necessary files and records to a machine-readable form in the computer-based system was ignored so that study could be concentrated on the actual operating system itself.[1] The type of computer was considered to be immaterial as long as its processing and storage capacities were sufficient for the library's needs. The physical location of the computer (in-house, separate department of a campus or city, or a service bureau) was assumed to have little or no effect on the operations studied and, therefore, was ignored in this research.

A very important point was that only operations in the critical paths of work in the alternative systems used as examples were studied. In order to be included in the critical path of work, an operation had to directly affect the movement of information or materials through the system; that is, if information or materials could not progress to

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[1]It is understood that the conversion of files and records to a machine-readable form is a difficult and expensive struggle; however, this problem (important as it is) was not central to this research.

the next step or phase of a system without the performance of an operation, then that operation was considered to be vital to the main flow of work and therefore was studied. This distinction was made because some component operations do not affect or change the basic system concept, whereas other operations directly affect the total system (66, p. 673).

The research was concerned primarily with the large percentage of library materials which can be acquired and processed in a routine manner through normal flows of work in a technical services system without special procedures or handling. Gifts and exchanges, government documents, out-of-print materials, and blanket orders were omitted unless the materials could be handled in normal routines such as those for domestic, in-print monographs.[1] Serial publications were excluded from the study because they required different handling procedures from monographs and normally are handled separately in a technical services system in any case, even though many of the operations are the same for serials as for monographs.

Finally, this research was concerned primarily with the operations and flow of work of a technical services system and not directly with equipment, supplies, and floor space. However, once the operations and work flows of a system have been established, modelled, and simulated, the

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[1]In the evaluation of real library systems, the library manager can enlarge his models to include these special materials or can model and study each type separately.

library manager can determine the other resources that will be necessary to maintain a system by studying the results of the simulations and their evaluations.

The five levels of a system discussed in Chapter II were used in the systems study of the manual and computer-based systems used as examples in this research. The two example systems were divided into two major sub-systems, as shown in Figure 5. These two sub-systems were:[1]

1. The acquisition of materials;
2. The processing of materials.

The goals of the systems and sub-systems are also indicated. Four activities of the acquisitions sub-system of the manual and computer-based systems used as examples were isolated, as shown in Figure 6:

1. Preliminary activities;
2. Verifying and searching;
3. Ordering;
4. Receiving.

The operations into which the activities were divided (see Appendices A and B for a full description) began with the receipt, screening, and sorting of incoming requests for purchase from materials selectors (such as faculty, staff, students, and the general public) prior to initiation of the acquisitions process. The requests are veri-

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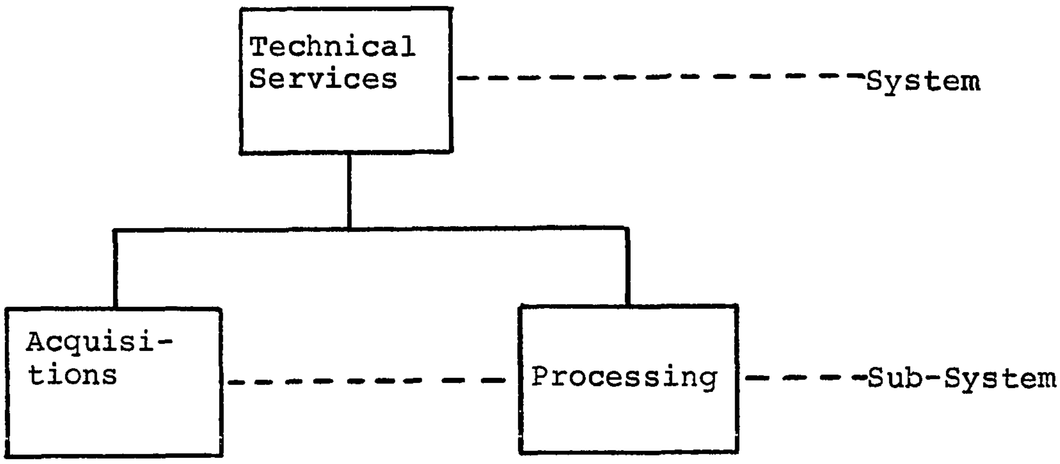
[1]Alternative names are given to the sub-systems and activities by different libraries. Some activities might be in different combinations and some might be emphasized more than others, but all appear to be universal to any technical services system, manual or computer-based.



GOAL OF THE TECHNICAL SERVICES SYSTEM: To acquire and organize knowledge in all fields required.

GOAL OF THE ACQUISITIONS SUB-SYSTEM: To acquire knowledge in all fields required.

GOAL OF THE PROCESSING SUB-SYSTEM: To organize knowledge in all fields required.

Fig. 5.--The two sub-systems of the manual and computer-based technical services systems used as examples in the research.

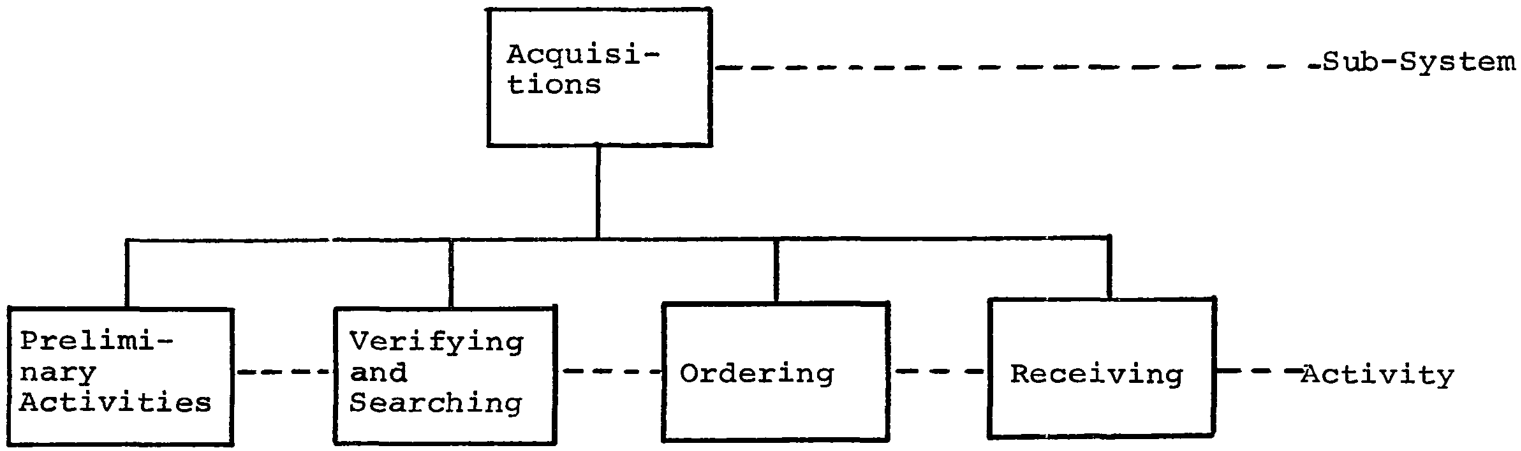


Fig. 6.--The four activities of the acquisitions sub-system of the manual and computer-based technical services systems used as examples in the research.

fied bibliographically and in pricing aids to ascertain their bibliographic existence, correctness, prices, and availability, and a search is made in the order or processing and card catalog files to make certain that requests are not on order, in process, or already in the library's collections. After incoming requests for purchase have been screened, verified, and searched and all duplicates or unavailable items removed, the remaining requests are ready to be ordered. Requests to be ordered are assigned vendor and order or fund numbers, purchase orders are prepared and distributed, funds are encumbered, and records of the orders are placed into various files to await either shipment or cancellation from vendors. Upon receipt of materials from vendors, the packages are opened and checked, received items are compared with order records and invoices, invoices are cleared, and fund accounts are updated.

Four activities of the processing sub-system of the manual and computer-based technical services systems used as examples were isolated, as shown in Figure 7:

1. Cataloging and classification;
2. Card production;
3. Physical processing of materials;
4. Filing of catalog and shelf list cards.

It is the function of cataloging and classification to organize library resources with suitable bibliographic controls to facilitate access to materials by library users

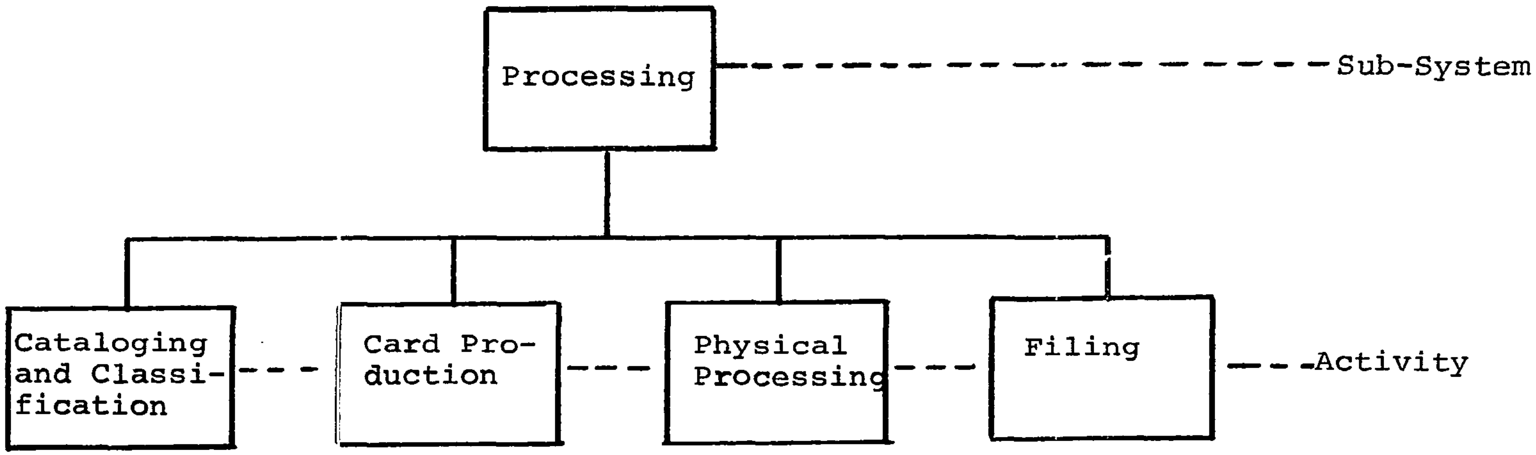


Fig. 7.--The four activities of the processing sub-system of the manual and computer-based technical services systems used as examples in this research.

(79, p. 168). This is accomplished by the descriptive and subject cataloging of materials acquired for the library's collections and the classification of these materials. Cataloging is the determination of forms of entry for materials and the preparation of their bibliographic descriptions for a catalog or index of the contents of the library (2, p. 25). Classification is the assigning of materials to their proper places in a system of classification, such as the Dewey Decimal Classification or the Library of Congress schemes (2, p. 30). Card production includes the preparation of author, title, subject, and reference cards for a card catalog and of entries for a shelf list.[1] If printed cards are purchased from, for example, the Library of Congress, the operations must include the typing of headings and call numbers on these cards.

The physical processing of materials includes the preparation of circulation cards and pockets (if required), pasting and property stamping, the marking or labelling of materials with call numbers, and performing a quality check on the processing.[2] If the circulation system used by the library requires circulation cards and pockets in items,

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[1]A shelf list is a file or listing of materials arranged in classed order as they stand on the shelves.

[2]These operations are sometimes referred to as "mechanical processes" (2, p. 87). Miscellaneous functions might include placing plastic jackets on books, placing pamphlets or paperbacks in binders, possibly minor repair or mending work, and others.

these must be typed or prepared in some manner. Brief identification of items can be typed or applied at the tops of pockets which are pasted inside items to contain the circulation cards. Most libraries place at least one property stamp in each item added to its collections for identification purposes; some place book plates in materials for added identification.

Marking or labelling includes the preparation and application of identification or "call number" labels to the spines or covers of materials. Some libraries still hand-letter call numbers on items, while others use labels printed by typewriter, computer, or other mechanical devices. After the processing of materials is complete, a visual quality check of each item should be made to ascertain that all steps have been performed in an acceptable manner. Catalog and shelf list cards for processed items must be filed for use. Filing includes preliminary sorting and arranging, filing, and revising of filing into the card catalog and shelf list.

Detailed results of the systems study of the manual and computer-based systems are shown in Appendices A and B, respectively. After the systems were divided into their component parts, flowcharts of their operations were constructed. The symbols used in constructing the flowcharts are shown in Appendix C, and the flowcharts of the manual and computer-based systems are in Appendices D and E, respectively. Some operations and procedures shown were not actually studied in this research but were included in the flowcharts for clarity of understanding. Operations included in the flowcharts but not studied are placed within curves.

Establishment of Evaluation Criteria for Operations in the Alternative Systems

Evaluation criteria for operations of the manual and computer-based systems used as examples in this research were established using methods discussed in Chapter II. Measurements from the work of Dougherty, Hendricks, Voos, and others reported in the literature and in unpublished reports were used when possible (30, 37, 96). When criteria were unavailable or not applicable, measurements were made of operations being performed. Standard procedures discussed in Chapter II for a time study were followed. The operations used as models were in operating libraries or computer centers in Oklahoma, Texas, and Colorado. For variability, the standard deviation of 10% as recommended by both Barnes and Nadler (6, p. 366; 66, p. 432) was used. All times used were standard, rather than normal times. The evaluation criteria were submitted to and reviewed, criticized, and validated by a select panel of practicing technical services librarians.[1] The panel approved the criteria included as examples in this

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[1]The members of the panel are listed in the acknowledgments section of this paper.

research. Evaluation criteria for operations in the manual technical services system are included in Appendix A and, for the computer-based system, in Appendix B.

Construction of Decision Models for Predicting System Performance

GPSS (General Purpose Simulation System) models were constructed for the manual and computer-based systems used as examples in this research. The models were based upon the results of the systems study, the system flowcharts, and the evaluation criteria for operations described in the previous section of this chapter. These system models (the decision models) became the means by which the alternative systems were simulated on the computer and their performances predicted. The system models for the manual and computer-based systems are shown in Appendices G and H, respectively. The GPSS symbols used in constructing the models for the alternative systems are in Appendix F.

Establishment of Decision Criteria for Determining the Best System

Four decision criteria (labelled DC_1, DC_2, DC_3, and DC_4 below) were established for determining the best alternative system used as examples in this research:

DC_1: Select the system which has the minimum average processing time for an item;

DC_2: Select the system which has the minimum average staff costs for processing an item;

DC_3: Select the system which utilizes the minimum average staff time in processing an item;

DC_4: Select the system which utilizes the minimum number of staff in processing an item.

An additional decision criterion was established which was used in the comparison of the performance values of the systems: an alternative had to be significantly superior statistically at the 5% level in both DC_1 and DC_2 to be considered the best system.

For the purpose of illustration, a computer cost of $100/hour and the following personnel costs were used:[1]

Bookkeeper: $3.00/hour;

Clerk: $2.50/hour;

Computer Operator: $3.00/hour;

Keyer: $2.75/hour;

Professional Librarian: $6.00/hour;

Searcher: $3.00/hour;

Sub-Professional: $4.00/hour;

Typist: $2.75/hour;

Verifier: $4.00/hour.

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[1] A library manager using this methodology of comparing alternative systems must substitute staff and associated costs applicable to his real situation.

Simulation of the Alternative Systems

The behavior of the manual and computer-based systems used as examples in this research were simulated separately on a digital computer, using the GPSS system models (the decision models) constructed earlier. The machine coding and computer simulation results for the manual system are in Appendix I and, for the computer-based system, in Appendix J.

Selection of the Best Alternative System

After the manual and computer-based technical services systems used as examples in this research were modelled and the performance of each was simulated on the computer, the results of the simulations were examined and analyzed in order to determine the quantitative values needed to select the best system.

The overall average processing times for items through the alternative systems (Decision Criterion 1 or DC_1) were obtained direct from the results of the simulations; these are labelled as "mean argument" in Table 4 of the statistical output for the manual system (see Appendix I), and in Table 5, for the computer-based system (see Appendix J). The times were converted from seconds used in the simulations to minutes and placed into the decision matrix in Table 7. The standard deviations from the average processing times were also obtained from the same tables in the statistical outputs, and the percentage difference of the average processing time through the computer-based system over the manual system and the statistical significance of the difference were computed. These values also were entered into the decision matrix in Table 7.

The average staff times required to process items through the alternative systems (Decision Criterion 3 or DC_3) were obtained from the storage statistics of the simulation outputs (see Appendices I and J). The staff times (in minutes) required to process an item through the manual system have been summarized in Table 1 by staff level (bookkeeper, clerk, professional, and so on) and, through the computer-based system, in Table 2. The standard deviations of times required by staff level from the total average staff times, the percentage difference of the total average staff time required in the computer-based system over the manual system, and the statistical significance of the difference were computed. The average staff times, the standard deviations, the percentage difference, and the statistical significance of the difference were entered into the decision matrix in Table 7.

The average staff costs required to process items through the alternative systems (Decision Criterion 2 or DC_2) were computed by multiplying the average staff times

TABLE 1

AVERAGE STAFF TIME REQUIRED TO PROCESS AN ITEM IN THE MANUAL TECHNICAL SERVICES SYSTEM

Staff Level	Average Processing Time Per Item, In Minutes
Bookkeeper	2.6
Clerk	33.2
Professional	29.7
Searcher	0.9
Sub-Professional	17.1
Typist	28.9
Verifier	9.6
Total	122.0

TABLE 2

AVERAGE STAFF TIME REQUIRED TO PROCESS AN ITEM IN THE COMPUTER-BASED TECHNICAL SERVICES SYSTEM

Staff Level	Average Processing Time Per Item, In Minutes
Clerk	47.0
Computer Operator	1.0
Keyer	15.6
Professional	29.7
Searcher	0.9
Sub-Professional	17.1
Verifier	9.6
Total	120.9

required to process items, summarized in Tables 1 and 2, by the staff costs per minute (see Page 55). These average costs are summarized by staff level in Table 3 for the manual system and in Table 4 for the computer-based system. The standard deviations of the costs required by staff level from the total average staff costs, the percentage difference of the total average staff cost required in the computer-based system over the manual system, and the statistical significance of the difference were computed. These values were also entered into the decision matrix in Table 7.

The total number of staff required in the alternative systems (Decision Criterion 4 or DC_4) was computed using the average staff times required to process items summarized in Tables 1 and 2. These times were multiplied by 10,000, which was chosen as an arbitrary increment of items to be processed. The number of staff required to process each incremental 10,000 items was computed by dividing the average processing times per 10,000 items in minutes by an estimated 115,200 working minutes per year for a staff member. The staff required in the manual system was summarized in Table 5 and, for the computer-based system, in Table 6. The standard deviations of the number of staff by levels from the total number of staff required, the percentage difference of the total number of staff required in the computer-based system over the

TABLE 3

AVERAGE STAFF COSTS TO PROCESS AN ITEM IN THE MANUAL TECHNICAL SERVICES SYSTEM

Staff Level	Average Processing Time Per Item, In Minutes	Staff Cost Per Minute	Total Staff Processing Cost Per Item
Bookkeeper	2.6	$0.05	$0.13
Clerk	33.2	0.04	1.33
Professional	29.7	0.10	2.97
Searcher	0.9	0.05	0.05
Sub-Professional	17.1	0.07	1.20
Typist	28.9	0.05	1.45
Verifier	9.6	0.07	0.67
Total	122.0	...	$7.80

TABLE 4

AVERAGE STAFF COSTS TO PROCESS AN ITEM IN THE COMPUTER-BASED TECHNICAL SERVICES SYSTEM

Staff Level	Average Processing Time Per Item, In Minutes	Staff Cost Per Minute	Total Staff Processing Cost Per Item
Clerk	47.0	$0.04	$1.88
Computer Operator	1.0	1.72	1.72
Keyer	15.6	0.05	0.78
Professional	29.7	0.10	2.97
Searcher	0.9	0.05	0.05
Sub-Professional	17.1	0.07	1.20
Verifier	9.6	0.07	0.67
Total	120.9	...	$9.27

Note: Staff cost per minute for computer operator includes $1.67/minute of computer time.

TABLE 5

STAFF REQUIRED FOR EACH 10,000 ITEMS PROCESSED
IN THE MANUAL TECHNICAL SERVICES SYSTEM

Staff Level	Average Processing Time Per Item, In Minutes	Average Processing Time Per 10,000 Items, In Minutes	Number of Staff Required Per 10,000 Items Processed
Bookkeeper	2.6	26,000	0.23
Clerk	33.2	332,000	2.88
Professional	29.7	297,000	2.58
Searcher	0.9	9,000	0.08
Sub-Professional	17.1	171,000	1.48
Typist	28.9	289,000	2.51
Verifier	9.6	96,000	0.83
Total	122.0	1,220,000	10.59

Note: Computations are based on 240 working days or 1,920 working hours or 115,200 working minutes per year per staff member.

TABLE 6

STAFF REQUIRED FOR EACH 10,000 ITEMS PROCESSED IN THE COMPUTER-BASED TECHNICAL SERVICES SYSTEM

Staff Level	Average Processing Time Per Item, In Minutes	Average Processing Time Per 10,000 Items, In Minutes	Number of Staff Required Per 10,000 Items Processed
Clerk	47.0	470,000	4.08
Computer Operator	1.0	10,000	0.09
Keyer	15.6	156,000	1.35
Professional	29.7	297,000	2.58
Searcher	0.9	9,000	0.08
Sub-Professional	17.1	171,000	1.48
Verifier	9.6	96,000	0.83
Total	120.9	1,209,000	10.49

Note: Computations are based on 240 working days or 1,920 working hours or 115,200 working minutes per year per staff member.

manual system, and the statistical significance of the difference were computed. The total number of staff required in each system, the standard deviations, the percentage difference, and the statistical significance of the difference were placed into the decision matrix in Table 7.

The values in the decision matrix in Table 7 were examined to select the best system. It should be remembered that one decision criterion (see Page 55) established for the best system was that it must be significantly superior statistically in both Decision Criterion 1 and Decision Criterion 2 at the 5% level.

A comparison of the manual and computer-based systems used as examples in this research in regard to Decision Criterion 1 (select the system which has the minimum average processing time for an item) indicated that an item would require 40.5% more processing time through the computer-based system than through the manual system. The difference was statistically significant at the 5% level. While the standard deviations of the two are similar, that of the manual system was 42.1% of its mean processing time, while that of the computer-based system was only 23.0%. This indicated only that the processing times for all items in the computer-based system were clustered closer to the mean processing time than in the manual system. Thus, a smaller deviation from the average proc-

TABLE 7

DECISION MATRIX FOR SELECTING THE BEST ALTERNATIVE TECHNICAL SERVICES SYSTEM*

Decision Criterion	Manual System (M)		Computer System (C)		% Difference, Computer Over Manual**	Test Statistic, Computer Over Manual***
	Mean Value	Stand. Dev.	Mean Value	Stand. Dev.		
DC_1 (Processing Time)	58.0 Min.	24.4 Min.	97.4 Min.	23.0 Min.	40.5%	59.85****
DC_2 (Processing Costs)	$7.80	$0.91	$9.27	$0.89	15.9%	59.85****
DC_3 (Staff Time)	122.0 Min.	12.5 Min.	120.9 Min.	15.3 Min.	(0.9%)	-2.48
DC_4 (Staff Number)	10.59 Staff	1.08 Staff	10.49 Staff	1.33 Staff	(1.0%)	-2.60

*All values shown are per transaction or item processed.

**$\frac{C - M}{M}$.

***The test statistic for significance of difference, computer over manual system, was:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - \delta}{\sqrt{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}} \sqrt{\frac{n_1 n_2 (n_1 + n_2 - 2)}{n_1 + n_2}}$$

****Indicates a statistically significant number at the 0.05 level.

essing time can be expected for items in the computer-based system than in the manual system.

In regard to Decision Criterion 2 (select the system which has the minimum average staff costs for processing an item), the staff costs for processing an item would cost 15.9% more through the computer-based system than through the manual system. The difference also was statistically significant at the 5% level. The computer-based system required 0.9% less staff time (Decision Criterion 3: select the system which utilizes the minimum average staff time in processing an item) to process an item than did the manual system, but the difference was not statistically significant at the 5% level. The number of staff required to process an item (Decision Criterion 4: select the system which utilizes the minimum number of staff in processing an item) through the computer-based system was 1.0% less than in the manual system. Again, the difference was not statistically significant.

Based upon an examination of the decision matrix values, described above, it was concluded that the manual system was the better of the two hypothetical technical services systems used as examples in this demonstration of the methodology of comparing alternative systems in libraries. This choice was made because the manual system was significantly superior in performance in the two decision criteria which were considered critical for the best system: Decision Criterion 1 and Decision Criterion 2. This decision did not include any intangible benefits, such as status and prestige, which might be attached to accepting an automated system over a manual one.

In addition to the provision of quantitative data for the four decision criteria used in the selection of the best alternative system, the results of the computer simulations contained other useful information for the library manager. For example, it was noted earlier that the manager also needed to know where staff would be required in each system and where the potential bottlenecks were.

The statistical output of the simulations for storages (staff), shown in Appendices I and J, will yield information as to where staff will be required in each system. The average time per unit column indicates the average time each storage (staff) was utilized in processing an item. Those storages (staff) requiring large average processing times per transaction and high average waiting times in the queue statistics for items to be processed indicates potential bottlenecks in the systems.

The results of the computer simulations of the two systems used as examples in this research are not sensitive to increases in volume of items processed. For example, in both the manual and the computer-based systems, the average processing time per item will remain unchanged whether 10,000 or 50,000 volumes are processed. The number of staff required per 10,000 items will also remain unchanged in both systems as the volumes of items processed increases. However, the total staff costs are very sensitive in both manual and computer-based systems. As the costs of staff fluctuates, the total staff processing costs per item will, of course, fluctuate. If staff costs in one system fluctuates, the same will occur in the other. But if, for example, hourly costs of a clerk increases from $2.50/hour to $4.00/hour, the total staff processing costs per item in the manual system will be increased by $0.99 and, in the computer-based system, by $1.41. This is due to the fact that less clerical time is used in the manual system than in the computer-based one.

The staff processing costs in the computer-based system is also very sensitive to computer costs incurred in processing items. Should a library happen to receive a different rate than $100/hour for computer time, the total staff processing cost per item will change accordingly. At a computer cost of $10/hour, the processing cost per item would be reduced to $7.77, which would be lower than the per-item staff processing cost in the manual system. At a computer cost of $200/hour, the processing cost would be increased to $10.93, which would increase the difference of the computer-based over the manual system from 15.9% to 28.6%. Thus, the desirability of the manual over the computer-based system used as examples would be increased.

In order to test the sensitivity of the performance times, the variation in the times was changed from a standard deviation of 10% to one of 5% and new simulations were run. In addition, selected performance times were altered slightly to see how the change would affect the results.

The average processing time for an item decreased from 58.0 to 43.7 minutes per item in the manual system and increased from 97.4 to 100.5 minutes in the computer-based system; this was an increase from 40.5% to a 56.5% difference between the two systems, which is still statistically significant at the 5% level. The average processing costs decreased in the manual system from $7.80 to $7.70 and increased from $9.27 to $9.41 per item in the computer-based one; the difference between the two increased from 15.9% to 18.2%, which is still significant.

Similar results occurred in the average staff time and the average staff number. However, the differences between both systems were statistically significant, whereas in the original simulations, they were not. The conclusion resulting from this particular analysis was that the performance times were sensitive to small changes in performance times of operations and their variations allowed, but not to an extent, in this case, that would change the alternative selected as the best system.

CONCLUSIONS

This study was structured from the thesis that a method could be developed through which quantitative measures could be determined for alternative technical services systems in libraries and then the systems could be compared and evaluated and accepted or rejected, based on established decision criteria. From this belief, four objectives were established:

1. To define and analyze the technical services division of a library as an operating system, considering both a manual and a computer-based operating system as examples;
2. To establish quantifiable evaluation criteria for measuring the component operations of alternative technical services systems;
3. To establish decision criteria for determining which is the best alternative system;
4. To construct a decision model for forecasting or predicting the performance of alternative technical services systems.

In Chapter II, a theoretical framework for a methodology by which alternative technical services systems in libraries could be compared and evaluated and the best system selected was developed. The framework consisted of six procedures or phases:

1. Performance of a systems study of the alternative technical services systems of a library:

a. Identification of the technical services division of the library as an operating system;

b. Determination of the goals and objectives and boundaries and parameters of the system;

c. Division of the alternative systems into their component parts;

d. Establishment of work flows through the systems.

2. Establishment and validation of evaluation criteria for component operations of the alternative systems;

3. Establishment of decision criteria for determining the best alternative system;

4. Construction of decision models for predicting system performance;

5. Simulation of the alternative systems;

6. Selection of the best alternative system.

To demonstrate the methodology, a hypothetical manual technical services system in a library was compared and evaluated against a hypothetical computer-based system (see Chapter III), using all of the six procedures outlined above. The results of the demonstration indicated that the average processing time per item in the manual system was 58.0 minutes, and for the computer-based system, 97.4 minutes. The average staff time required per transaction in the manual system was 122.0 minutes; for the computer-based system, 120.9. minutes. The number of staff required in the manual system was 10.59, and, in the computer-based system, 10.49. The cost per transaction through the manual system was $7.80, and through the computer-based system, $9.27. These costs were for personnel only. Based on four decision criteria established for the best system (select the system which has the minimum average processing time for an item; select the system which has the minimum average personnel costs for processing an item; select the system which utilizes the minimum average staff time in processing an item; and select the system which utilizes the minimum number of staff in processing an item), it was concluded that the manual technical services system was the better system. This decision was made because the computer-based system required 40.5% more processing time and 15.9% more personnel costs than the manual system; these differences were deemed sufficient to select the manual over the computer-based system, even though the latter was slightly lower (0.9%) in staff time required and slightly lower (1.0%) in staff number.

Some general conclusions from this research, the usefulness of the methodology to other departments or subsystems of the library, and some recommendations and future work which might be undertaken are discussed below.

Conclusions from the Research

The general conclusion resulting from this research was that the methodology could provide a valid, quantitative basis for comparing and evaluating alternative technical services systems in libraries and for selecting the best system.

Another conclusion from the research was that essential or desirable modifications in an existing or in proposed alternative systems could be detected and changes to improve the systems made after (or possibly during) the final comparison and evaluation of the alternatives and the selection of the best system. For example, it was evident from an examination of Tables 1 through 6 that the staff time and the number of staff required in the manual and computer-based systems used as examples in this research were almost equal. With knowledge gained from the comparison of the systems, the library manager could re-analyze the operations in either or both systems and perhaps rework the flows of work, streamline some critical operations further, or otherwise reduce the times required to perform some operations. In this manner, a form of feedback can be utilized to improve the systems and therefore to increase their margin of acceptability or desirability in the decision matrix as the best system is selected. It is possible that the design of an alternative system being considered could be improved to the extent that, upon further simulations, it could become the best system and thereby reverse a previous decision to reject it.

It was further concluded that this methodology could be useful in answering questions such as those posed in Chapter I:

1. Where will staff be needed in the systems;
2. Where are the potential bottlenecks;
3. How much volume can be expected from a new system.

As a result of the comparison of the two systems used as examples in this research, the library manager could have determined the number and level of personnel required in each activity of the systems. Bottlenecks can be determined by examination of the storages (staffs) and queue statistics in the computer simulations to identify delays in the system. The volume of work which could be expected from the systems would be dependent upon the number of staff the library manager would be willing to utilize in the system.

From the successful analysis phase of the methodology, it was apparent that the technical services department or division of a library could be defined as a system and therefore could be analyzed and flowcharted as an operating system with common management science techniques which have been available to business and industry for a generation or more but almost unused by librarians prior to the introduction of the computer to library routines.

Establishing criteria for the performance of operations of a technical services system was relatively difficult but not impossible. Library materials being processed in most technical services systems are of various shapes, sizes, and types which often require tasks of varying intellectual levels. This was overcome to a large extent in the examples used in this research by a standardization of operations which reduced the intellectual decisions to a minimum. A general rule (though not a new one by any means) was that the more intellectual an operation or task, the more difficult it was to establish evaluation criteria for them. The most intellectual of all operations in technical services were those involved in the cataloging and classification of materials. Realistic and adequate evaluation criteria were critical to obtaining accurate results from this methodology.

The establishment of decision criteria for determining the best system reflected the needs of the library manager for quantitative values by which he could evaluate the alternative systems. The criteria selected for the systems used as examples in this research probably encompasses the most important points a library manager would need to know when comparing systems: processing time, staff time, number of staff, and costs of processing. When the values in the decision matrix used in determining the best system are the same or almost equal, the library manager must either place more emphasis or weight upon other more important or clear-cut criteria.

The decision models constructed for forecasting or predicting the performance of the alternative systems grew logically out of the results of the systems study and the charting of the work flows through the systems (notice the similarity between the flowcharts in Appendices D and E and the GPSS models of the same system in Appendices G and H).

Recommendations for Future Study

As a result of the knowledge gained in this study and of the background of the researcher in technical services work, some recommendations for future study can be made, which would add to the work begun here. It is recommended that:

1. More complex technical services systems encompassing such sub-systems as gifts and exchanges, out-of-print materials, blanket orders, serials, and so on, be studied to determine if the methodology could still be utilized;

2. Additional study be conducted to differentiate between titles and volumes or items being processed through the systems. In this study, the transactions were equated to single titles being processed, without consideration that there might be more than one copy of a title and that the additional copies of the same title will require lower processing times;

3. Equipment, supplies, and space costs be considered in future studies to give a more complete cost comparison for technical services work;

4. More study on the time variability of operations is needed;

5. The methodology be tried on a real system and a proposed system to replace it, rather than on hypothetical systems.

A general recommendation is that the library manager who wishes to use this methodology should ask a time study expert from business or industry to establish the time standards for the technical services operations under study. There is no valid reason, in the opinion of this researcher, why the librarian should learn this technique if he can work closely with such a specialist from another field.

Applicability of the Methodology to Other Library Operations

The technical services department or division of a library is product oriented; that is, the department's main purpose is to produce a product (processed materials) for use by a consumer (a library user of materials). In processing materials for use, it has been demonstrated that technical services can be separated into a logical sequence of events or operations which progressively moves requests for purchase of books, pamphlets, films, and so on (raw materials) through predetermined steps or phases of processing (verifying, searching, ordering, receiving, cataloging and classification, and so on) which results in processed materials ready for use by readers (an end product).

Therefore, the methodology studied in this research should be applicable to most assembly line type systems in libraries. Evaluation criteria can be established for operations in the library, and these systems can be modelled in

GPSS or other similar computer language and simulated on the computer.

Consequently, other sub-systems of the library (circulation, for example) may be evaluated, as long as the system can be divided into a logical sequence of operations which can be assigned quantitative evaluation criteria and which can be modelled and simulated on a computer. Thus, costly and time-consuming errors in implementing new systems other than technical services which later might be revealed to be impractical and economically unsound could be avoided or minimized.

BIBLIOGRAPHY AND REFERENCES

BIBLIOGRAPHY AND REFERENCES

1. Abramson, Norman. Information Theory and Coding. New York: McGraw-Hill, 1963.

2. American Library Association. Committee on Library Terminology. A. L. A. Glossary of Library Terms, With a Selection of Terms in Related Fields. Edited by Elizabeth H. Thompson. Chicago: American Library Association, 1943.

3. American National Standards Institute. Standard Flowchart Symbols and Their Use in Information Processing (X3.5). New York: American National Standards Institute, 1971.

4. American Telephone and Telegraph Company. Data Communication in Business; an Introduction. Edited by Edgar C. Gentle Jr. New York: American Telephone and Telegraph Company, 1965.

5. Aslib Research Department. "The Analysis of Library Processes." Journal of Documentation, XXVI (March, 1970), 30-45.

6. Barnes, Ralph M. Motion and Time Study; Design and Measurement of Work. 5th ed. New York: Wiley, 1963.

7. Barton, Richard F. A Primer on Simulation and Gaming. Englewood Cliffs, N. J.: Prentice-Hall, 1970.

8. Baumol, William J.; Black, Stanley W.; Stengel, Margaret E.; and Kime, Linda A. "The Costs of Library and Informational Services." Libraries at Large: Tradition, Innovation, and the National Interest. Edited by Douglas M. Knight and E. Shepley Nourse. New York: R. R. Bowker, 1969.

9. Bell, Daniel. "The Year 2000--The Trajectory of an Idea." Toward the Year 2000; Work in Progress. Edited by Daniel Bell. New York: Harper, 1968.

10. Booz, Allen and Hamilton, Inc. *Problems in University Library Management.* Washington, D.C.: Association of Research Libraries, 1970.

11. *Bowker Annual of Library and Book Trade Information, 1971.* New York: R. R. Bowker, 1970.

12. Brandon, Dick H. *Management Planning for Data Processing.* Princeton, N. J.: Brandon/Systems Press, 1970.

13. Buffa, Elwood S. *Models for Production and Operations Management.* New York: Wiley, 1963.

14. Burns, Robert W. "A Generalized Methodology for Library Systems Analysis." *College and Research Libraries*, XXXII (July, 1971), 295-303.

15. Canada, John R. *Intermediate Economic Analysis for Management and Engineering.* Englewood Cliffs, N. J.: Prentice-Hall, 1971.

16. Canadian Association of College and University Libraries. University Library Standards Committee. *Guide to Canadian University Library Standards; Report, 1961-1964, and Statistical Appendices, 1963-1966.* Montreal? Canadian Association of College and University Libraries, 1967.

17. Caras, Gus J. "Computer Simulation of a Small Information System." *American Documentation*, XVIV (April, 1968), 120-2.

18. Chamis, Alice Yanosko. "The Design of Information Systems: the Use of Systems Analysis." *Special Libraries*, LX (January, 1969), 21-31.

19. Chapin, Ned. *Flowcharts.* Princeton, N. J.: Auerback Pub., 1971.

20. Chapman, Edward A.; St. Pierre, Paul L.; and Lubans, John Jr. *Library Systems Analysis Guidelines.* New York: Wiley-Interscience, 1970.

21. Churchman, C. West. "An Analysis of the Concept of Simulation." *Symposium on Simulation Models.* Edited by Austin C. Hoggatt and Frederick E. Balderston. Cincinnati: South-Western Pub. Co., 1963.

22. ________. *The Systems Approach.* New York: Delta Books, 1968.

23. Clark, Donald T., and Gottfried, Bert A. *Dictionary of Business and Finance.* New York: Crowell, 1957.

24. Coney, Donald. "The Administration of Technical Processes." *Current Issues in Library Administration.* Edited by Carleton B. Joeckel. Chicago: University of Chicago Press, 1939.

25. Cremeans, John E. "The Trend in Simulation." *Computers and Automation*, XVII (January, 1968), 44-8.

26. Cuadra, Carlos A. "Libraries and the Technological Forces Affecting Them." *ALA Bulletin*, LXIII (June, 1969), 759-68.

27. ________. *Technology and Libraries.* Washington, D.C.: National Advisory Commission on Libraries and System Development Co., 1967.

28. Dawson, John M. "A Brief History of the Technical Services in Libraries." *Library Resources & Technical Services*, VI (Summer, 1962), 197-204.

29. DeGennaro, Richard. "The Development and Administration of Automated Systems in Academic Libraries." *Journal of Library Automation*, I (March, 1968), 75-91.

30. Dougherty, Richard M., and Heinritz, Fred J. *Scientific Management of Library Operations.* New York: Scarecrow Press, 1966.

31. Emshoff, James R., and Sisson, Roger L. *Design and Use of Computer Simulation Models.* New York: Macmillan, 1970.

32. Greenberg, Stanley. *GPSS Primer.* New York: Wiley, 1972.

33. Gull, C. D. "Logical Flow Charts and Other New Techniques for the Administration of Libraries and Information Centers." *Library Resources & Technical Services*, XII (Winter, 1968), 47-66.

34. Hamburg, Morris; Ramist, Leonard E.; and Bommer, Michael R. W. "Library Objectives and Performance Measures and Their Use in Decision Making." *Library Quarterly*, XLII (January, 1972), 107-28.

35. Hayes, Robert M., and Becker, Joseph. *Handbook of Data Processing for Libraries*. New York: Becker and Hayes, 1970.

36. ________. "Library Systems Analysis." *Data Processing in Public and University Libraries*. Washington, D. C.: Spartan Books, 1966.

37. Hendricks, Donald D. *Comparative Costs of Book Processing in a Processing Center and in Five Individual Libraries*. Springfield, Illinois: Illinois State Library, 1966.

38. Heyel, Carl. *Encyclopedia of Management*. New York: Reinhold, 1963.

39. International Business Machines, Inc. *General Purpose Simulation System/360: Introductory User's Manual*. 4th ed. White Plains: International Business Machines, Inc., 1968.

40. ________. *General Purpose Simulation System/360: User's Manual*. White Plains: International Business Machines, Inc., 1967.

41. Jacob, Mary Ellen L. "Standardized Costs for Automated Library Systems." *Journal of Library Automation*, III (September, 1970), 207-17.

42. Jordain, Philip B., and Breslau, Michael. *Condensed Computer Encyclopedia*. New York: McGraw-Hill, 1969.

43. Kent, Allen, and Lancour, Harold, eds. *Encyclopedia of Library and Information Science*. Vol. 2. New York: Dekker, 1969.

44. Kilgour, Frederick G. "The Economic Goal of Library Automation." *College and Research Libraries*, XXX (July, 1967), 307-11.

45. ________. "Evolving, Computerizing, Personalizing." *American Libraries*, III (February, 1972), 141-7.

46. ________. "History of Library Computerization." *Journal of Library Automation*, III (September, 1970), 218-29.

47. Kozumplik, William A. "Time and Motion Study of Library Operations." *Special Libraries*, LVIII (October, 1967), 585-8.

48. Lazzaro, Victor, ed. *Systems and Procedures; a Handbook for Business and Industry*. 2nd ed. Englowood Cliffs, N. J.: Prentice-Hall, 1968.

49. Leimkuhler, Ferdinand F. "Systems Analysis in University Libraries." *College and Research Libraries*, XXVII (January, 1966), 13-8.

50. Leonard, Lawrence E.; Maier, Joan M.; and Dougherty, Richard M. *Centralized Book Processing: A Feasibility Study Based on Colorado Academic Libraries*. New York: Scarecrow Press, 1969.

51. Licklider, J. C. R. *Libraries of the Future*. Cambridge, Mass.: MIT Press, 1965.

52. Logsdon, R. H. "Time and Motion Studies in Libraries." *Library Trends*, II (January, 1954), 401-9.

53. Lyle, Guy R. *The Administration of the College Library*. 3rd ed. New York: H. W. Wilson, 1961.

54. McCormick, Ernest J. *Human Factors Engineering*. 3rd ed. New York: McGraw-Hill, 1970.

55. McKinsey, and Company, Inc. "Unlocking the Computer's Profit Potential." *Computers and Automation*, XVIII (April, 1969), 24-33.

56. McMillan, Claude, and Gonzalez, Richard F. *Systems Analysis; A Computer Approach to Decision Models*. Rev. ed. Homewood, Ill.: Irwin, 1968.

57. Markuson, Barbara Evans. "An Overview of Library Systems and Automation." *Datamation*, XVI (February, 1970), 60-8.

58. Martin, Francis F. *Computer Modeling and Simulation*. New York: Wiley, 1968.

59. Martin, James, and Norman, Adrian R. D. *The Computerized Society: An Appraisal of the Impact of Computers on Society Over the Next Fifteen Years*. Englewood Cliffs, N. J.: Prentice-Hall, 1970.

60. Meier, Robert C.; Newell, William T.; and Pazer, Harold L. *Simulation in Business and Economics*. Englewood Cliffs, N. J.: Prentice-Hall, 1969.

61. Miller, R. A. *Cost Accounting for Libraries; A Technique for Determining the Labor Costs of Acquisition and Cataloging Work*. Unpub. Ph.D. Dissertation. University of Chicago, 1936.

62. Mize, Joe H., and Cox, J. Grady. *Essentials of Simulation*. Englewood Cliffs, N. J.: Prentice-Hall, 1968.

63. Moore, Edythe. "Systems Analysis: An Overview." *Special Libraries*, LVIII (February, 1967), 87-90.

64. Morgenthaler, George W. "The Theory and Application of Simulation in Operations Research." *Progress in Operations Research*. Edited by Russell L. Ackoff. New York: Wiley, 1961.

65. Morsch, Lucile M. "Scientific Management in Cataloging." *Library Trends*, II (January, 1954), 472-85.

66. Nadler, Gerald. *Work Design*. Homewood, Illinois: Irwin, 1963.

67. Nance, Richard E. *Towards a Unifying Structure for Discrete Event Simulation*. Paper Submitted to the Newsletter of the Special Interest Group on Simulation of the Association for Computing Machinery. Dallas: Computer Science/Operations Research Center, Institute of Technology, Southern Methodist University, 1971.

68. Naylor, Thomas H., *et al*. *Computer Simulation Techniques*. New York: Wiley, 1966.

69. Optner, Stanford L. *Systems Analysis for Business Management*. Englewood Cliffs, N. J.: Prentice-Hall, 1960.

70. Overmyer, LaVahn. Library Automation: A Critical Review. Washington, D. C.: U. S. Office of Education, Bureau of Research, 1969.

71. Parker, Ralph H. "Economic Considerations." Data Processing in Public and University Libraries. Edited by John Harvey. Washington, D. C.: Spartan Books, 1966.

72. Payne, Eugene Edgar. Investigation and Development of a Computer-Assisted Planning Model for Community Emergency Care Systems. Unpub. Ph.D. Dissertation, University of Oklahoma, 1970.

73. Perritt, Roscoe. "Motivating Learning Through Simulation." Data Processing Magazine, XIII (Winter, 1971), 59-61.

74. Pierce, W. O'D. Work Measurement in Public Libraries. New York: Social Sciences Research Council, 1949.

75. Piercy, Esther J. "Organization and Control of Materials." Local Public Library Administration. Edited by Roberta Bowler. Chicago: International City Managers' Association, 1964.

76. Randall, William M., ed. The Acquisition and Cataloging of Books; Papers Presented Before the Library Institute at the University of Chicago, July 29 to August 9, 1940. Chicago: University of Chicago Press, 1940.

77. Reichmann, Felix. "The Costs of Cataloging." Library Trends, II (October, 1953), 290-317.

78. ________. "Management and Operation." Library Trends, III (April, 1955), 462-70.

79. Rogers, Rutherford D., and Weber, David G. University Library Administration. New York: H. W. Wilson, 1971.

80. Ross, Joel E. Management by Information System. Englewood Cliffs, N. J.: Prentice-Hall, 1970.

81. Seiler, John A. Systems Analysis in Organizational Behavior. Homewood, Illinois: Irwin and the Dorsey Press, 1967.

82. Senders, J. W. "Information Storage Requirements for the Contents of the World's Libraries." Science, CXLI (September, 1963), 1067-8.

83. Shaw, Ralph, ed. "Scientific Management in Libraries." Library Trends, II (January, 1954).

84. Stephens, Irving E. "Computer Simulation of Library Operations: An Evaluation of an Administrative Tool." Special Libraries, LXI (July-August, 1970), 280-7.

85. Storm, Herman R. "Some Common Types of Technical Services Departments; Standard Features and Variations." Wisconsin Library Bulletin, LXIII (May-June, 1967), 166-7.

86. Swank, Raynard C. "The Catalog Department in the Library Organization." Library Quarterly, XVIII (January, 1948), 24-32.

87. Tauber, Maurice F. "Management Improvement in Libraries." College and Research Libraries, XV (April, 1954), 188-96.

88. ________ et al. Technical Services in Libraries: Acquisitions, Cataloging, Classification, Binding, Photographic Reproduction, and Circulation Operations. New York: Columbia University Press, 1953.

89. Tesovnik, Mary E., and DeHart, Florence E. "Unpublished Studies of Technical Service Time and Costs: A Selected Bibliography." Library Resources & Technical Services, XIV (Winter, 1970), 56-67.

90. Thomas, P. A. Task Analysis of Library Operations. London: Aslib, 1971.

91. Tocher, K. D. The Art of Simulation. London: English Universities Press, 1963.

92. Trotier, A. H. "Organization and Administration of Cataloging Processes." Library Trends, II (October, 1953), 264-78.

93. U. S. Congress. Senate. Committee on Government Operations. Summary of Activities Toward Interagency Coordination. Report No. 369. Washington, D. C.: U. S. Government Printing Office, 1965.

94. U. S. National Center for Educational Statistics. Library Statistics of Colleges and Universities; Fall, 1969, Data for Individual Institutions. Washington, D. C.: U. S. National Center for Educational Statistics, 1970.

95. Veaner, Allen B. "The Application of Computers to Library Technical Processing." College and Research Libraries, XXXI (January, 1970), 36-42.

96. Voos, Henry. "Standard Times for Certain Clerical Activities in Technical Processing." Library Resources & Technical Services, X (Spring, 1966), 223-7.

97. Waldron, Rodney K. "Implications of Technological Progress for Librarians." College and Research Libraries, XIX (March, 1958), 118-23+.

98. Warheit, I. A. "When Some Library Systems Fail-- Is It the System or the Librarian?" Wilson Library Bulletin, XLVI (September, 1971), 52-8.

99. Wasserman, Paul. The Librarian and the Machine; Observations on the Applications of Machines in Administration of College and University Libraries. Detroit: Gale Research, 1965.

100. Welch, Helen M. "Technical Service Costs, Statistics, and Standards." Library Resources & Technical Services, XI (Fall, 1967), 436-42.

101. Wessel, C. J. Criteria for Evaluating the Effectiveness of Library Operations and Services. Final Report. 3 Vols. Washington, D. C.: John I. Thompson and Co., 1967-69.

102. Wright, Wyllis E. "Some Aspects of Technical Processes." Library Trends, I (July, 1952), 73-82.

103. Wynar, Don. "Cost Analysis in a Technical Services Division." Library Resources & Technical Services, VII (Fall, 1963), 312-26.

APPENDIX A

OPERATIONS OF A MANUAL TECHNICAL SERVICES SYSTEM

Sub-System: Acquisitions

Activity: Preliminary Activities

Operation 1: Sort Incoming Request Forms.

Objective: To sort incoming requests for purchase from materials selectors (faculty, staff, students, general public) into categories (domestic current and non-current; foreign current and non-current, for example) for easier processing.

Criterion: A clerk can sort an incoming request form in 3 seconds.

Assumption: Requests for purchase are submitted on standardized forms.

Task 1: Scan Request Form;

Task 2: Place Form into Category.

Operation 2: Alphabetize Request Forms.

Objective: To alphabetize incoming request forms in each category and to match, mark, and remove any duplicate forms located.

Criterion: A clerk can alphabetize an incoming request form in 9 seconds.

Assumption: Five per cent of incoming request forms are duplicates of each other and will be returned to selectors without further processing.

Task 1: Merge Form into Sequence;

Task 2: Match Any Duplicate;

Task 3: Mark and Remove Duplicate.

Sub-System: Acquisitions

Activity: Verifying and Searching

Operation 1: Verify Requests in Bibliographic Sources.

Objective: To determine the bibliographic existence and correctness of incoming requests for purchase and to correct or supplement information given.

Criterion: A verifier can locate one request form bibliographically and complete its verification in 507 seconds.

Assumption: Information to be verified is: author/main entry, title, edition, publisher, publication date, and LC card number.

Task 1: Locate Bibliographic Citation;

Task 2: Correct or Supplement Information on Request Form;

Task 3: Indicate Source of Information.

Operation 2: Verify Prices and Availability.

Objective: To determine the prices and availability of incoming requests for purchase.

Criterion: A verifier can locate the price and determine the availability of one request for purchase in 67 seconds.

Assumption: Five per cent of all requests for purchase are out-of-print and will be returned to selectors without further processing, or, channelled to other systems.

Task 1: Locate Price and Availability Information;

Task 2: Correct or Supplement Information on Request Form;

Task 3: Indicate Source of Information.

Operation 3: Search Requests in Order File.

Objective: To determine if incoming requests for purchase are on order or in process for the library's collections.

Criterion: A searcher can check one incoming request for purchase in the order file in 25 seconds.

Assumptions:

1. The "on order" and "in process" files are combined into one "order file;"

2. Five per cent of all requests for purchase are already on order or in process for the library's collections.

Task 1: Locate Position in File;

Task 2: Compare Request Form With File;

Task 3: Match Any Duplicate;

Task 4: Mark and Remove Duplicate.

Operation 4: Search Requests in Card Catalog.

Objective: To determine if incoming requests for purchase are in the library's collections.

Criterion: A searcher can check one incoming request for purchase in the card catalog in 31 seconds.

Assumption: Five per cent of all requests for purchase are already in the library's collections.

Task 1: Locate Position in File;

Task 2: Compare Request Form With File;

Task 3: Match Any Duplicate;

Task 4: Mark and Remove Duplicate.

Sub-System: Acquisitions

Activity: Ordering

Operation 1: Assign Vendors and Order Numbers.

Objective: To determine from whom requests for purchase will be ordered and to assign order numbers to the requests.

Criterion: A professional can assign vendor and order numbers to a request form in 42 seconds.

Assumption: Order numbers reflect fund numbers.

Task 1: Scan Request Form;

Task 2: Assign Request to Vendor;

Task 3: Assign Order Number.

Operation 2: Prepare Multiple-Copy Order Forms.

Objective: To prepare orders to vendors for verified and searched requests for purchase.

Criterion: A typist can prepare a multiple-copy order form in 338 seconds.

Assumption: Fan-fold, multiple-copy order forms are submitted to vendors as purchase orders.

Task 1: Type Form;

Task 2: Proof Typing;

Task 3: Burst Form.

Operation 3: Sort Order Forms.

Objective: To sort all orders to the same vendors together.

Criterion: A clerk can sort an order form in 3 seconds.

Task 1: Scan Order Form;

Task 2: Place Form into Category.

Operation 4: Prepare Purchase Requisitions.[1]

Objective: To provide purchase requisitions for groups of orders to vendors.

Criterion: A clerk can prepare a purchase requisition in 11 seconds.

Assumptions:

1. A custom-made form is used as a purchase requisition;
2. Orders to vendors will contain an average of 50 order forms each.

Task 1: Type Form;

Task 2: Proof Typing;

Task 3: Burst Form.

Operation 5: Forward Orders to Vendors.

Objective: To distribute orders for materials to vendors.

Criterion: A clerk can package and forward an order form to a vendor in 1 second.

Assumption: Orders to vendors will contain an average of 50 order forms each.

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[1]This operation is included to indicate that some libraries are required by their business offices to prepare purchase requisitions for blocks or groups of individual multiple-copy order forms sent to vendors.

<u>Task 1</u>: Package Form;

<u>Task 2</u>: Forward Order to Vendor.

<u>Operation 6</u>: Encumber Funds.

Objective: To encumber funds for purchase orders to vendors.

Criterion: A bookkeeper can encumber funds for an item in 65 seconds.

<u>Task 1</u>: Sort Form by Order/Fund Number;

<u>Task 2</u>: Calculate Amount of Order;

<u>Task 3</u>: Post Encumbrance to Account.

<u>Operation 7</u>: File Forms.

Objective: To place forms into the order file as records of orders placed with vendors.

Criterion: A clerk can file a form in the order file in 135 seconds.

<u>Task 1</u>: Locate Position in File;

<u>Task 2</u>: Compare Order Form With File;

<u>Task 3</u>: Place Form in Sequence in File.

Sub-System: Acquisitions

Activity: Receiving

Operation 1: Open Packages.

Objective: To serve as a central point for the receipt of incoming shipments of materials from vendors.

Criterion: A clerk can open and unpack an item received in 15 seconds.

Task 1: Remove Wrapping From Package;

Task 2: Place Item on Truck;

Task 3: Arrange Item in Invoice Order.

Operation 2: Verify Correctness of Items Shipped.

Objective: To determine if items received from vendors are as ordered.

Criterion: A clerk can verify the correctness of an item received in 252 seconds.

Assumption: A copy of the order form is inserted in an item received as a "rider" workslip to be used in later processing.

Task 1: Pull Form From Order File;

Task 2: Compare Item With Order Form and Invoice;

Task 3: Check Item Off Invoice;

Task 4: Insert Form in Item.

Operation 3: Clear Records in Order File.

Objective: To indicate in the order file that items have been received and are now "in process."

Criterion: A clerk can clear one record in the order file in 54 seconds.

Assumption: The "on order" and "in process" files are combined into one "order file."

Task 1: Locate Position in Order File;

Task 2: Remove Form For Received Item;

Task 3: Stamp Date Received on Form;

Task 4: Replace Form in File.

Operation 4: Clear Invoices.

Objective: To check, approve, and forward invoices from vendors for payment.

Criterion: A clerk can clear an item on an invoice in 80 seconds.

Assumptions:

1. Checks to vendors for payment of items shipped are not prepared in technical services;

2. An average of 25 items are on an invoice.

Task 1: Check Invoice for Discrepancy;

Task 2: Correct any Discrepancy;

Task 3: Approve and Forward Invoice for Payment.

Operation 5: Update Accounting Reports.

Objective: To update accounting reports for funds expended for items received.

Criterion: A bookkeeper can update the accounting report for an item received in 92 seconds.

Task 1: Post Amount to Fund Account;

Task 2: Calculate Free Balance.

Operation 6: Place Accession Numbers in Items.[1]

Objective: To prove a unique number to each item received for identification purposes.

Criterion: A clerk can accession an item in 106 seconds.

Assumption: Accession numbers are stamped once on a rider workslip and once in an item.

Task 1: Stamp Accession Number on Rider Workslip;

Task 2: Stamp Accession Number in Item.

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[1]Many libraries no longer accession items; some still do.

Sub-System: Processing

Activity: Cataloging and Classification

Operation 1: Search in LC Card/Slip Files.

Objective: To determine if LC cards or proofslips are available and waiting in the files.

Criterion: A clerk can search for one LC card set or proofslip in a file in 164 seconds.

Assumptions:

1. LC cards and proofslips are in two separate files, but the search process is the same for both;
2. LC card file is arranged numerically by LC card number; LC proofslip file is arranged by title;
3. Fifty per cent of all items to be processed will have either LC cards or proofslips available in the files.

Task 1: Locate Position in File;

Task 2: Compare Order Form With File;

Task 3: Remove Card Set/Proofslip From File;

Task 4: Insert LC Card Set/Proofslip in Item.

IF LC CARDS/PROOFSLIPS ARE AVAILABLE:

Operation 2: Check LC Cards/Proofslips for Correctness.

Objective: To determine if information on LC cards or proofslips is correct and complete for items in hand.

Criterion: A cataloger can check one set of LC cards or proofslips for correctness and completeness in 291 seconds.

Assumption: The cataloger may or may not be a professional librarian; probably the cataloger would be a sub-professional.

Task 1: Compare LC Cards/Proofslip with Item;

Task 2: Note Any Changes or Additions to be Made.

Operation 3: Check Subject Headings.

Objective: To determine if the subject headings on LC cards or proofslips are acceptable.

Criterion: A cataloger can check the subject headings on an LC card or proofslip in 146 seconds.

Assumptions:

1. LC subject headings are used;

2. A title will be assigned an average of three subject headings.

Task 1: Locate Position in List;

Task 2: Compare LC Card/Proofslip with List;

Task 3: Note Any Changes or Additions to be Made.

Operation 4: Check in Shelf List.

Objective: To ascertain that there is no conflict between information on an LC card or proofslip and items in the shelf list which have been previously processed.

Criterion: A cataloger can check an LC card or proofslip in the shelf list in 146 seconds.

Task 1: Locate Position in File;

Task 2: Compare LC Card/Proofslip with File;

Task 3: Note Any Changes or Additions to be Made.

IF NO LC CARDS/PROOFSLIPS ARE AVAILABLE:

<u>Operation 5</u>: Search in NUC, Etc., For Copy.

Objective: To locate and copy complete bibliographic information necessary for the cataloging and classification of items which do not have LC cards or proofslips available.

Criterion: A clerk can locate and copy bibliographic information in the NUC, etc., for an item in 336 seconds.

Assumptions:

1. A portable photocopier is used to copy bibliographic information;
2. Seventy-five per cent of those items remaining without LC cards or proofslips (that is, 38% of all items being processed) will have full LC copy available from the NUC or other sources.

<u>Task 1</u>: Locate Bibliographic Citation;

<u>Task 2</u>: Compare Form with Citation;

<u>Task 3</u>: Transfer Bibliographic Information to Workslip;

<u>Task 4</u>: Indicate Source of Information.

<u>Operation 6</u>: Check Workslips for Correctness.

Objective: To determine if information on workslips is correct and complete for items in hand.

Criterion: A cataloger can check one workslip for correctness and completeness in 61 seconds.

Assumption: The cataloger may or may not be a professional librarian; probably the cataloger would be a subprofessional.

Task 1: Compare Workslip With Item;

Task 2: Note Any Changes or Additions to be Made.

Operation 7: Check Subject Headings.

Objective: To determine if the subject headings on workslips are acceptable.

Criterion: A cataloger can check the subject headings on a workslip in 146 seconds.

Assumptions:

1. LC subject headings are used;
2. A title will be assigned an average of three subject headings.

Task 1: Locate Position in List;

Task 2: Compare Workslip with List;

Task 3: Note any Changes to be Made.

Operation 8: Check in Shelf List.

Objective: To ascertain that there are no conflicts between information on workslips and items in the shelf list which have been previously processed.

Criterion: A cataloger can check a workslip in the shelf list in 146 seconds.

Task 1: Locate Position in File;

Task 2: Compare Workslip with File;

Task 3: Note Any Changes or Additions to be Made.

IF ORIGINAL CATALOGING IS NECESSARY:

Operation 9: Collect Data on Workslips.

Objective: To collect information (author, title, and other bibliographic data elements) for materials necessary for cataloging on workslips.

Criterion: A cataloger can collect the necessary information for cataloging and classifying a title on a workslip in 200 seconds.

Assumption: Twenty-five per cent of those items without LC cards or proofslips available (that is, 12% of all items being processed) must be cataloged originally.

Task 1: Scan Essential Parts of Item;

Task 2: Record Information on Workslip.

Operation 10: Establish Main Entries.

Objective: To determine the correct main entries for items being cataloged according to rules accepted or adopted by the library.

Criterion: A cataloger can establish the main entry for a title being cataloged in 802 seconds.

Task 1: Compare Workslip, Item, and Other Aids;

Task 2: Note Any Changes or Additions to be Made.

Operation 11: Assign Classification Numbers.

Objective: To assign classification numbers to items being processed.

Criterion: A cataloger can assign a classification number to a title being processed in 350 seconds.

Assumption: LC classification is used.

Task 1: Compare Item and Classification Scheme;

Task 2: Record Classification Number on Workslip.

Operation 12: Assign Subject Headings.

Objective: To assign subject headings to items being processed.

Criterion: A cataloger can assign subject headings to a title being processed in 250 seconds.

Assumptions:
1. LC subject headings are used;
2. A title will be assigned an average of three subject headings.

Task 1 : Locate Position in List;

Task 2: Compare Item and Workslip with List;

Task 3: Record Subject Heading Selected on Workslip.

Operation 13: Check in Shelf List.

Objective: To ascertain that there are no conflicts between information on workslips and items in the shelf list which have been previously processed.

Criterion: A cataloger can check a workslip in the shelf list in 146 seconds.

Task 1: Locate Position in File;

Task 2: Compare Workslip with File;

Task 3: Note Any Changes or Additions to be Made.

Sub-System: Processing

Activity: Card Production

IF LC CARD SETS ARE AVAILABLE:

Operation 1: Type Call Numbers on Cards.

Objective: To add the call numbers selected for titles to each of the cards in sets of LC cards.

Criterion: A typist can add call numbers to a set of LC cards in 120 seconds.

Assumptions:
1. A set of LC cards contains an average of six cards;
2. Only one card catalog and one shelf list are maintained by the library.

Operation 2: Type Added Entries on Cards.

Objective: To add headings (subject headings, titles, joint authors, etc.) to the tops of cards in sets of LC cards.

Criterion: A typist can add added entries to a set of LC cards in 200 seconds.

Assumptions:
1. A set of LC cards contains an average of six cards;
2. Only one card catalog and one shelf list are maintained by the library.

Operation 3: Type Information on Shelf Cards.

Objective: To add information such as accession numbers, locations, costs, etc., to cards for the shelf list file.

Criterion: A typist can add information to the shelf list card of a set of LC cards in 185 seconds.

Assumption: Only one shelf list is maintained by the library.

IF LC PROOFSLIPS ARE AVAILABLE:

Operation 4: Type Call Numbers on LC Proofslips.

Objective: To add the call numbers selected for titles to LC proofslips prior to reproduction.

Criterion: A typist can add a call number to an LC proofslip in 20 seconds.

Operation 5: Calculate and Note Number of Cards Needed.

Objective: To determine the number of cards necessary to prepare a complete set of catalog and shelf cards for a title.

Criterion: A clerk can calculate and note the number of cards needed for a set of cards for a title in 10 seconds.

Assumptions:

1. A set of cards contains an average of six cards;
2. Only one card catalog and one shelf list are maintained by the library.

IF NEITHER LC CARDS NOR PROOFSLIPS ARE AVAILABLE:

Operation 6: Type Main Entry Cards.

Objective: To prepare main entry (author) cards for copy to be reproduced to prepare complete sets of cards for items being processed.

Criterion: A typist can prepare a main entry card for a title in 344 seconds.

<u>Operation 7</u>: Calculate and Note Number of Cards Needed.

Objective: To determine the number of cards necessary to prepare a complete set of catalog and shelf cards for a title.

Criterion: A clerk can calculate and note the number of cards needed for a set of cards for a title in 10 seconds.

Assumptions:

1. A set of cards contains an average of six cards;
2. Only one card catalog and one shelf list are maintained by the library.

REPRODUCTION OF SETS OF CARDS:

<u>Operation 8</u>: Sort Cards/Slips by Number of Cards Needed.

Objective: To sort copy (LC proofslips or typed main entry cards) to be reproduced into groups according to the number of cards needed per set.

Criterion: A clerk can sort copy for a set of cards to be reproduced in 10 seconds.

<u>Operation 9</u>: Photocopy Card Sets.

Objective: To prepare sufficient copies of LC proofslips or typed main entry cards for complete sets of catalog and shelf list cards.

Criterion: A clerk can photocopy a card set in 160 seconds.

Assumptions:

1. A set of cards contains an average of six cards;
2. Xerox photocopying method is used.

Task 1: Place Card/Slip on Mount;

Task 2: Place Mount on Scanner of Machine;

Task 3: Photocopy;

Task 4: Remove Mount from Scanner;

Task 5: Remove Card/Slip from Mount.

Operation 10: Assemble Card Sets.

Objective: To assemble all copies of a card set together.

Criterion: A clerk can assemble a set of cards in 20 seconds.

Task 1: Tear or Cut Cards Apart;

Task 2: Place Copies of a Card Set Together.

FINISH CARD SETS:

Operation 11: Type Added Entries on Cards.

Objective: To add headings (subject headings, titles, joint authors, etc.) to the tops of cards in sets of reproduced cards.

Criterion: A typist can add added entries to a set of reproduced cards in 200 seconds.

Assumptions:

1. A set of reproduced cards contains an average of six cards;
2. Only one card catalog and one shelf list are maintained by the library.

Operation 12: Type Information on Shelf Cards.

Objective: To add information such as accession numbers, locations, costs, etc., to cards for the shelf list file.

Criterion: A typist can add information to the shelf list card of a set of reproduced cards in 185 seconds.

Assumption: Only one shelf list is maintained by the library.

Sub-System: Processing

Activity: Physical Processing of Materials

Operation 1: Type Information on Circulation Cards.

Objective: To prepare circulation cards for items being processed.

Criterion: A typist can type the call number, brief author, brief title, and accession number on a circulation card in 56 seconds.

Assumption: Circulation cards are necessary for the circulation system used by the library.

Operation 2: Type Information on Pockets.

Objective: To prepare pockets to contain circulation cards.

Criterion: A typist can type the call number, brief author, brief title, and accession number on a pocket in 56 seconds.

Assumption: Pockets are necessary to contain the circulation cards prepared for items.

Operation 3: Paste Pockets, Etc., in Items.

Objective: To paste pockets, book plates, etc., in items being processed.

Criterion: A clerk can paste a pocket and other items (a book plate, for example) in an item in 45 seconds.

Assumption: One pocket and one other item is pasted in an item being processed.

Task 1: Apply paste/glue to back of pocket or book plate;

Task 2: Locate Position for Pocket/Book Plate;

Task 3: Place Pocket/Book Plate in Position.

Operation 4: Property Stamp Items.

Objective: To provide items being processed with stamps or property identification.

Criterion: A clerk can apply property stamps to an item in 15 seconds.

Assumption: The property stamp is placed in two places in each item.

Task 1: Locate Position for Stamp;

Task 2: Place Stamp in Item.

Operation 5: Type Call Numbers on Labels.

Objective: To prepare labels to be placed on items for identification and retrieval purposes.

Criterion: A typist can prepare a call number label in 48 seconds.

Assumption: The Se-Lin labelling system is used.

Operation 6: Apply Labels to Items.

Objective: To apply call number labels to the spines of items being processed.

Criterion: A clerk can apply a call number label to an item in 79 seconds.

Task 1: Cut Strip of Tape;

Task 2: Peel Backing from Tape;

Task 3: Place Label on Item;

Task 4: Heat Seal Label.

Operation 7: Perform Quality Check on Items.

Objective: To check all items for completeness and correctness of processing.

Criterion: A clerk can check an item for completeness and correctness of processing in 55 seconds.

Sub-System: Processing

Activity: Filing

Operation 1: Check Cards for Errors and Completeness.

Objective: To check each card of a card set for completeness and correctness and general quality of workmanship.

Criterion: A clerk can check a set of cards for errors and completeness in 75 seconds.

Task 1: Check Cards for Errors.

Task 2: Separate Catalog Cards from Shelf Cards.

Operation 2: Arrange Catalog Cards Prior to Filing.

Objective: To arrange all cards into alphabetical sequence prior to their being filed into the card catalog.

Criterion: A clerk can alphabetize a set of cards in 25 seconds.

Assumptions:

1. The catalog cards are sorted into alpha sequence according to the top line of each card;
2. Cards are accumulated and filed once a week;
3. A set of cards contains an average of five cards.

Operation 3: File Catalog Cards.

Objective: To merge cards for processed items into the card catalog file.

Criterion: A clerk can file a set of cards in 300 seconds.

Assumptions:

1. Only one card catalog is maintained by the library;
2. The card catalog is undivided.

Task 1: Locate Position in File;

Task 2: Compare Card With File;

Task 3: Merge Card Into File.

Operation 4: Arrange Shelf Cards Prior to Filing.

Objective: To arrange shelf cards into sequence required prior to their being filed into the shelf list.

Criterion: A clerk can arrange a shelf list card into sequence in 9 seconds.

Assumptions:

1. The shelf cards are sorted into sequence by call number;
2. Cards are accumulated and filed once a week.

Operation 5: File Shelf Cards.

Objective: To merge cards for processed items into the shelf list file.

Criterion: A clerk can file a shelf list card in 50 seconds.

Operation 6: Revise Filing.

Objective: To proof the filing of catalog and shelf list cards before the cards are lowered and locked into trays.

Criterion: A professional or trained clerk can revise one set of cards in 34 seconds.

Assumption: A set of cards contains an average of six cards.

Task 1: Compare Card With File;

Task 2: Drop Card and Lock Into Place.

APPENDIX B

OPERATIONS OF A COMPUTER-BASED TECHNICAL SERVICES SYSTEM

Sub-System: Acquisitions

Activity: Preliminary Activities

Operation 1: Sort Incoming Request Forms.

Objective: To sort incoming requests for purchase from materials selectors (faculty, staff, students, general public) into categories (domestic current and non-current; foreign current and non-current, for example) for easier processing.

Criterion: A clerk can sort an incoming request form in 3 seconds.

Assumption: Requests for purchase are submitted on standardized forms.

Task 1: Scan Request Form;

Task 2: Place Form Into Category.

Operation 2: Alphabetize Request Forms.

Objective: To alphabetize incoming request forms in each category and to match, mark, and remove any duplicate forms located.

Criterion: A clerk can alphabetize an incoming request form in 9 seconds.

Assumption: Five per cent of incoming request forms are duplicates of each other and will be returned to selectors without further processing.

Task 1: Merge Form Into Sequence;

Task 2: Match Any Duplicate;

Task 3: Mark and Remove Duplicate.

Sub-System: Acquisitions

Activity: Verifying and Searching

Operation 1: Verify Requests in Bibliographic Sources.

Objective: To determine the bibliographic existence and correctness of incoming requests for purchase and to correct or supplement information given.

Criterion: A verifier can locate one request form bibliographically and complete its verification in 507 seconds.

Assumption: Information to be verified is: author/main entry, title, edition, publisher, publication date, and LC card number.

Task 1: Locate Bibliographic Citation;

Task 2: Correct or Supplement Information on Request Form;

Task 3: Indicate Source of Information.

Operation 2: Verify Prices and Availability.

Objective: To determine the prices and availability of incoming requests for purchase.

Criterion: A verifier can locate the price and determine the availability of one request for purchase in 67 seconds.

Assumption: Five per cent of all requests for purchase are out-of-print and will be returned to selectors without further processing, or, channelled to other systems.

Task 1: Locate Price and Availability Information;

Task 2: Correct or Supplement Information on Request Form;

Task 3: Indicate Source of Information.

Operation 3: Search Requests in Order List.

Objective: To determine if incoming requests for purchase are on order or in process for the library's collections.

Criterion: A searcher can check one incoming request for purchase in the processing list in 25 seconds.

Assumptions:

1. The "on order" and "in process" files are combined in one computer produced processing list;

2. Five per cent of all requests for purchase are already on order or in process for the library's collections.

Task 1: Locate Position in List;

Task 2: Compare Request Form with List;

Task 3: Match Any Duplicate;

Task 4: Mark and Remove Duplicate.

Operation 4: Search Requests in Card Catalog.

Objective: To determine if incoming requests for purchase are in the library's collections.

Criterion: A searcher can check one incoming request for purchase in the card catalog in 31 seconds.

Assumption: Five per cent of all requests for purchase are already in the library's collections.

Task 1: Locate Position in File;

Task 2: Compare Request Form with File;

Task 3: Match Any Duplicate;

Task 4: Mark and Remove Duplicate.

Sub-System: Acquisitions

Activity: Ordering

Operation 1: Assign Vendors and Order Numbers.

Objective: To determine from whom requests for purchase will be ordered and to assign order numbers to the requests.

Criterion: A professional can assign vendor and order numbers to a request form in 42 seconds.

Assumption: Order numbers reflect fund numbers.

Task 1: Scan Request Form;

Task 2: Assign Request to Vendor;

Task 3: Assign Order Number.

Operation 2: Transfer Information to Machine-Readable Form.

Objective: To transfer information on request forms to a machine-readable form for machine storage and manipulation.

Criterion: A clerk can key a request in 338 seconds.

Assumptions:

1. Punch cards are used as the medium of input to the computer system;
2. Access to the computer system is off-line.

Operation 3: Verify Keying.

Objective: To machine verify the keying in order to locate and correct any errors made.

Criterion: A clerk can verify a request in 338 seconds.

Operation 4: Generate Purchase Orders.

Objective: To prepare orders to vendors for verified and searched requests for purchase.

Criterion: A computer system can generate a purchase order for an item in 9 seconds.

Assumptions:
1. Fan-fold, multiple-copy order forms are submitted to vendors as purchase orders;
2. Criteria includes set-up time for the computer system.

Operation 5: Update Order/Processing List.

Objective: To insert into the order/processing file a record of new items to be ordered.

Criterion: A computer system can update the processing list for an item in 5 seconds.

Assumptions:
1. The order/processing file is in disk storage;
2. Criteria includes set-up time for the computer system.

Operation 6: Update Accounting File

Objective: To encumber funds for purchase orders to vendors.

Criterion: A computer system can update the accounting file for an item in 5 seconds.

Assumption: Criteria includes set-up time for the computer system.

Operation 7: Generate Update/Notify Cards.

Objective: To provide a means for later "notifying" the computer system that items have been received and to update the information stored for items.

Criterion: The computer system can punch an update/notify card for an item in 4 seconds.

Assumptions: 1. Update/Notify cards are punch cards;

2. Criteria includes set-up time for the computer system.

<u>Operation 8</u>: Forward Orders to Vendors.

Objective: To distribute orders for materials to vendors.

Criterion: A clerk can burst, package, and forward an order form to a vendor in 2 seconds.

Assumption: Orders to vendors will contain an average of 50 order forms each.

<u>Task 1</u>: Burst Form;

<u>Task 2</u>: Package Form;

<u>Task 3</u>: Forward Order to Vendor.

<u>Operation 9</u>: File Update/Notify Cards.

Objective: To place update/notify cards into a suspense file to await shipment of materials ordered.

Criterion: A clerk can file an update/notify card for an item in 1 second.

<u>Task 1</u>: Locate Position in File;

<u>Task 2</u>: Compare Update/Notify Card with File;

<u>Task 3</u>: Place Card in Sequence in File.

Sub-System: Acquisitions

Activity: Receiving

Operation 1: Open Packages.

Objective: To serve as a central point for the receipt of incoming shipments of materials from vendors.

Criterion: A clerk can open and unpack an item received in 15 seconds.

Task 1: Remove Wrapping from Package;

Task 2: Place Item on Truck;

Task 3: Arrange Item in Invoice Order.

Operation 2: Verify Correctness of Items Shipped.

Objective: To determine if items received from vendors are as ordered.

Criterion: A clerk can verify the correctness of an item received in 252 seconds.

Task 1: Remove Update/Notify Card for Item from File;

Task 2: Compare Item with Update/Notify Card and Invoice;

Task 3: Mark Update/Notify Card;

Task 4: Check Item Off Invoice.

Operation 3: Clear Invoices.

Objective: To check, approve, and forward invoices from vendors for payment.

Criterion: A clerk can clear an item on an invoice in 80 seconds.

Assumptions:

1. Checks to vendors for payment of items shipped are not prepared in technical services;
2. An average of 25 items are on an invoice.

Task 1: Check Invoice for Discrepancy;

Task 2: Correct Any Discrepancy;

Task 3: Approve and Forward Invoice for Payment.

Operation 4: Update Order/Processing File.

Objective: To indicate in the order/processing list that items have been received and are now "in process."

Criterion: A computer system can update the order/processing file for an item in 5 seconds.

Assumptions:

1. The update/notify card is used as input to the computer system to trigger the update of the processing file;
2. The criteria includes set-up time for the computer system.

Operation 5: Update Accounting File.

Objective: To update the accounting file for funds expended for items received.

Criterion: A computer system can update the accounting file for an item in 5 seconds.

Assumption: Criteria includes set-up time for the computer system.

Operation 6: Match Records Against MARC Data Base.

Objective: To match and retrieve MARC records for the maximum number of items received and to print workslips for MARC records and records not found in the MARC data base.

Criterion: A computer system can match and print a MARC record in a data base for an item in 5 seconds.

Assumptions: 1. Seventy-five per cent of all items will have full cataloging data (MARC records or complete information from LC cards or proofslips);

2. Criteria includes set-up time for the computer system.

<u>Task 1</u>: Match MARC Record;

<u>Task 2</u>: Print Workslip.

Sub-System: Processing

Activity: Cataloging and Classification

Operation 1: Sort Workslips.

Objective: To sort those workslips with full cataloging data from those with no or partial data.

Criterion: A clerk can sort a workslip in 3 seconds.

Assumption: Seventy-five per cent of all items to be processed will have full cataloging data (MARC records or data from LC cards or proofslips).

Task 1: Scan Workslip;

Task 2: Place Workslip in Category.

IF FULL CATALOGING DATA IS AVAILABLE ON WORKSLIPS:

Operation 2: Check Workslips for Correctness.

Objective: To determine if information on workslips is correct and complete for items in hand.

Criterion: A cataloger can check one workslip for correctness and completeness in 291 seconds.

Assumption: The cataloger may or may not be a professional librarian; probably the cataloger would be a sub-professional.

Task 1: Compare Workslip with Item;

Task 2: Note Any Changes or Additions to be Made.

Operation 3: Check Subject Headings.

Objective: To determine if the subject headings on workslips are acceptable.

Criterion: A cataloger can check the subject headings on a workslip in 146 seconds.

Assumptions:

1. LC subject headings will be used;

2. A title will be assigned an average of three subject headings.

Task 1: Locate Position in List;

Task 2: Compare Workslip with List;

Task 3: Note Any Changes or Additions to be Made.

Operation 4: Check in Shelf List.

Objective: To ascertain that there is no conflict between information on a workslip and items in the shelf list which have been processed previously.

Criterion: A cataloger can check a workslip in the shelf list in 146 seconds.

Task 1: Locate Position in File;

Task 2: Compare Workslip with File;

Task 3: Note Any Changes or Additions to be Made.

IF FULL CATALOGING DATA IS NOT AVAILABLE ON WORKSLIPS:

Operation 5: Search in NUC, Etc., for Copy.

Objective: To locate and copy complete bibliographic information necessary for the cataloging and classification of items which do not have full cataloging data available.

Criterion: A clerk can locate and copy bibliographic information in the NUC, etc., for an item in 336 seconds.

Assumption: Twelve and a half per cent of all items without full cataloging data at the beginning of the process will have full LC copy available upon further search.

Task 1: Locate Bibliographic Citation;

Task 2: Compare Workslip with Citation;

Task 3: Transfer Bibliographic Information to Workslip;

Task 4: Indicate Source of Information.

Operation 6: Check Workslips for Correctness.

Objective: To determine if information on workslips is correct and complete for items in hand.

Criterion: A cataloger can check one workslip for correctness and completeness in 61 seconds.

Assumption: The cataloger may or may not be a professional librarian; probably the cataloger would be a subprofessional.

Task 1: Compare Workslip with Item;

Task 2: Note Any Changes or Additions to be Made.

Operation 7: Check Subject Headings.

Objective: To determine if the subject headings on workslips are acceptable.

Criterion: A cataloger can check the subject headings on a workslip in 146 seconds.

Assumptions:

1. LC subject headings were used;

2. A title will be assigned an average of three subject headings.

Task 1: Locate Position in List;

Task 2: Compare Workslip with List;

Task 3: Note Any Changes or Additions to be Made.

Operation 8: Check in Shelf List.

Objective: To ascertain that there are no conflicts between information on workslips and items in the shelf list which have been previously processed.

Criterion: A cataloger can check a workslip in the shelf list in 146 seconds.

Task 1: Locate Position in File;

Task 2: Compare Workslip with File;

Task 3: Note Any Changes or Additions to be Made.

IF ORIGINAL CATALOGING IS NECESSARY:

Operation 9: Collect Data on Workslips.

Objective: To collect on workslips information necessary to describe materials (books, pamphlets, and so on) by author, title, and other bibliographic data elements.

Criterion: A cataloger can collect the necessary information for cataloging and classifying a title on a workslip in 200 seconds.

Assumption: Twelve and a half per cent of those items remaining must have original cataloging.

Task 1: Scan Essential Parts of Items;

Task 2: Record Information on Workslip.

Operation 10: Establish Main Entries.

Objective: To determine the correct main entries for items being cataloged according to rules accepted or adopted by the library.

Criterion: A cataloger can establish the main entry for a title being cataloged in 802 seconds.

Task 1: Compare Workslip, Item, and Other Aids;

Task 2: Note Any Changes or Additions to be Made.

Operation 11: Assign Classification Numbers.

Objective: To assign classification numbers to items being processed.

Criterion: A cataloger can assign a classification number to a title being processed in 350 seconds.

Assumption: LC classification is used.

Task 1: Compare Item and Classification Scheme;

Task 2: Record Classification Number on Workslip.

Operation 12: Assign Subject Headings.

Objective: To assign subject headings to items being processed.

Criterion: A cataloger can assign subject headings to a title being processed in 250 seconds.

Assumptions:

1. LC subject headings will be used;
2. A title will be assigned an average of three subject headings.

Task 1: Locate Position in File;

Task 2: Compare Subject Heading Selected on Workslip;

Task 3: Record Subject Heading Selected on Workslip.

Operation 13: Check in Shelf List.

Objective: To ascertain that there are no conflicts between information on workslips and items in the shelf list which have been previously processed.

Criterion: A cataloger can check a workslip in the shelf list in 146 seconds.

Task 1: Locate Position in File;

Task 2: Compare Workslip with File;

Task 3: Note Any Changes or Additions to be Made.

Sub-System: Processing

Activity: Card Production

Operation 1: Key Update Cards for Catalog Cards.

Objective: To transfer update information for catalog records to a machine-readable form prior to updating of the processing list.

Criterion: A clerk can key update information for a title in 130 seconds.

Assumptions:

1. Punch cards are used as the medium of input to the computer system;

2. Access to the computer system is offline.

Operation 2: Verify Keying.

Objective: To machine verify the keying in order to locate and correct any errors made in keying.

Criterion: A clerk can verify update information for a title in 130 seconds.

Operation 3: Update Order/Processing File.

Objective: To add new or corrected information to catalog records in the processing file before catalog cards are prepared.

Criterion: A computer system can update the order/processing file for an item in 5 seconds.

Assumption: Criteria includes set-up time for the computer system.

Operation 4: Print Catalog Cards.

Objective: To prepare sets of cards (author, title, subject, reference, shelf list, etc.) for items being processed.

Criterion: A computer system can print a set of catalog cards in 10 seconds.

Assumptions:

1. A set of catalog cards contains an average of six cards;
2. Criteria includes set-up time for the computer system.

<u>Operation 5</u>: Punch Circulation Cards and Print Labels.

Objective: To prepare circulation cards and identification labels for items being processed.

Criterion: A computer system can punch a circulation card and print a set of labels for an item in 4 seconds.

Assumptions:

1. Machine-readable circulation cards are necessary for the circulation system used by the library;
2. Sets of labels include book pocket labels and spine labels;
3. Criteria includes set-up time for the computer system.

Sub-System: Processing

Activity: Physical Processing of Materials

Operation 1: Match Processing Materials with Items.

Objective: To match sets of circulation cards and labels with their corresponding items being processed.

Criterion: A clerk can match all processing materials with an item in 164 seconds.

Assumption: Items awaiting the preparation of processing materials are arranged in title sequence.

Task 1: Compare Processing Materials with Item;

Task 2: Place Processing Materials in Item or in Sequence.

Operation 2: Paste Pockets, Etc., in Items.

Objective: To paste pockets, book plates, etc., in items being processed.

Criterion: A clerk can paste a pocket and other items (a book plate, for example) in an item in 45 seconds.

Assumption: One pocket and one other item is pasted in an item being processed.

Task 1: Apply Paste/Glue to Back of Pocket or Book Plate;

Task 2: Locate Position for Pocket/Book Plate;

Task 3: Place Pocket/Book Plate in Position.

Operation 3: Property Stamp Items.

Objective: To provide items being processed with stamps of property identification.

Criterion: A clerk can property stamp an item in 15 seconds.

Assumption: The property stamp is placed in two places in each item.

Task 1: Locate Position for Stamp;

Task 2: Place Stamp in Item.

Operation 4: Apply Labels to Items.

Objective: To apply labels of identification and retrieval to the pockets in items and on the spines of items.

Criterion: A clerk can apply labels to an item in 79 seconds.

Assumption: One label is placed on the pocket of an item and one on its spine.

Task 1: Place Label on Pocket;

Task 2: Place Label on Spine;

Task 3: Apply Protective Coating to Label on Spine.

Operation 5: Perform Quality Check on Items.

Objective: To check all items for completeness and correctness of processing.

Criterion: A clerk can check an item for completeness and correctness of processing in 55 seconds.

Sub-System: Processing

Activity: Filing

Operation 1: Sort Catalog Cards and Shelf Cards.

Objective: To separate the catalog cards from shelf cards prior to filing.

Criterion: A clerk can sort a set of cards in 3 seconds.

Operation 2: Arrange Catalog Cards Prior to Filing.

Objective: To arrange all cards into alphabetical sequence prior to their being filed into the card catalog.

Assumptions:

1. The catalog cards are sorted into alpha sequence according to the top line of each card;
2. Cards are accumulated and filed once a week;
3. A set of cards contains an average of five cards.

Operation 3: File Catalog Cards.

Objective: To merge cards for processed items into the card catalog file.

Criterion: A clerk can file a set of cards in 300 seconds.

Assumptions:

1. Only one card catalog is maintained by the library;
2. The card catalog is undivided.

Task 1: Locate Position in File;

Task 2: Compare Card with File;

Task 3: Merge Card into File.

Operation 4: Arrange Shelf Cards Prior to Filing.

Objective: To arrange shelf cards into sequence required prior to their being filed into the shelf list.

Criterion: A clerk can arrange a shelf list card into sequence in 9 seconds.

Assumptions:
1. The shelf cards are sorted into sequence by call number;
2. Cards are accumulated and filed once a week.

Operation 5: File Shelf Cards.

Objective: To merge cards for processed items into the shelf list file.

Criterion: A clerk can file a shelf list card in 50 seconds.

Operation 6: Revise Filing.

Objective: To proof the filing of catalog and shelf list cards before the cards are lowered and locked into trays.

Criterion: A professional or trained clerk can revise one set of cards in 34 seconds.

Assumption: A set of cards contains an average of six cards.

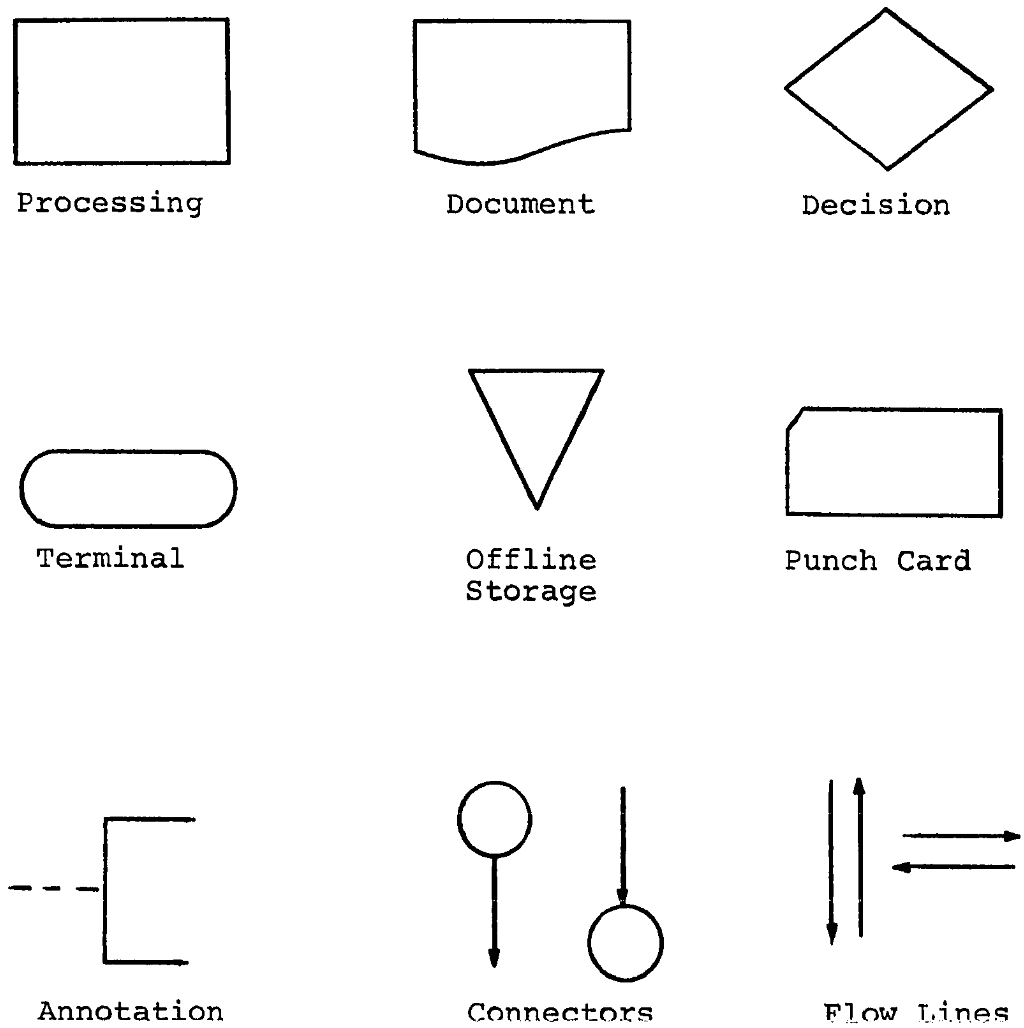
Task 1: Compare Card with File;

Task 2: Drop Card and Lock into Place.

APPENDIX C

STANDARD FLOWCHARTING SYMBOLS

Standard Flowchart Symbols[1]



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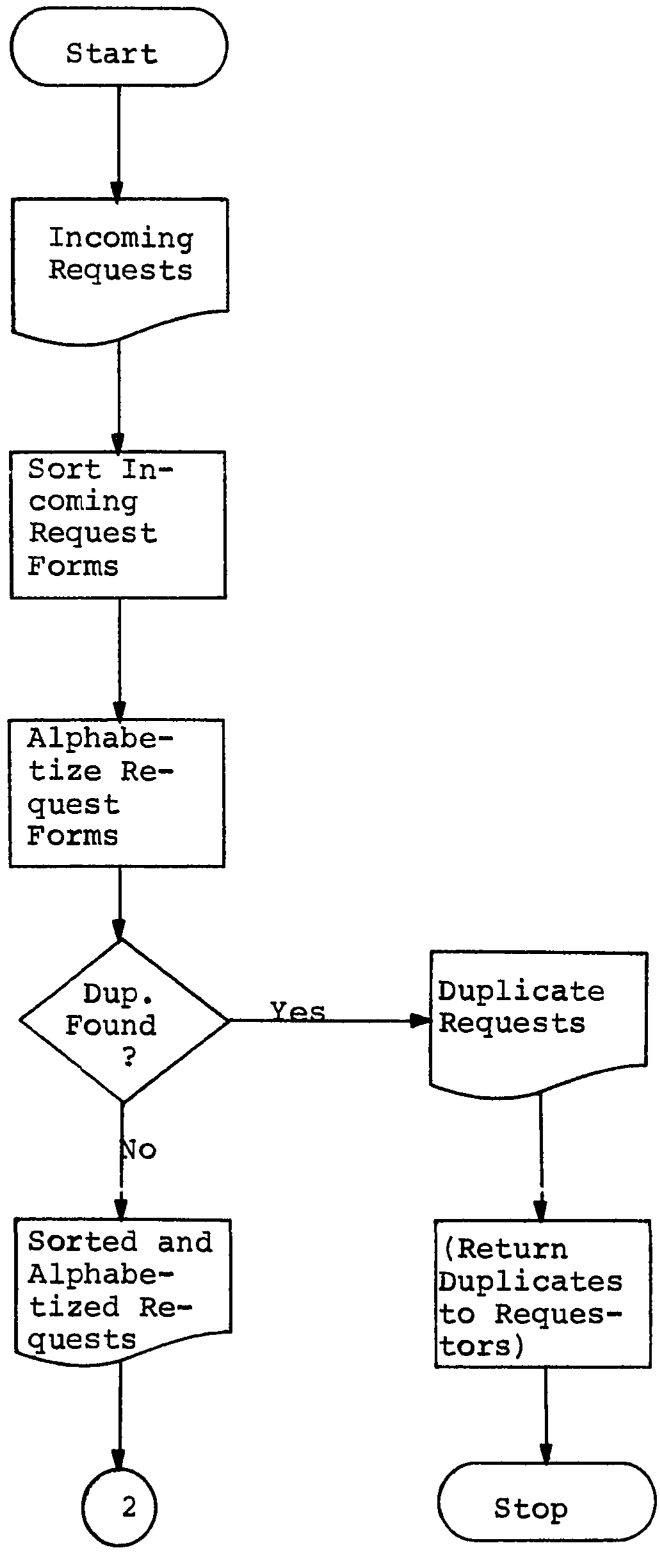
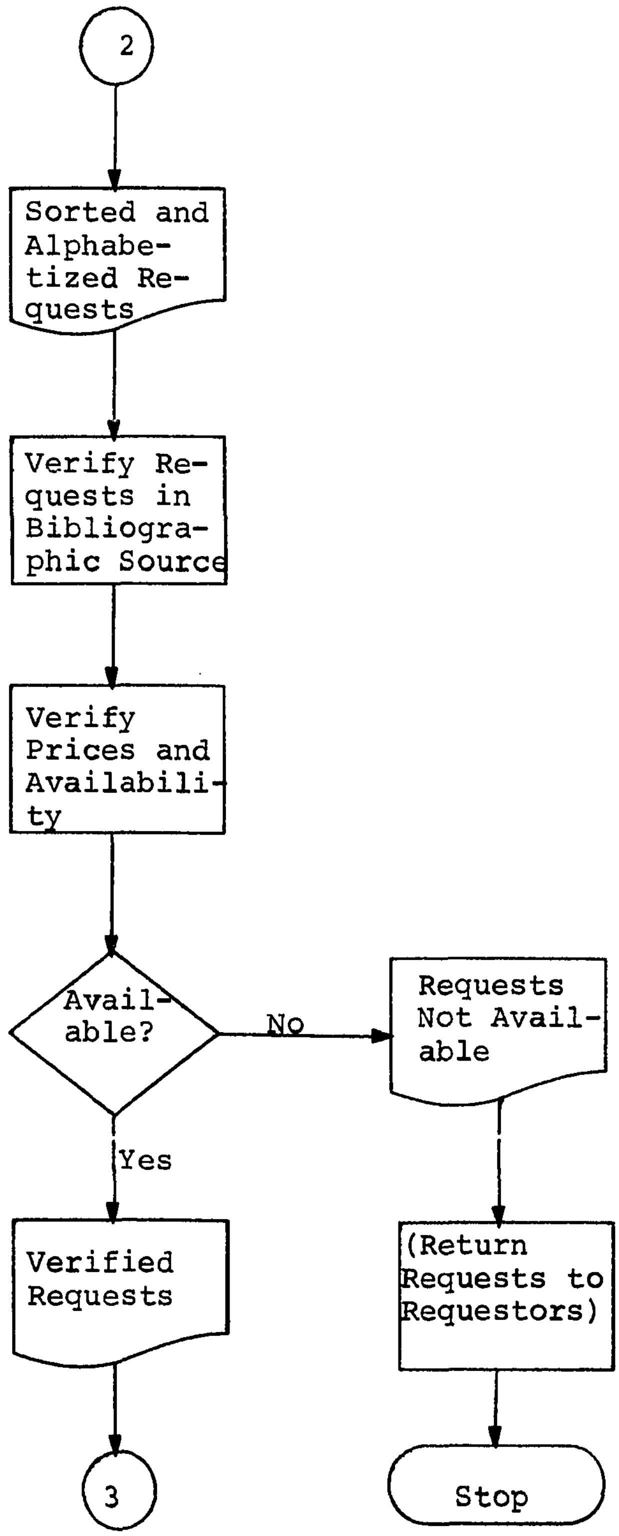
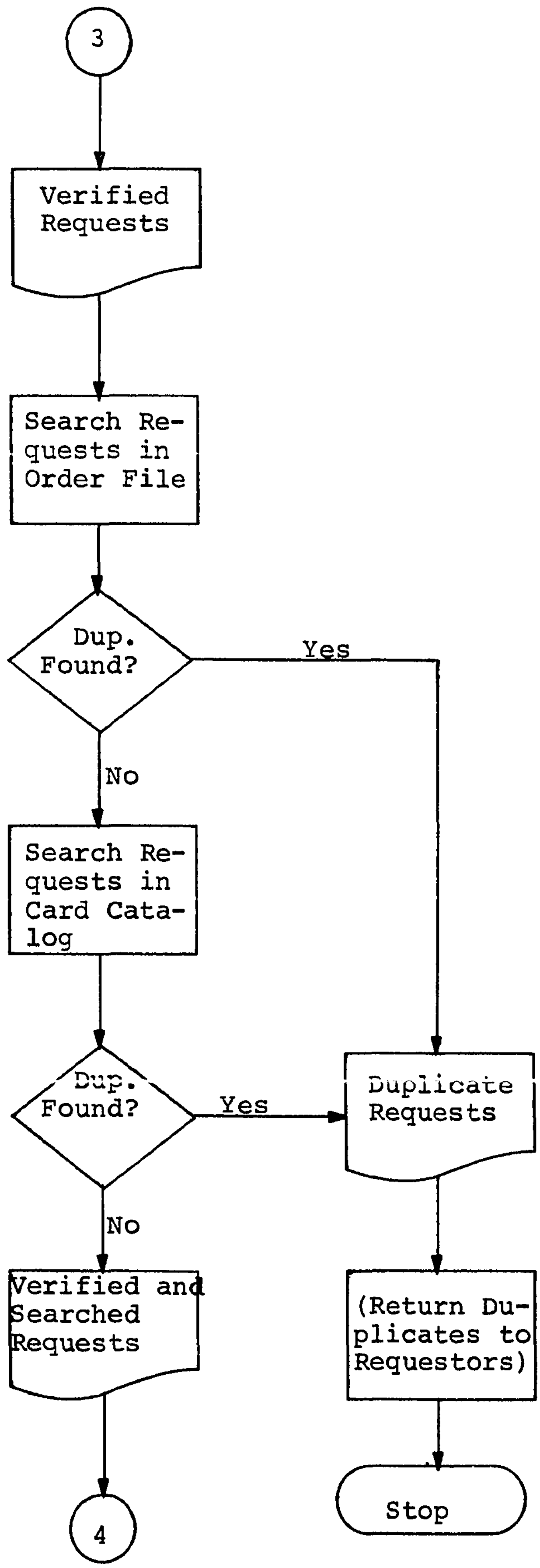
[1]Adapted from the American National Standards Institute (3).

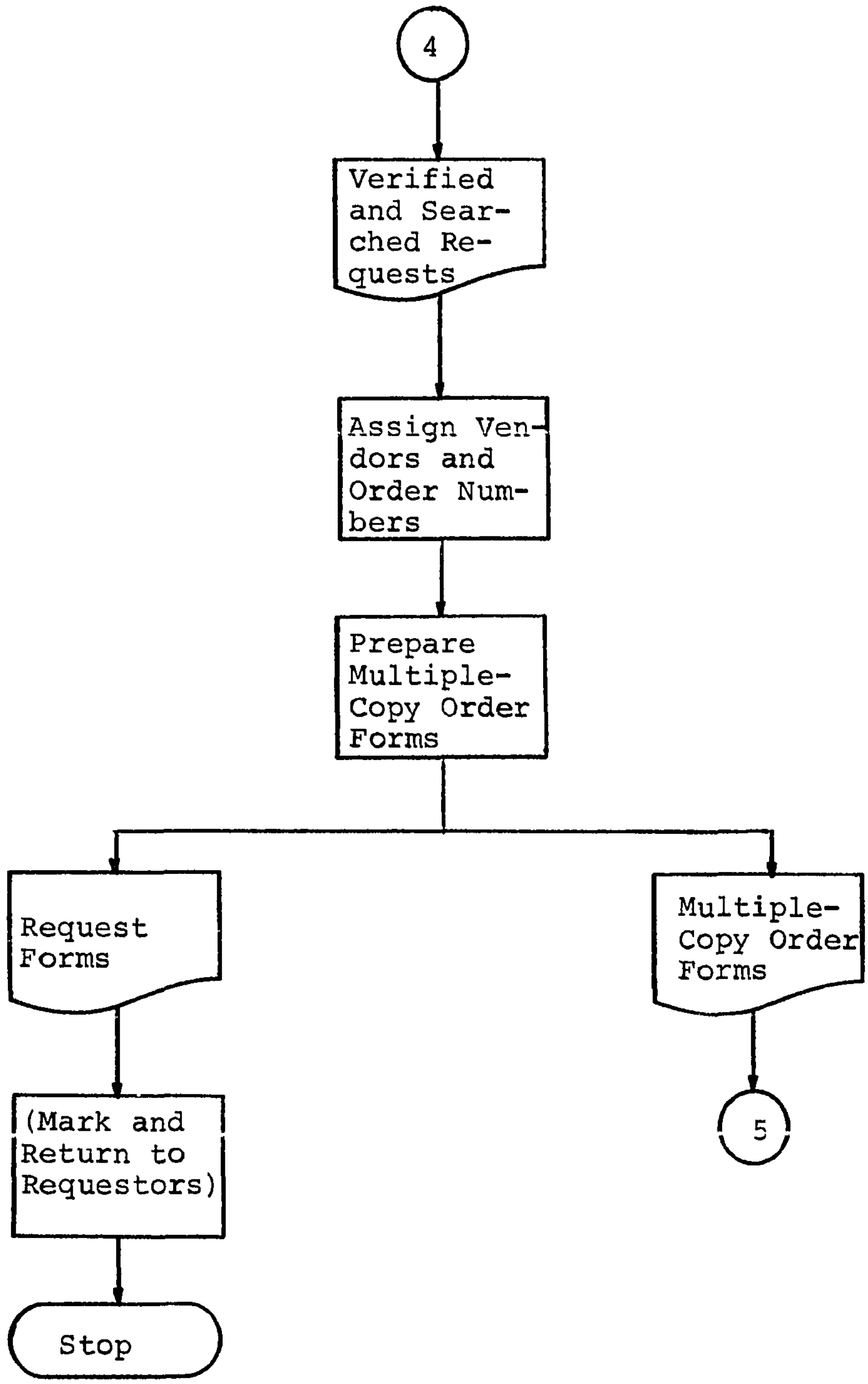
APPENDIX D

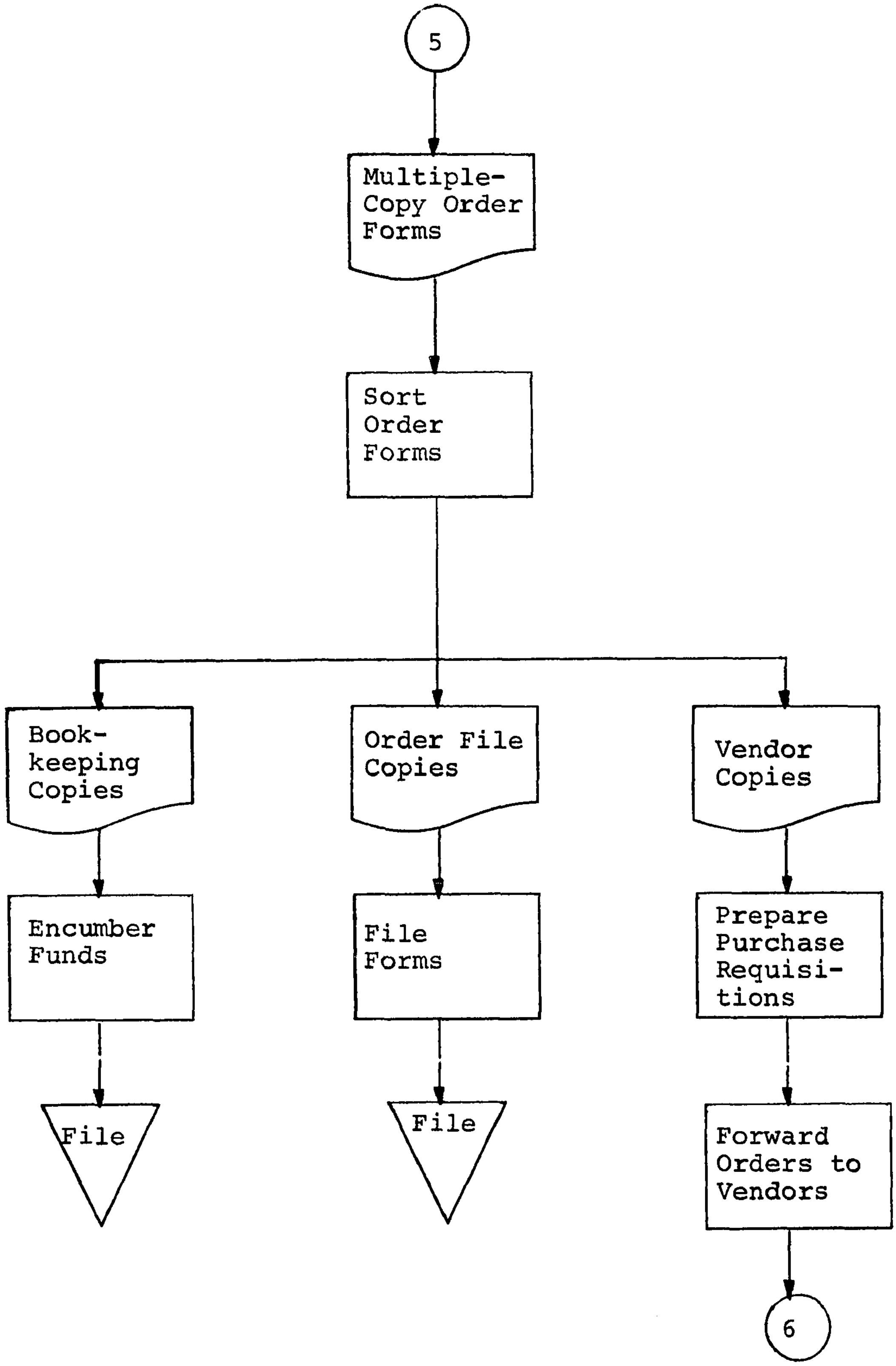
FLOWCHARTS FOR A MANUAL TECHNICAL SERVICES SYSTEM

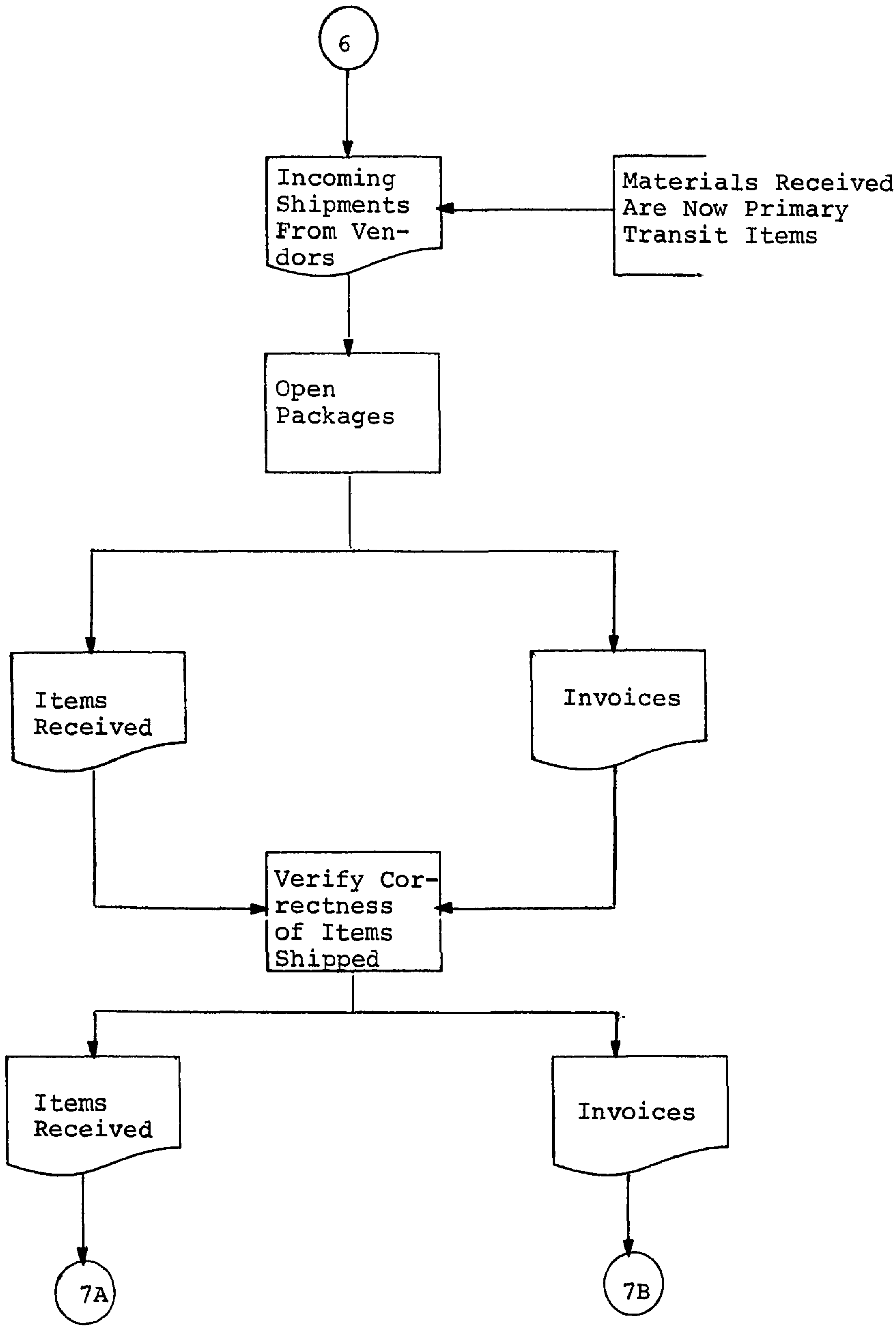

Start
Incoming Requests
Sort Incoming Request Forms
Alphabetize Request Forms
Dup. Found ?
Yes
Duplicate Requests
No
Sorted and Alphabetized Requests
(Return Duplicates to Requestors)
2
Stop

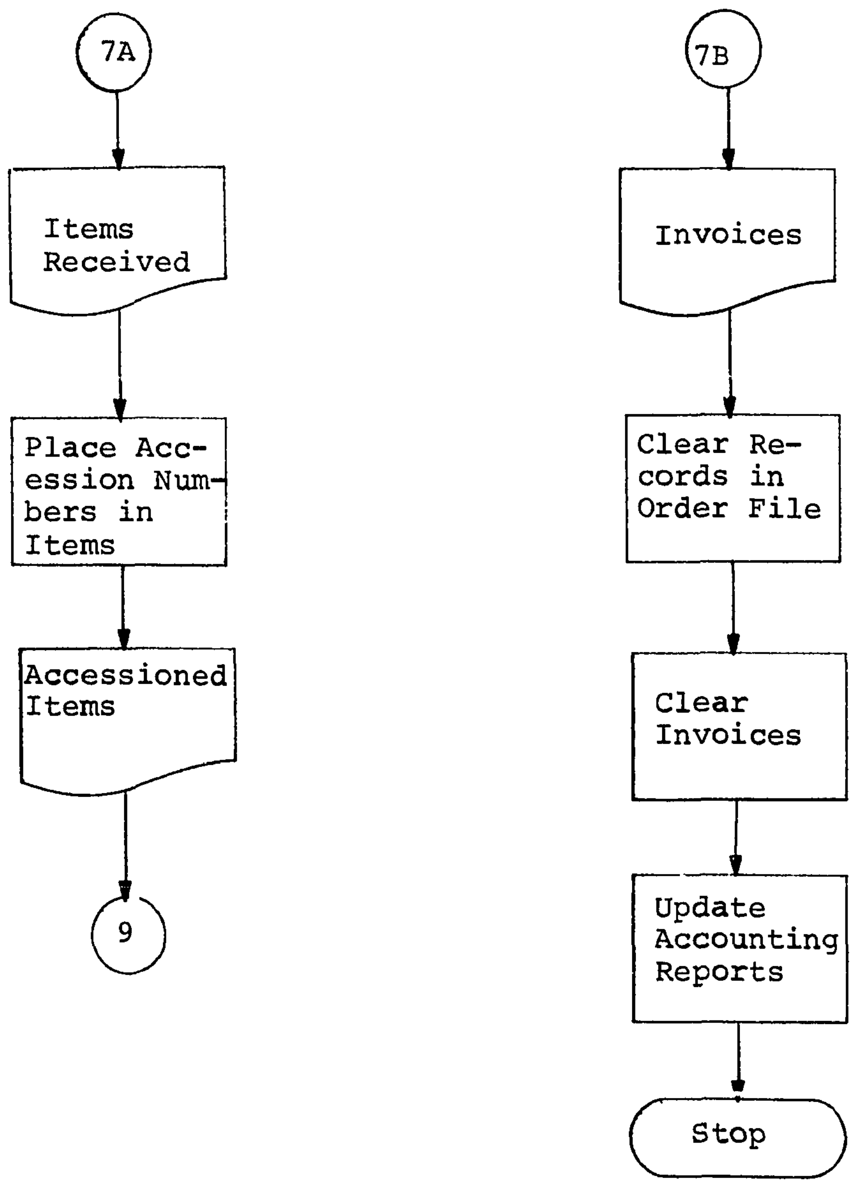

2
Sorted and Alphabe-tized Re-quests
Verify Re-quests in Bibliogra-phic Source
Verify Prices and Availabili-ty
Avail-able?
No
Requests Not Avail-able
Yes
Verified Requests
(Return Requests to Requestors)
3
Stop

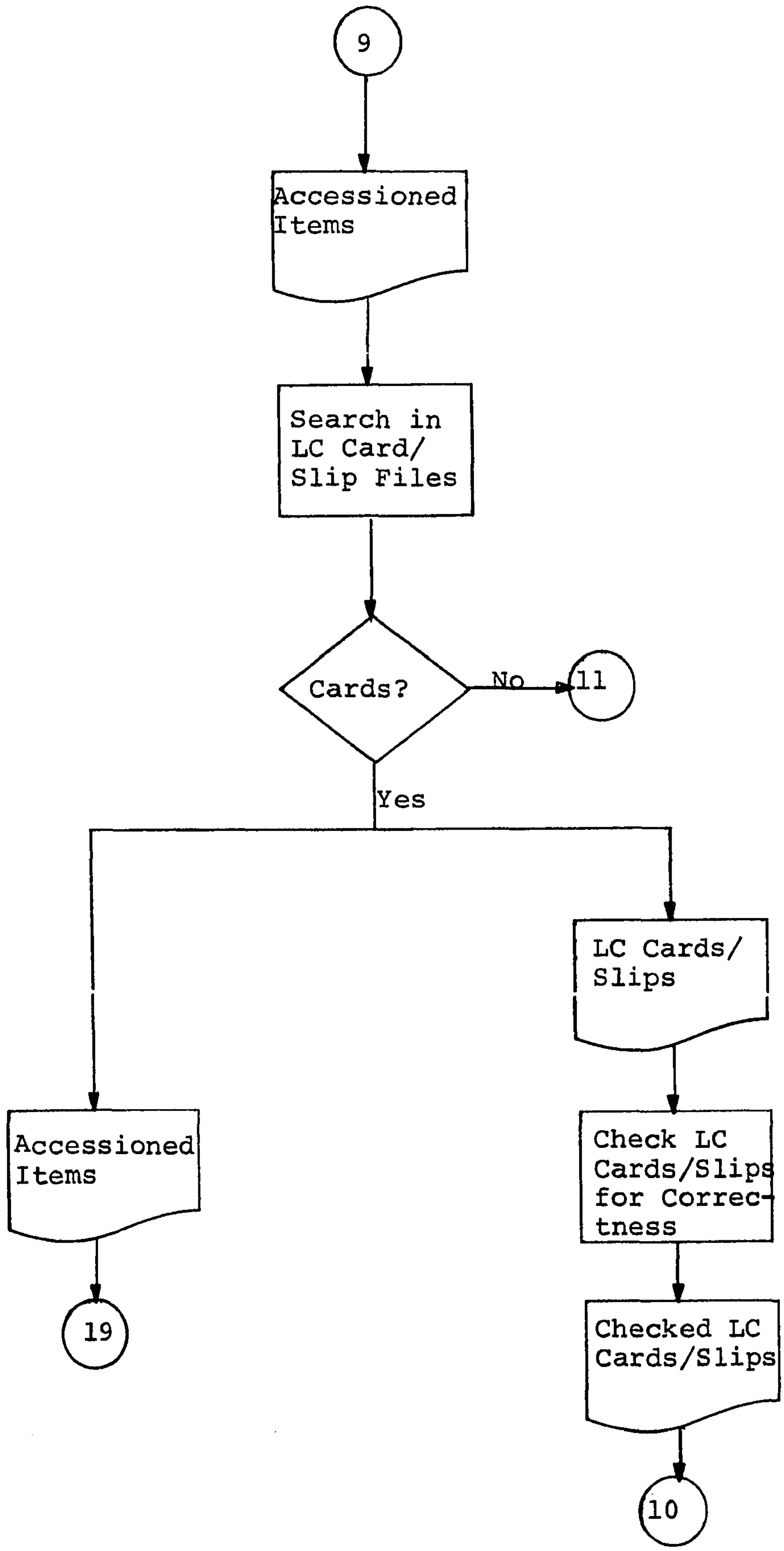

3
Verified Requests
Search Requests in Order File
Dup. Found?
Yes
No
Search Requests in Card Catalog
Dup. Found?
Yes
No
Duplicate Requests
Verified and Searched Requests
(Return Duplicates to Requestors)
4
Stop

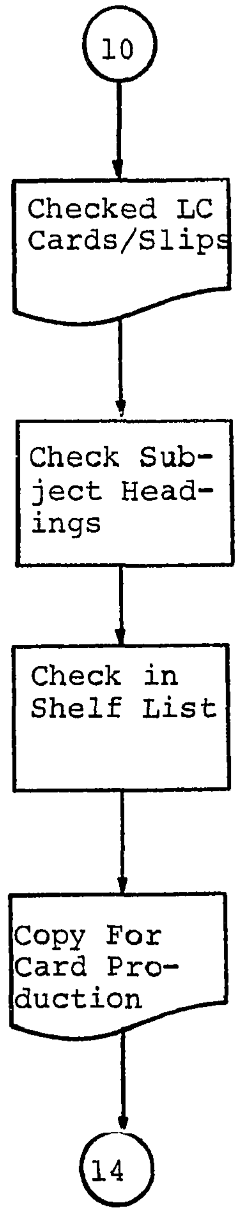

4
Verified and Searched Requests
Assign Vendors and Order Numbers
Prepare Multiple-Copy Order Forms
Request Forms
Multiple-Copy Order Forms
(Mark and Return to Requestors)
5
Stop

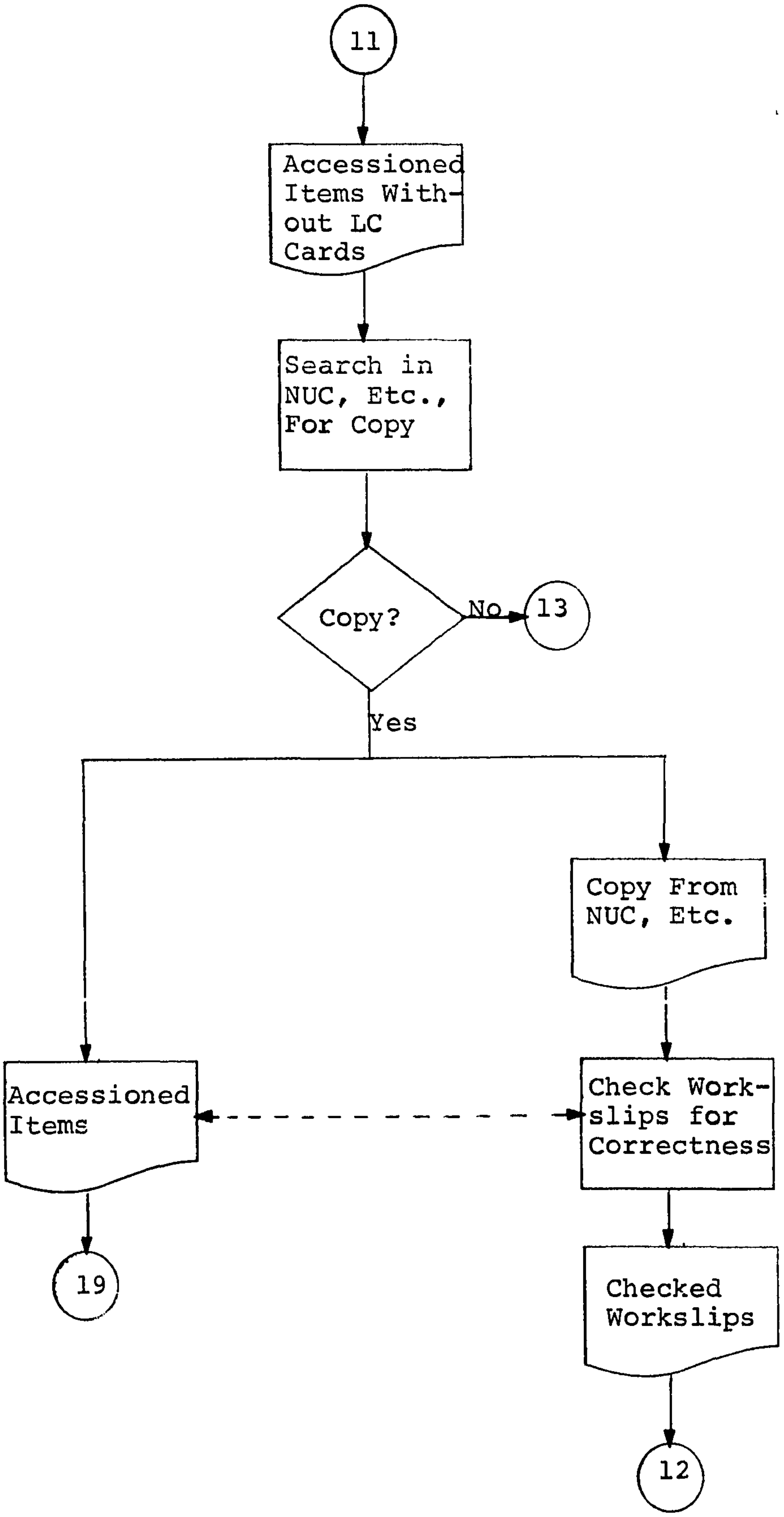

5
Multiple-
Copy Order
Forms
Sort
Order
Forms
Book-
keeping
Copies
Order File
Copies
Vendor
Copies
Encumber
Funds
File
Forms
Prepare
Purchase
Requisi-
tions
File
File
Forward
Orders to
Vendors
6

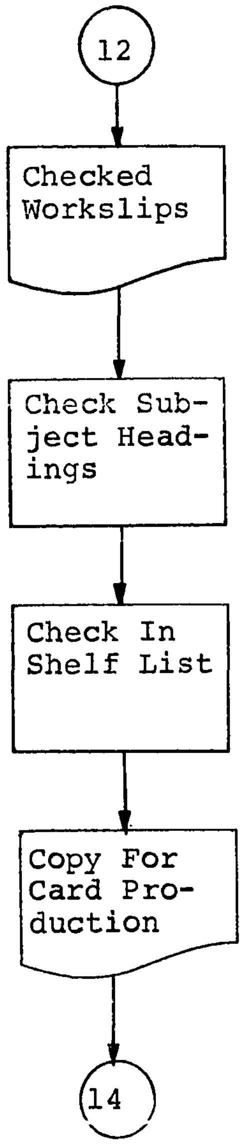

6
Incoming Shipments From Vendors
Materials Received Are Now Primary Transit Items
Open Packages
Items Received
Invoices
Verify Correctness of Items Shipped
Items Received
Invoices
7A
7B

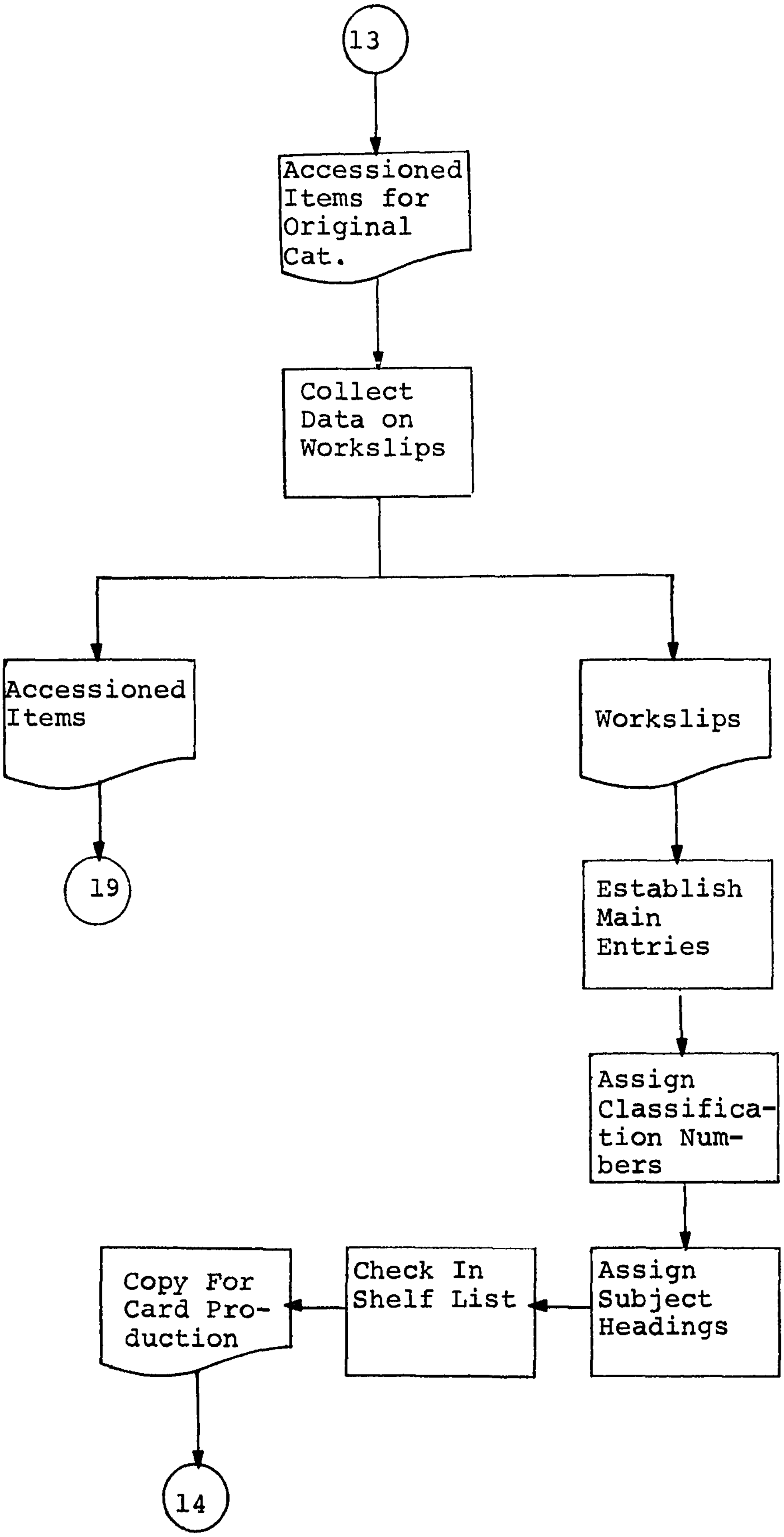

7A
Items Received
Place Accession Numbers in Items
Accessioned Items
9
7B
Invoices
Clear Records in Order File
Clear Invoices
Update Accounting Reports
Stop

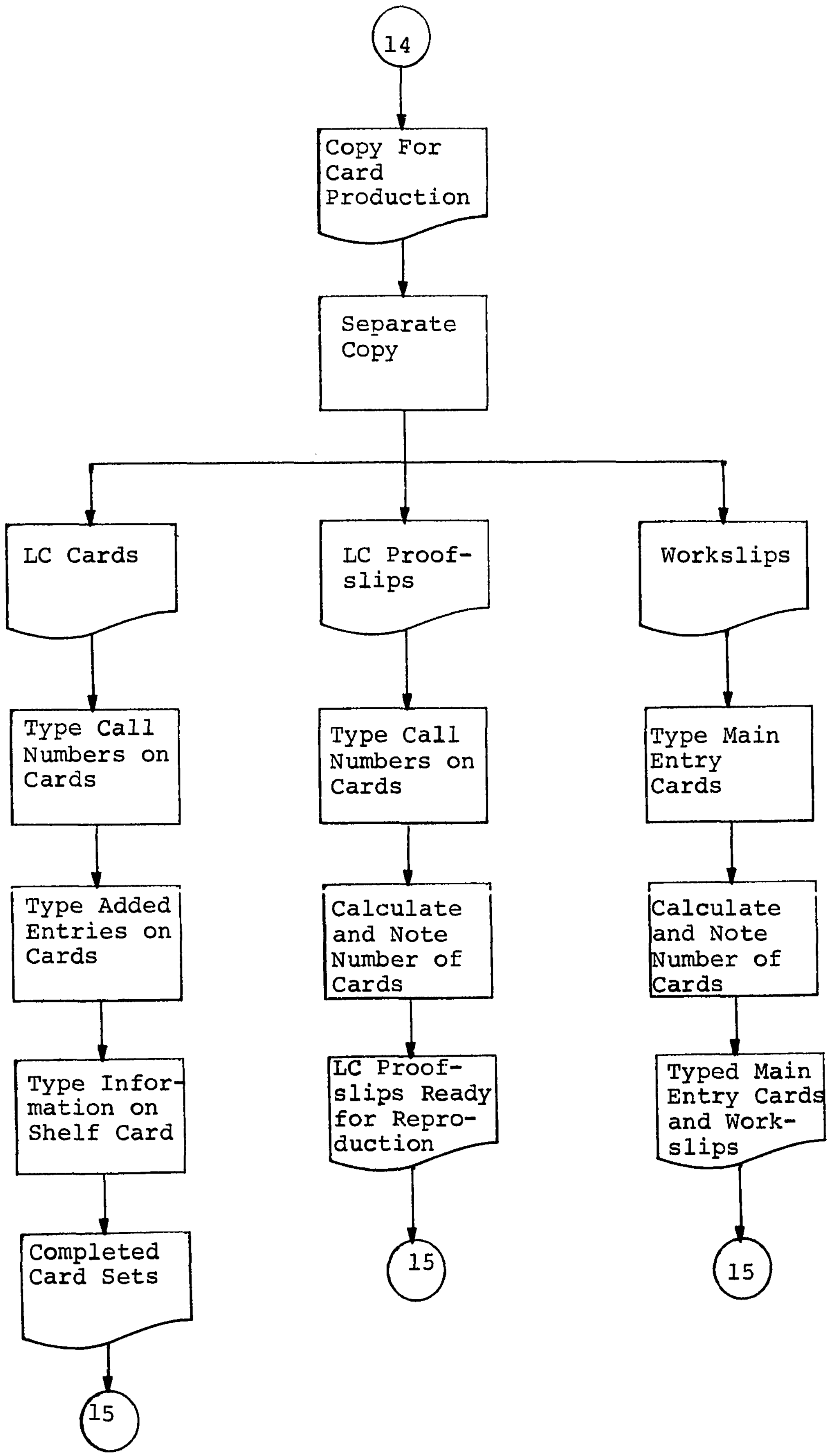

9
Accessioned Items
Search in LC Card/ Slip Files
Cards?
No
11
Yes
LC Cards/ Slips
Check LC Cards/Slips for Correctness
Checked LC Cards/Slips
10
Accessioned Items
19

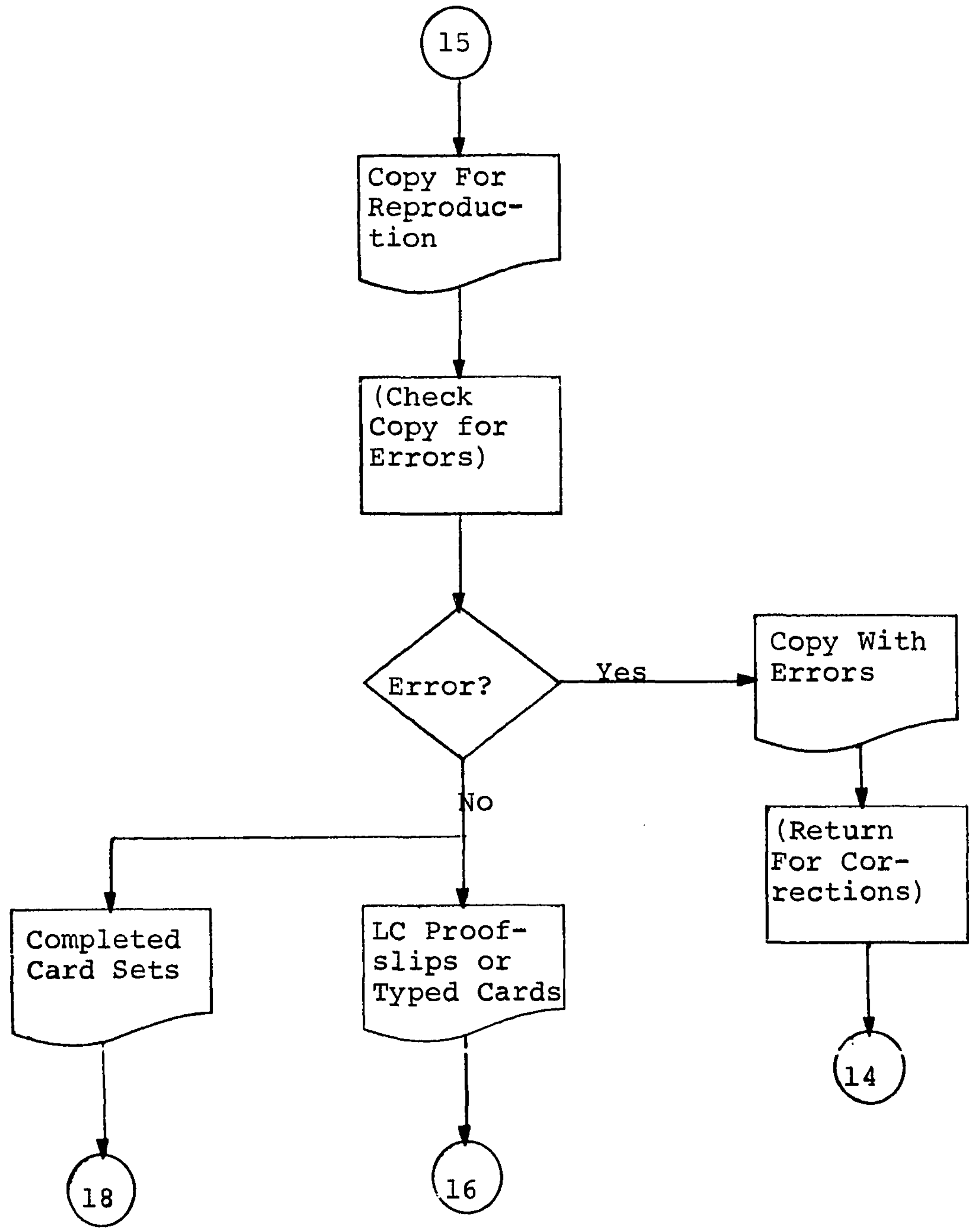

10
Checked LC Cards/Slips
Check Subject Headings
Check in Shelf List
Copy For Card Production
14

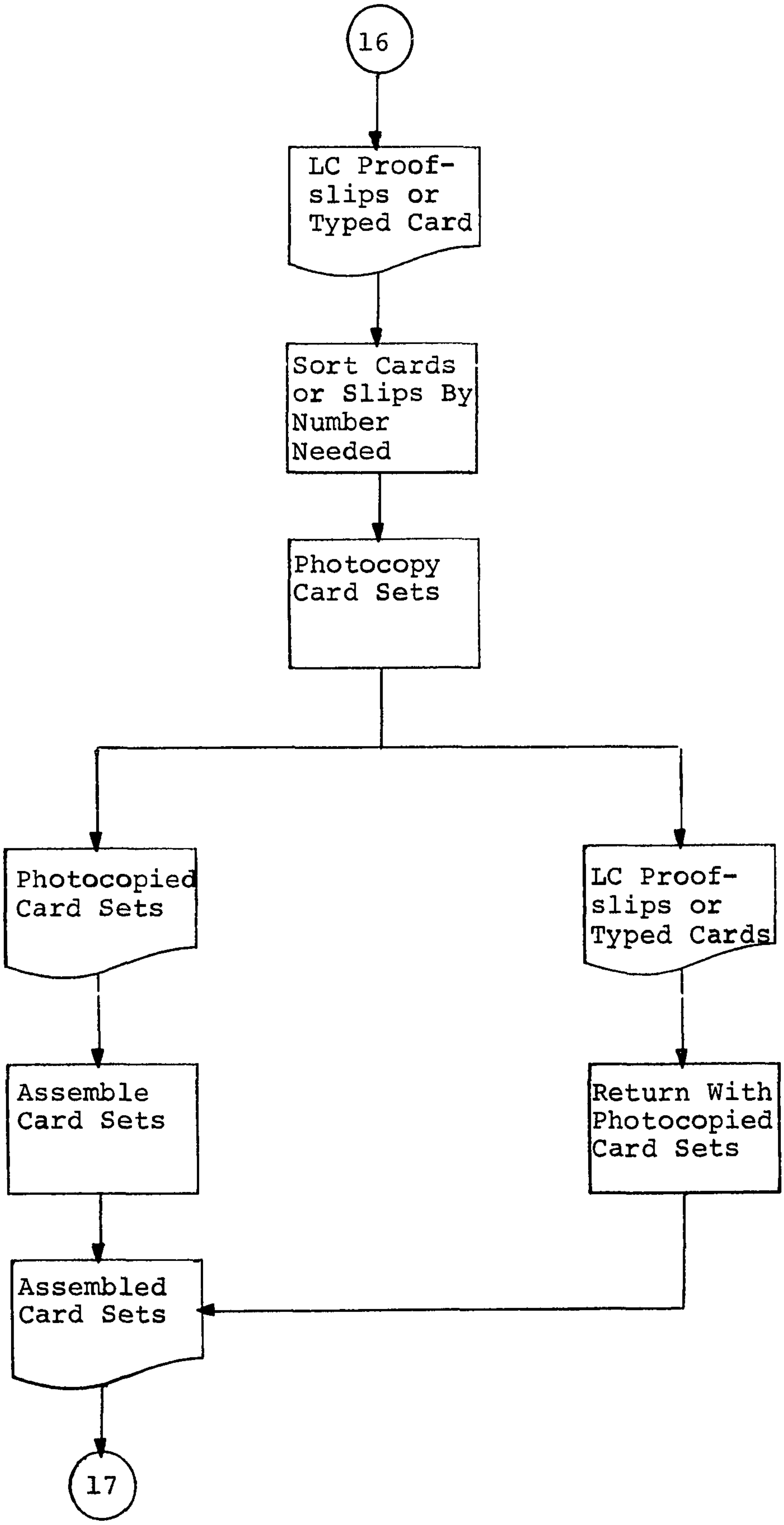

11
Accessioned Items Without LC Cards
Search in NUC, Etc., For Copy
Copy?
No
13
Yes
Copy From NUC, Etc.
Accessioned Items
Check Workslips for Correctness
19
Checked Workslips
12

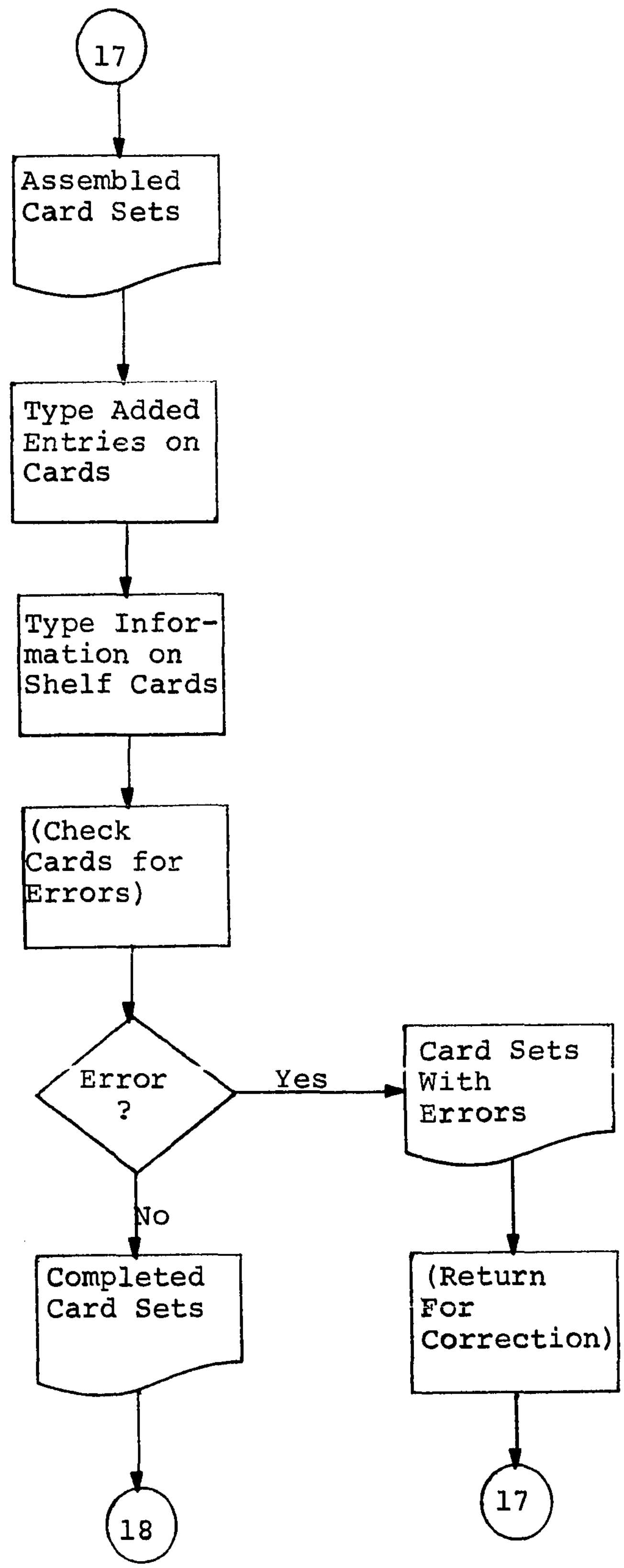

12
Checked Workslips
Check Subject Headings
Check In Shelf List
Copy For Card Production
14

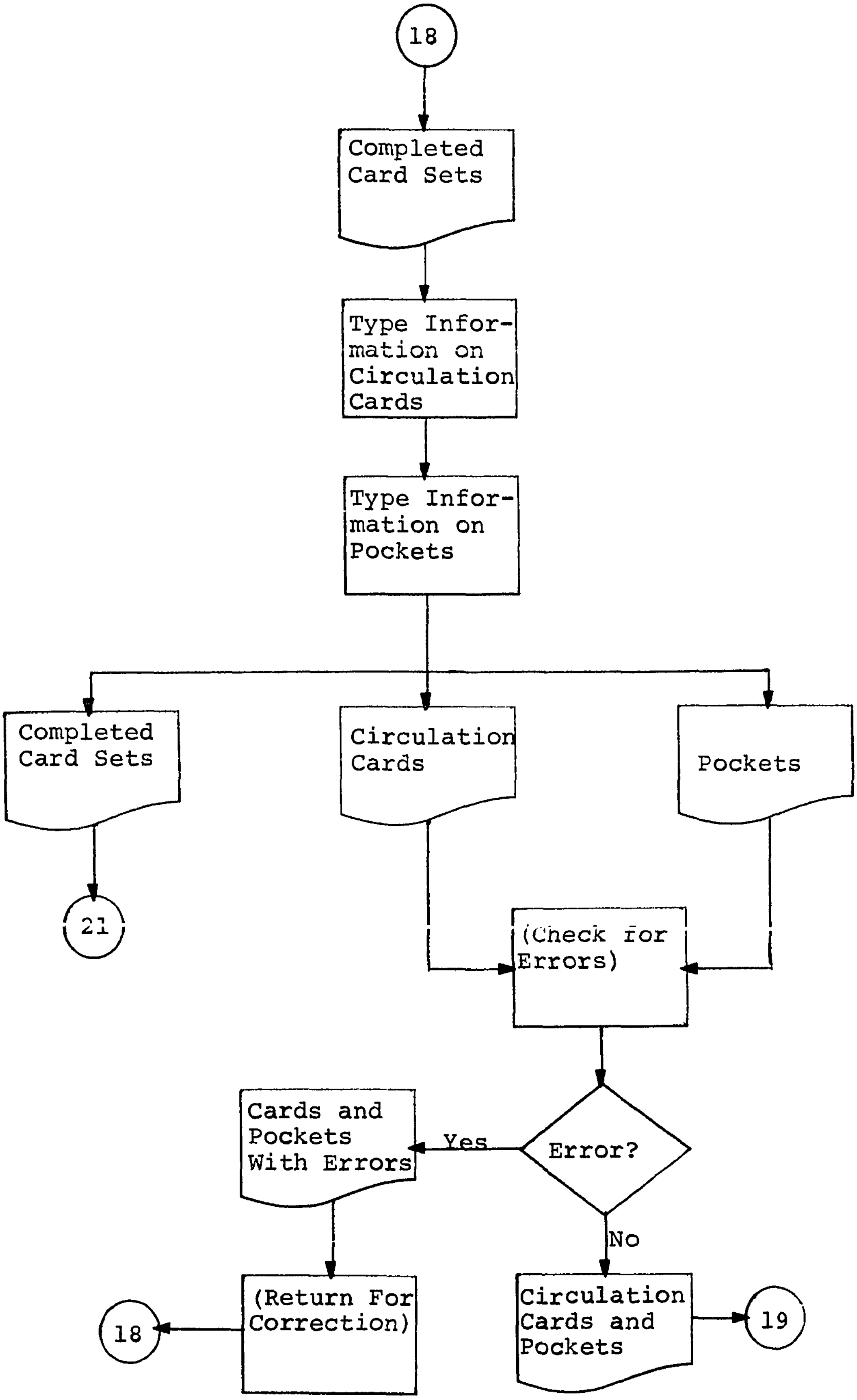

13
Accessioned Items for Original Cat.
Collect Data on Workslips
Accessioned Items
Workslips
19
Establish Main Entries
Assign Classification Numbers
Assign Subject Headings
Check In Shelf List
Copy For Card Production
14

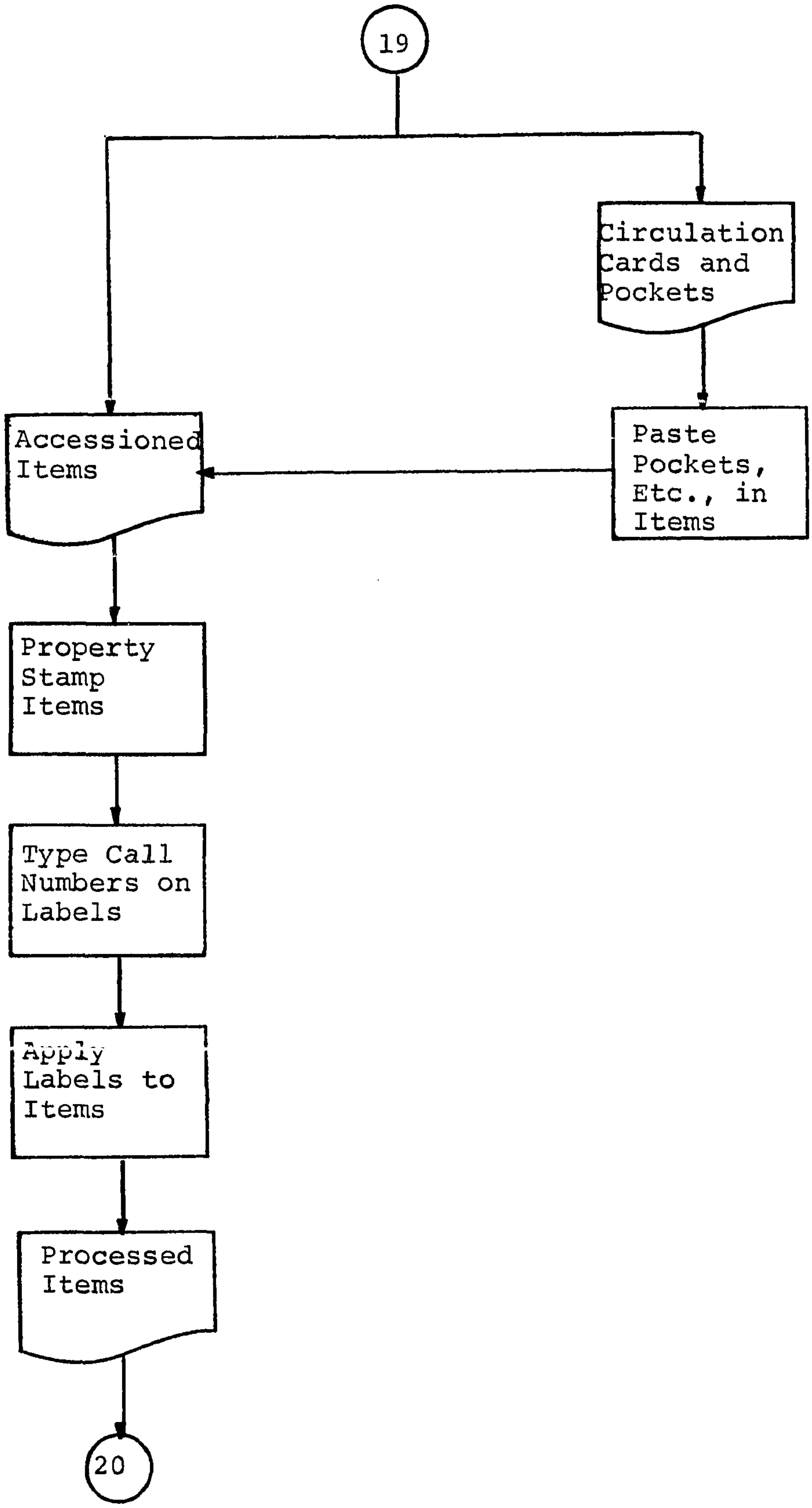

14
Copy For Card Production
Separate Copy
LC Cards
LC Proof-slips
Workslips
Type Call Numbers on Cards
Type Call Numbers on Cards
Type Main Entry Cards
Type Added Entries on Cards
Calculate and Note Number of Cards
Calculate and Note Number of Cards
Type Information on Shelf Card
LC Proofslips Ready for Reproduction
Typed Main Entry Cards and Workslips
Completed Card Sets
15
15
15

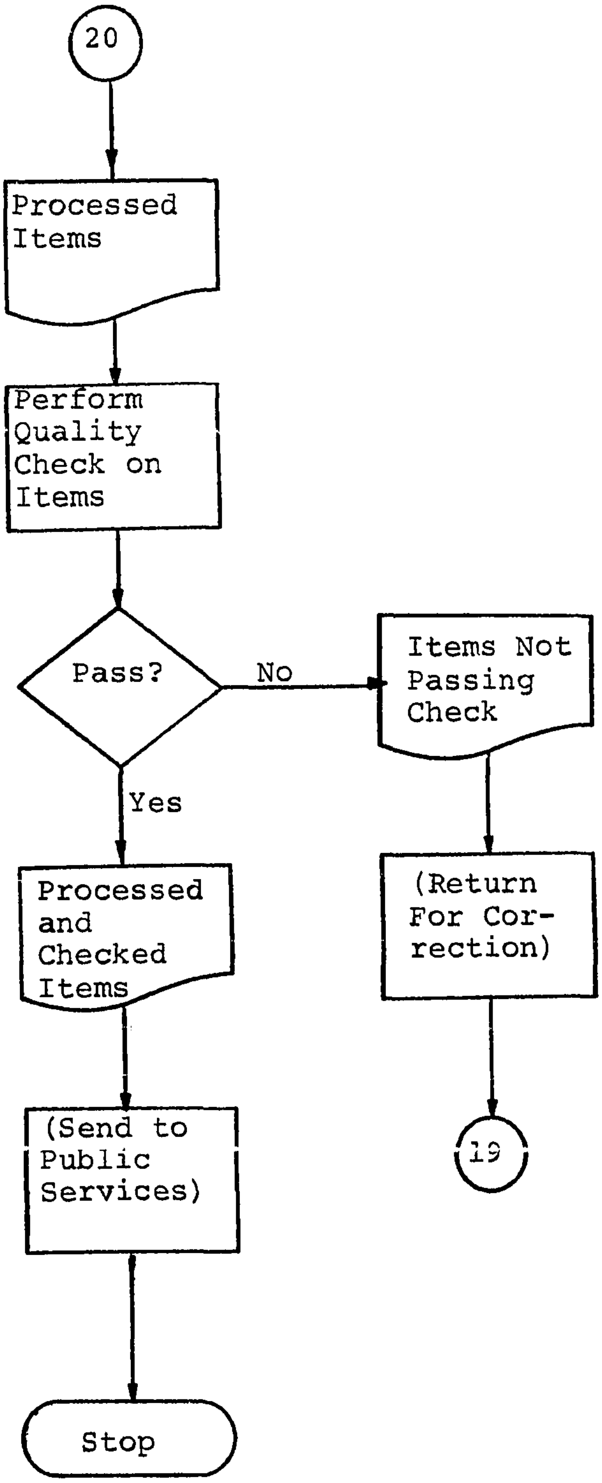

15
Copy For Reproduc-tion
(Check Copy for Errors)
Error?
Yes
No
Copy With Errors
(Return For Cor-rections)
14
Completed Card Sets
LC Proof-slips or Typed Cards
18
16

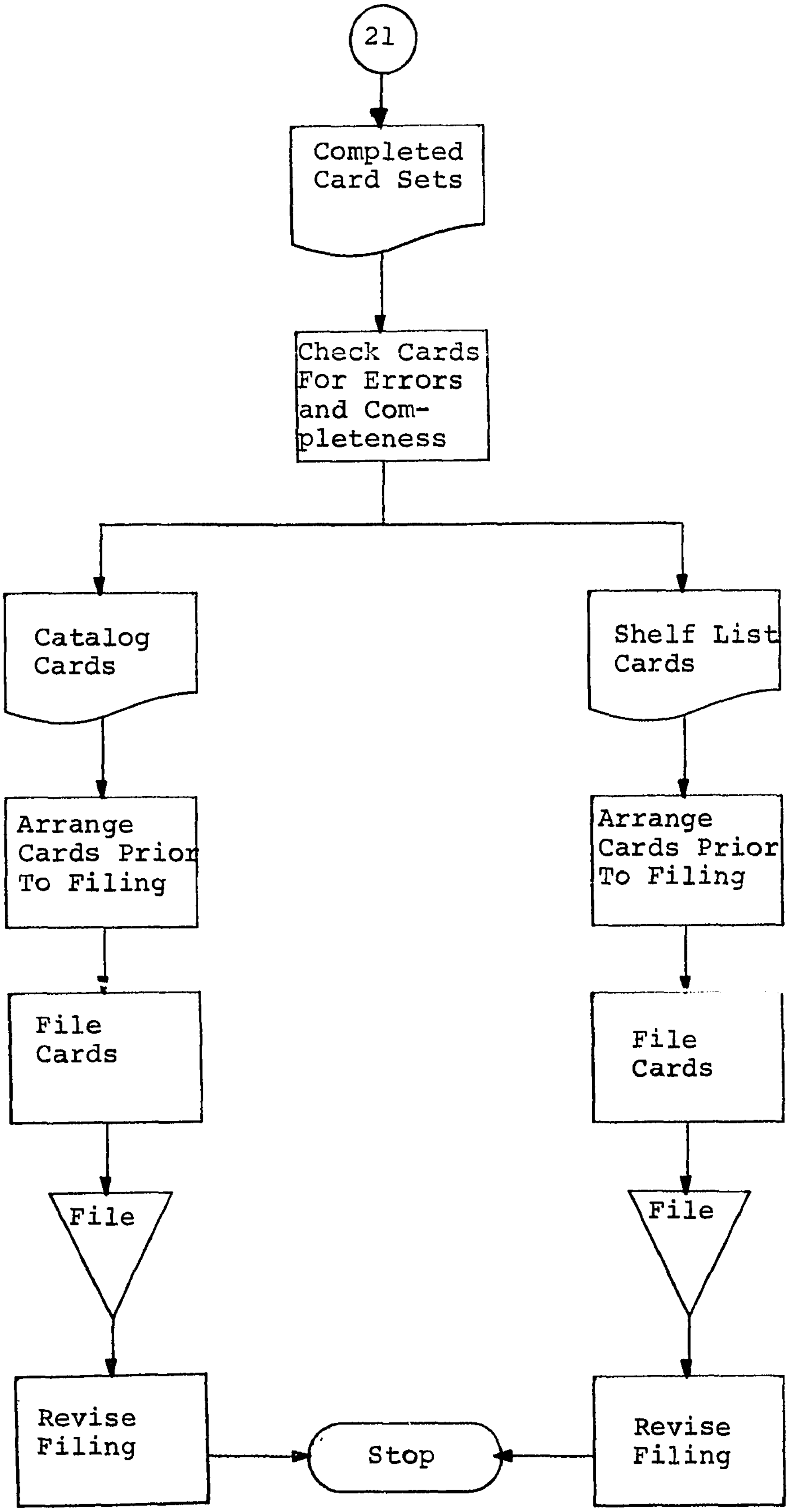

16
LC Proof-slips or Typed Card
Sort Cards or Slips By Number Needed
Photocopy Card Sets
Photocopied Card Sets
LC Proof-slips or Typed Cards
Assemble Card Sets
Return With Photocopied Card Sets
Assembled Card Sets
17


17
Assembled Card Sets
Type Added Entries on Cards
Type Information on Shelf Cards
(Check Cards for Errors)
Error ?
Yes
Card Sets With Errors
No
Completed Card Sets
(Return For Correction)
18
17


18
Completed Card Sets
Type Information on Circulation Cards
Type Information on Pockets
Completed Card Sets
Circulation Cards
Pockets
21
(Check for Errors)
Error?
Yes
Cards and Pockets With Errors
No
(Return For Correction)
18
Circulation Cards and Pockets
19

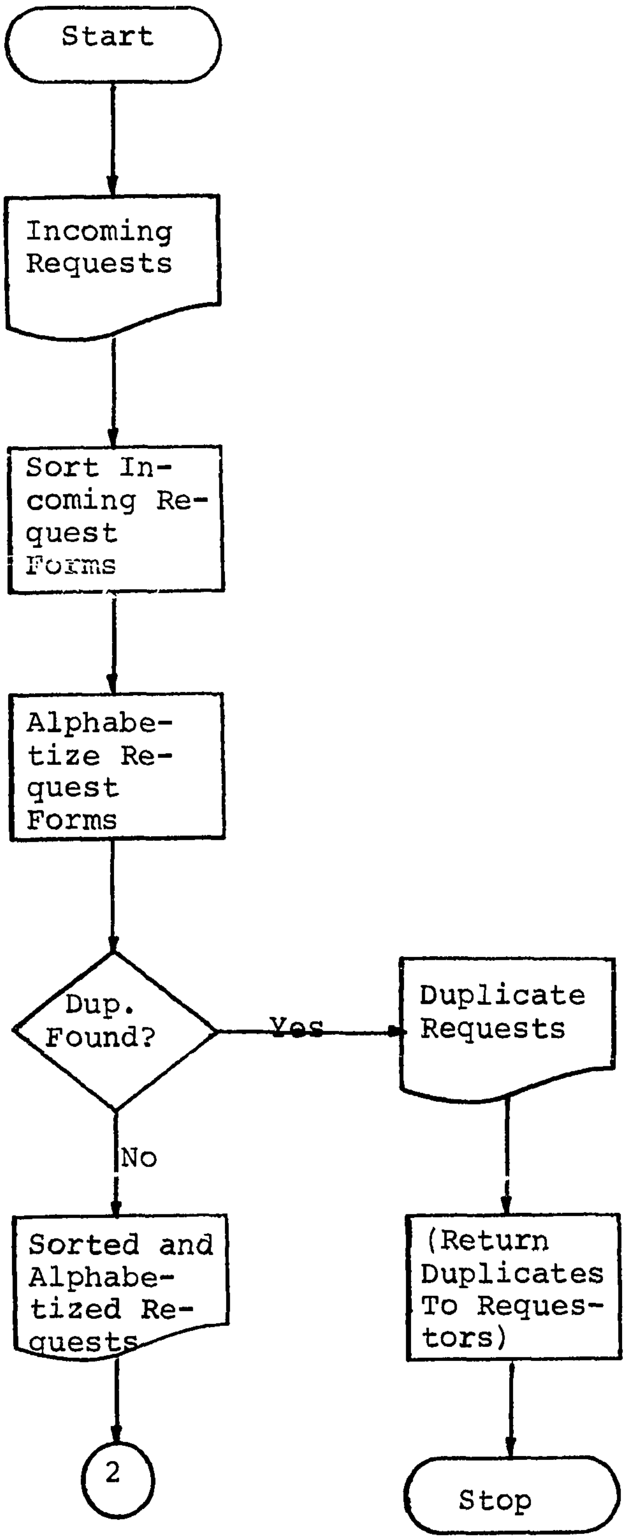

19
Circulation Cards and Pockets
Paste Pockets, Etc., in Items
Accessioned Items
Property Stamp Items
Type Call Numbers on Labels
Apply Labels to Items
Processed Items
20

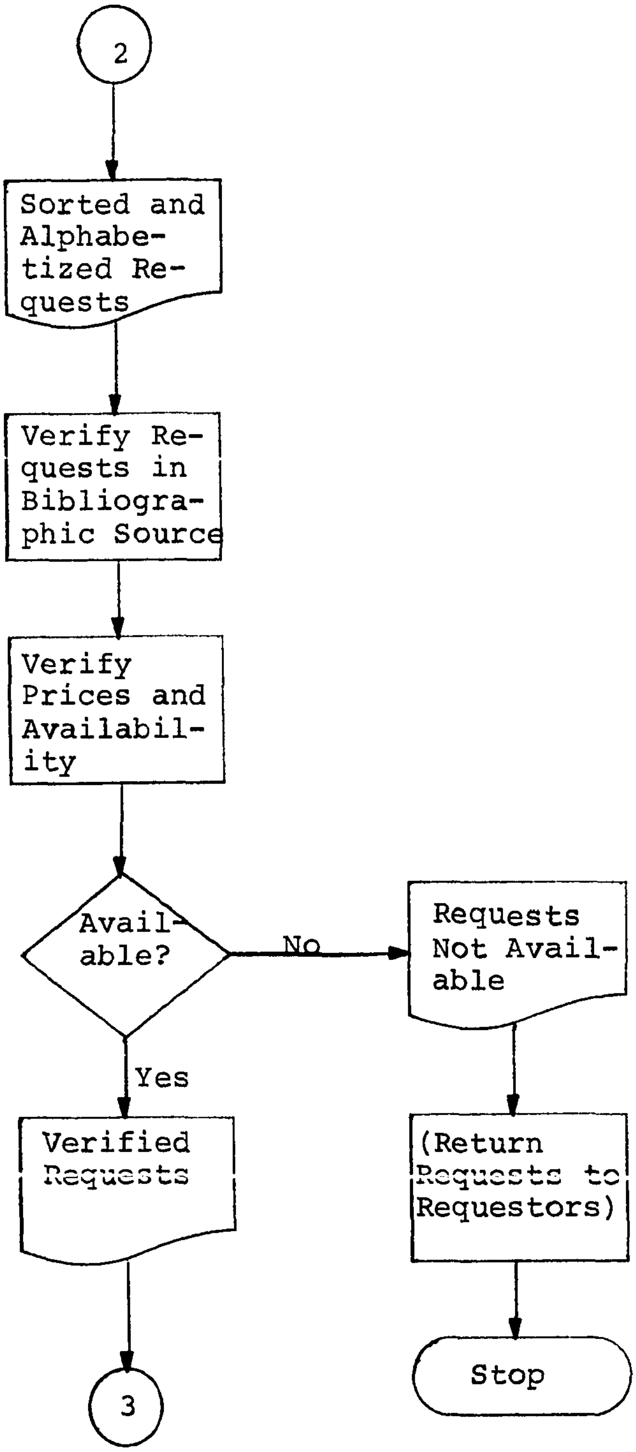

20
Processed Items
Perform Quality Check on Items
Pass?
No
Items Not Passing Check
Yes
Processed and Checked Items
(Return For Correction)
(Send to Public Services)
19
Stop

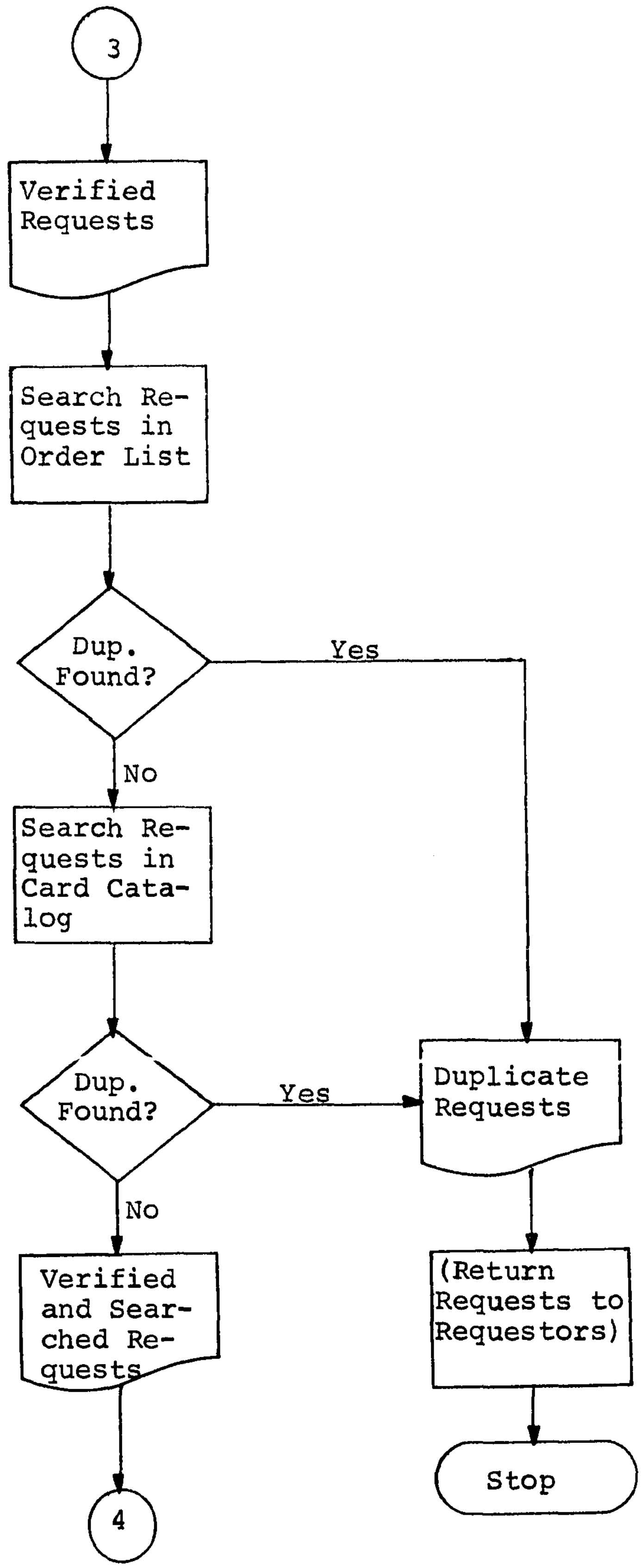

21
Completed Card Sets
Check Cards For Errors and Completeness
Catalog Cards
Shelf List Cards
Arrange Cards Prior To Filing
Arrange Cards Prior To Filing
File Cards
File Cards
File
File
Revise Filing
Stop
Revise Filing

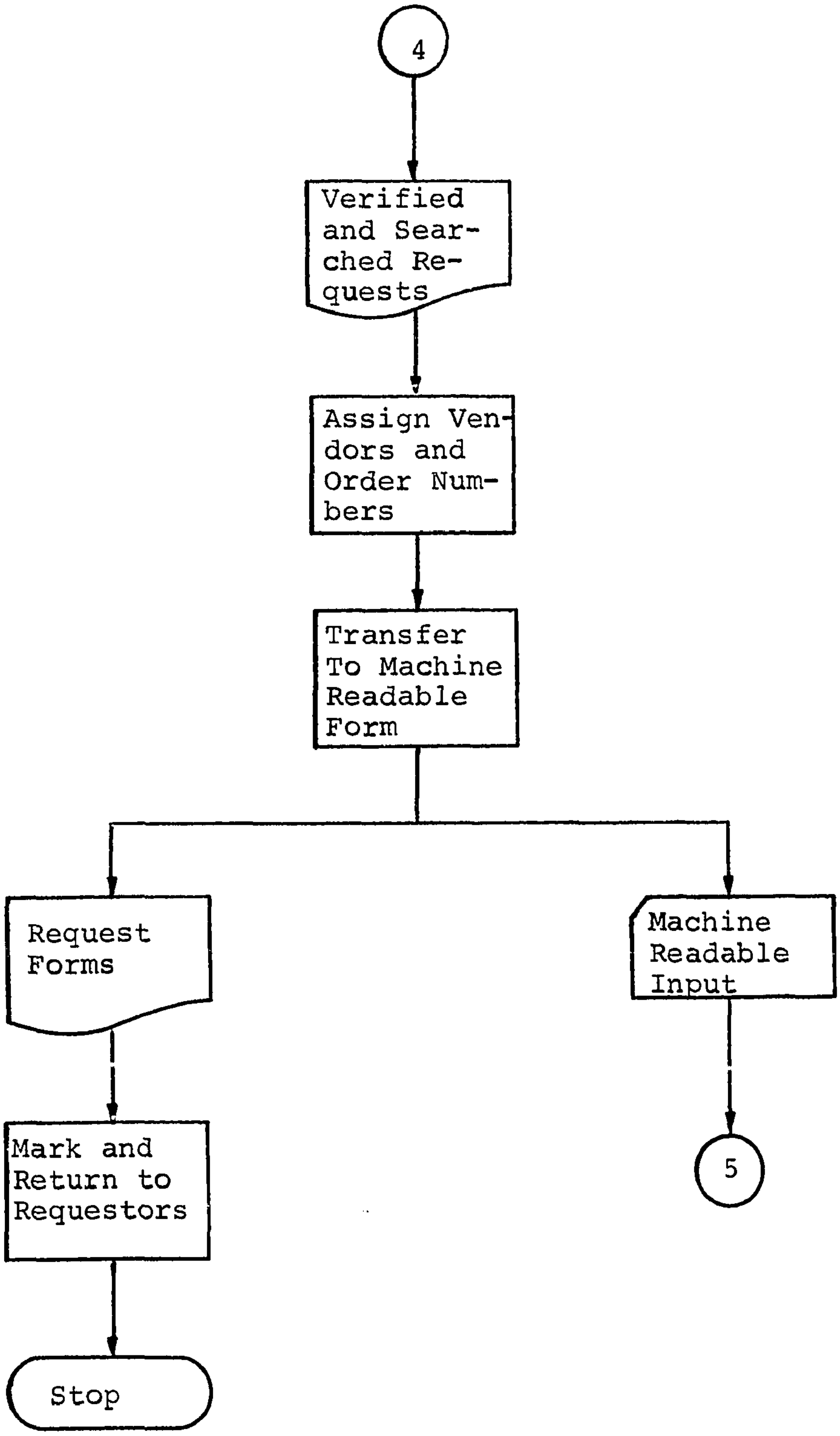
APPENDIX E

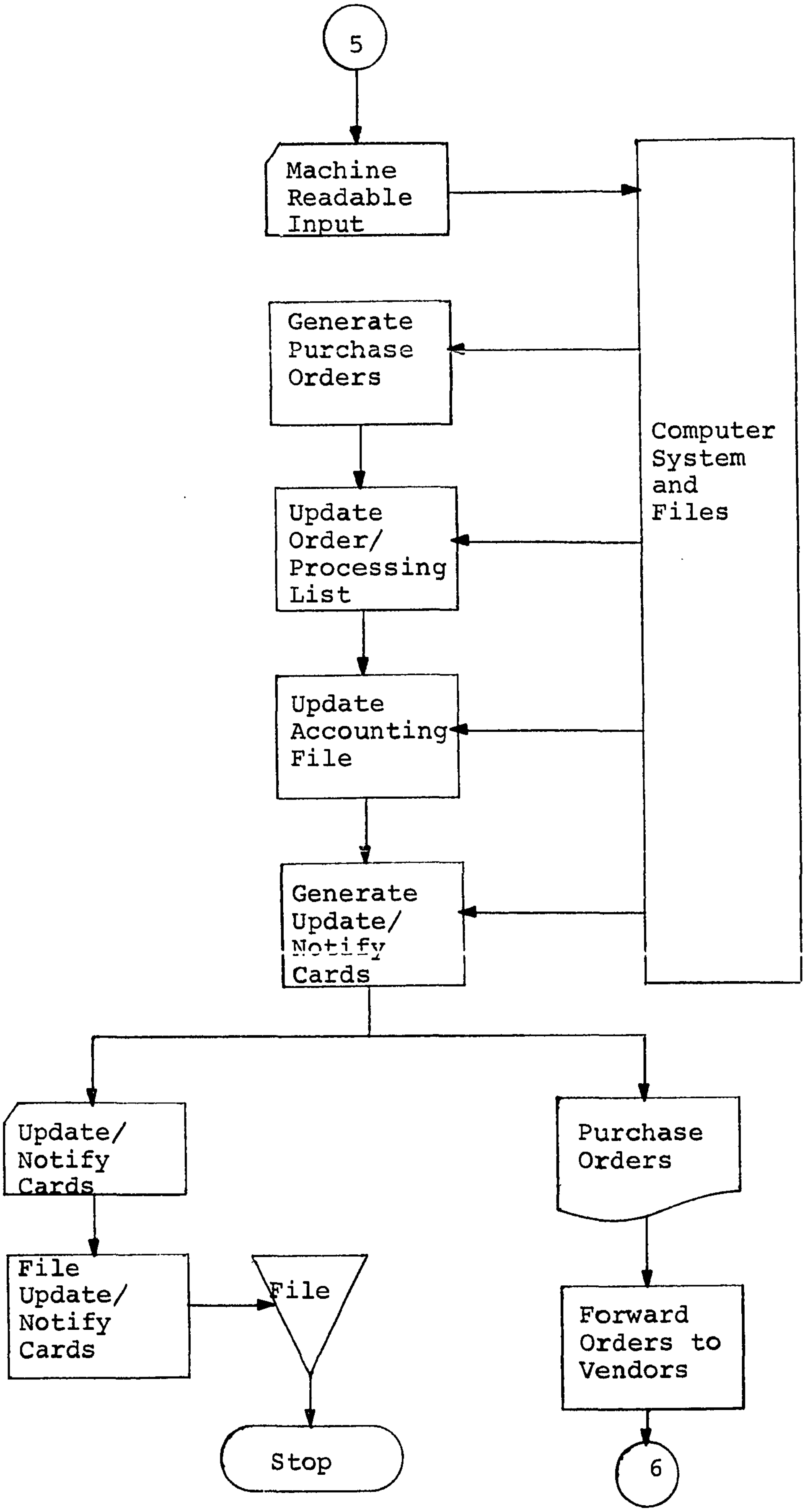
FLOWCHARTS FOR A COMPUTER-BASED TECHNICAL SERVICES SYSTEM

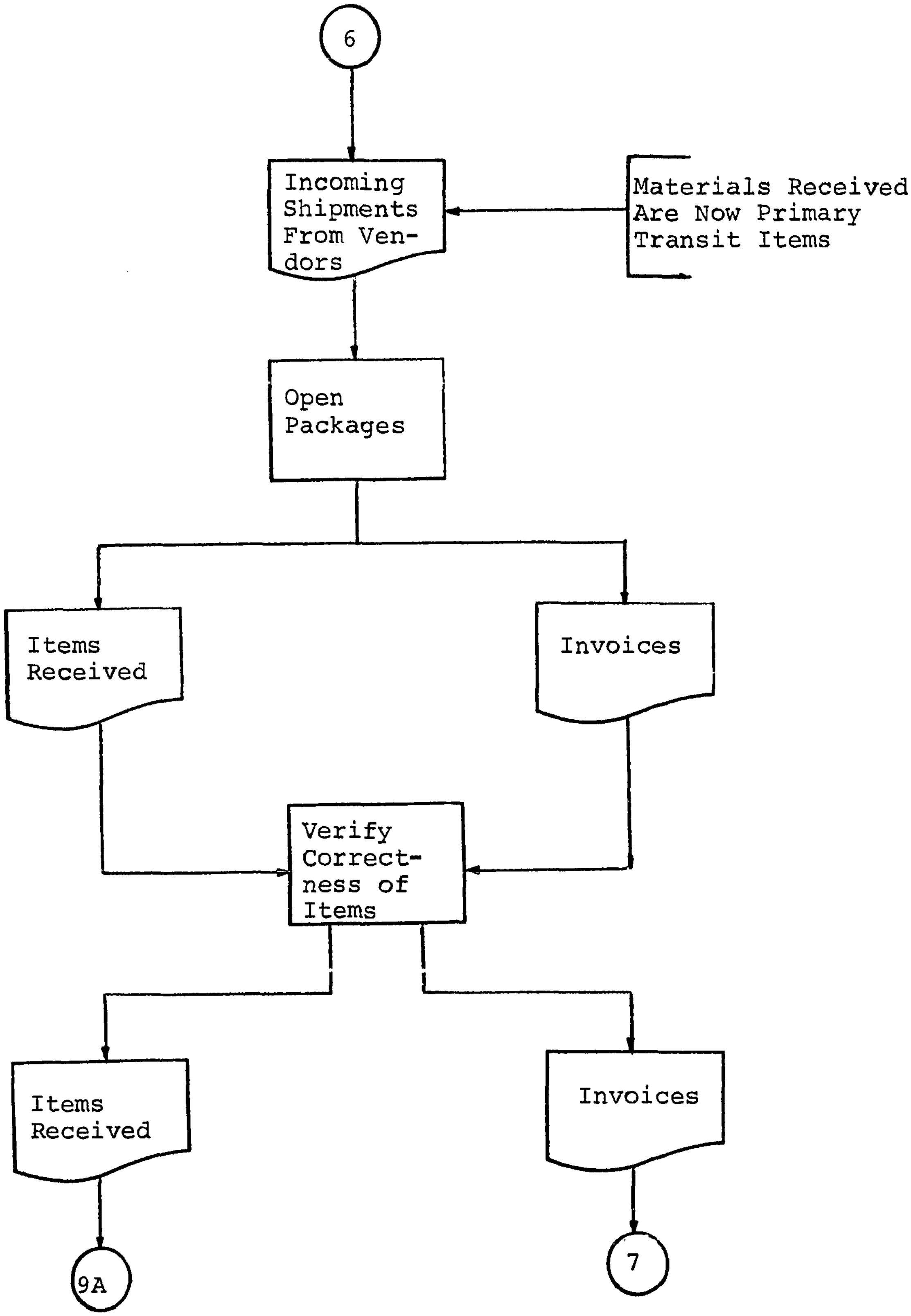

Start
Incoming Requests
Sort Incoming Request Forms
Alphabetize Request Forms
Dup. Found?
Yes
Duplicate Requests
No
Sorted and Alphabetized Requests
(Return Duplicates To Requestors)
2
Stop

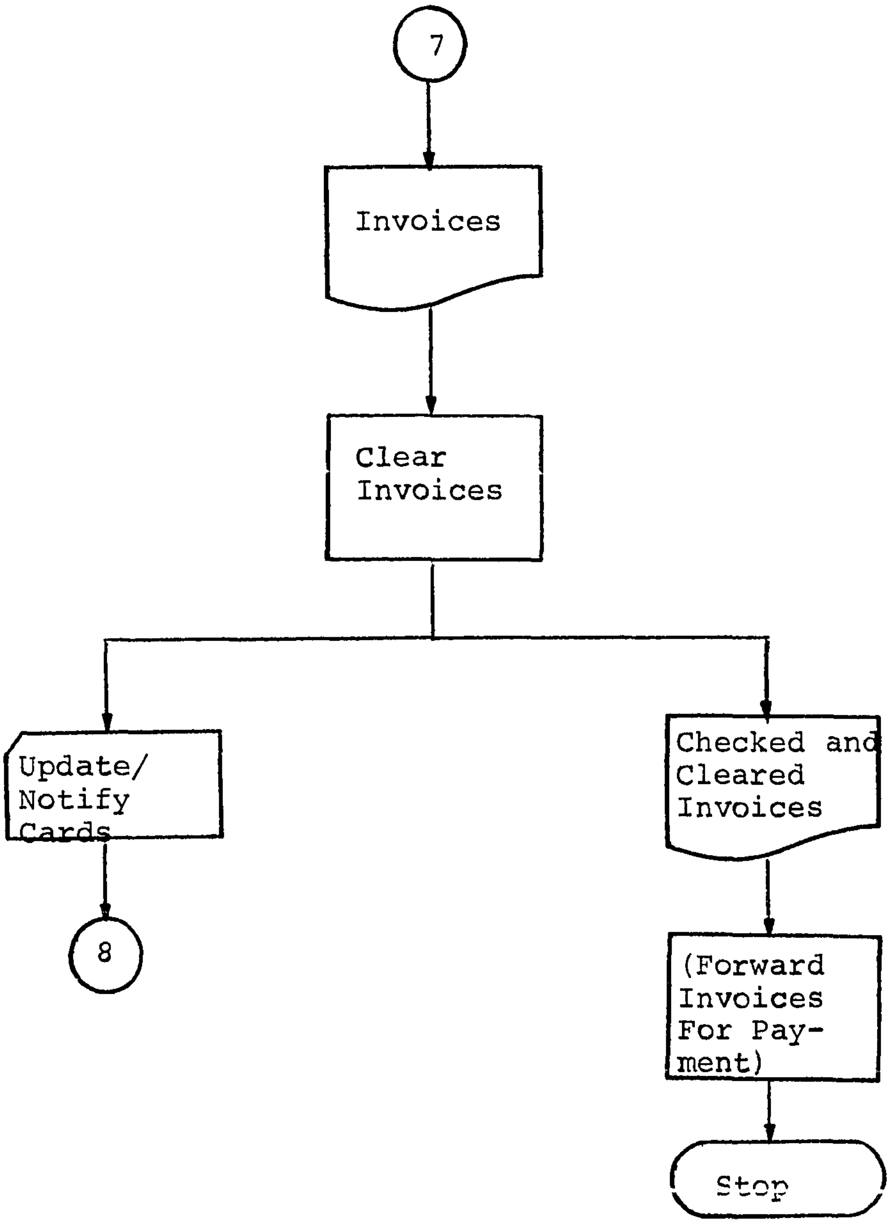

2
Sorted and Alphabe- tized Re- quests
Verify Re- quests in Bibliogra- phic Source
Verify Prices and Availabil- ity
Avail- able?
No
Requests Not Avail- able
Yes
Verified Requests
(Return Requests to Requestors)
3
Stop

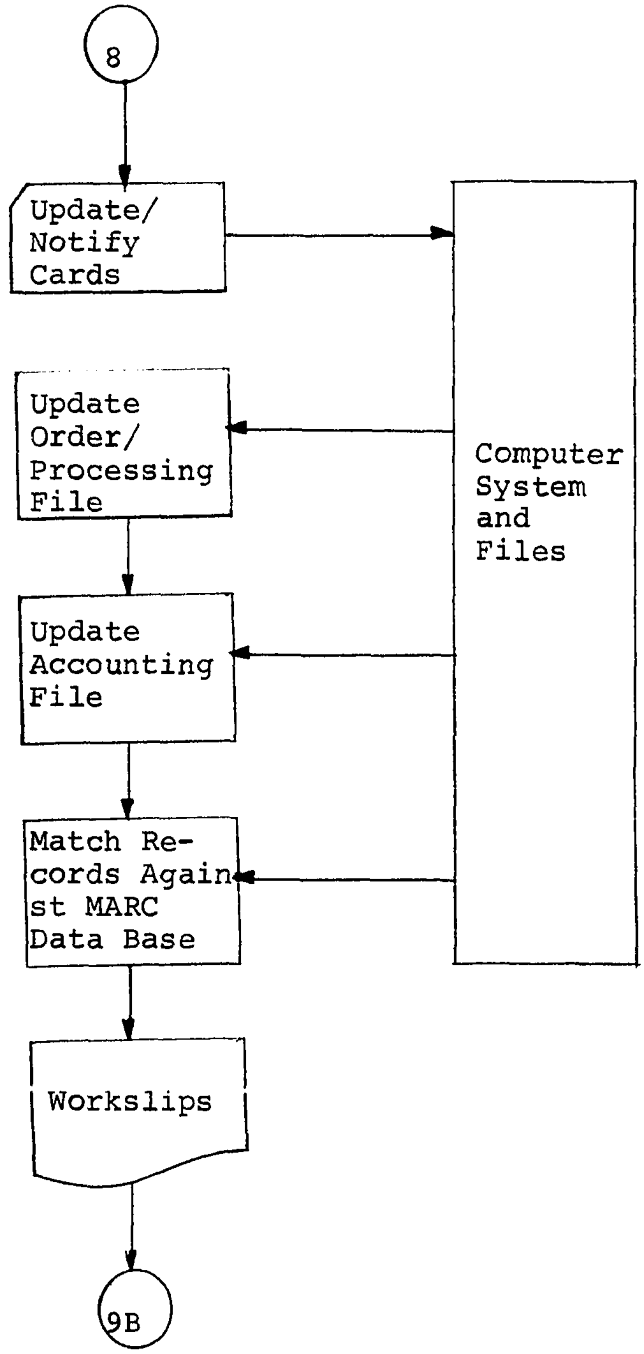

3
Verified Requests
Search Requests in Order List
Dup. Found?
Yes
No
Search Requests in Card Catalog
Dup. Found?
Yes
No
Duplicate Requests
Verified and Searched Requests
(Return Requests to Requestors)
4
Stop

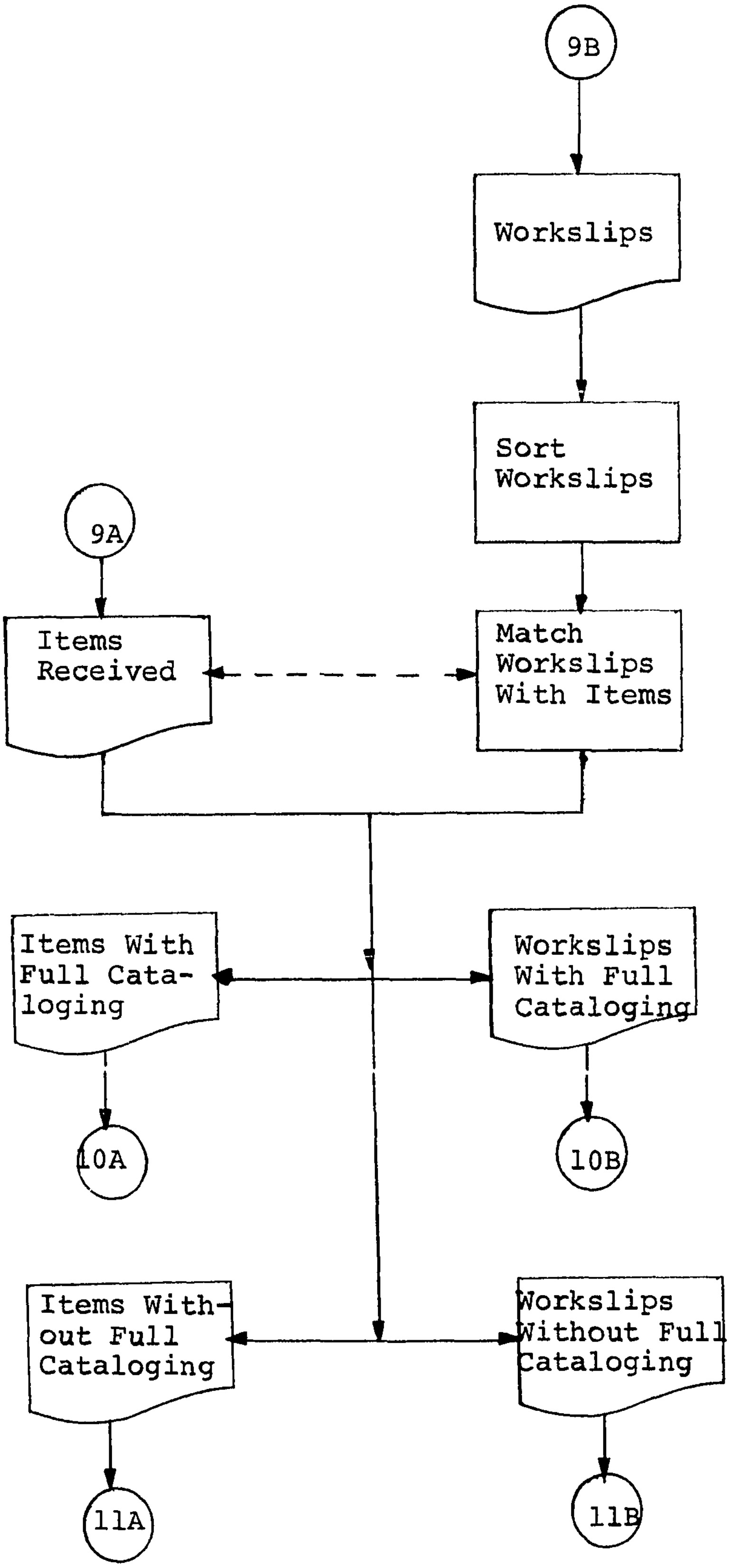

4
Verified and Searched Requests
Assign Vendors and Order Numbers
Transfer To Machine Readable Form
Request Forms
Machine Readable Input
Mark and Return to Requestors
5
Stop

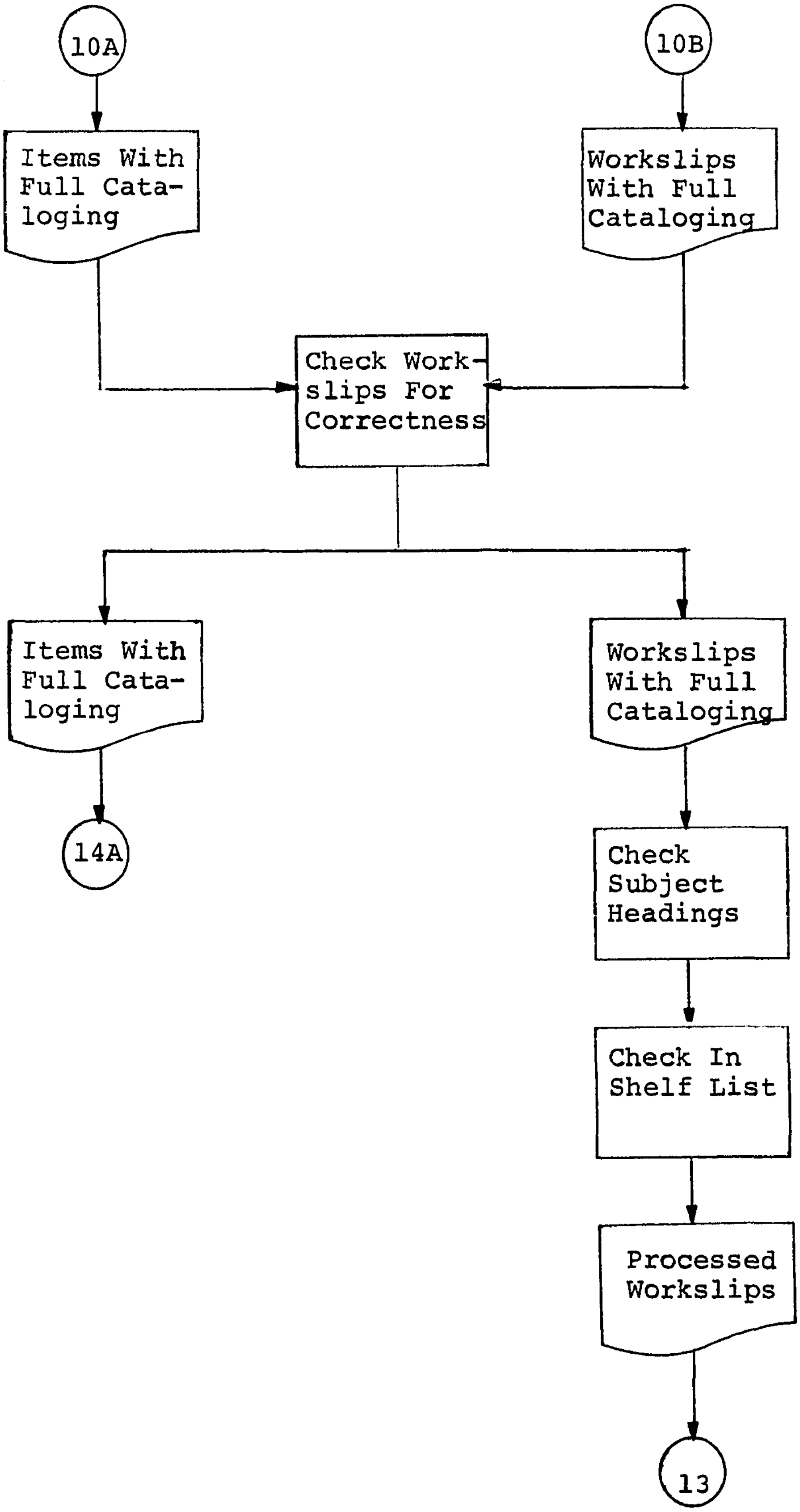

5
Machine Readable Input
Computer System and Files
Generate Purchase Orders
Update Order/ Processing List
Update Accounting File
Generate Update/ Notify Cards
Update/ Notify Cards
Purchase Orders
File Update/ Notify Cards
File
Forward Orders to Vendors
Stop
6

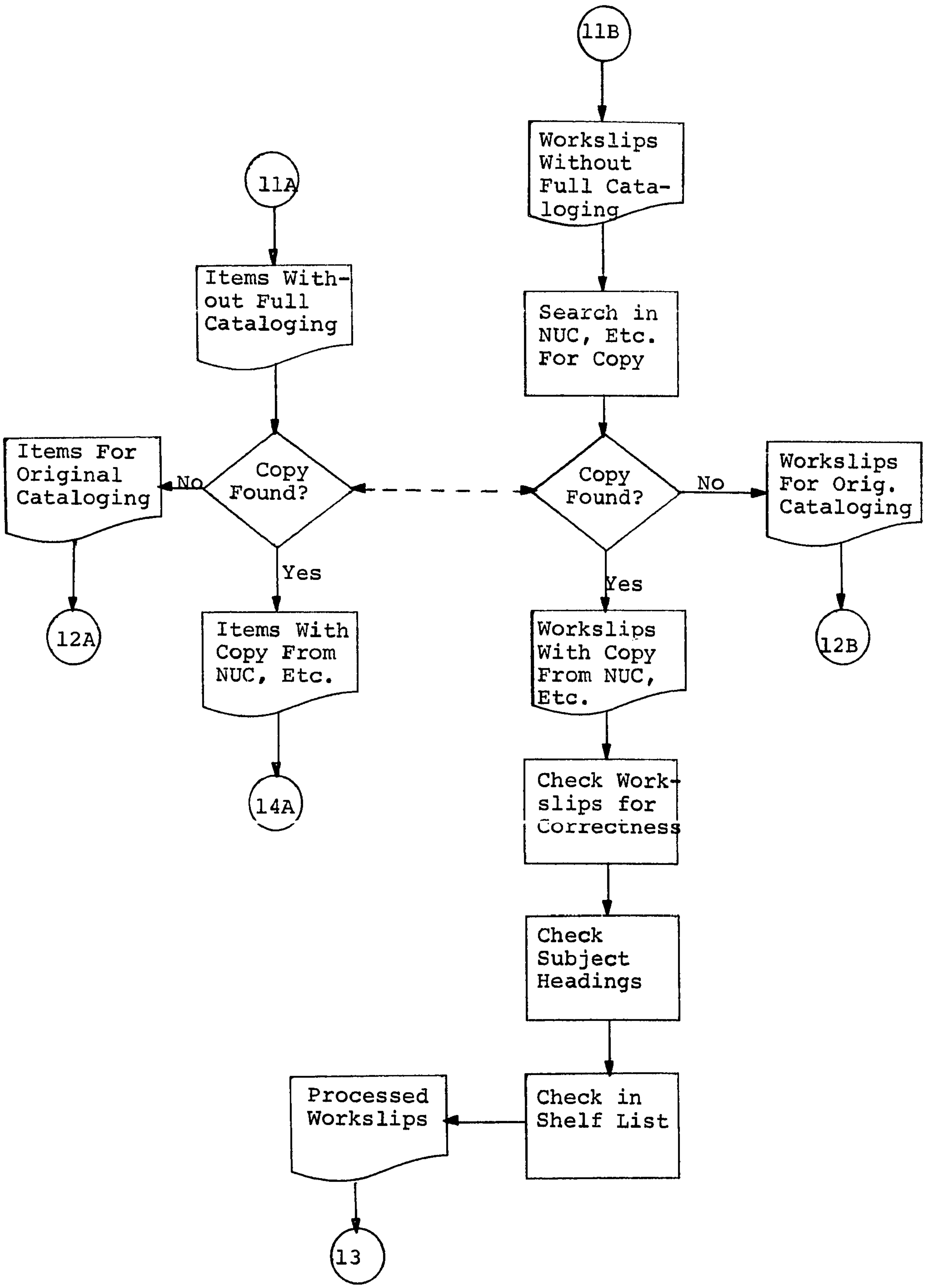

6
Incoming Shipments From Ven-dors
Materials Received Are Now Primary Transit Items
Open Packages
Items Received
Invoices
Verify Correct-ness of Items
Items Received
Invoices
9A
7

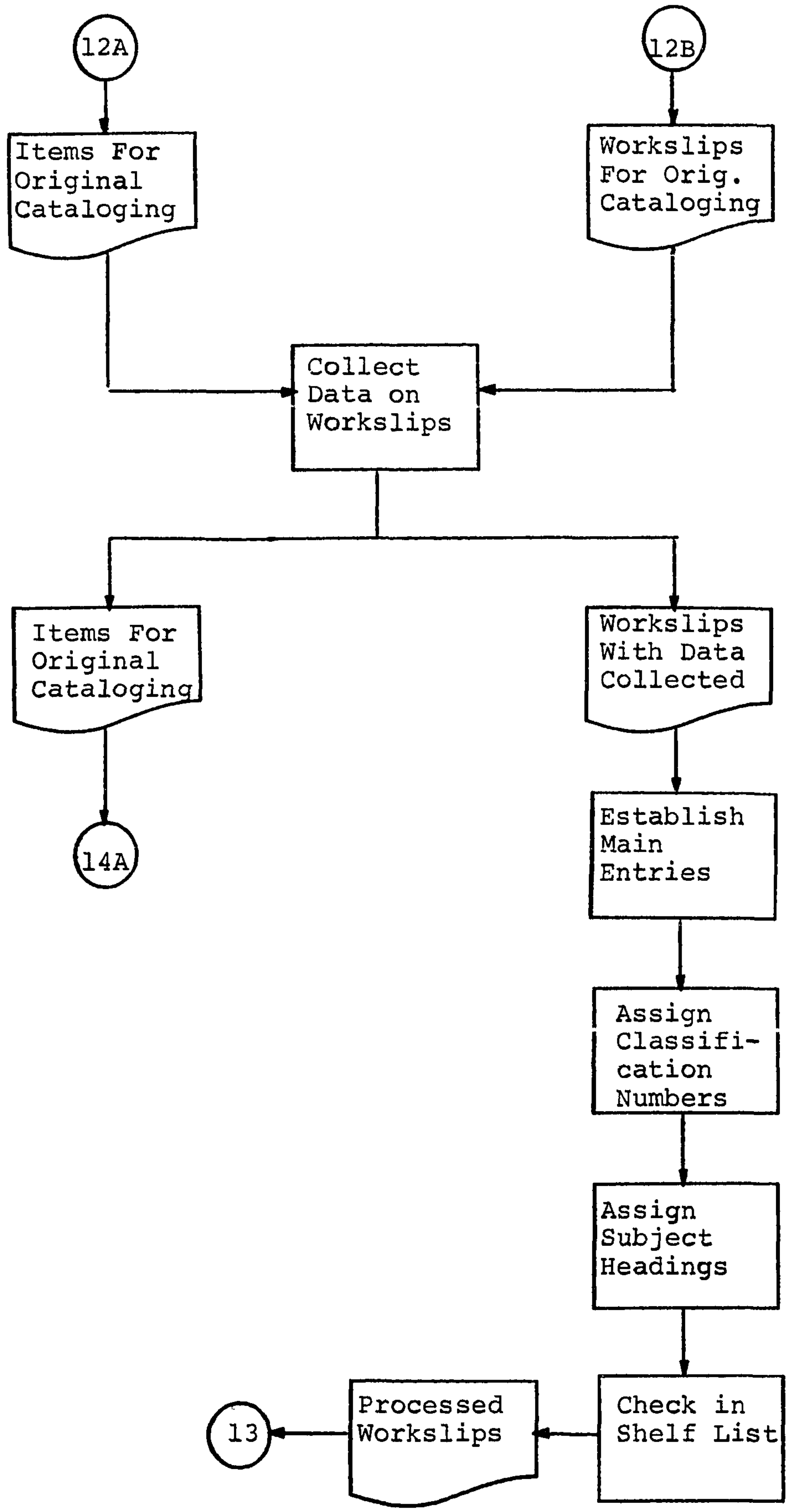

7
Invoices
Clear Invoices
Update/ Notify Cards
8
Checked and Cleared Invoices
(Forward Invoices For Payment)
Stop

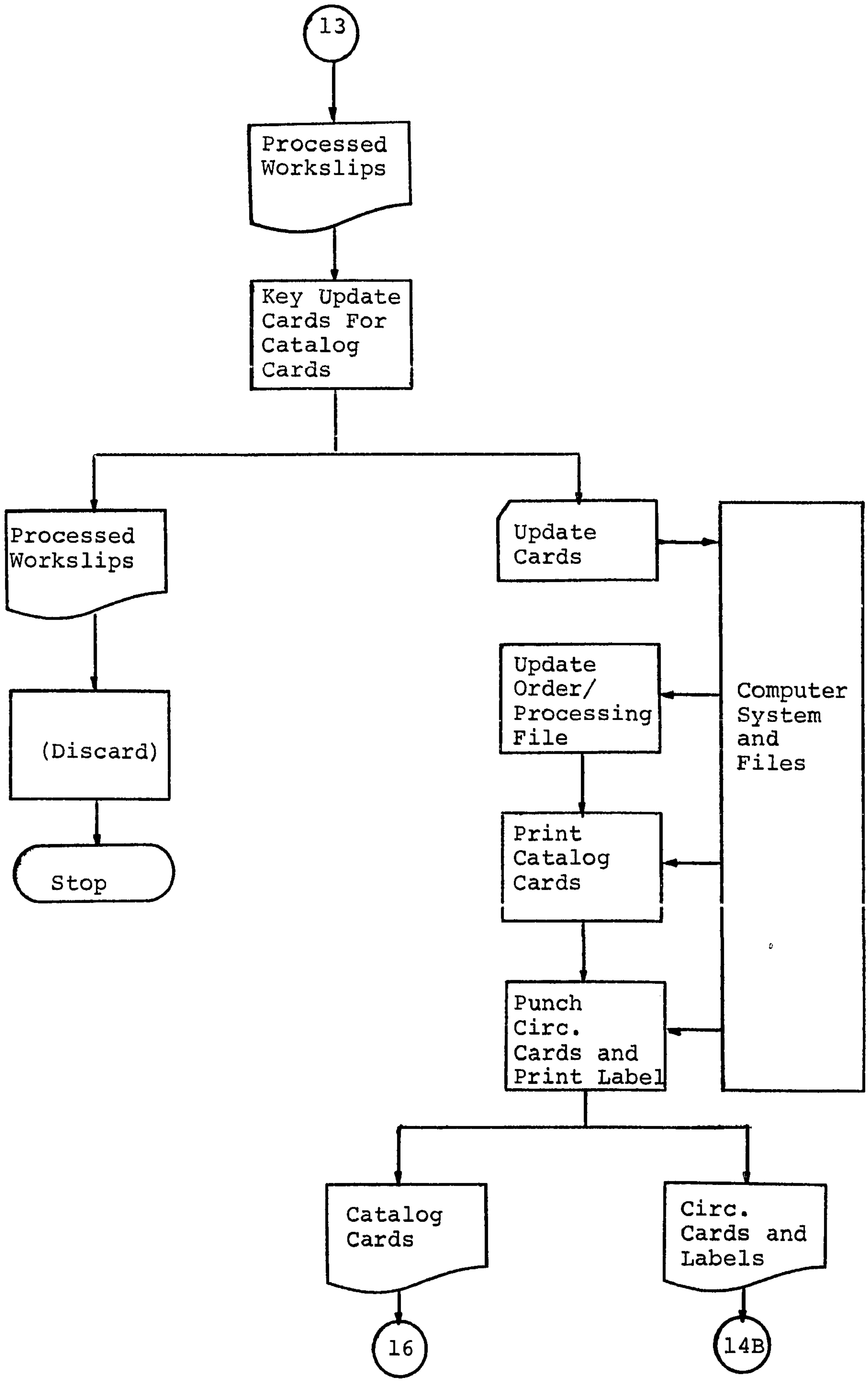

8
Update/
Notify
Cards
Update
Order/
Processing
File
Update
Accounting
File
Match Re-
cords Against MARC
Data Base
Workslips
Computer
System
and
Files
9B

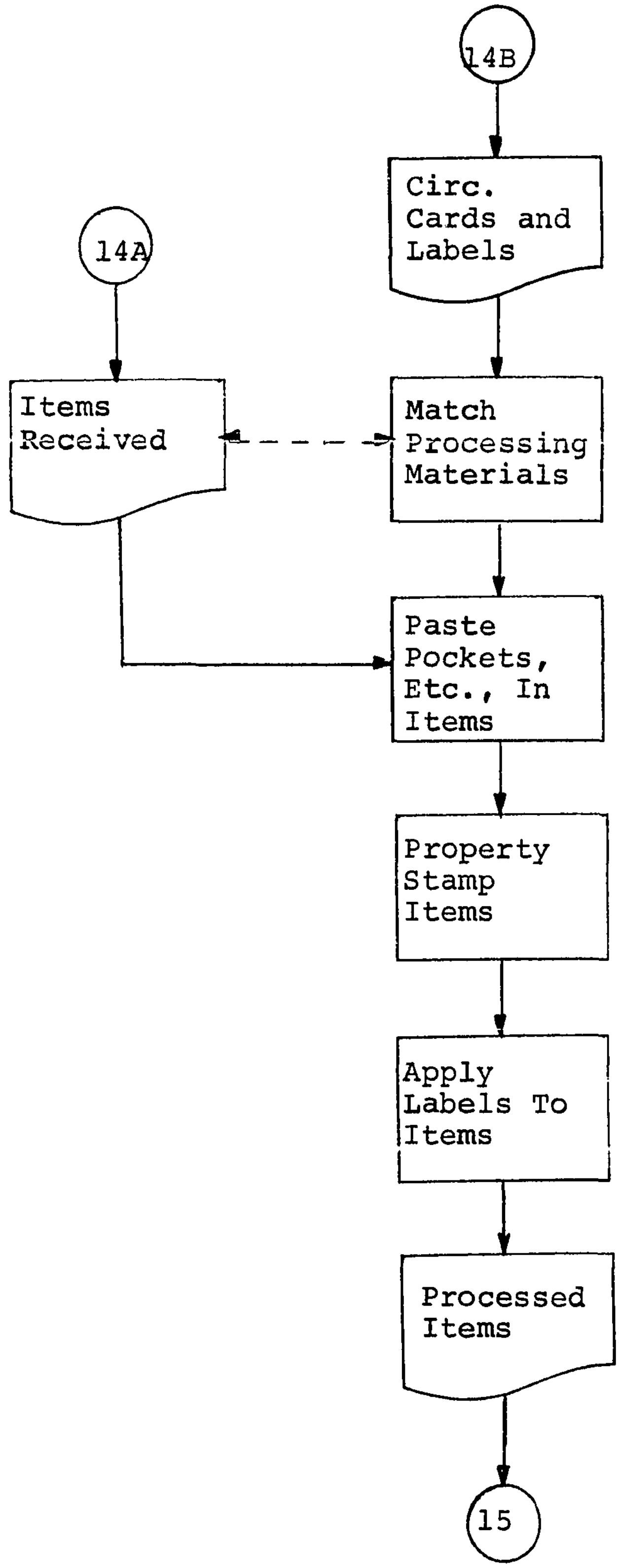

9B
Workslips
Sort Workslips
9A
Items Received
Match Workslips With Items
Items With Full Cataloging
Workslips With Full Cataloging
10A
10B
Items Without Full Cataloging
Workslips Without Full Cataloging
11A
11B

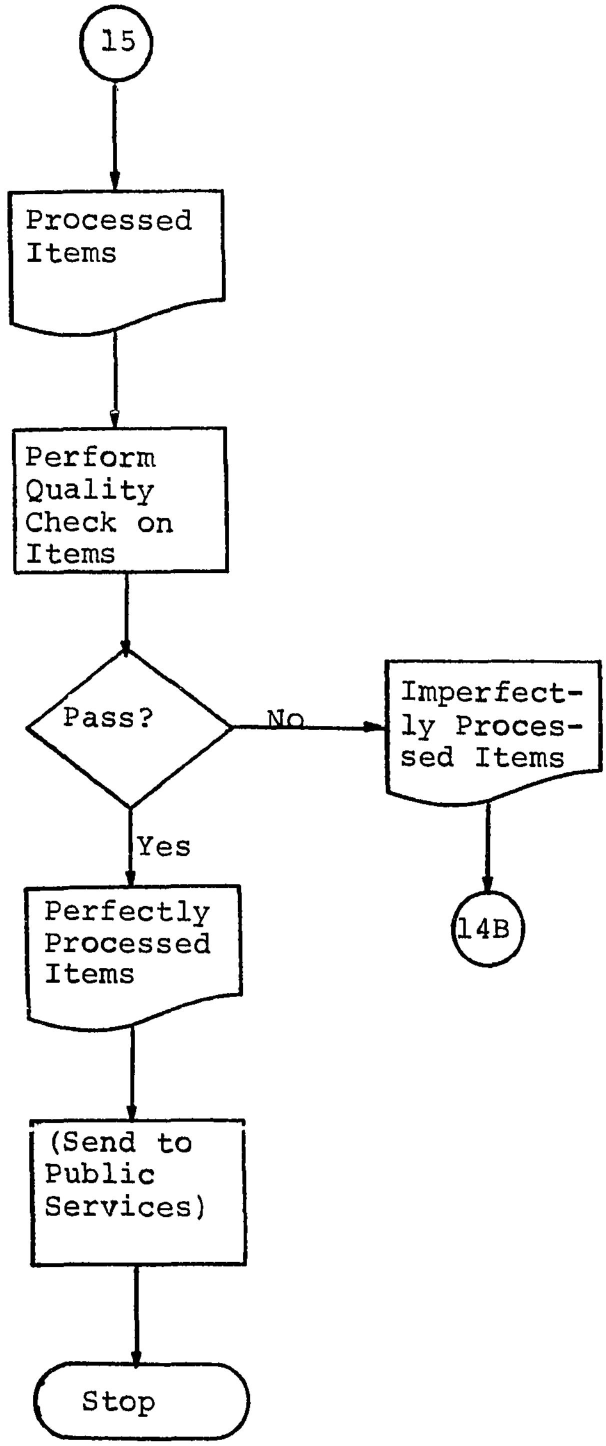

10A
10B
Items With Full Cata-loging
Workslips With Full Cataloging
Check Work-slips For Correctness
Items With Full Cata-loging
Workslips With Full Cataloging
14A
Check Subject Headings
Check In Shelf List
Processed Workslips
13

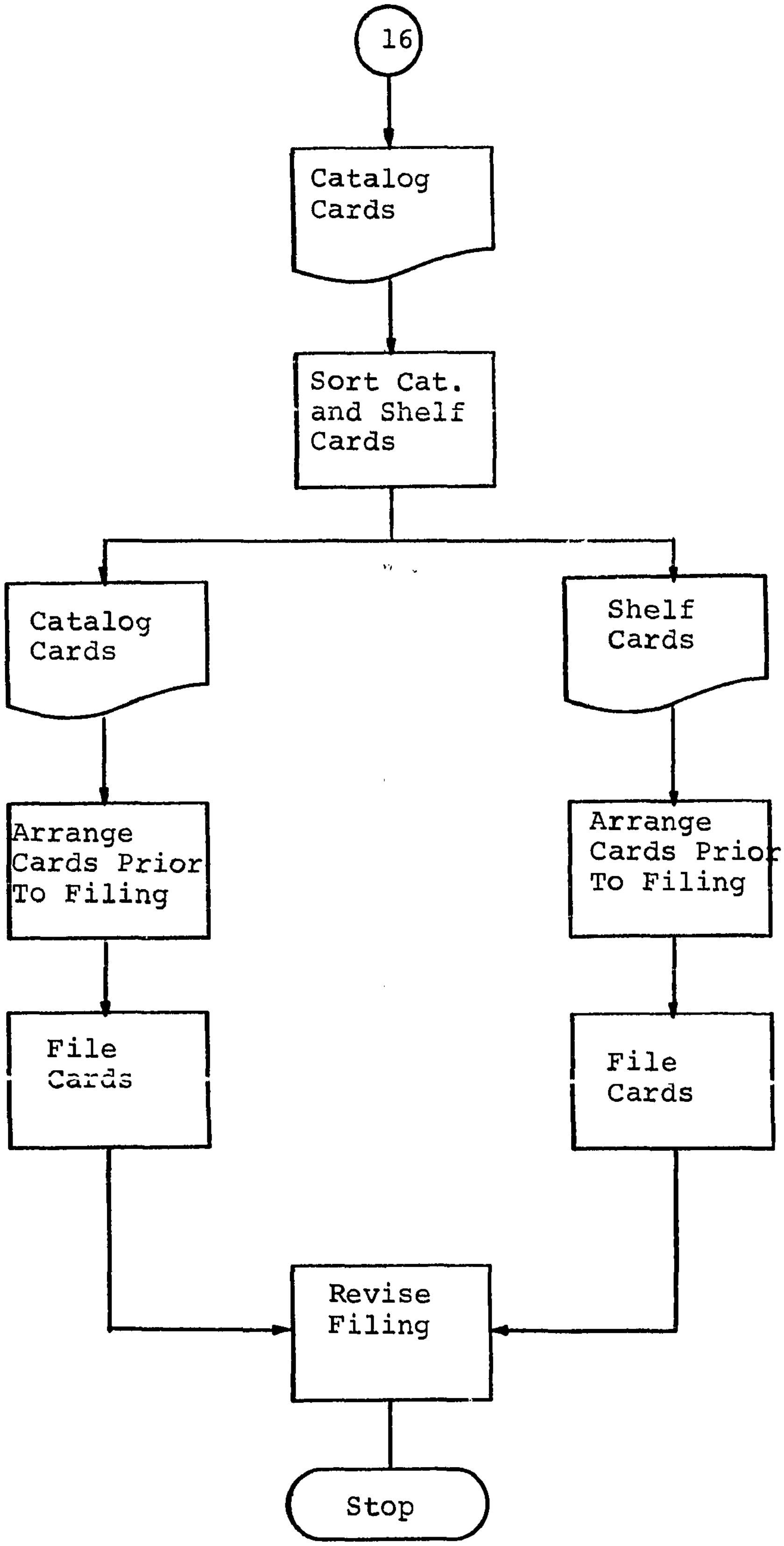

11B
Workslips Without Full Cataloging
11A
Items Without Full Cataloging
Search in NUC, Etc. For Copy
Items For Original Cataloging
No
Copy Found?
Copy Found?
No
Workslips For Orig. Cataloging
Yes
Yes
12A
Items With Copy From NUC, Etc.
Workslips With Copy From NUC, Etc.
12B
14A
Check Workslips for Correctness
Check Subject Headings
Processed Workslips
Check in Shelf List
13


12A
12B
Items For Original Cataloging
Workslips For Orig. Cataloging
Collect Data on Workslips
Items For Original Cataloging
Workslips With Data Collected
14A
Establish Main Entries
Assign Classifi-cation Numbers
Assign Subject Headings
Check in Shelf List
Processed Workslips
13


13
Processed Workslips
Key Update Cards For Catalog Cards
Processed Workslips
(Discard)
Stop
Update Cards
Update Order/ Processing File
Print Catalog Cards
Punch Circ. Cards and Print Label
Computer System and Files
Catalog Cards
Circ. Cards and Labels
16
14B


14B
Circ. Cards and Labels
14A
Items Received
Match Processing Materials
Paste Pockets, Etc., In Items
Property Stamp Items
Apply Labels To Items
Processed Items
15

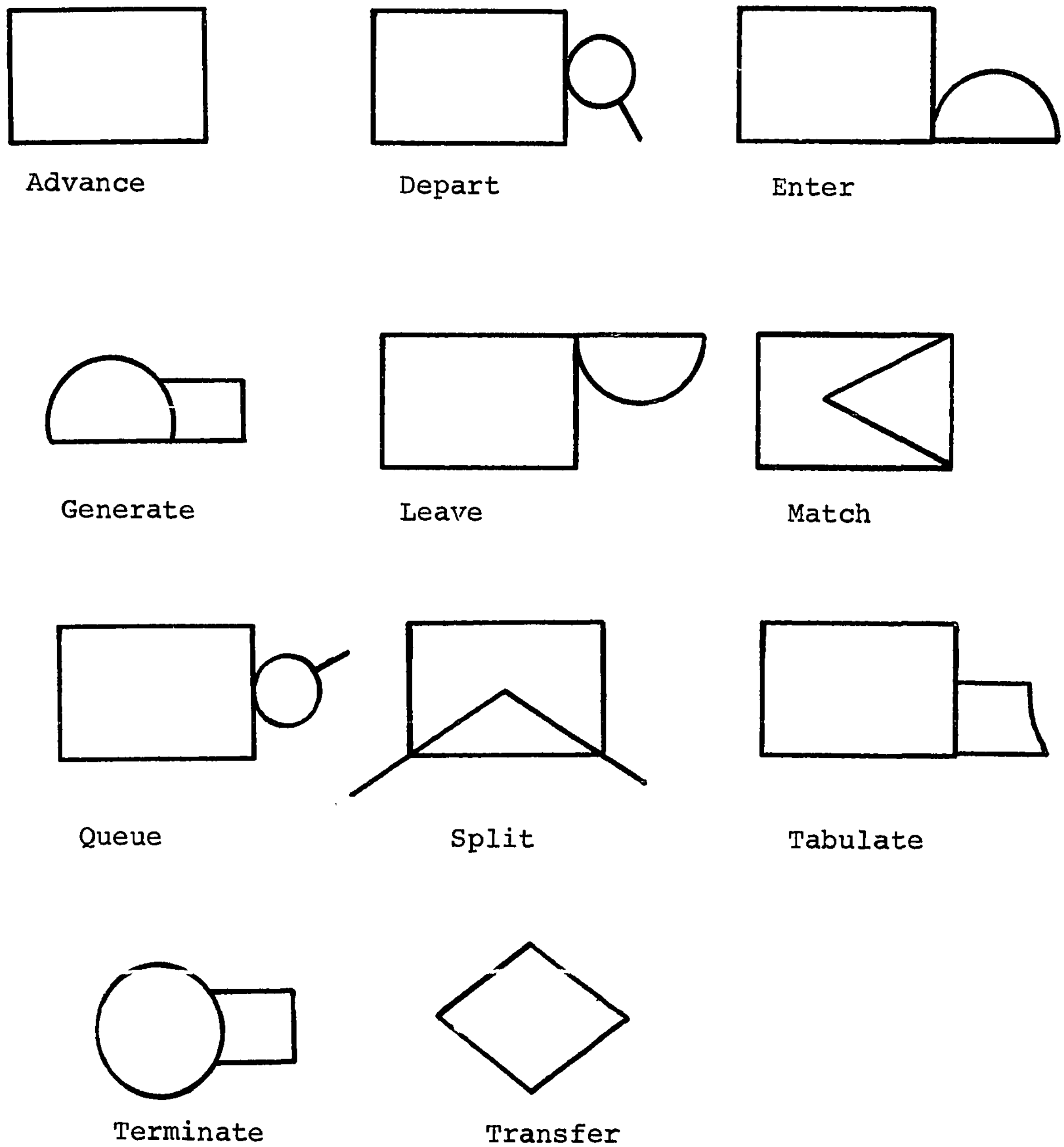

15
Processed Items
Perform Quality Check on Items
Pass?
No
Imperfectly Processed Items
14B
Yes
Perfectly Processed Items
(Send to Public Services)
Stop


16
Catalog Cards
Sort Cat. and Shelf Cards
Catalog Cards
Shelf Cards
Arrange Cards Prior To Filing
Arrange Cards Prior To Filing
File Cards
File Cards
Revise Filing
Stop

APPENDIX F

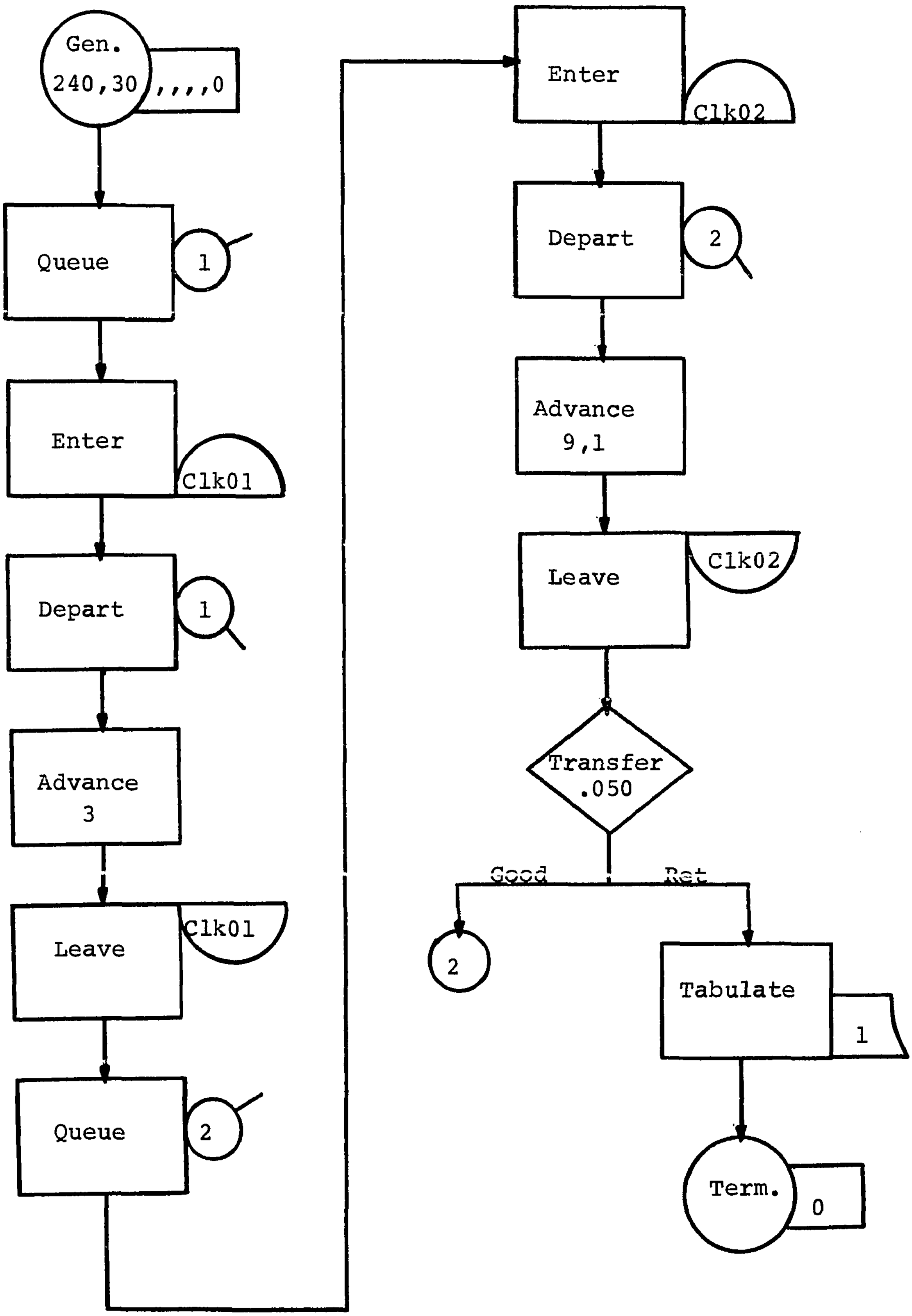
GPSS SYMBOLS

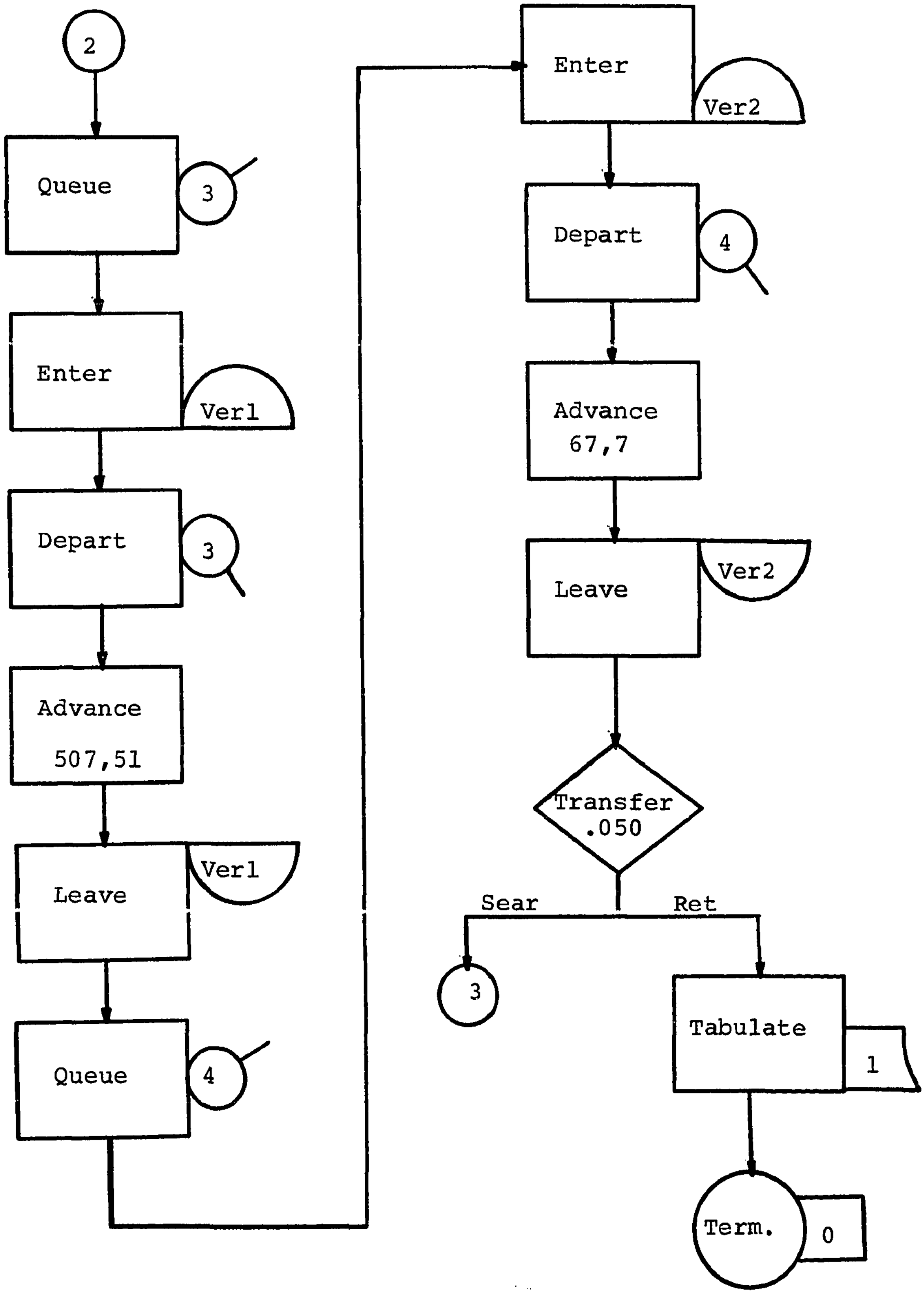
Standard GPSS Symbols

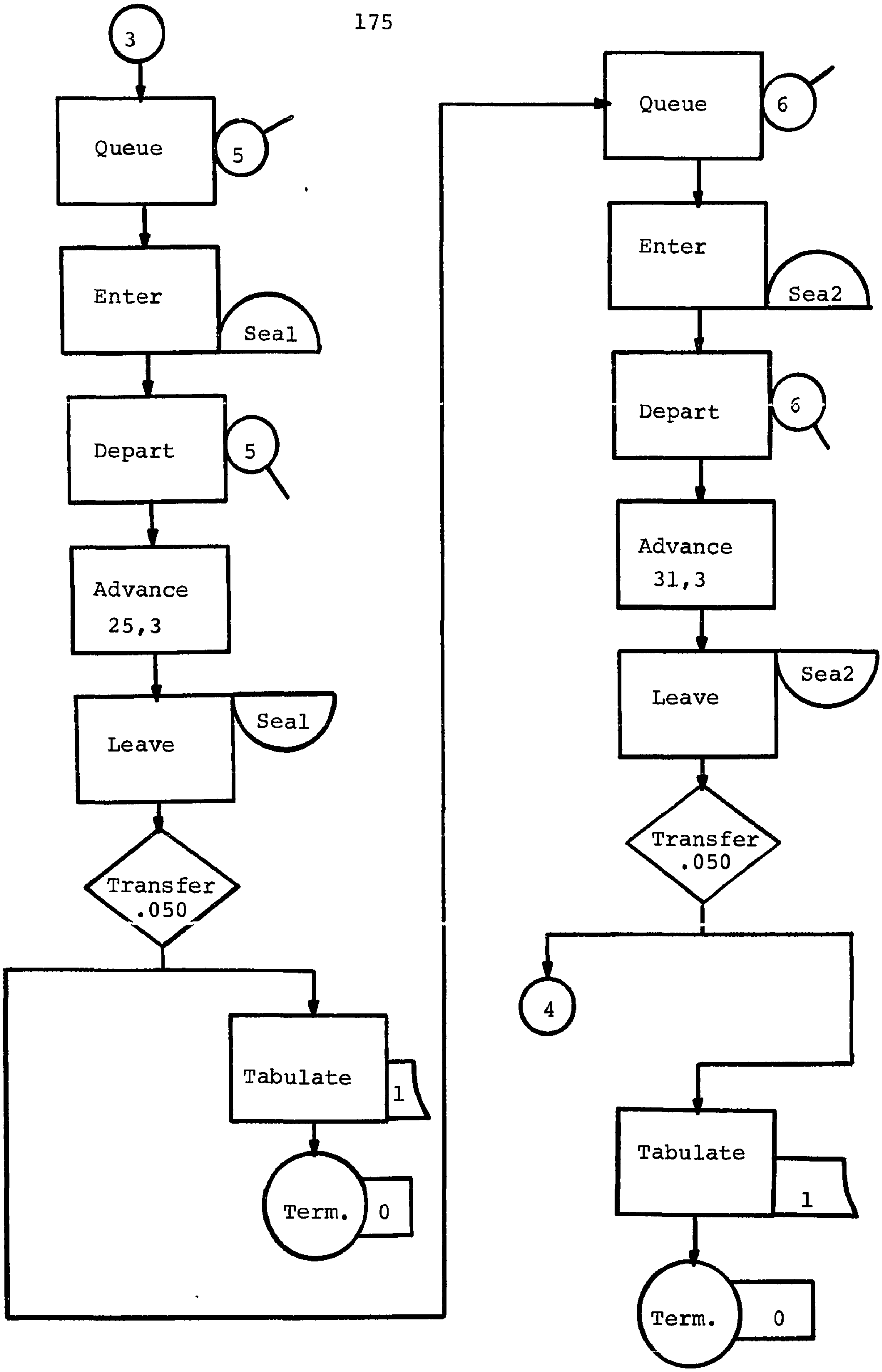


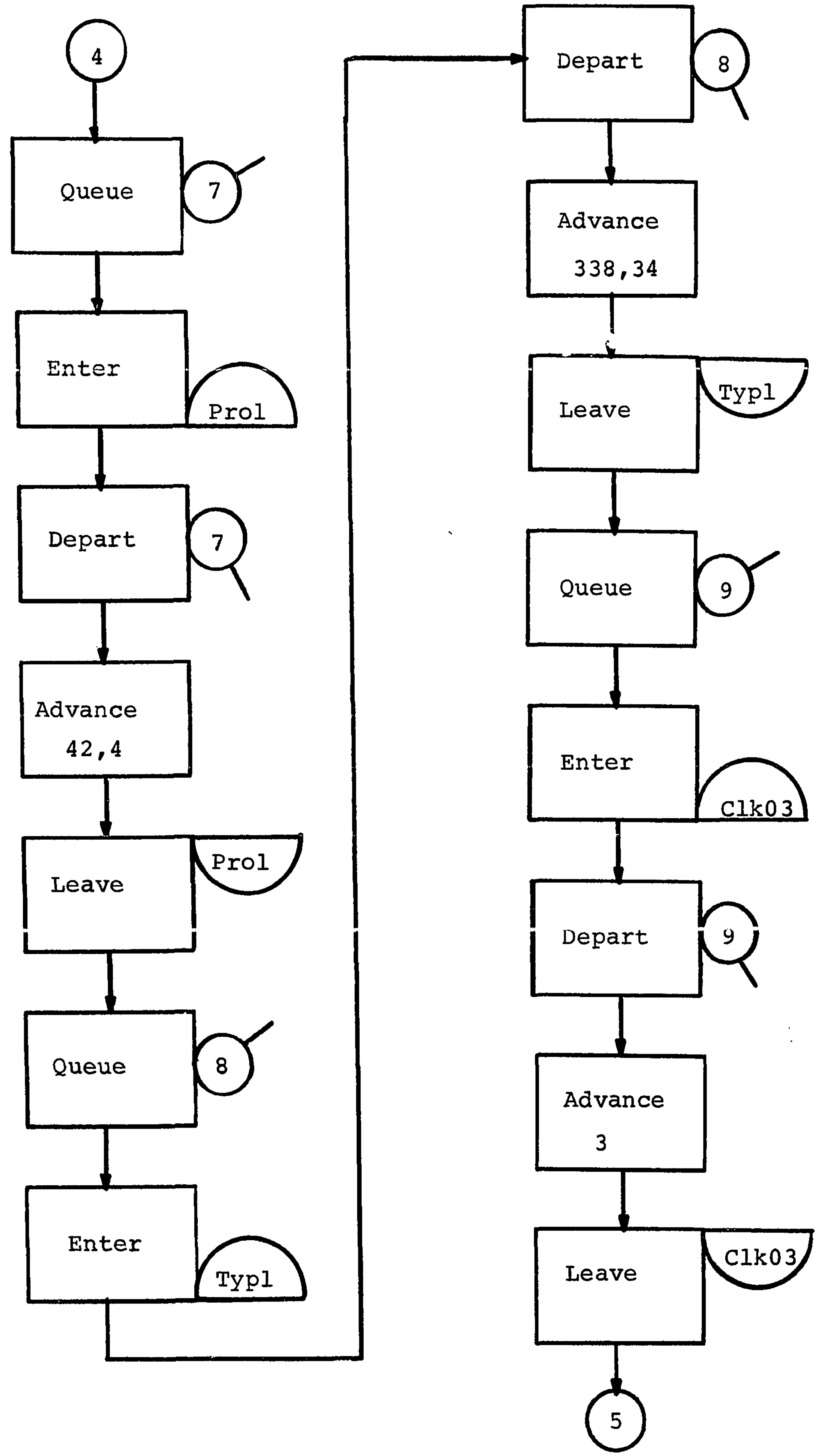
APPENDIX G

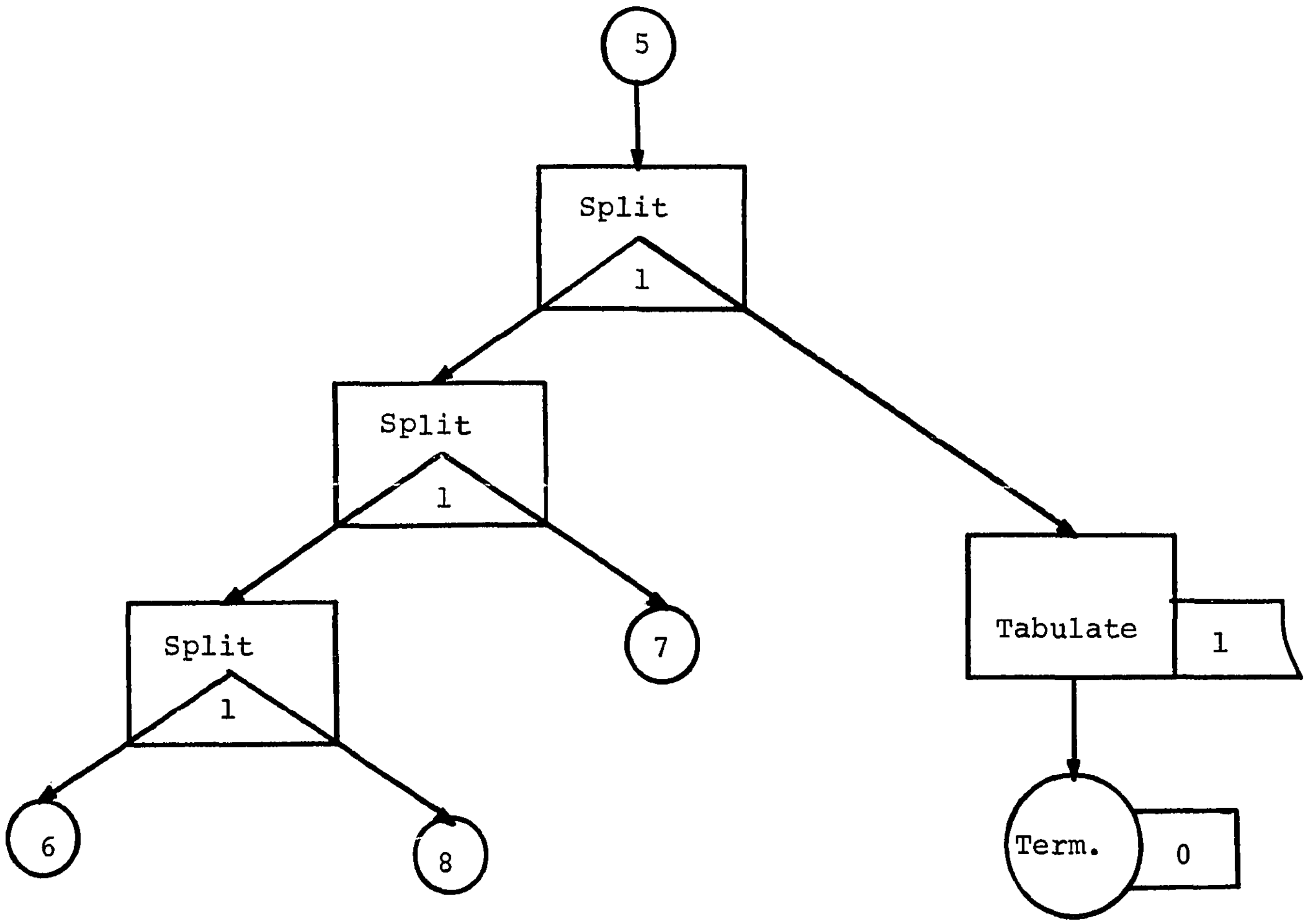
GPSS MODEL FOR A MANUAL TECHNICAL SERVICES SYSTEM

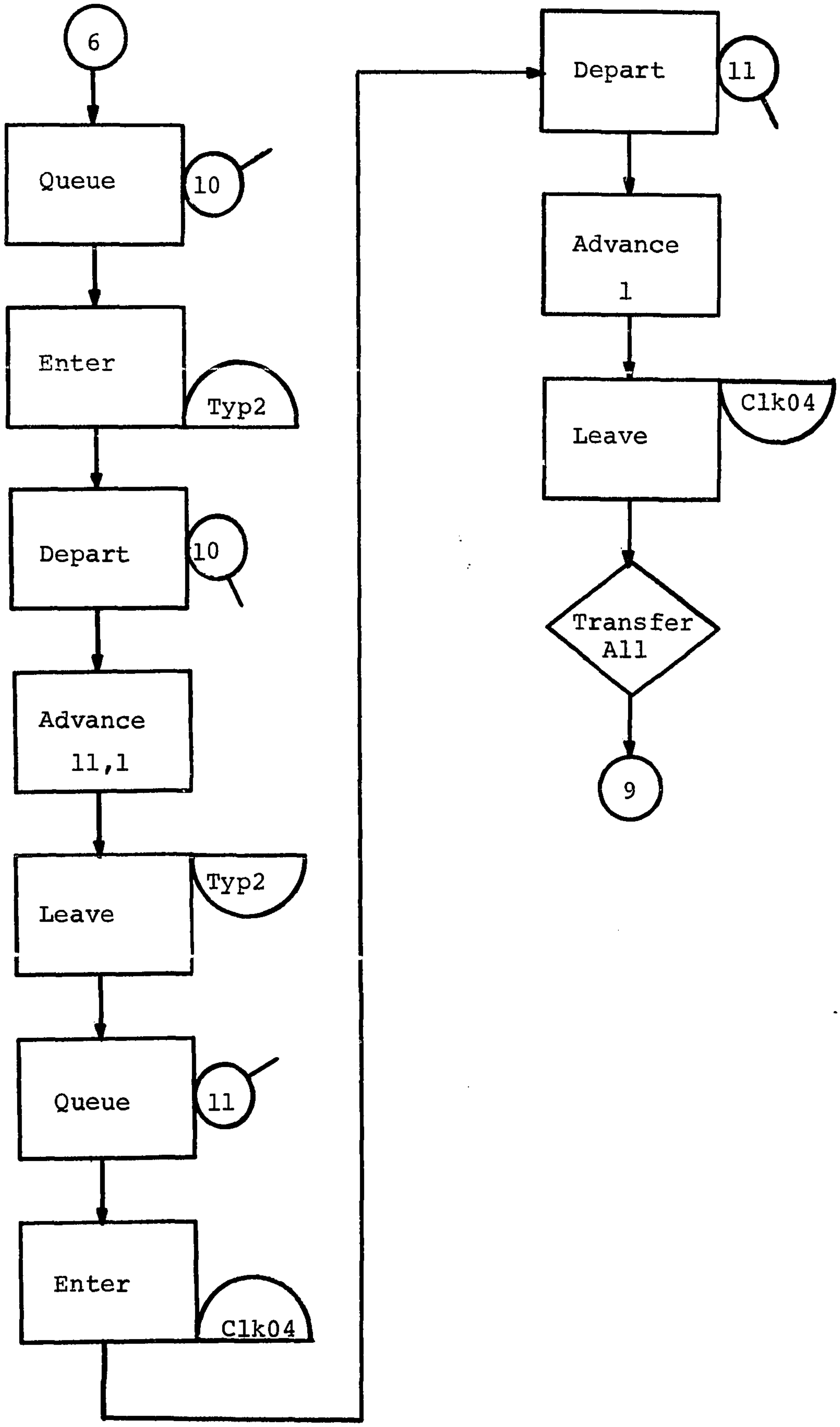

Gen.
240,30
,,,,0
Queue
1
Enter
Clk01
Depart
1
Advance
3
Leave
Clk01
Queue
2
Enter
Clk02
Depart
2
Advance
9,1
Leave
Clk02
Transfer
.050
Good
Ret
2
Tabulate
1
Term.
0

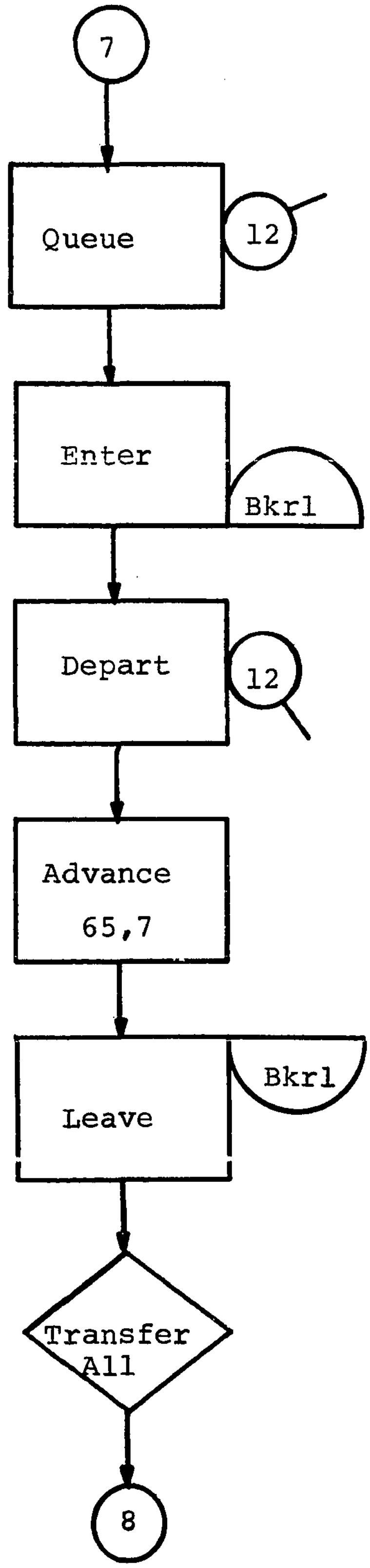

2
Queue
3
Enter
Ver1
Depart
3
Advance
507,51
Leave
Ver1
Queue
4
Enter
Ver2
Depart
4
Advance
67,7
Leave
Ver2
Transfer
.050
Sear
Ret
3
Tabulate
1
Term.
0

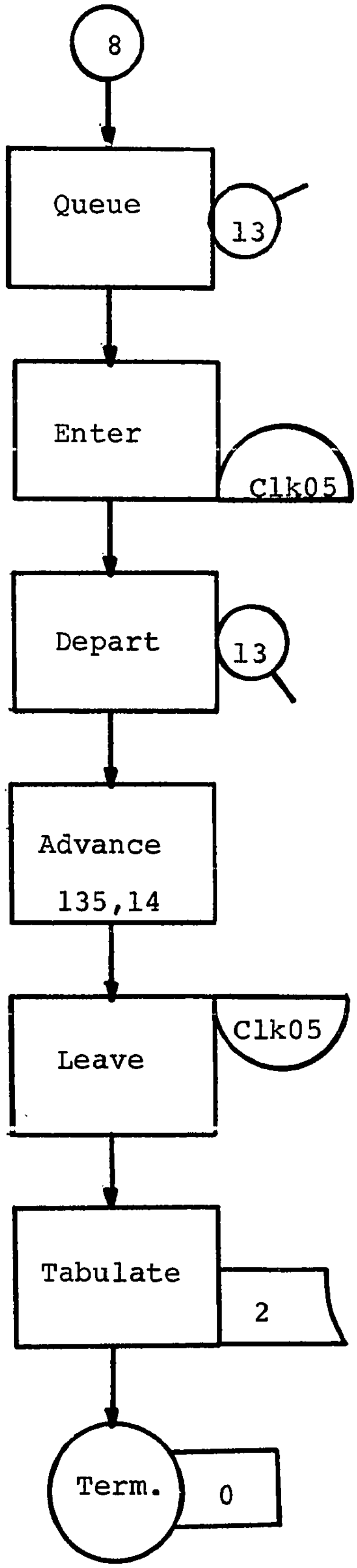

3
Queue
5
Enter
Seal
Depart
5
Advance
25,3
Leave
Seal
Transfer
.050
Tabulate
1
Term.
0
Queue
6
Enter
Sea2
Depart
6
Advance
31,3
Leave
Sea2
Transfer
.050
4
Tabulate
1
Term.
0


4
Queue
7
Enter
Prol
Depart
7
Advance
42,4
Leave
Prol
Queue
8
Enter
Typl
Depart
8
Advance
338,34
Leave
Typl
Queue
9
Enter
Clk03
Depart
9
Advance
3
Leave
Clk03
5

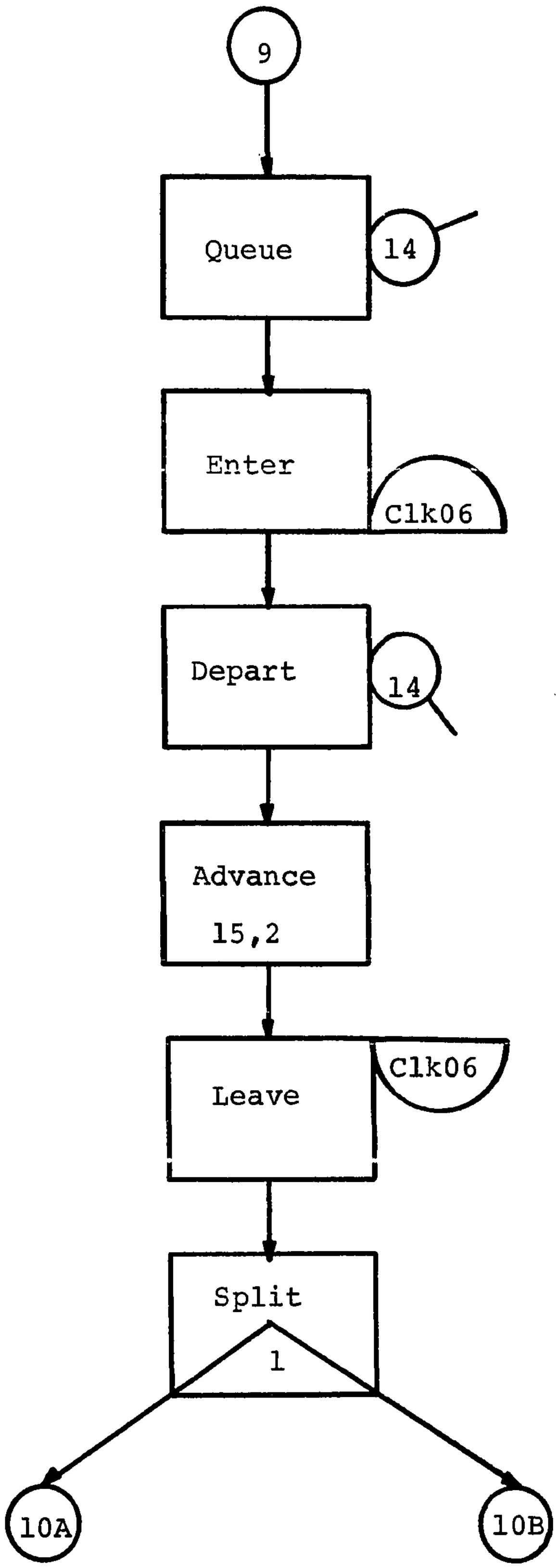

5
Split
1
Split
1
Split
1
6
8
7
Tabulate
1
Term.
0

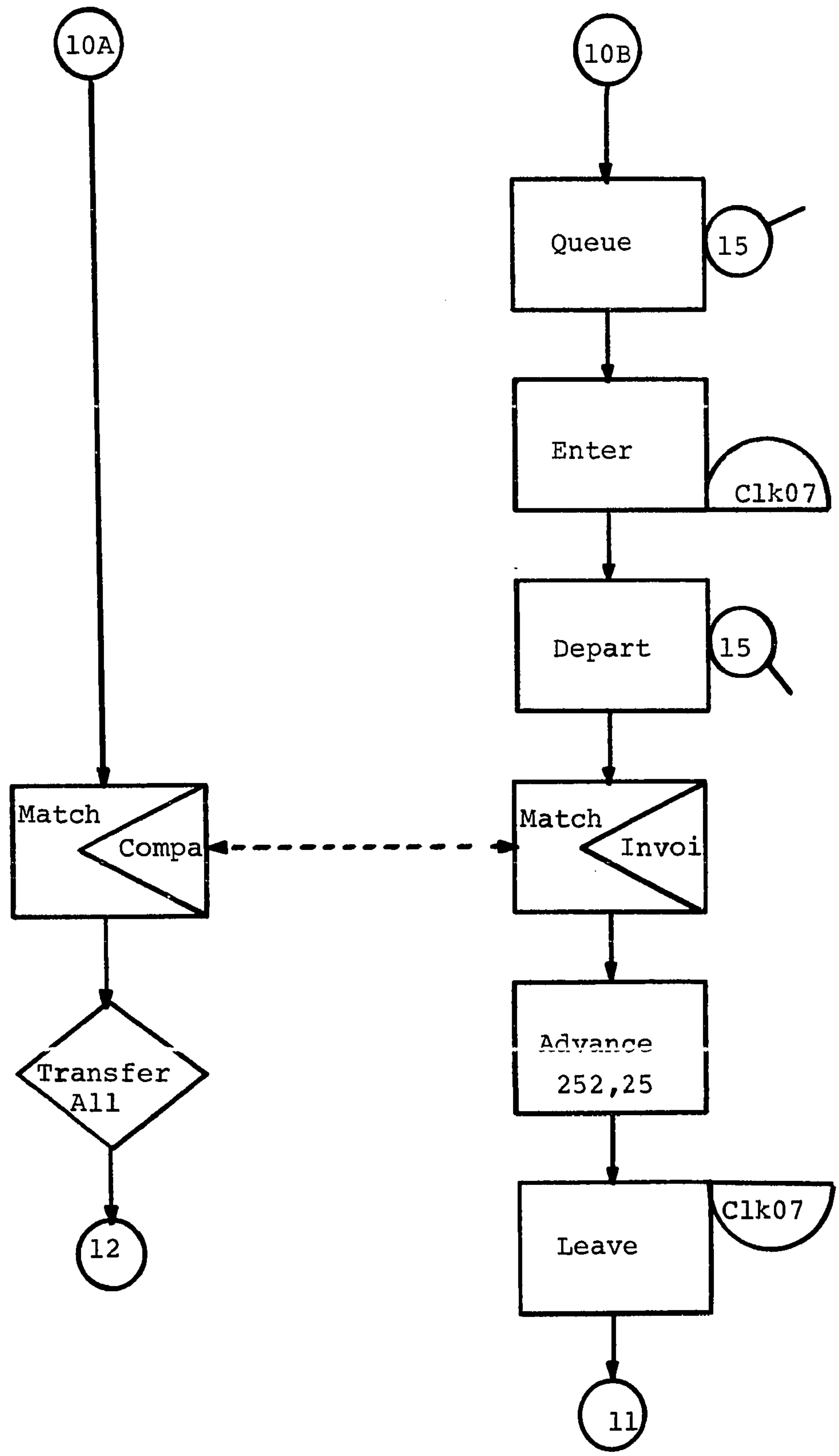

6
Queue
10
Enter
Typ2
Depart
10
Advance
11,1
Leave
Typ2
Queue
11
Enter
Clk04
Depart
11
Advance
1
Leave
Clk04
Transfer
All
9

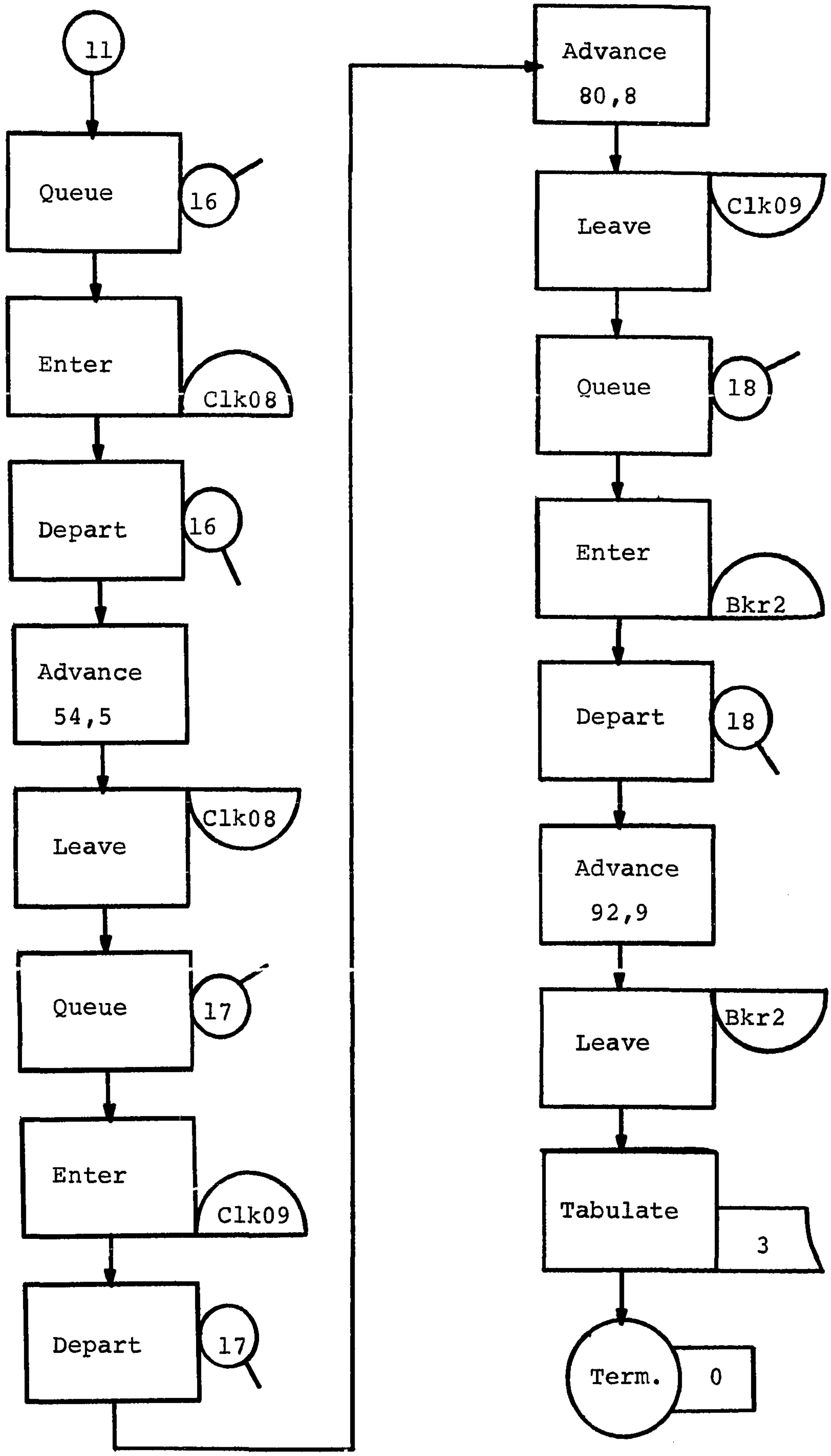

7
Queue
12
Enter
Bkrl
Depart
12
Advance
65,7
Leave
Bkrl
Transfer
All
8

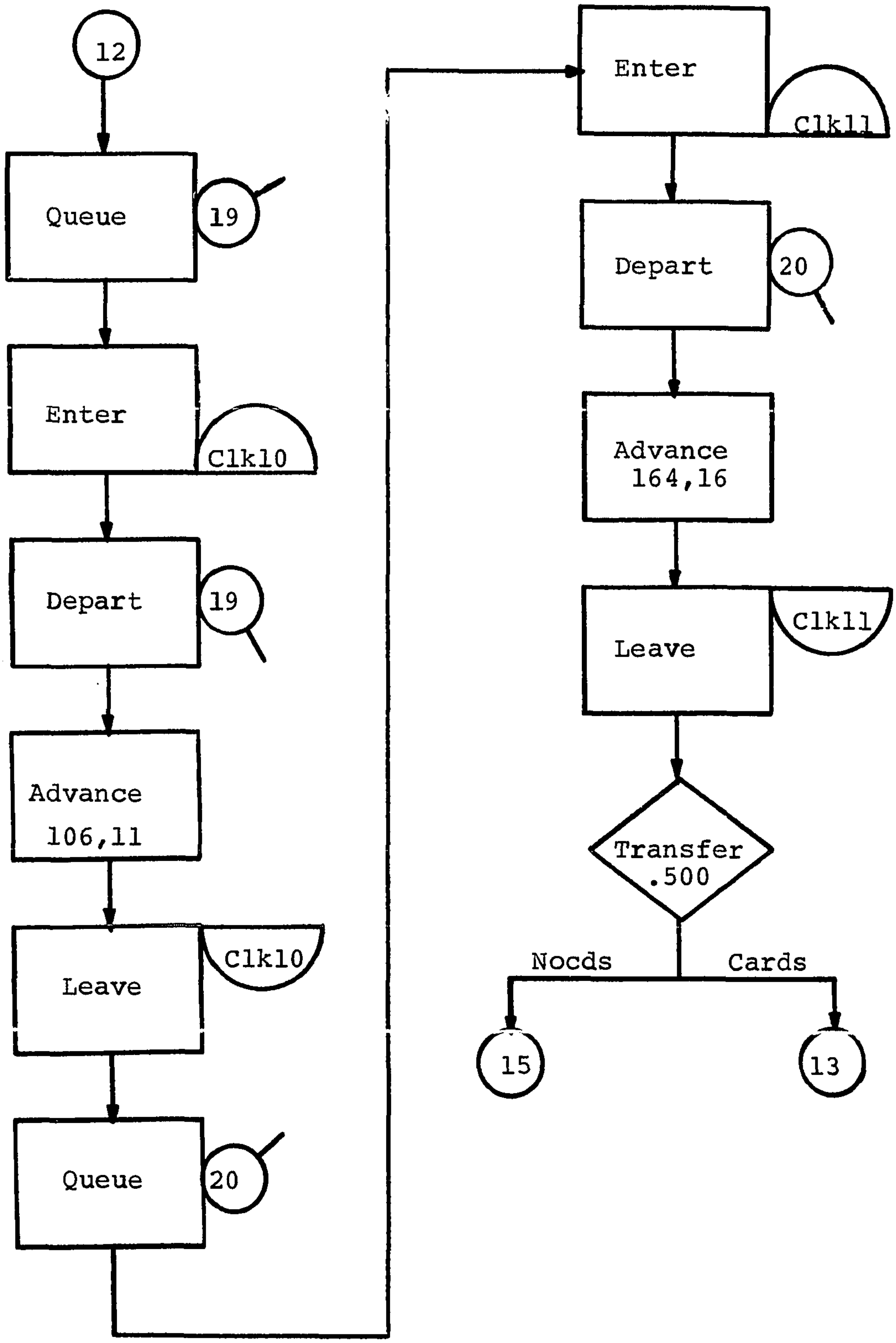


8
Queue
13
Enter
Clk05
Depart
13
Advance
135,14
Leave
Clk05
Tabulate
2
Term.
0

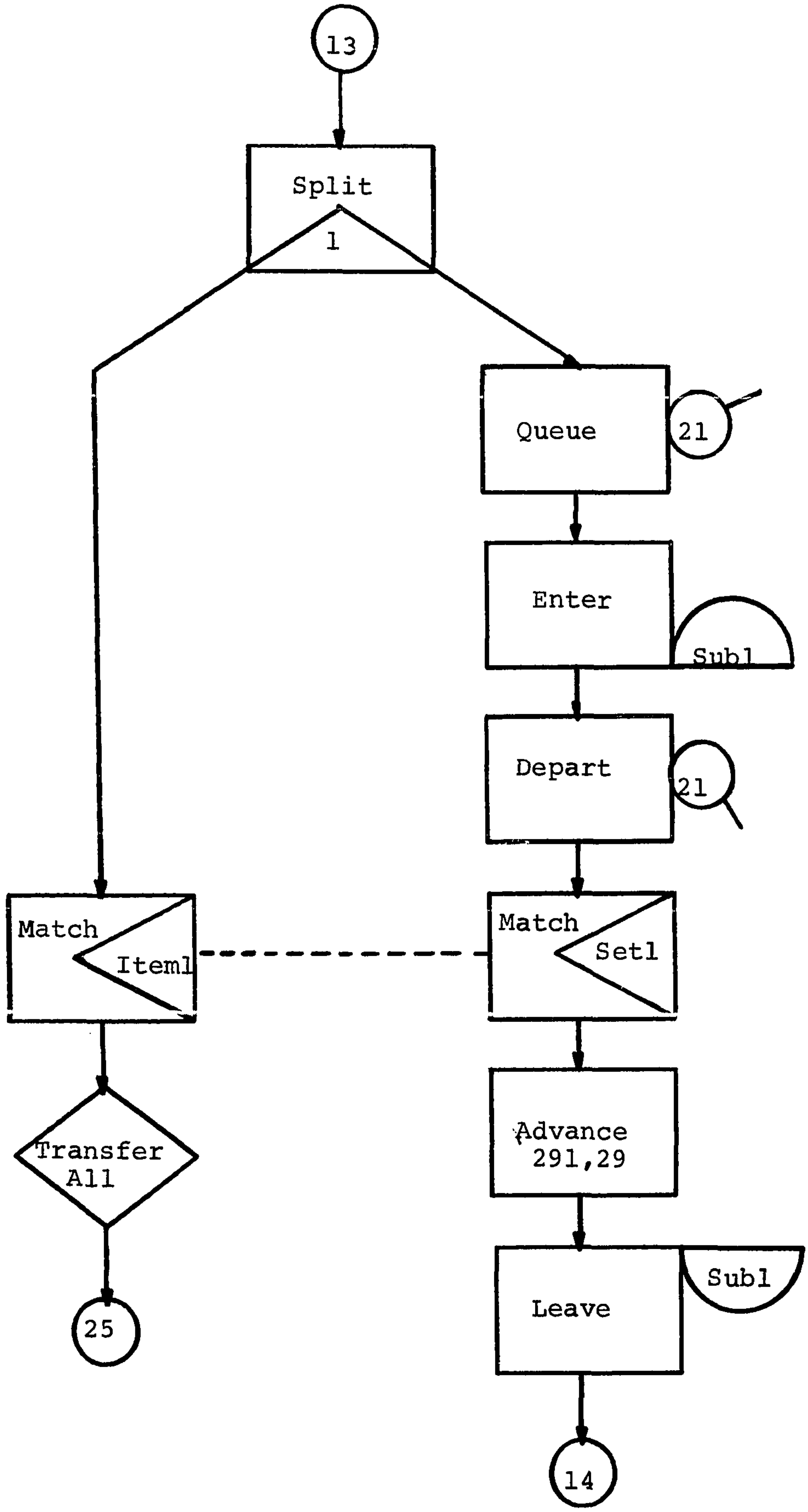

9
Queue
14
Enter
Clk06
Depart
14
Advance
15,2
Leave
Clk06
Split
1
10A
10B

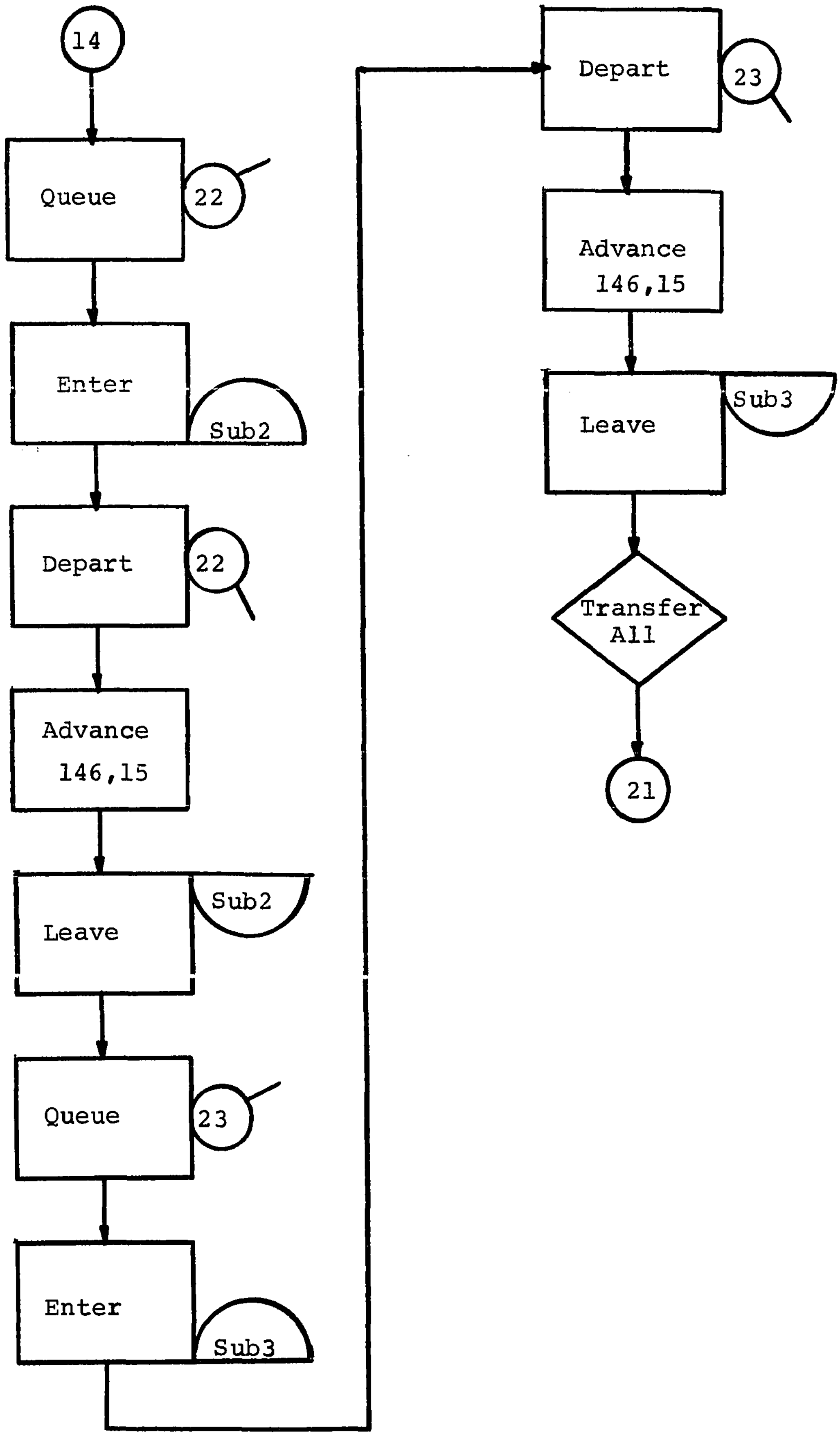

10A
10B
Queue
15
Enter
Clk07
Depart
15
Match
Compa
Match
Invoi
Transfer
All
Advance
252,25
12
Leave
Clk07
11

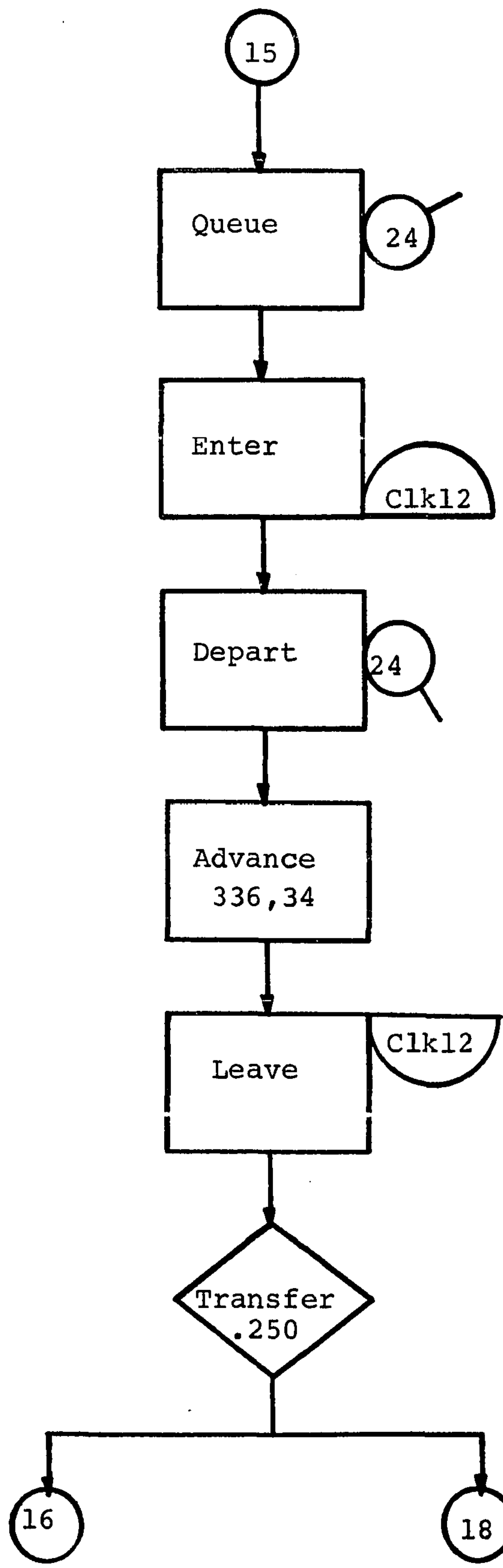

11
Queue
16
Enter
Clk08
Depart
16
Advance
54,5
Leave
Clk08
Queue
17
Enter
Clk09
Depart
17
Advance
80,8
Leave
Clk09
Queue
18
Enter
Bkr2
Depart
18
Advance
92,9
Leave
Bkr2
Tabulate
3
Term.
0

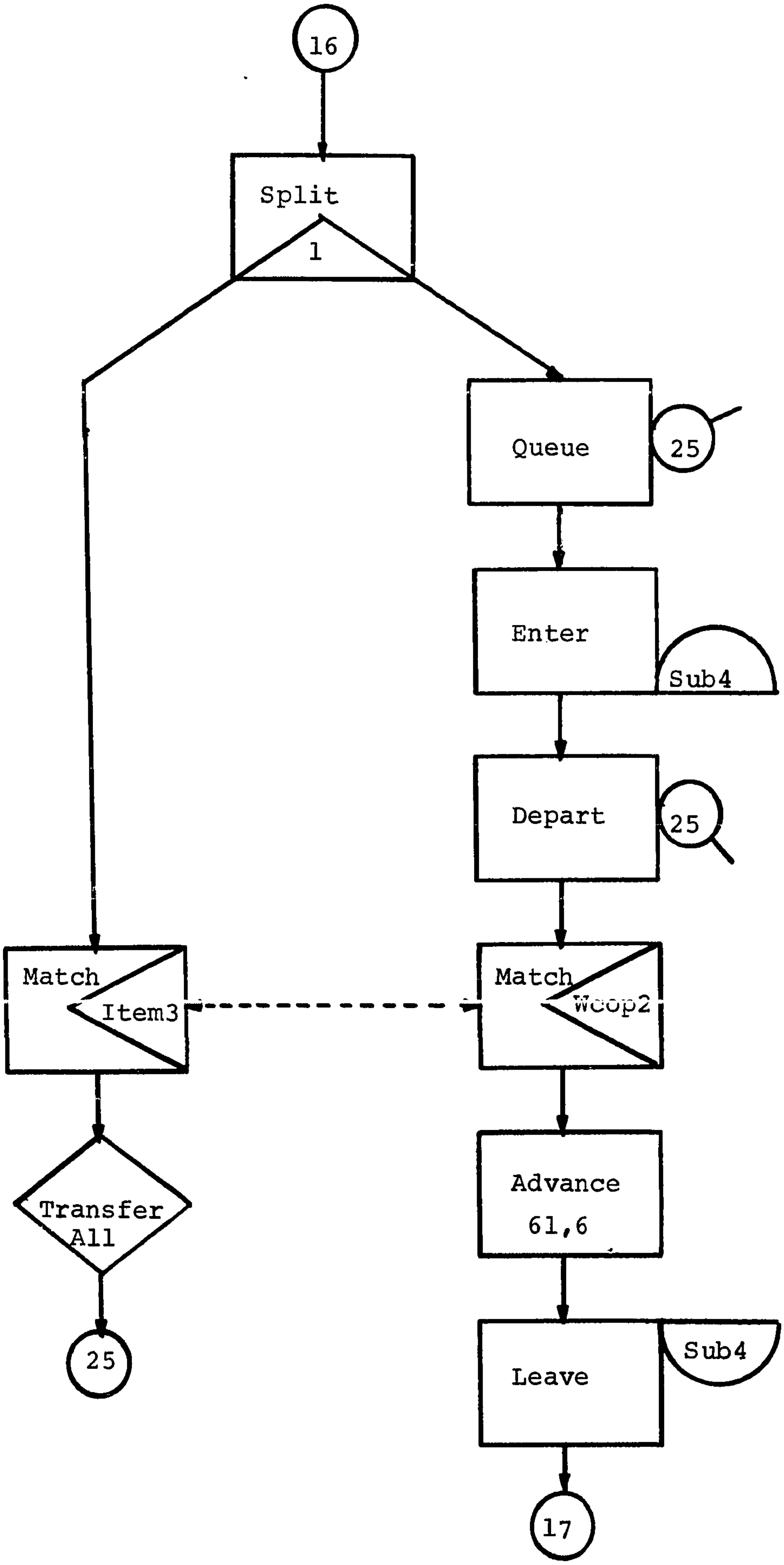


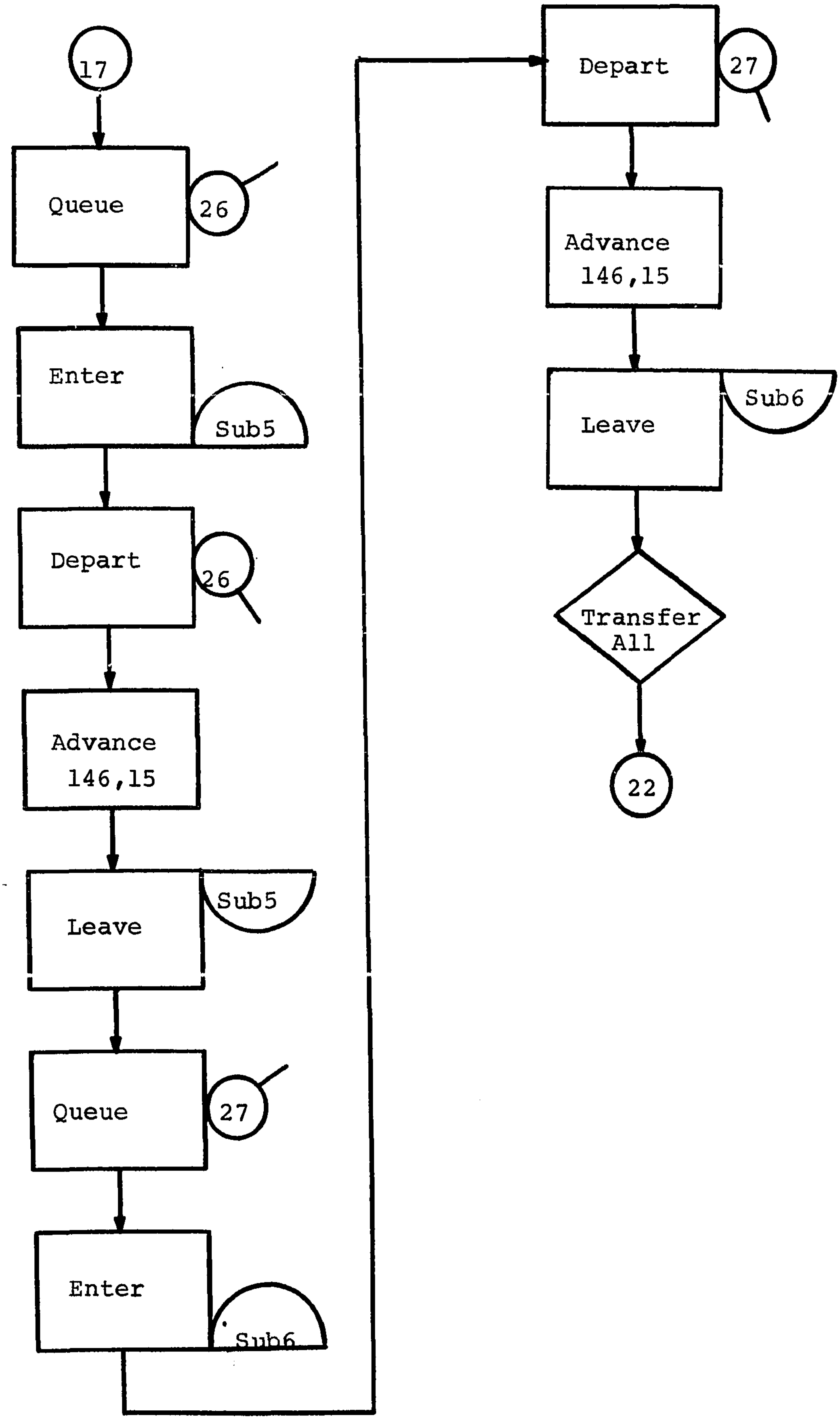
12
Queue
19
Enter
Clk10
Depart
19
Advance
106,11
Leave
Clk10
Queue
20
Enter
Clk11
Depart
20
Advance
164,16
Leave
Clk11
Transfer
.500
Nocds
Cards
15
13

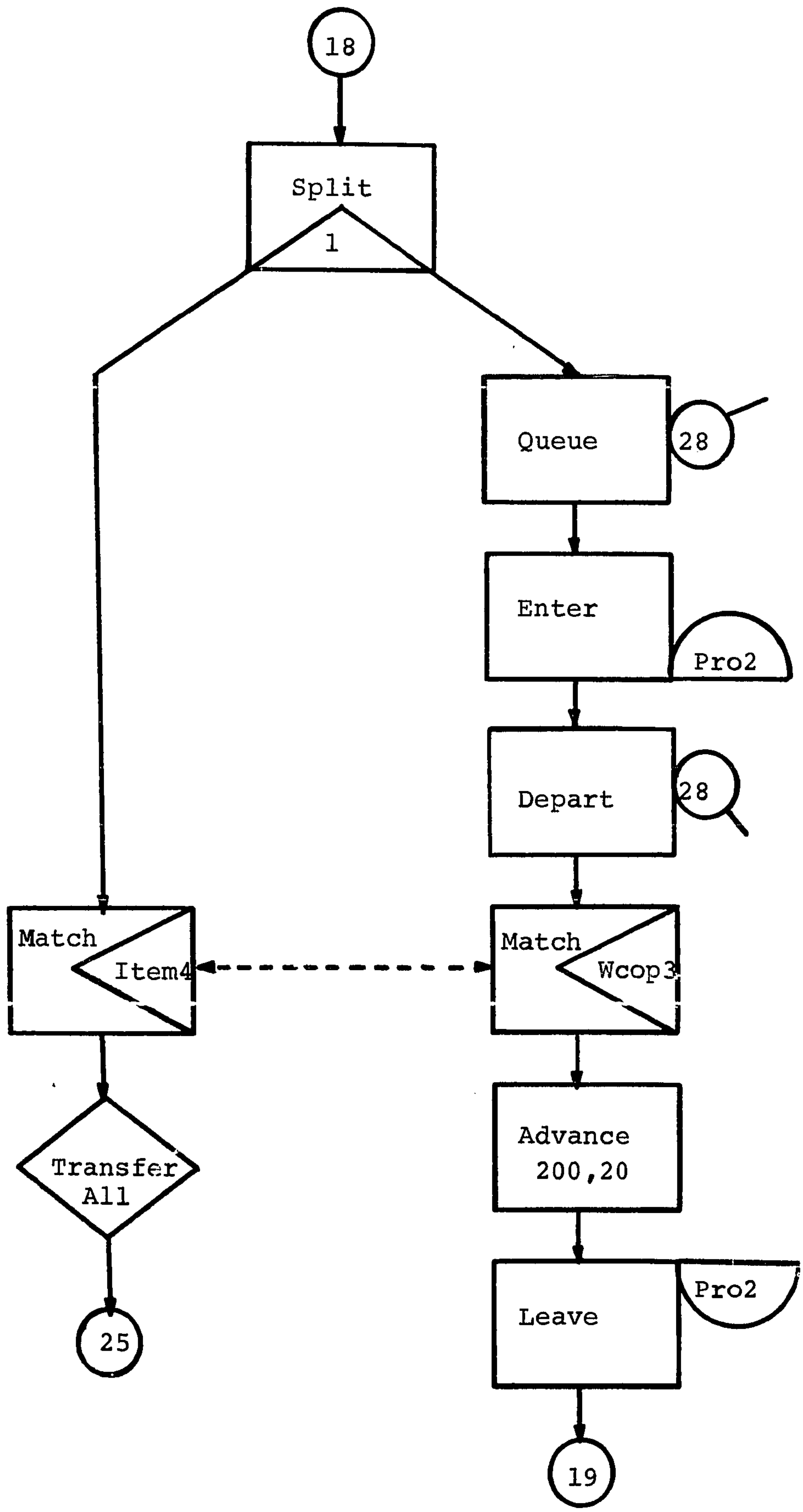

13
Split
1
Queue
21
Enter
Subl
Depart
21
Match
Iteml
Match
Setl
Transfer
All
Advance
291,29
Leave
Subl
25
14

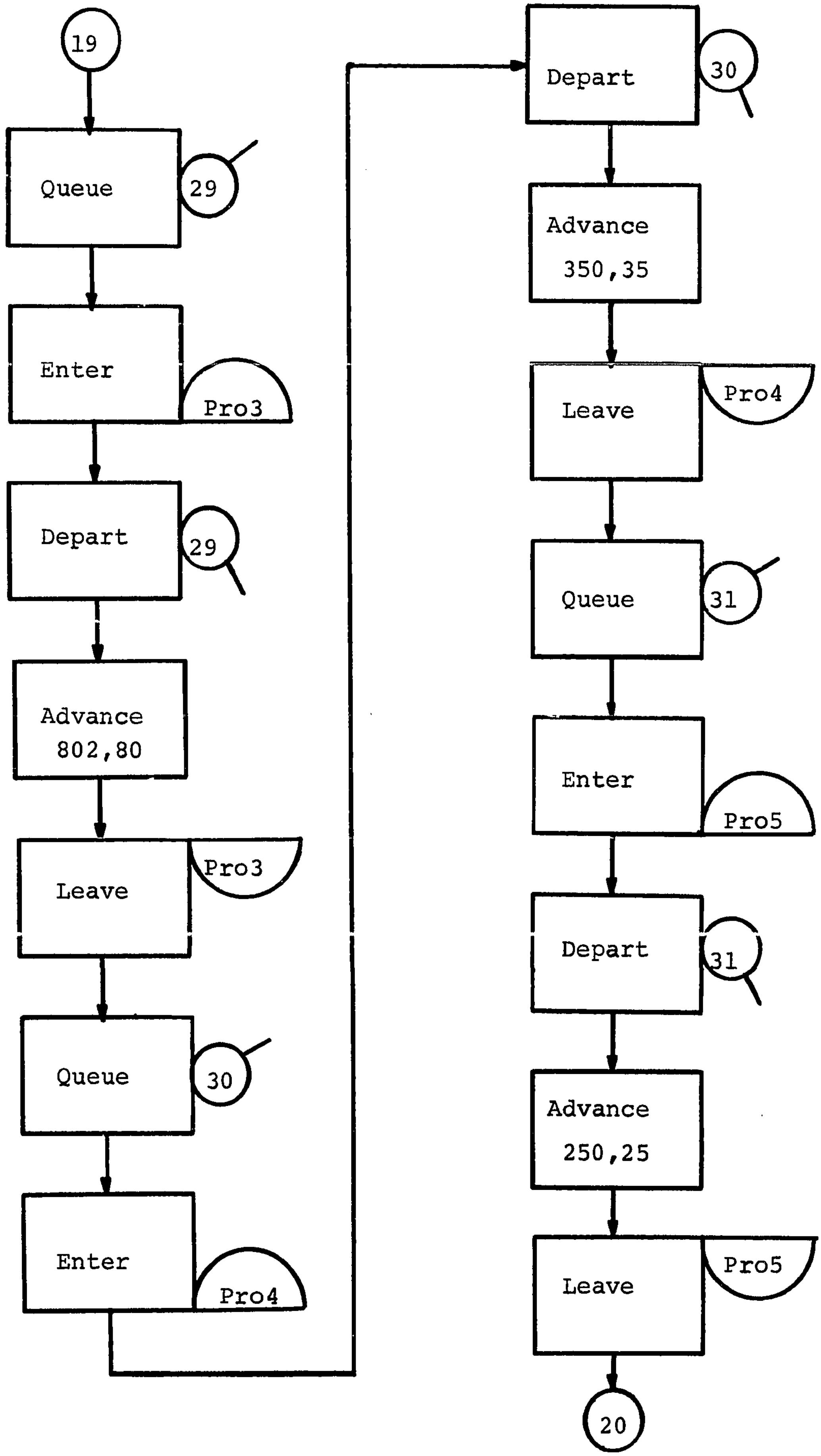

14
Queue
22
Enter
Sub2
Depart
22
Advance
146,15
Leave
Sub2
Queue
23
Enter
Sub3
Depart
23
Advance
146,15
Leave
Sub3
Transfer
All
21

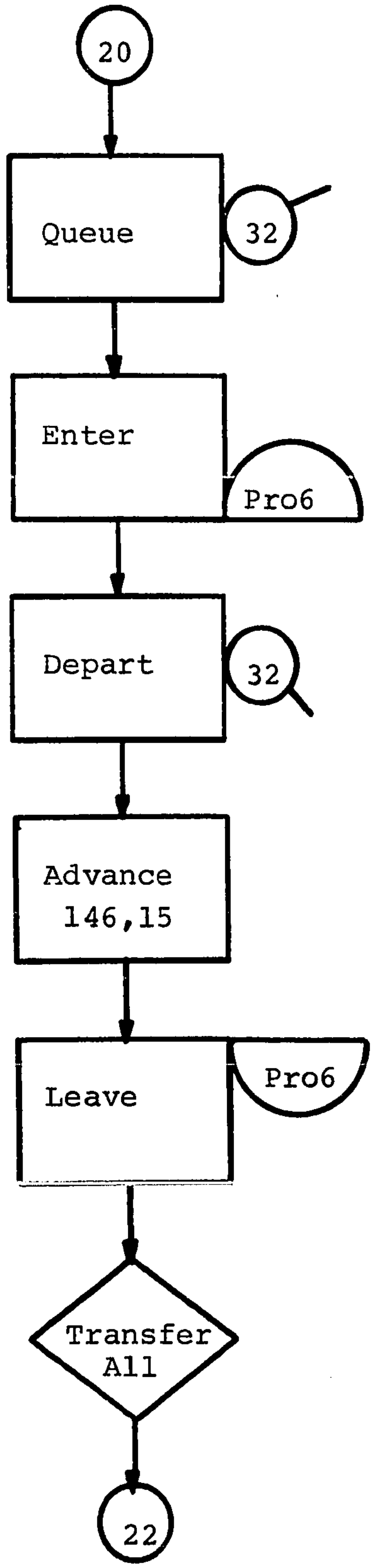

15
Queue
24
Enter
Clk12
Depart
24
Advance
336,34
Leave
Clk12
Transfer
.250
16
18

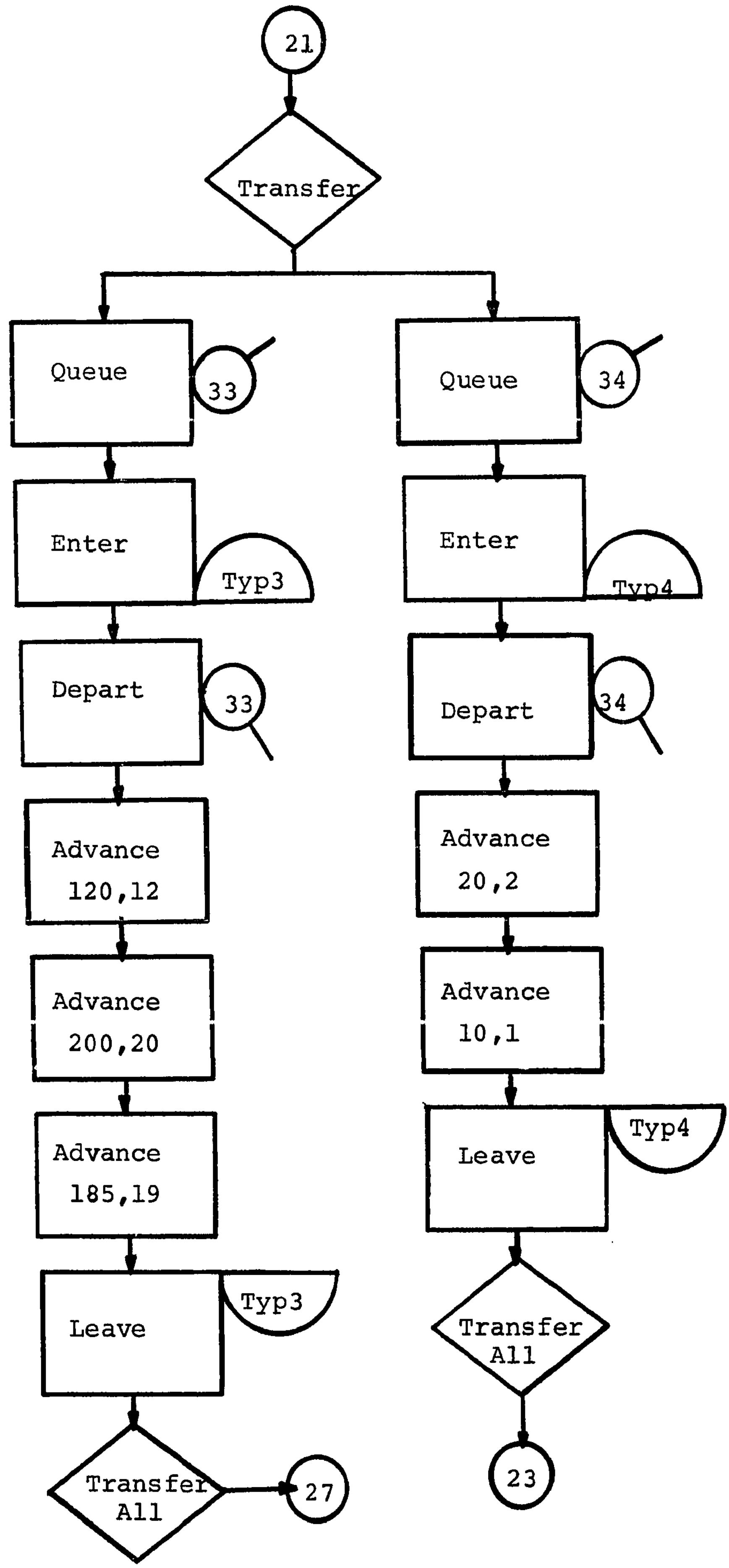

16
Split
1
Queue
25
Enter
Sub4
Depart
25
Match
Item3
Match
Wcop2
Transfer
All
25
Advance
61,6
Leave
Sub4
17

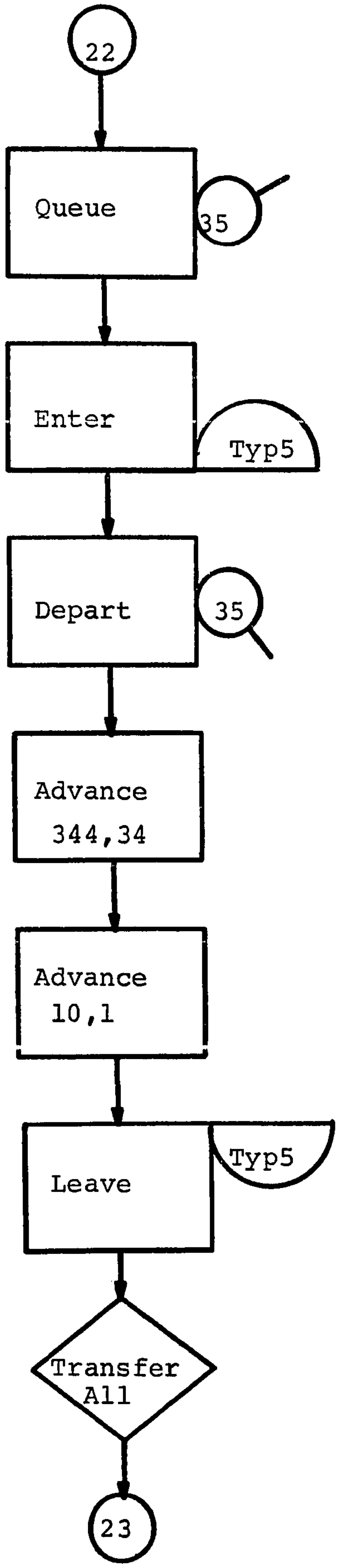

17
Queue
26
Enter
Sub5
Depart
26
Advance
146,15
Leave
Sub5
Queue
27
Enter
Sub6
Depart
27
Advance
146,15
Leave
Sub6
Transfer
All
22

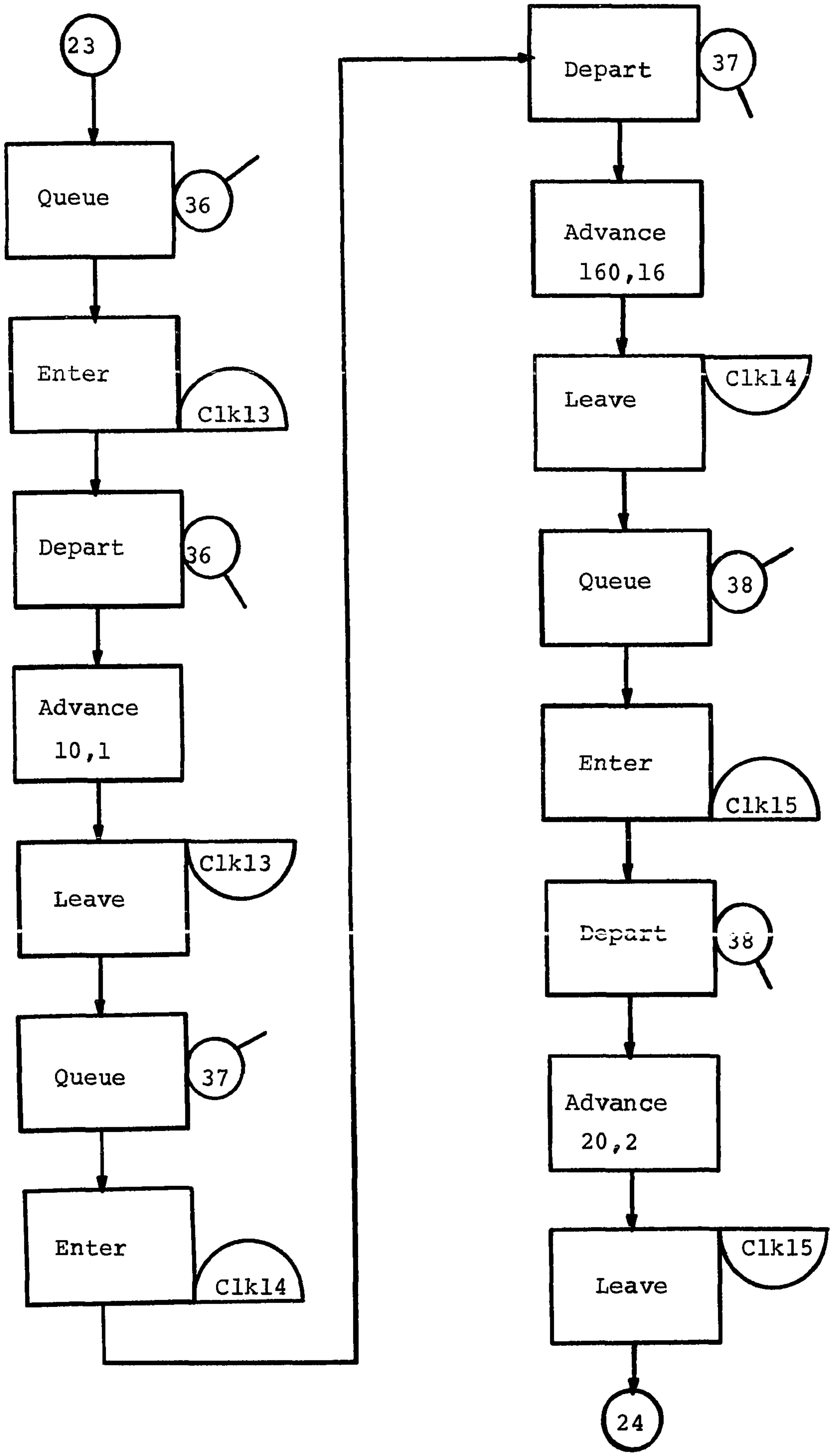

18
Split
1
Queue
28
Enter
Pro2
Depart
28
Match
Item4
Match
Wcop3
Transfer
All
25
Advance
200,20
Leave
Pro2
19

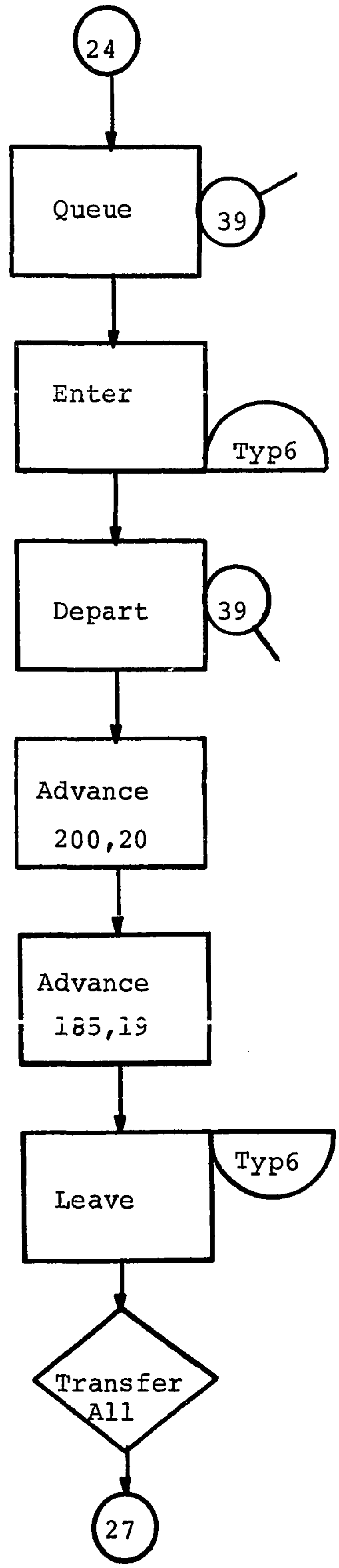

19
Queue
29
Enter
Pro3
Depart
29
Advance
802,80
Leave
Pro3
Queue
30
Enter
Pro4
Depart
30
Advance
350,35
Leave
Pro4
Queue
31
Enter
Pro5
Depart
31
Advance
250,25
Leave
Pro5
20

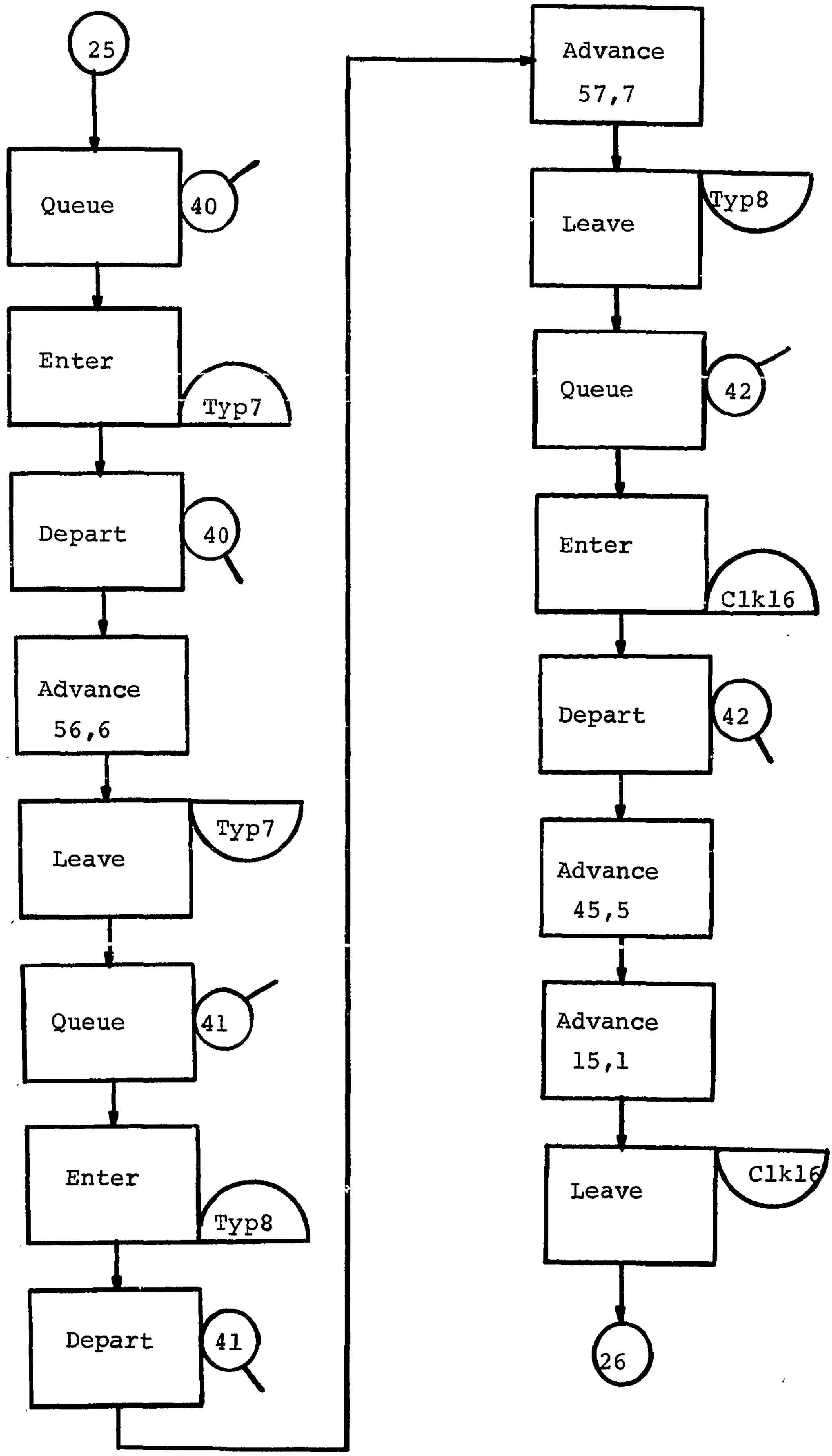

20
Queue
32
Enter
Pro6
Depart
32
Advance
146,15
Leave
Pro6
Transfer
All
22

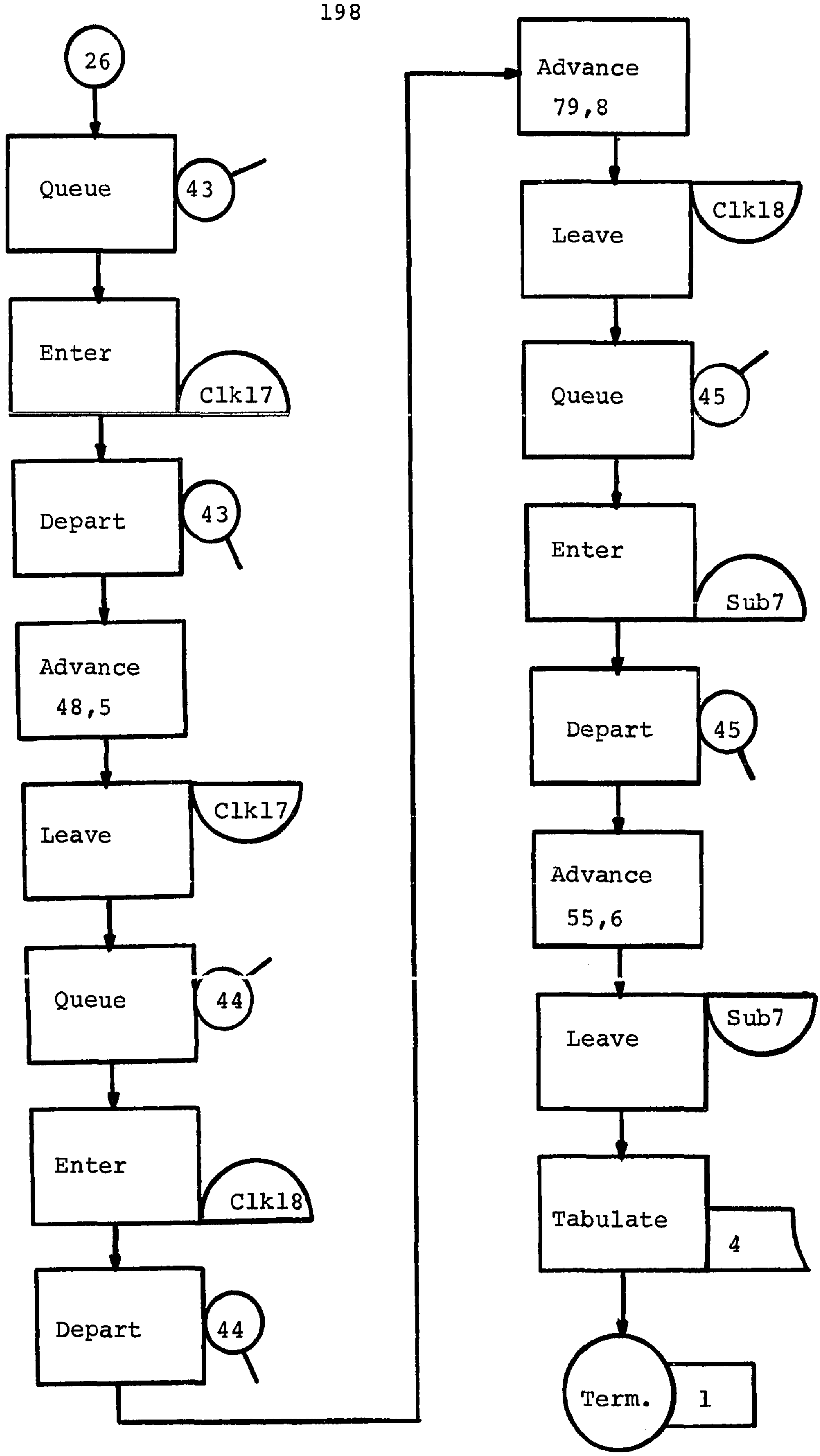

21
Transfer
Queue
33
Enter
Typ3
Depart
33
Advance
120,12
Advance
200,20
Advance
185,19
Leave
Typ3
Transfer
All
27
Queue
34
Enter
Typ4
Depart
34
Advance
20,2
Advance
10,1
Leave
Typ4
Transfer
All
23

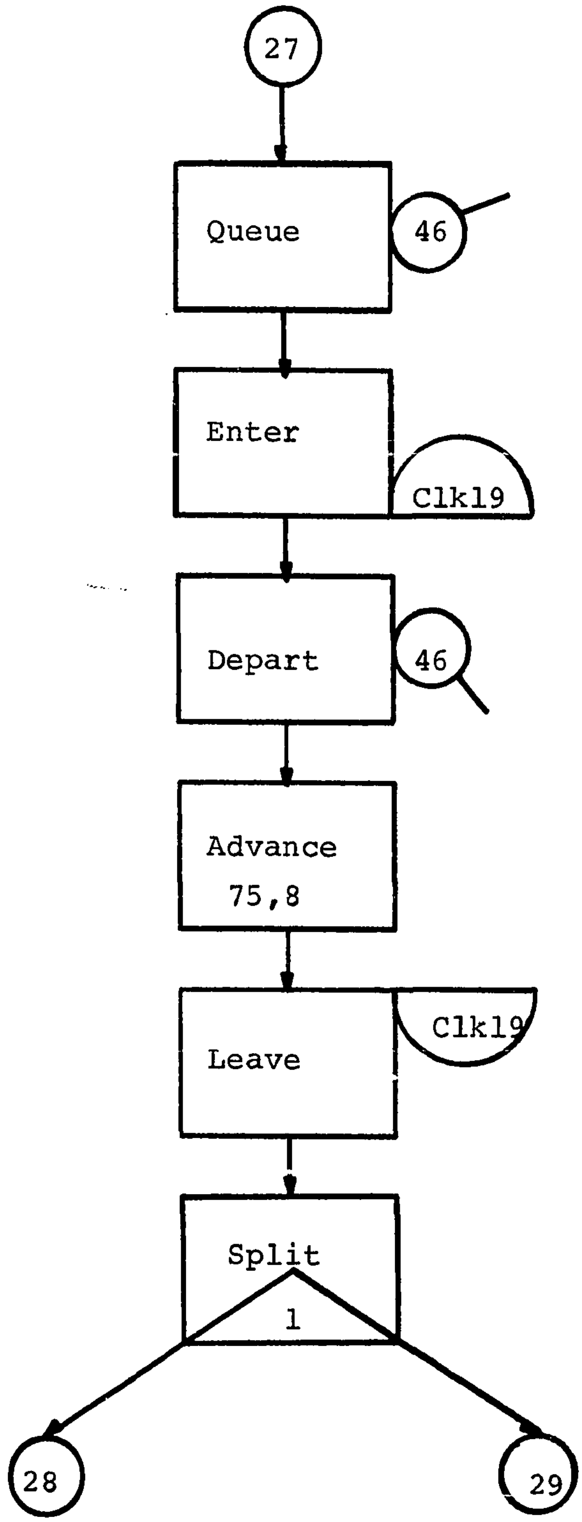

22
Queue
35
Enter
Typ5
Depart
35
Advance
344,34
Advance
10,1
Leave
Typ5
Transfer
All
23

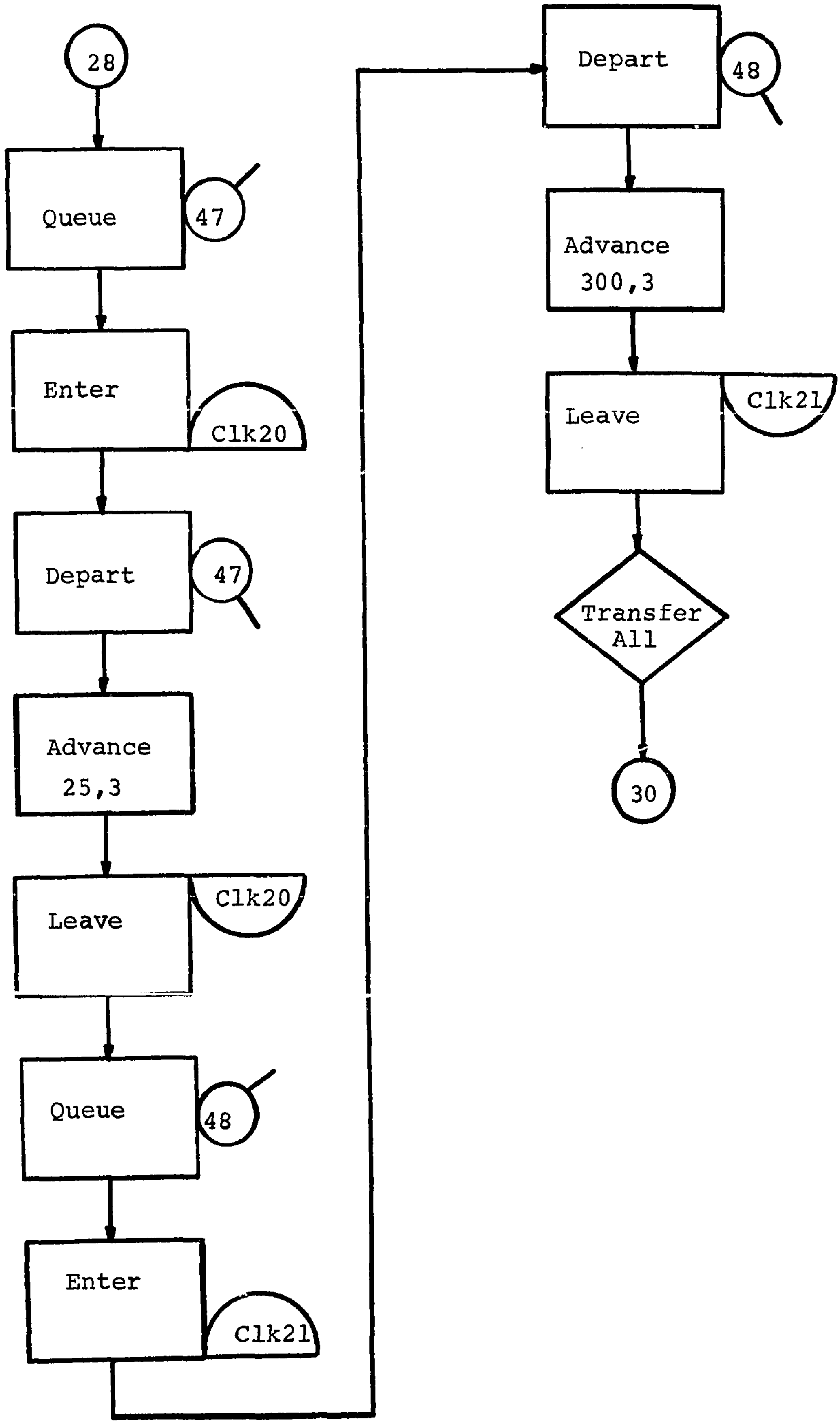

23
Queue
36
Enter
Clk13
Depart
36
Advance
10,1
Leave
Clk13
Queue
37
Enter
Clk14
Depart
37
Advance
160,16
Leave
Clk14
Queue
38
Enter
Clk15
Depart
38
Advance
20,2
Leave
Clk15
24

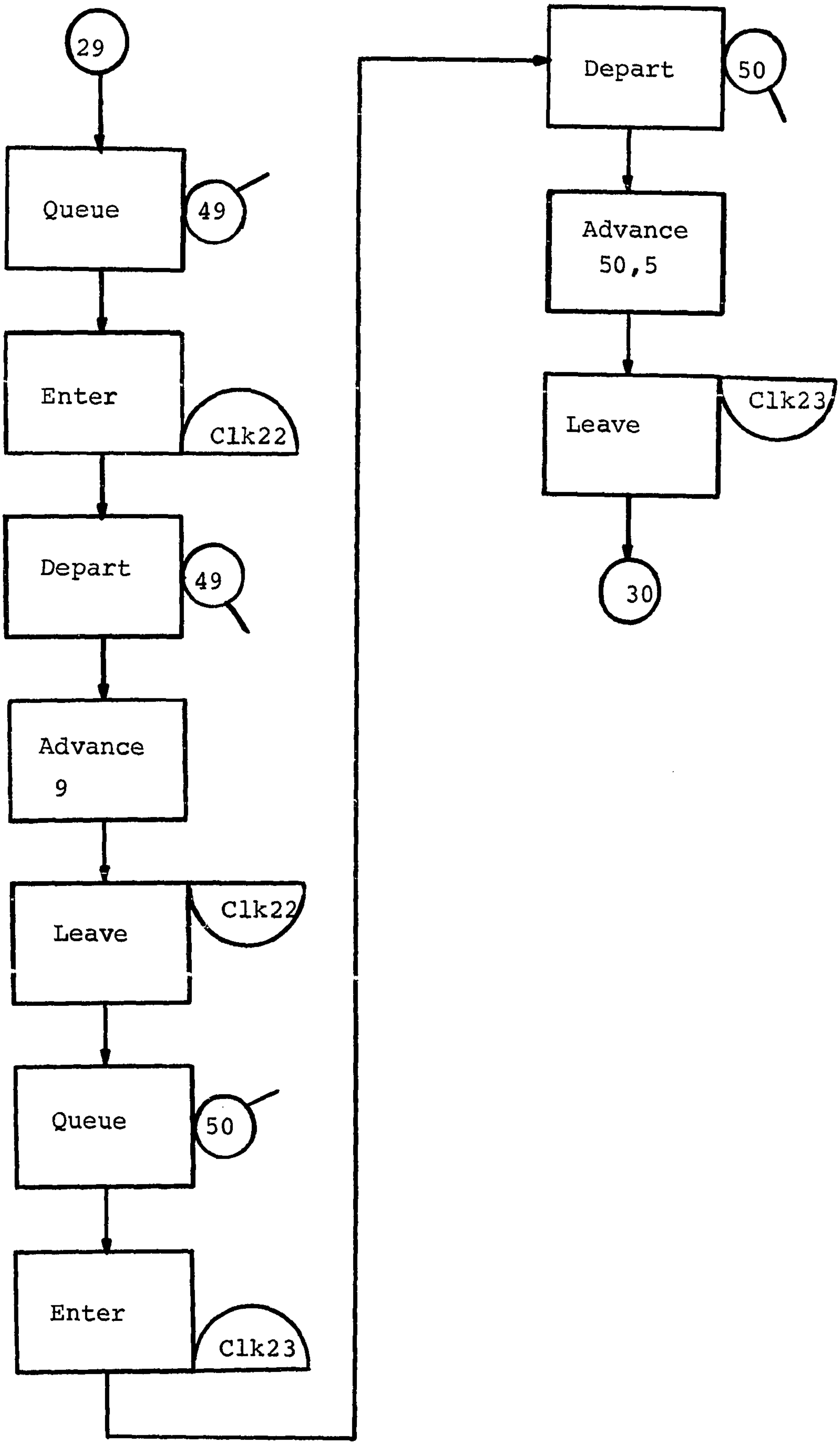

24
Queue
39
Enter
Typ6
Depart
39
Advance
200,20
Advance
185,19
Leave
Typ6
Transfer
All
27

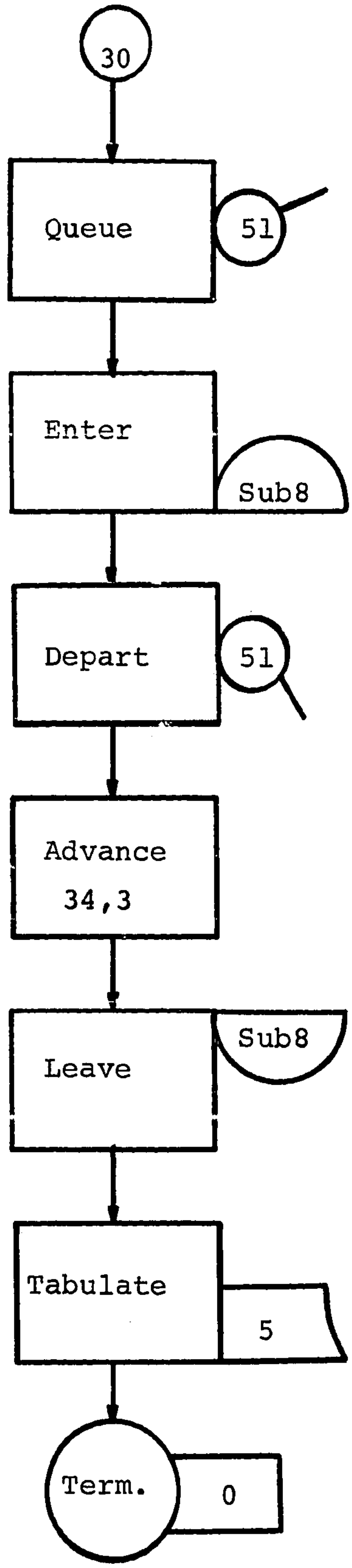

25
Queue
40
Enter
Typ7
Depart
40
Advance
56,6
Leave
Typ7
Queue
41
Enter
Typ8
Depart
41
Advance
57,7
Leave
Typ8
Queue
42
Enter
Clk16
Depart
42
Advance
45,5
Advance
15,1
Leave
Clk16
26


26
Queue
43
Enter
Clk17
Depart
43
Advance
48,5
Leave
Clk17
Queue
44
Enter
Clk18
Depart
44
Advance
79,8
Leave
Clk18
Queue
45
Enter
Sub7
Depart
45
Advance
55,6
Leave
Sub7
Tabulate
4
Term.
1


27
Queue
46
Enter
Clk19
Depart
46
Advance
75,8
Leave
Clk19
Split
1
28
29


28
Queue
47
Enter
Clk20
Depart
47
Advance
25,3
Leave
Clk20
Queue
48
Enter
Clk21
Depart
48
Advance
300,3
Leave
Clk21
Transfer
All
30

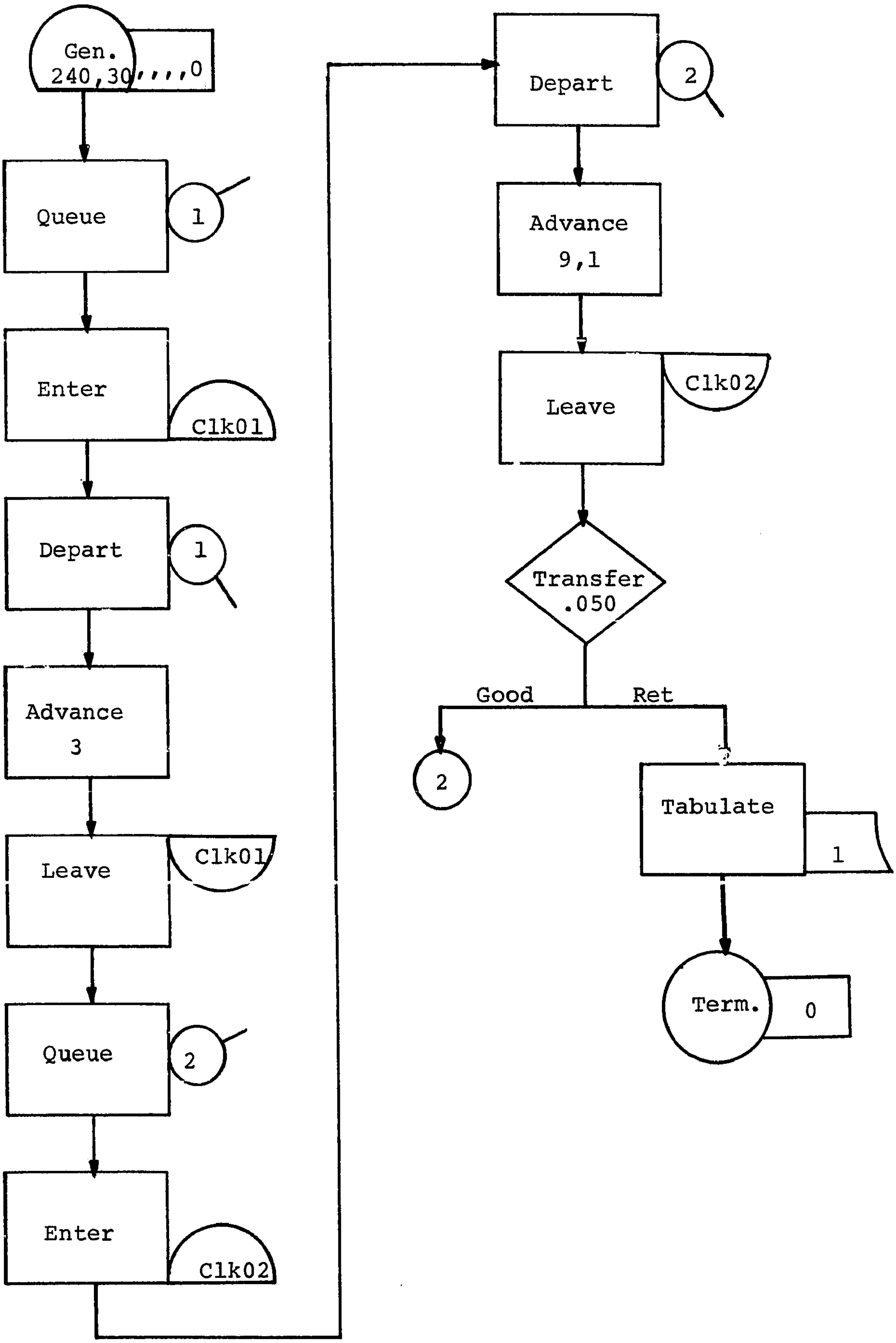

29
Queue
49
Enter
Clk22
Depart
49
Advance
9
Leave
Clk22
Queue
50
Enter
Clk23
Depart
50
Advance
50,5
Leave
Clk23
30



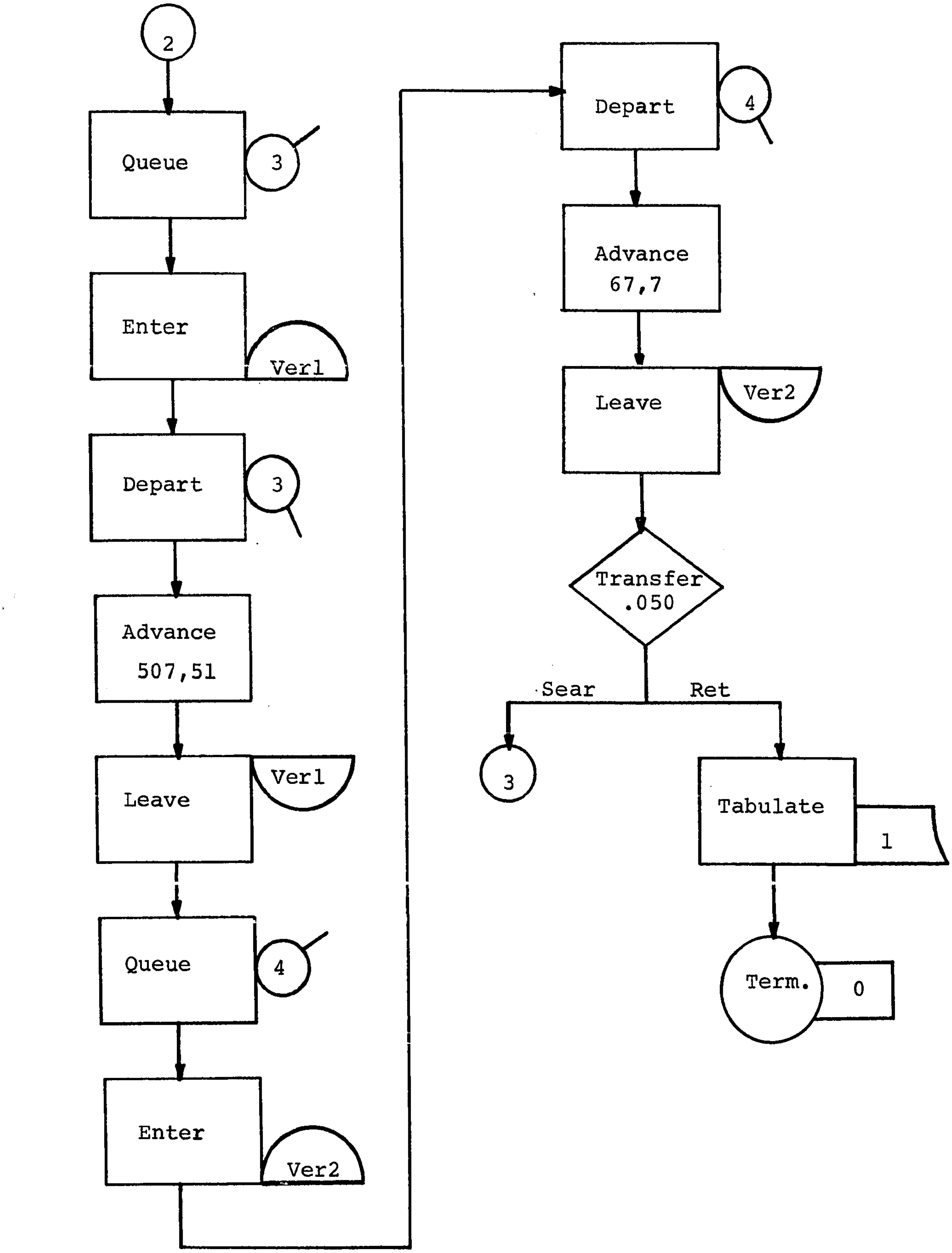
30
Queue
51
Enter
Sub8
Depart
51
Advance
34,3
Leave
Sub8
Tabulate
5
Term.
0

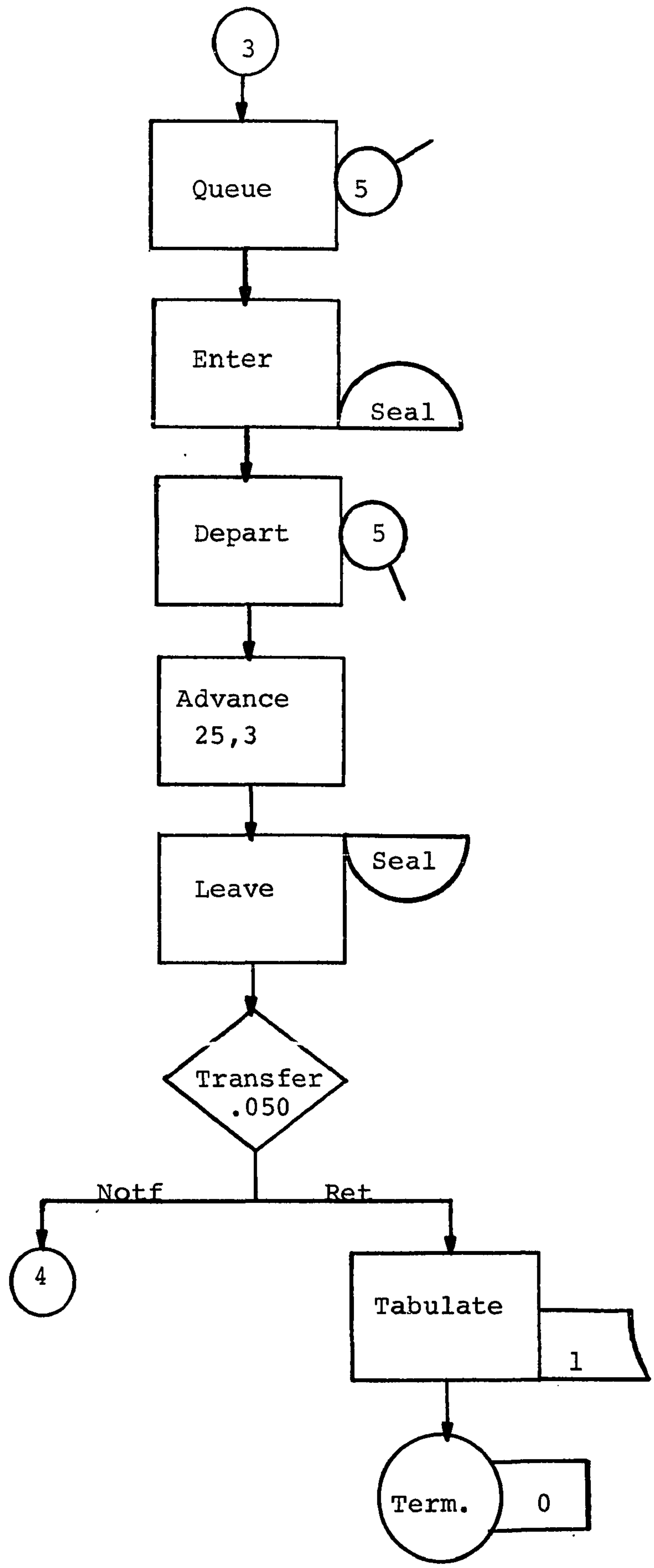
APPENDIX H

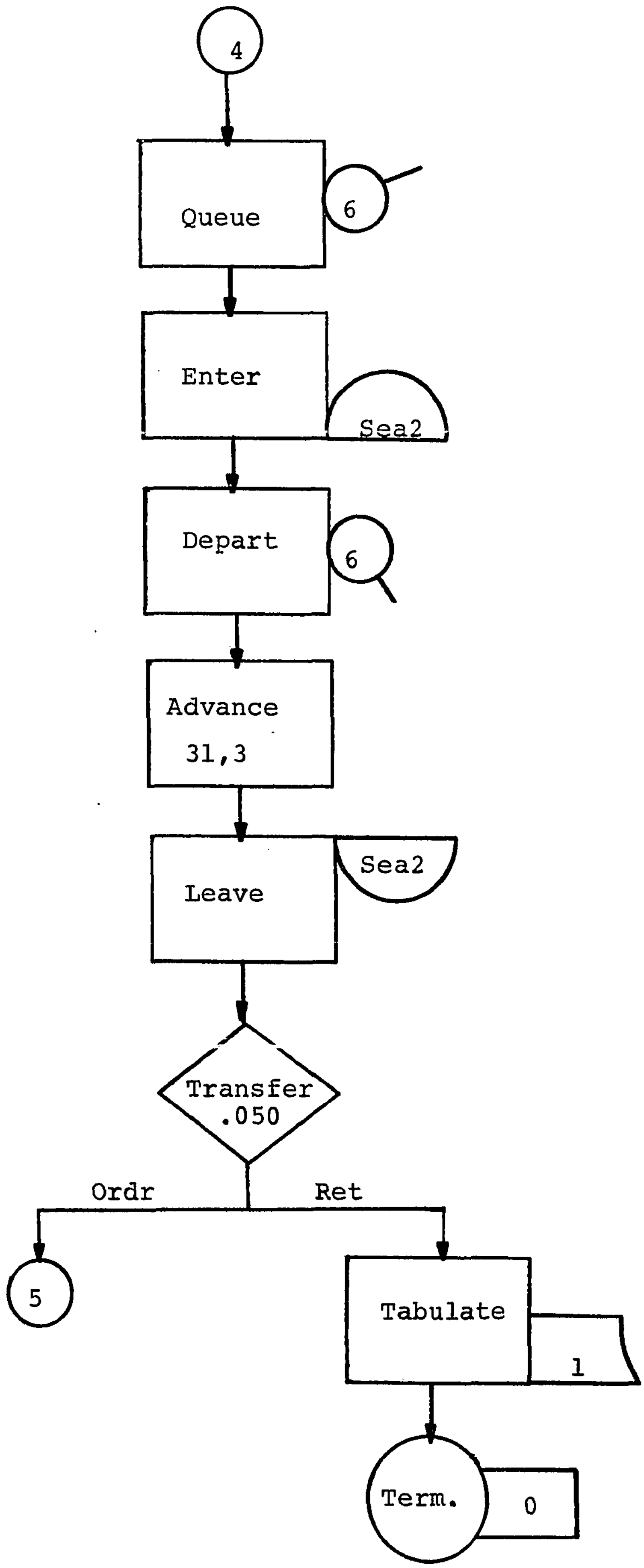
GPSS MODEL FOR A COMPUTER-BASED TECHNICAL SERVICES SYSTEM

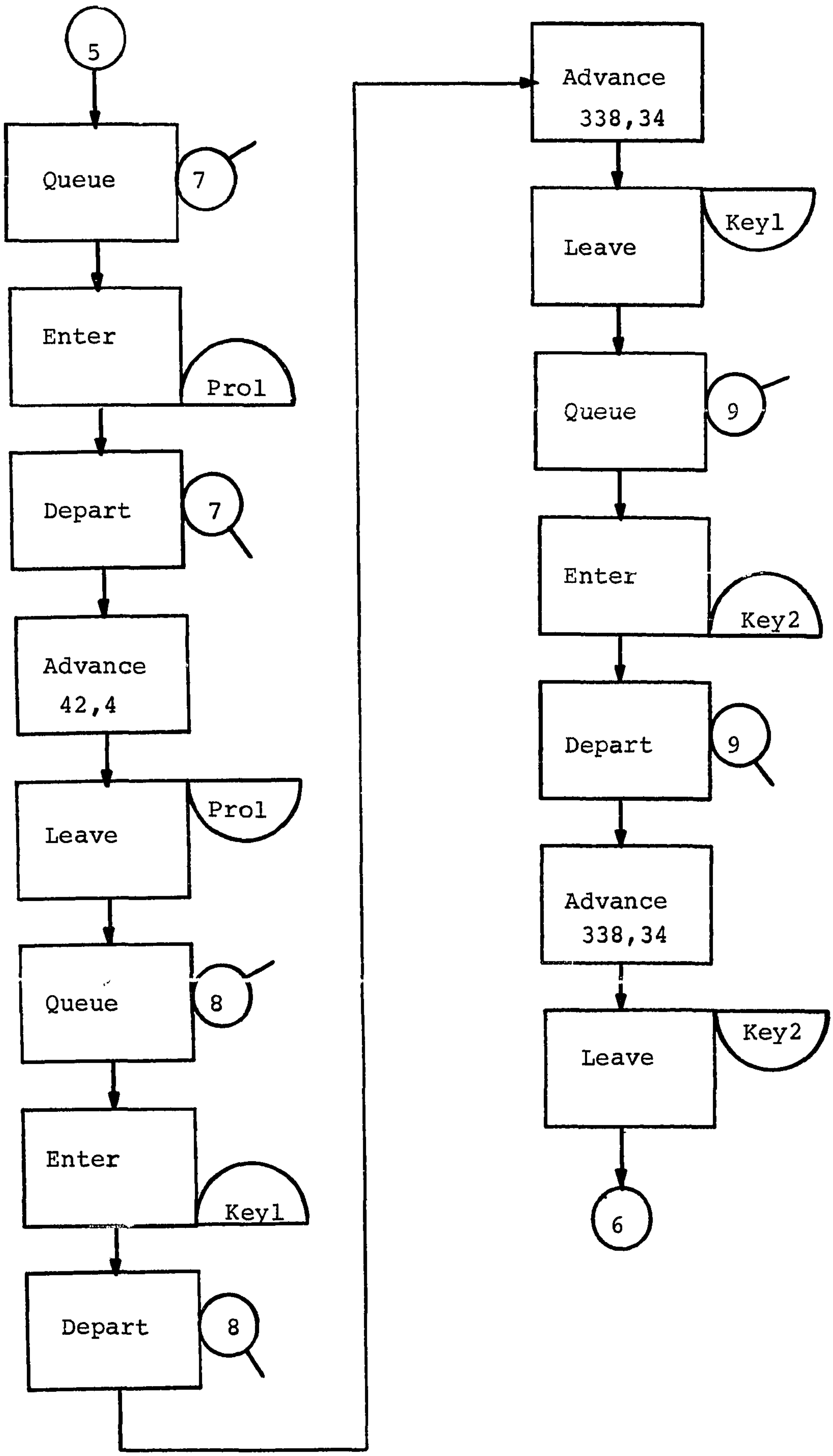


Gen.
240,30,,,,0
Queue
1
Enter
Clk01
Depart
1
Advance
3
Leave
Clk01
Queue
2
Enter
Clk02
Depart
2
Advance
9,1
Leave
Clk02
Transfer
.050
Good
Ret
2
Tabulate
1
Term.
0

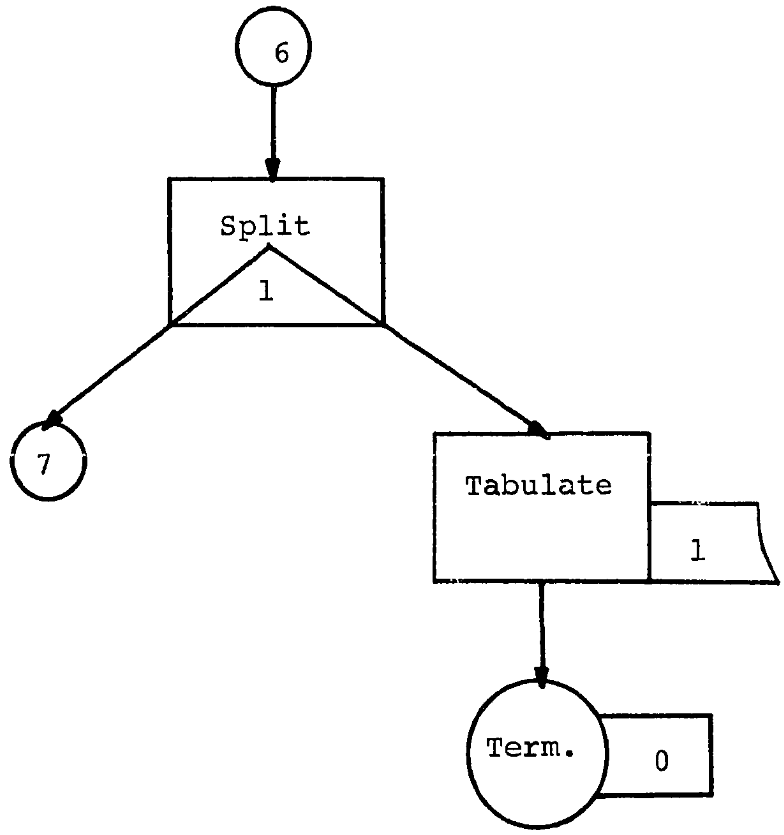

2
Queue
3
Enter
Ver1
Depart
3
Advance
507,51
Leave
Ver1
Queue
4
Enter
Ver2
Depart
4
Advance
67,7
Leave
Ver2
Transfer
.050
Sear
Ret
3
Tabulate
1
Term.
0

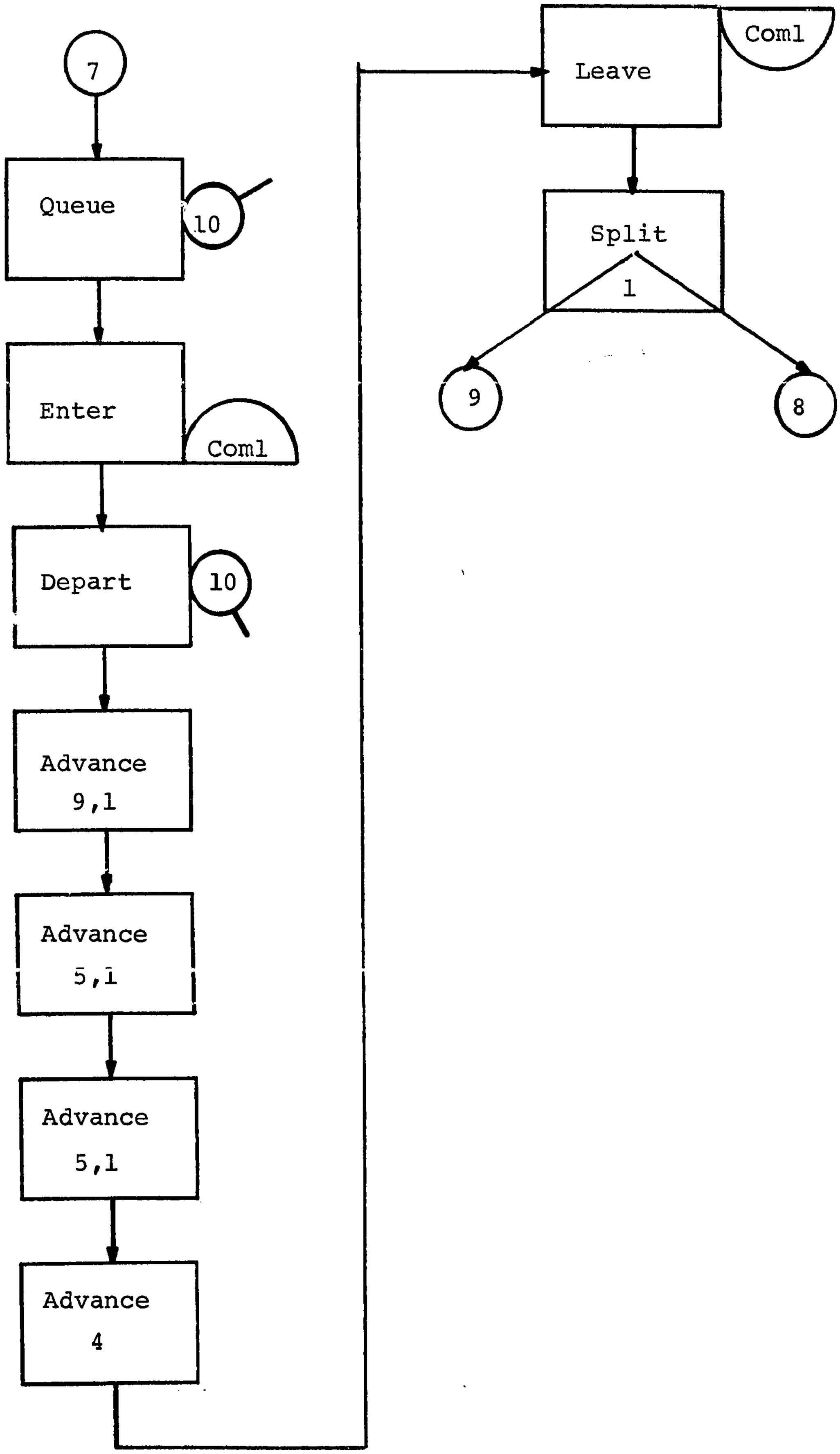

3
Queue
5
Enter
Seal
Depart
5
Advance
25,3
Leave
Seal
Transfer
.050
Notf
Ret
4
Tabulate
1
Term.
0


4
Queue
6
Enter
Sea2
Depart
6
Advance
31,3
Leave
Sea2
Transfer
.050
Ordr
Ret
5
Tabulate
1
Term.
0

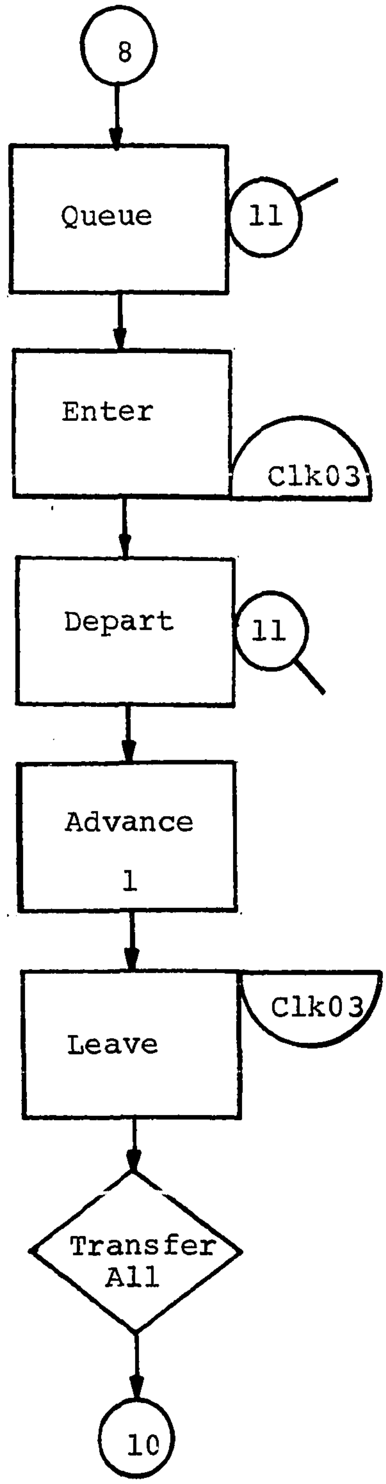


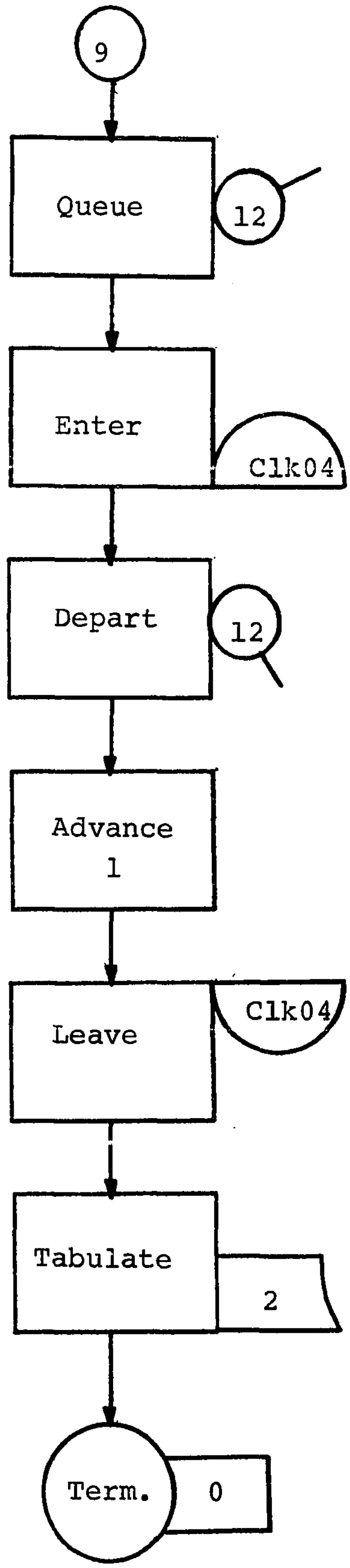
5
Queue
7
Enter
Prol
Depart
7
Advance
42,4
Leave
Prol
Queue
8
Enter
Key1
Depart
8
Advance
338,34
Leave
Key1
Queue
9
Enter
Key2
Depart
9
Advance
338,34
Leave
Key2
6

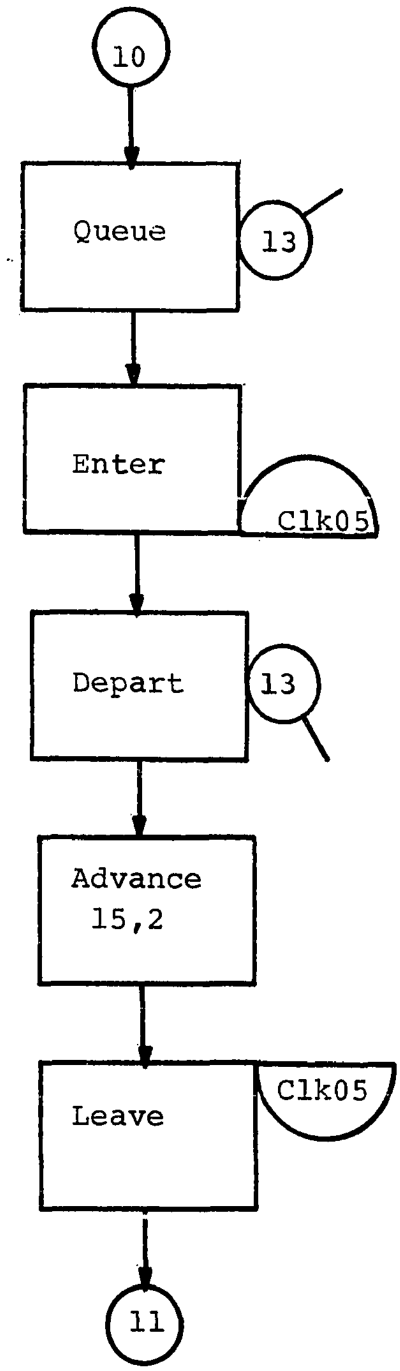

6
Split
1
7
Tabulate
1
Term.
0

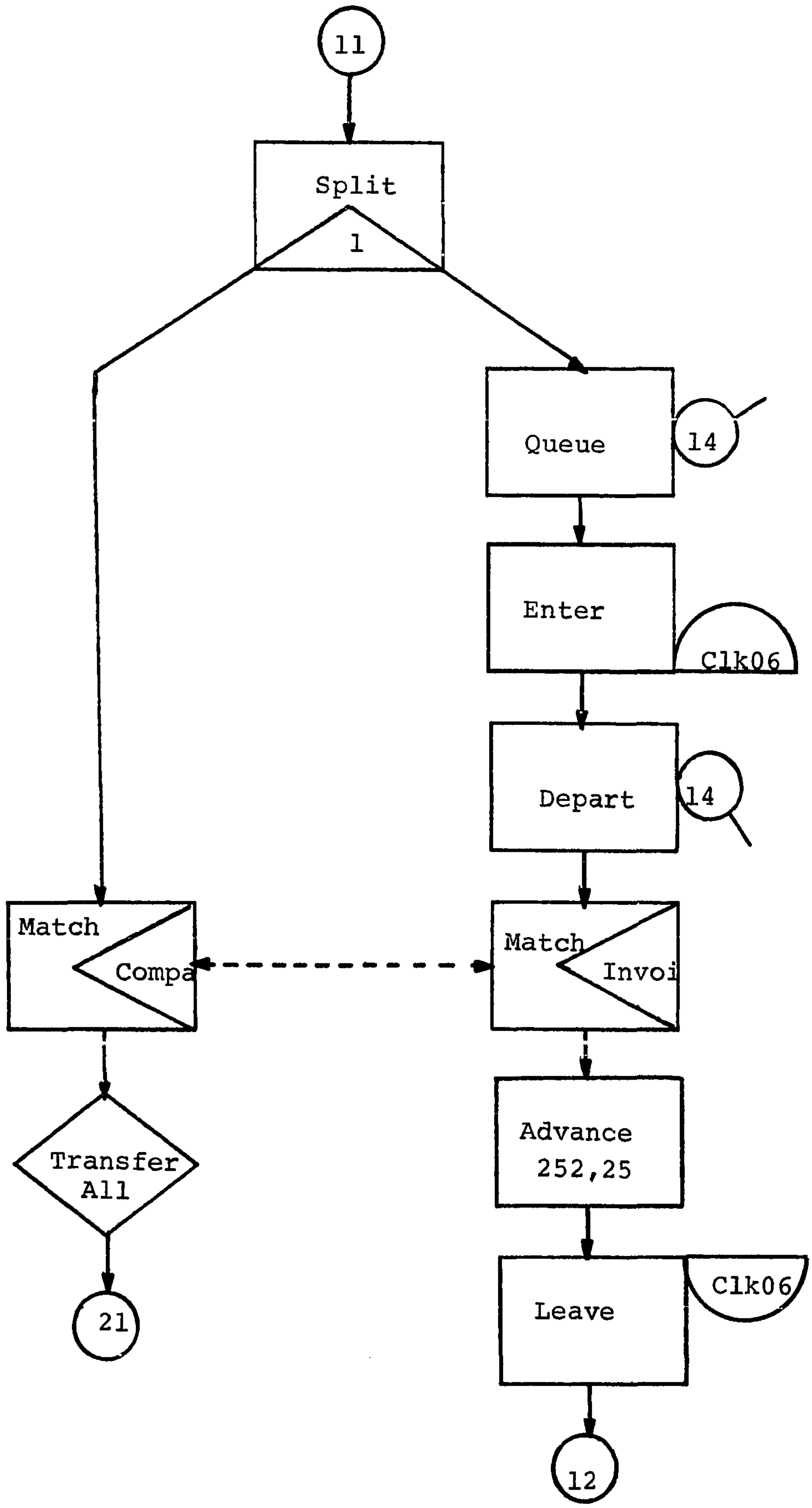


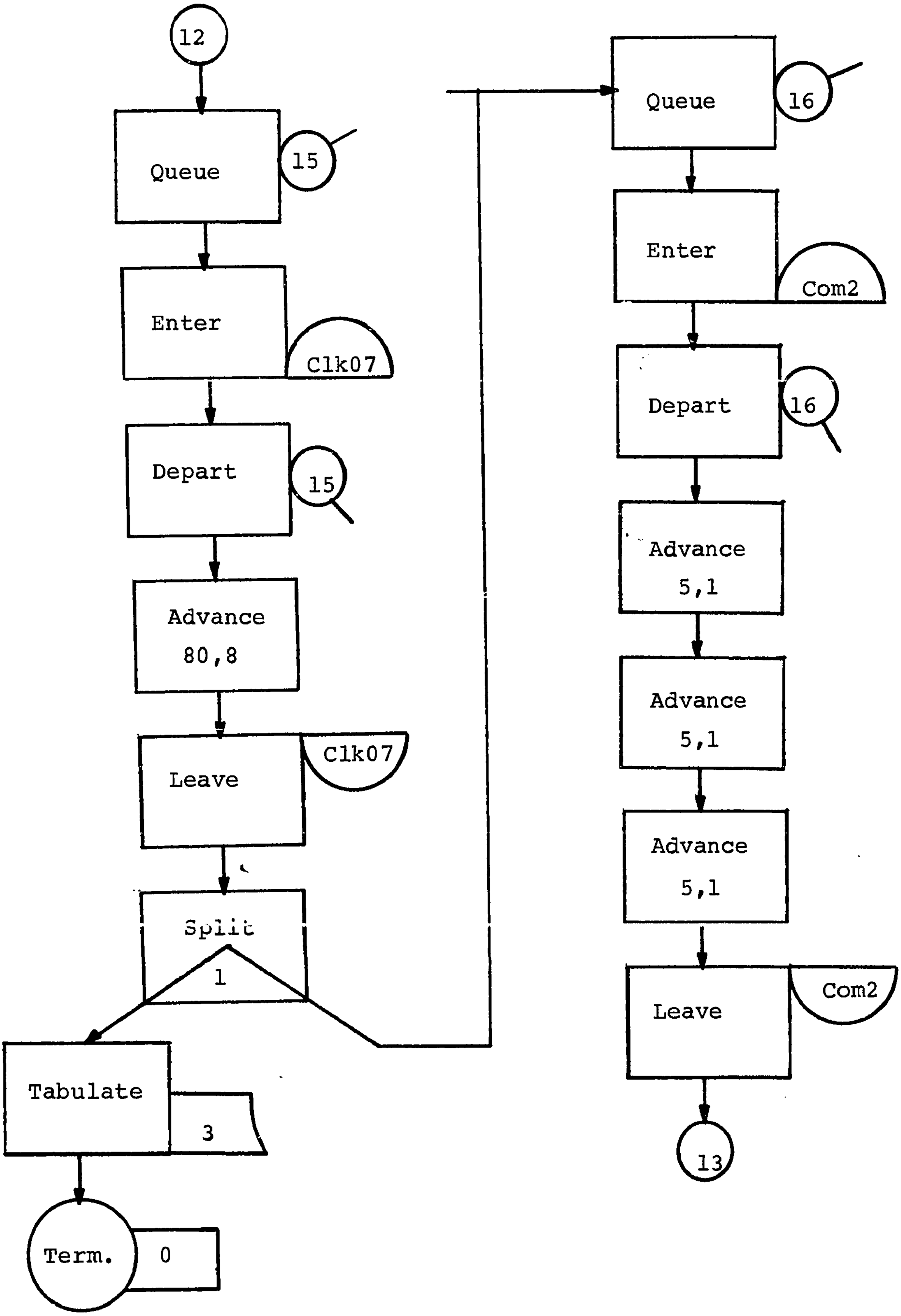
7
Queue
10
Enter
Coml
Depart
10
Advance
9,1
Advance
5,1
Advance
5,1
Advance
4
Leave
Coml
Split
1
9
8

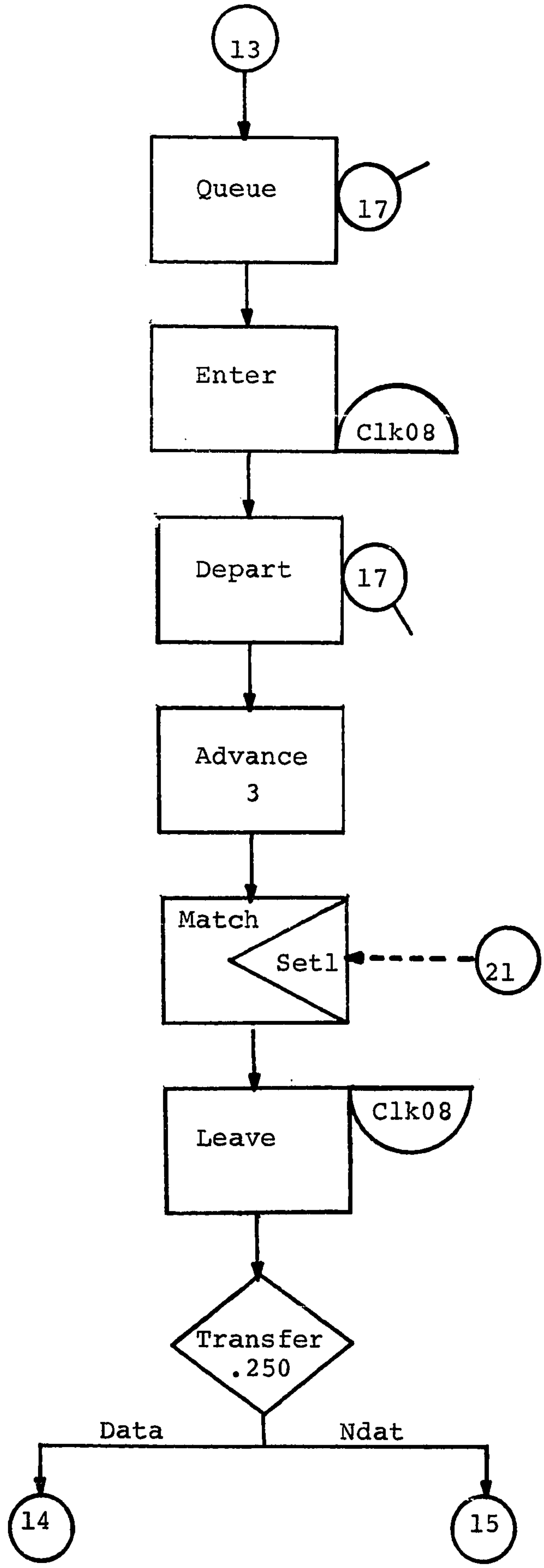

8
Queue
11
Enter
Clk03
Depart
11
Advance
1
Leave
Clk03
Transfer
All
10

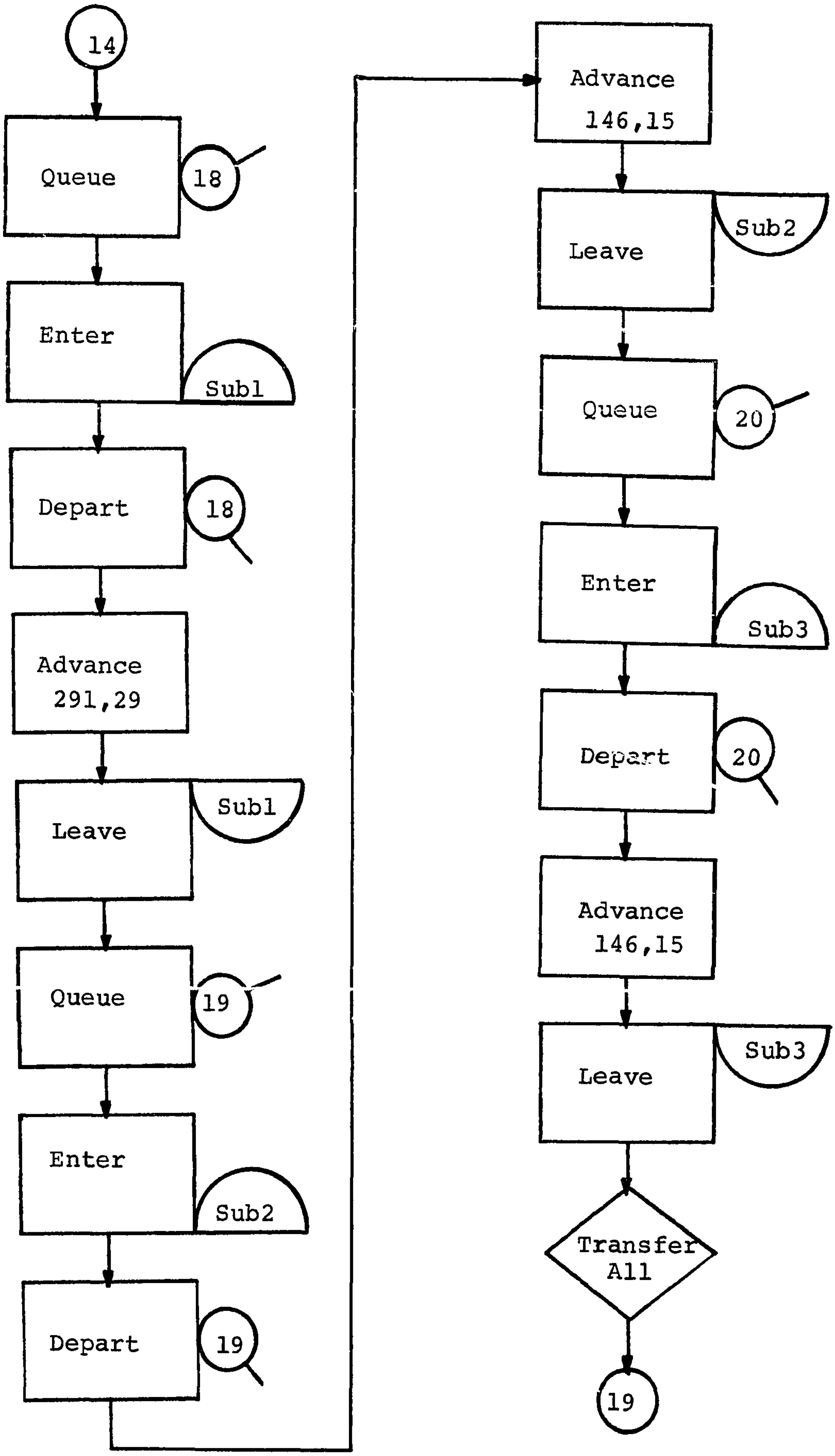

9
Queue
12
Enter
Clk04
Depart
12
Advance
1
Leave
Clk04
Tabulate
2
Term.
0

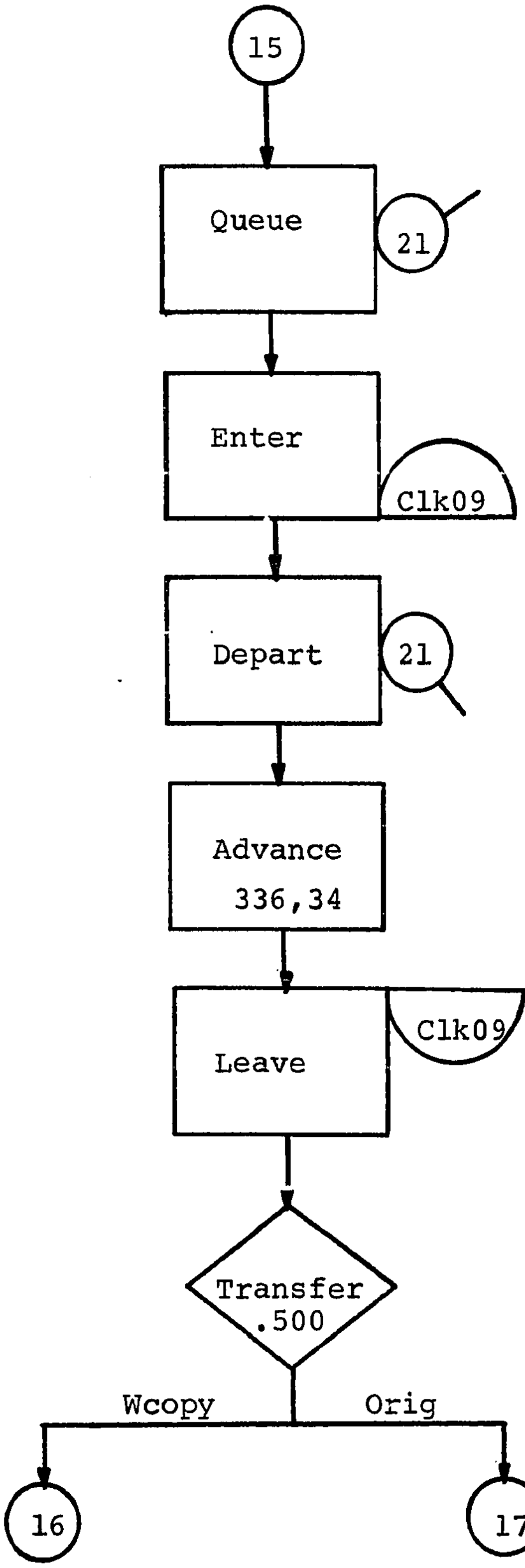

10
Queue
13
Enter
Clk05
Depart
13
Advance
15,2
Leave
Clk05
11

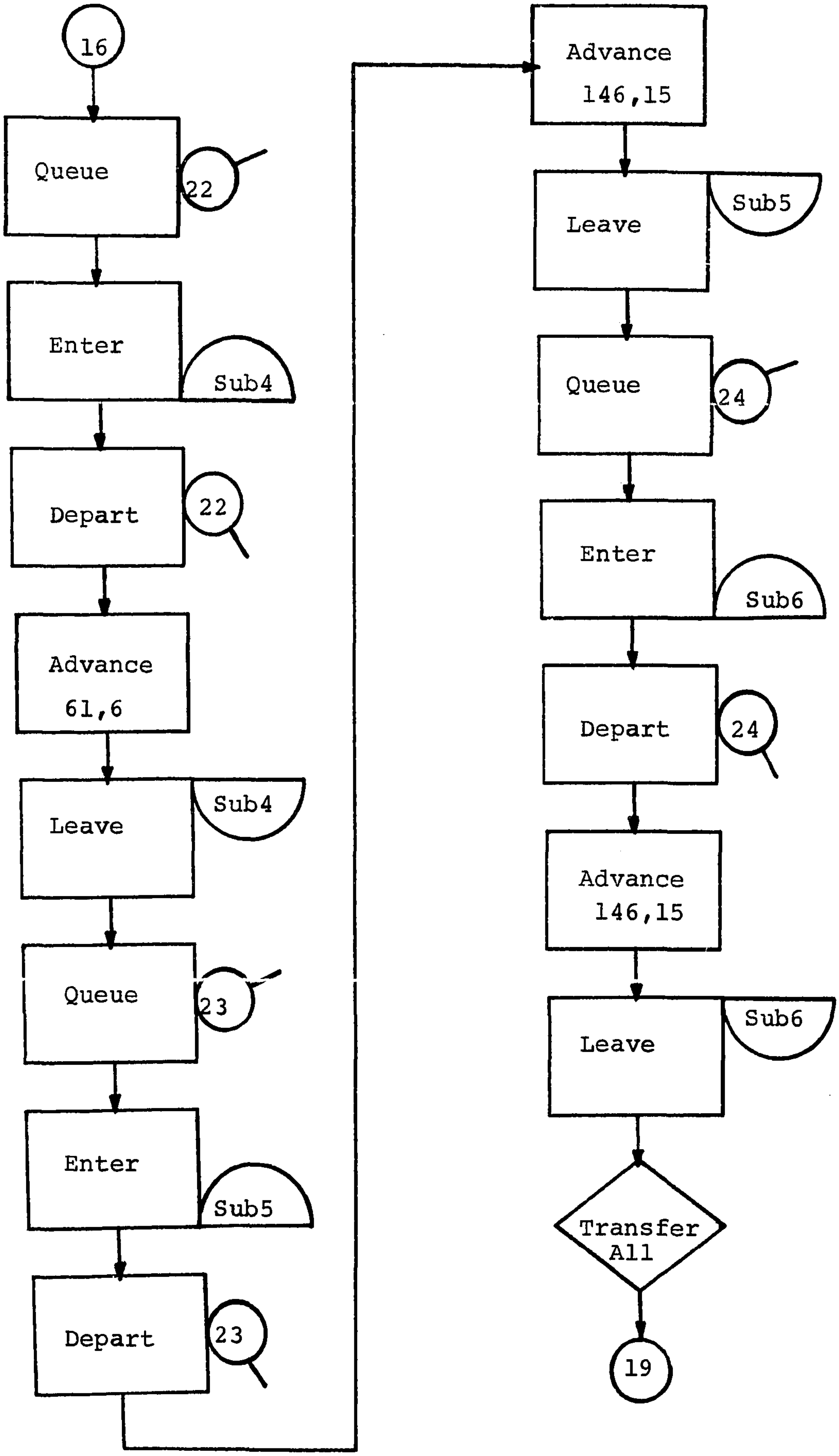

11
Split
1
Queue
14
Enter
Clk06
Depart
14
Match
Compa
Match
Invoi
Transfer
All
Advance
252,25
Leave
Clk06
21
12

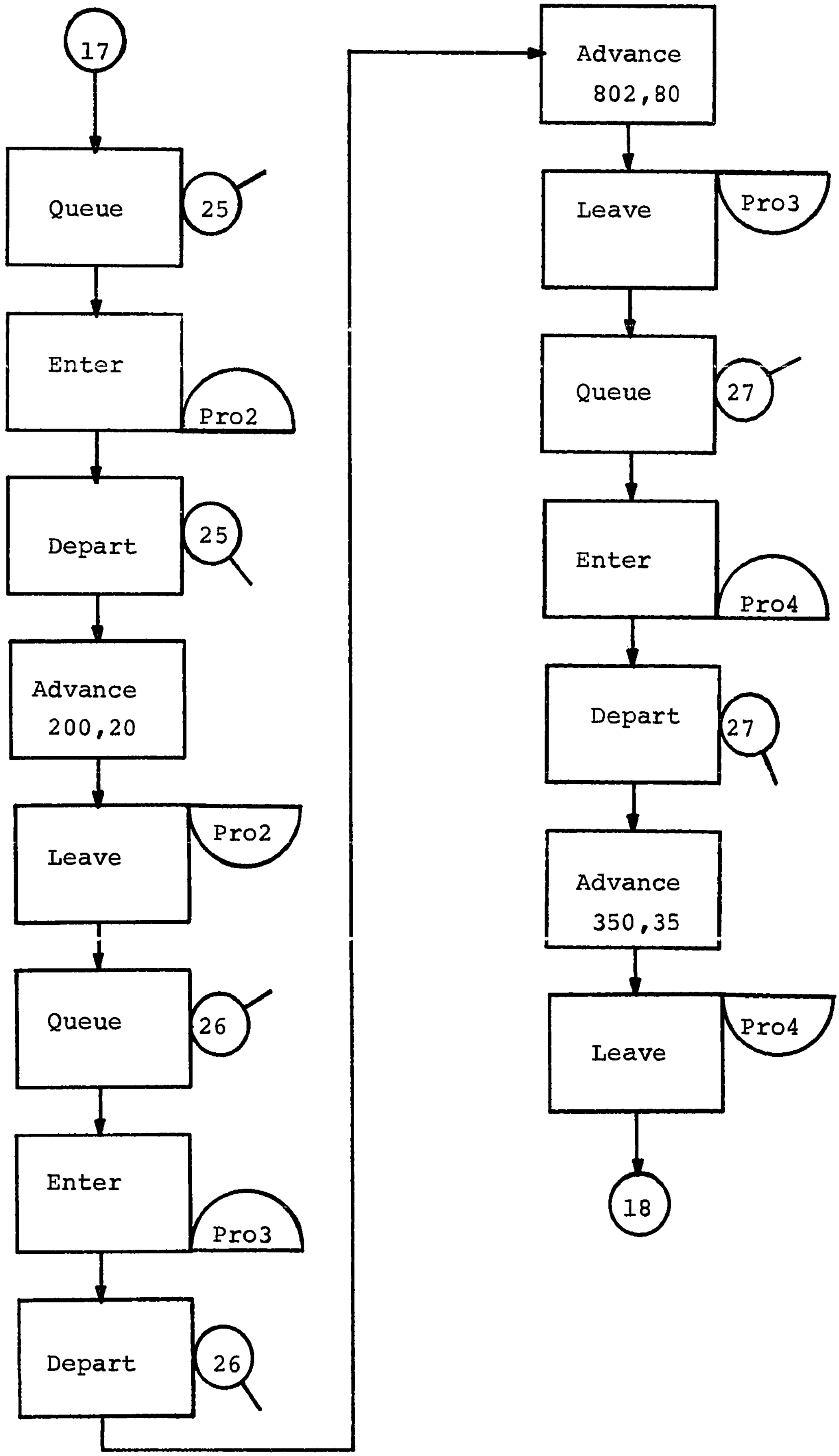

12
Queue
15
Enter
Clk07
Depart
15
Advance
80,8
Leave
Clk07
Split
1
Tabulate
3
Term.
0
Queue
16
Enter
Com2
Depart
16
Advance
5,1
Advance
5,1
Advance
5,1
Leave
Com2
13

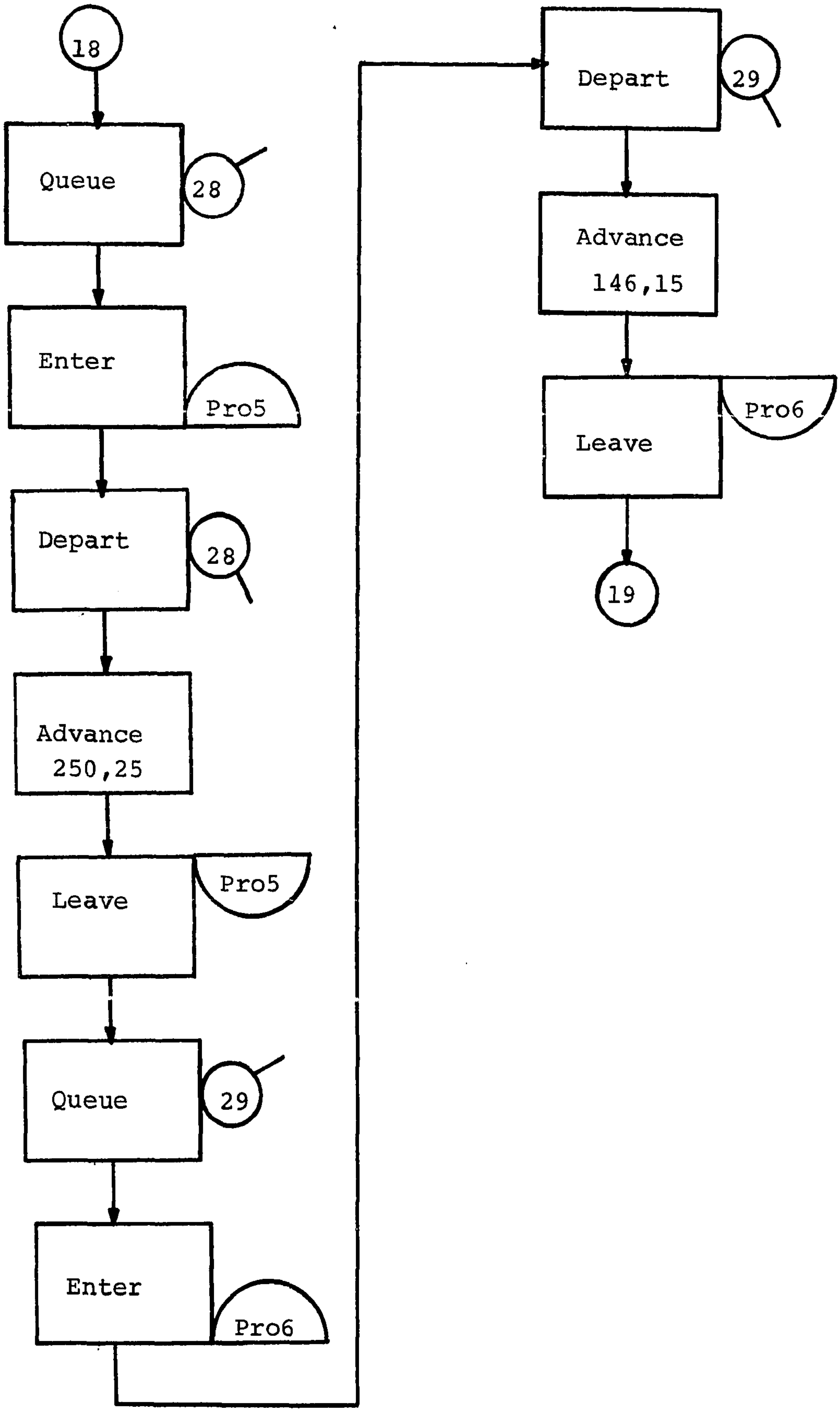

13
Queue
17
Enter
Clk08
Depart
17
Advance
3
Match
Set1
21
Leave
Clk08
Transfer
.250
Data
Ndat
14
15

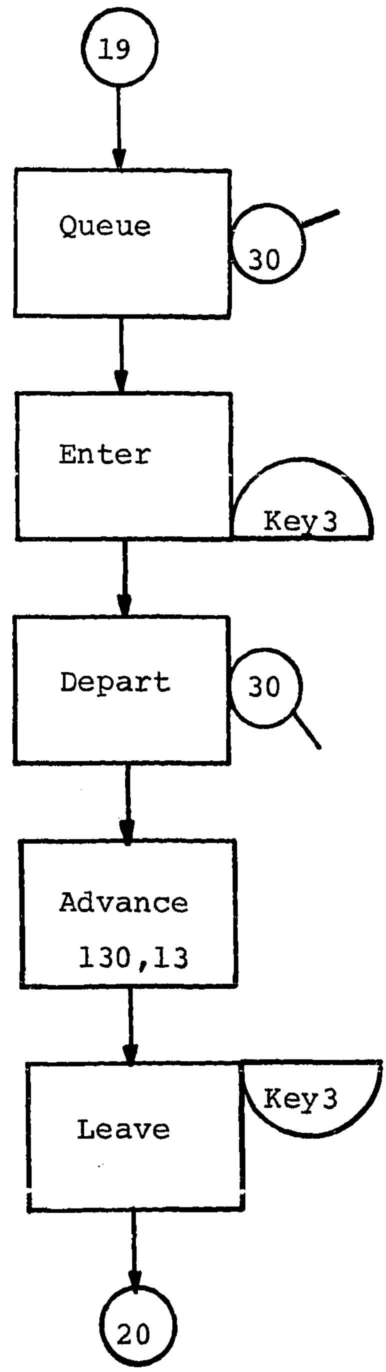

14
Queue
18
Enter
Sub1
Depart
18
Advance
291,29
Leave
Sub1
Queue
19
Enter
Sub2
Depart
19
Advance
146,15
Leave
Sub2
Queue
20
Enter
Sub3
Depart
20
Advance
146,15
Leave
Sub3
Transfer
All
19

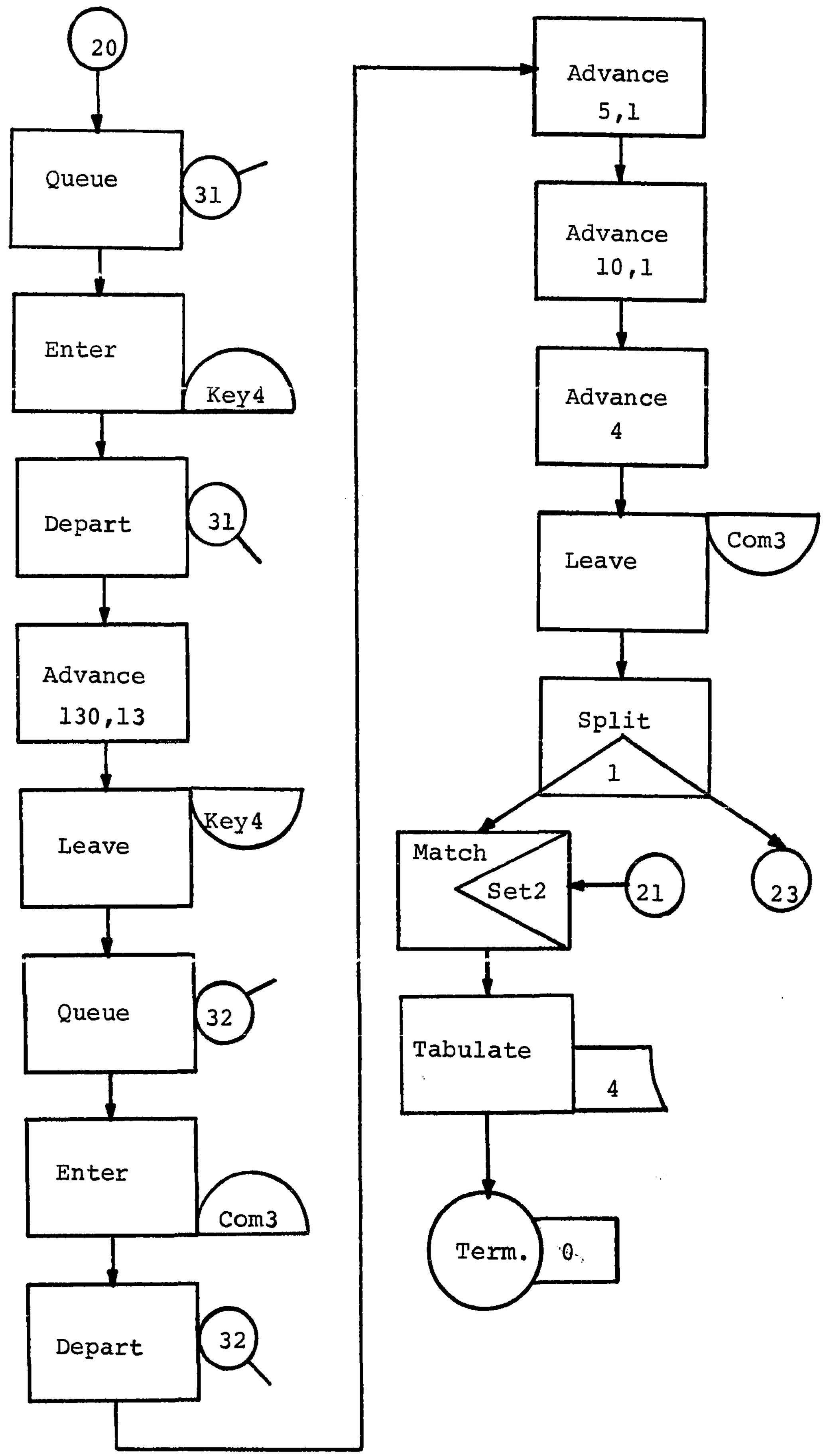

15
Queue
21
Enter
Clk09
Depart
21
Advance
336,34
Leave
Clk09
Transfer
.500
Wcopy
Orig
16
17

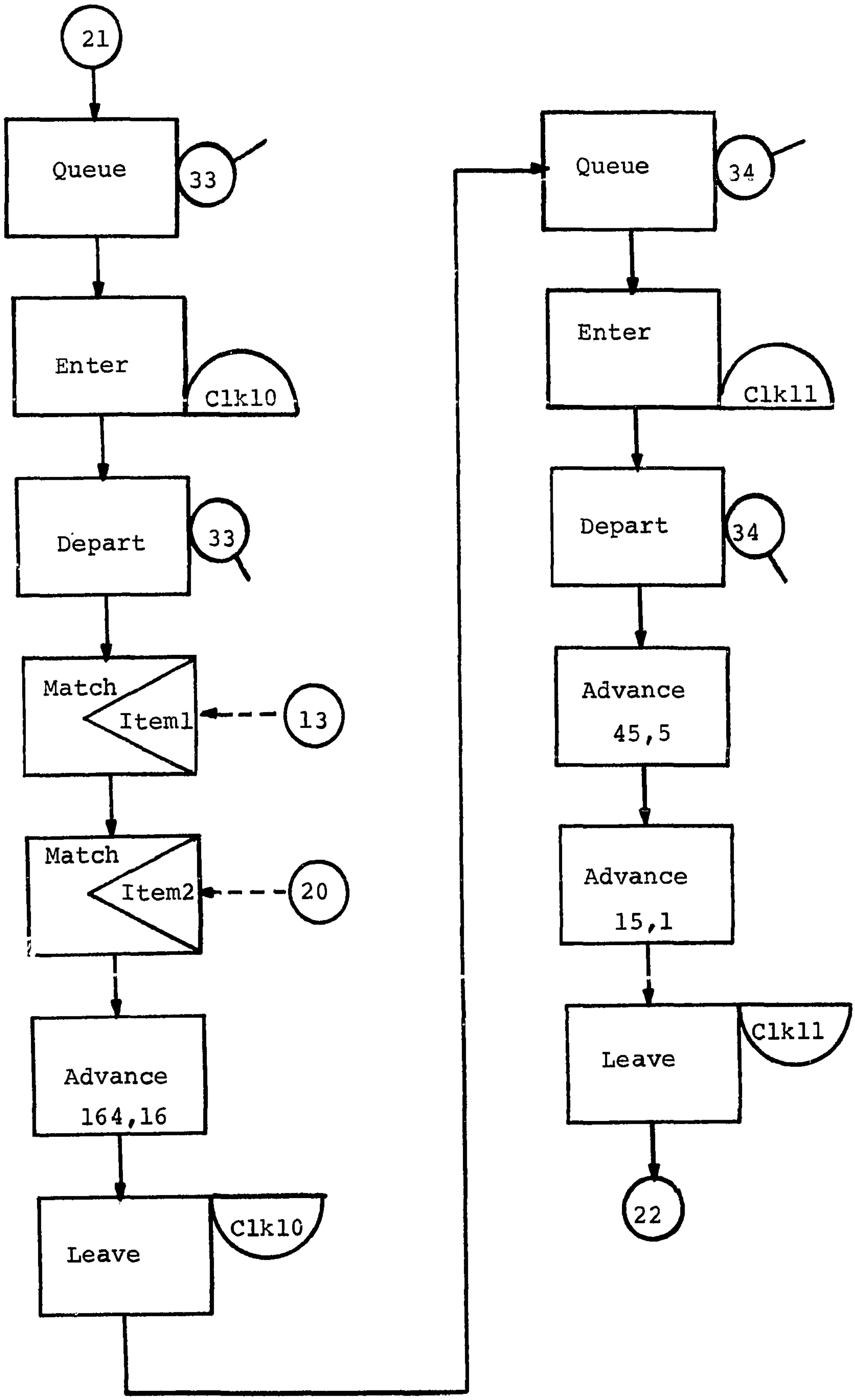

16
Queue
22
Enter
Sub4
Depart
22
Advance
61,6
Leave
Sub4
Queue
23
Enter
Sub5
Depart
23
Advance
146,15
Leave
Sub5
Queue
24
Enter
Sub6
Depart
24
Advance
146,15
Leave
Sub6
Transfer
All
19


17
Queue
25
Enter
Pro2
Depart
25
Advance
200,20
Leave
Pro2
Queue
26
Enter
Pro3
Depart
26
Advance
802,80
Leave
Pro3
Queue
27
Enter
Pro4
Depart
27
Advance
350,35
Leave
Pro4
18

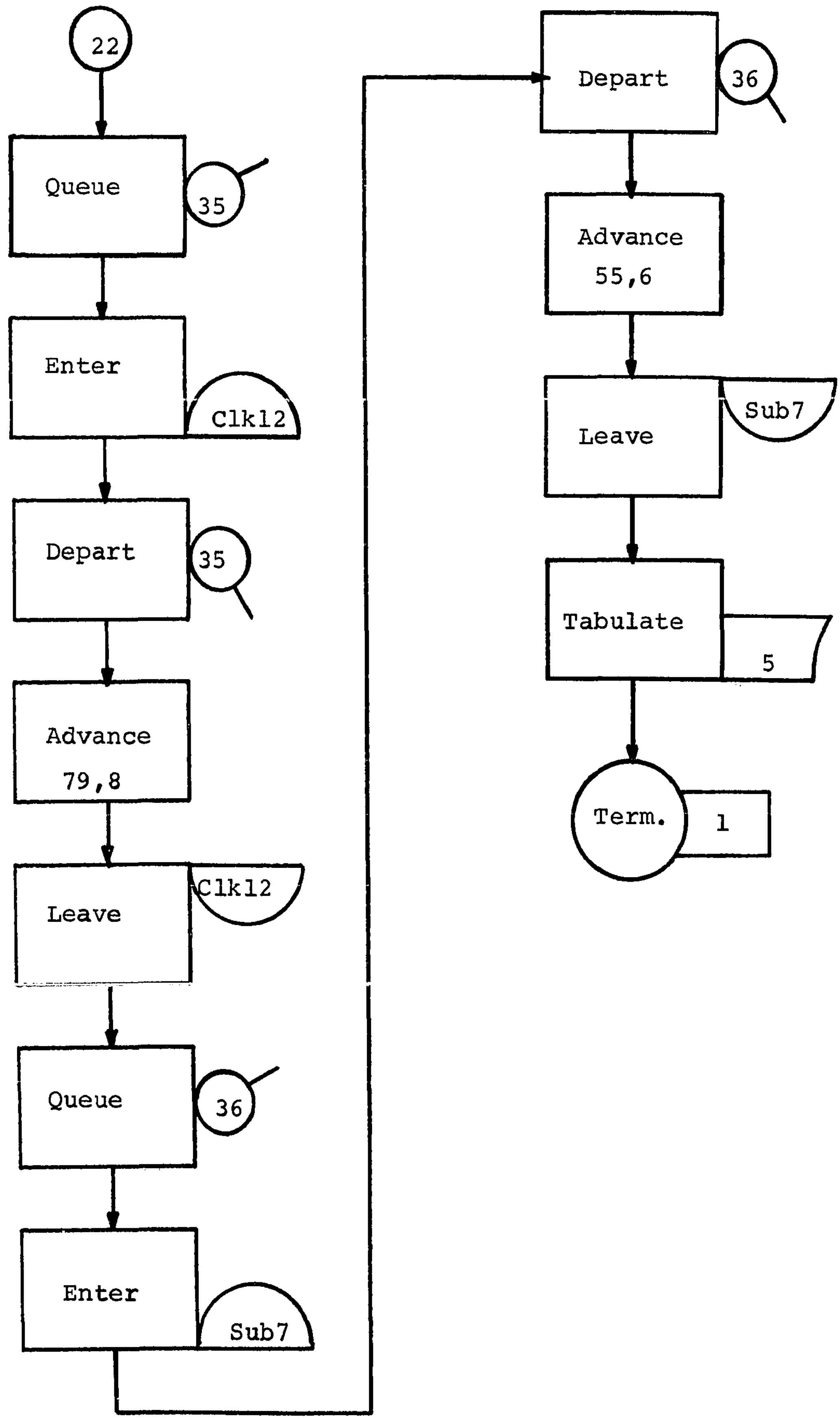

18
Queue
28
Enter
Pro5
Depart
28
Advance
250,25
Leave
Pro5
Queue
29
Enter
Pro6
Depart
29
Advance
146,15
Leave
Pro6
19

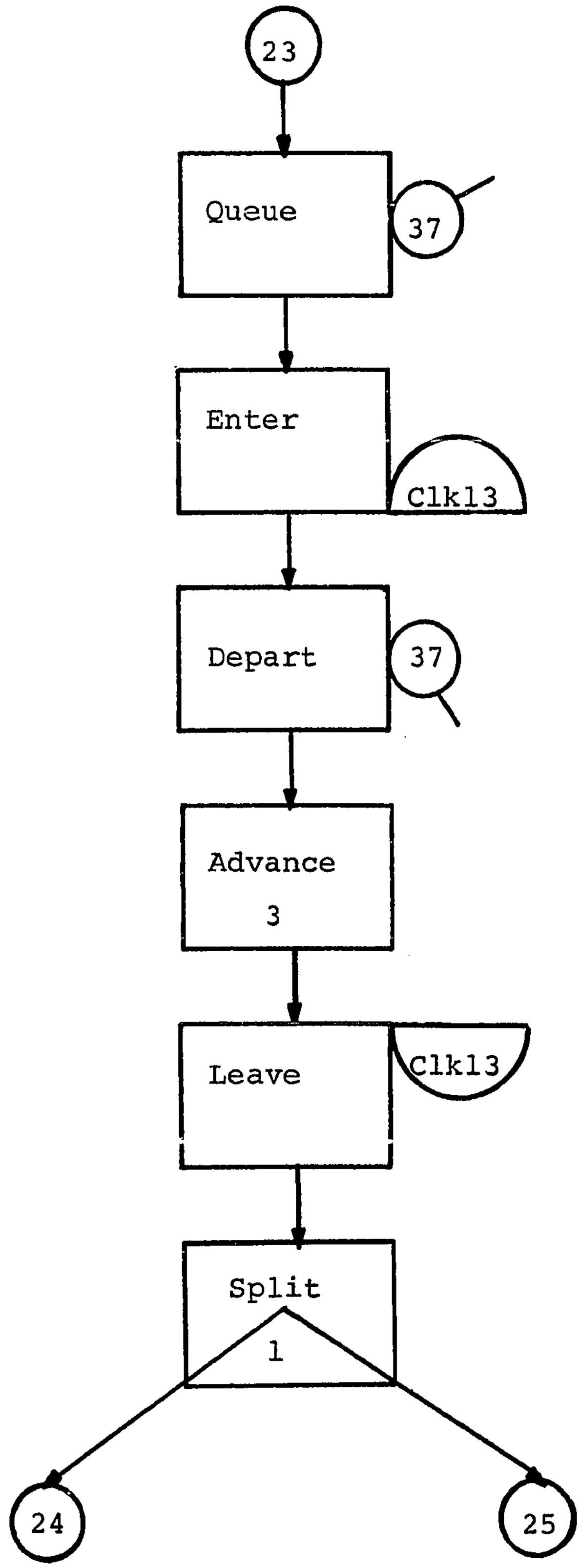

19
Queue
30
Enter
Key3
Depart
30
Advance
130,13
Leave
Key3
20


20
Queue
31
Enter
Key4
Depart
31
Advance
130,13
Leave
Key4
Queue
32
Enter
Com3
Depart
32
Advance
5,1
Advance
10,1
Advance
4
Leave
Com3
Split
1
Match
Set2
21
23
Tabulate
4
Term.
0

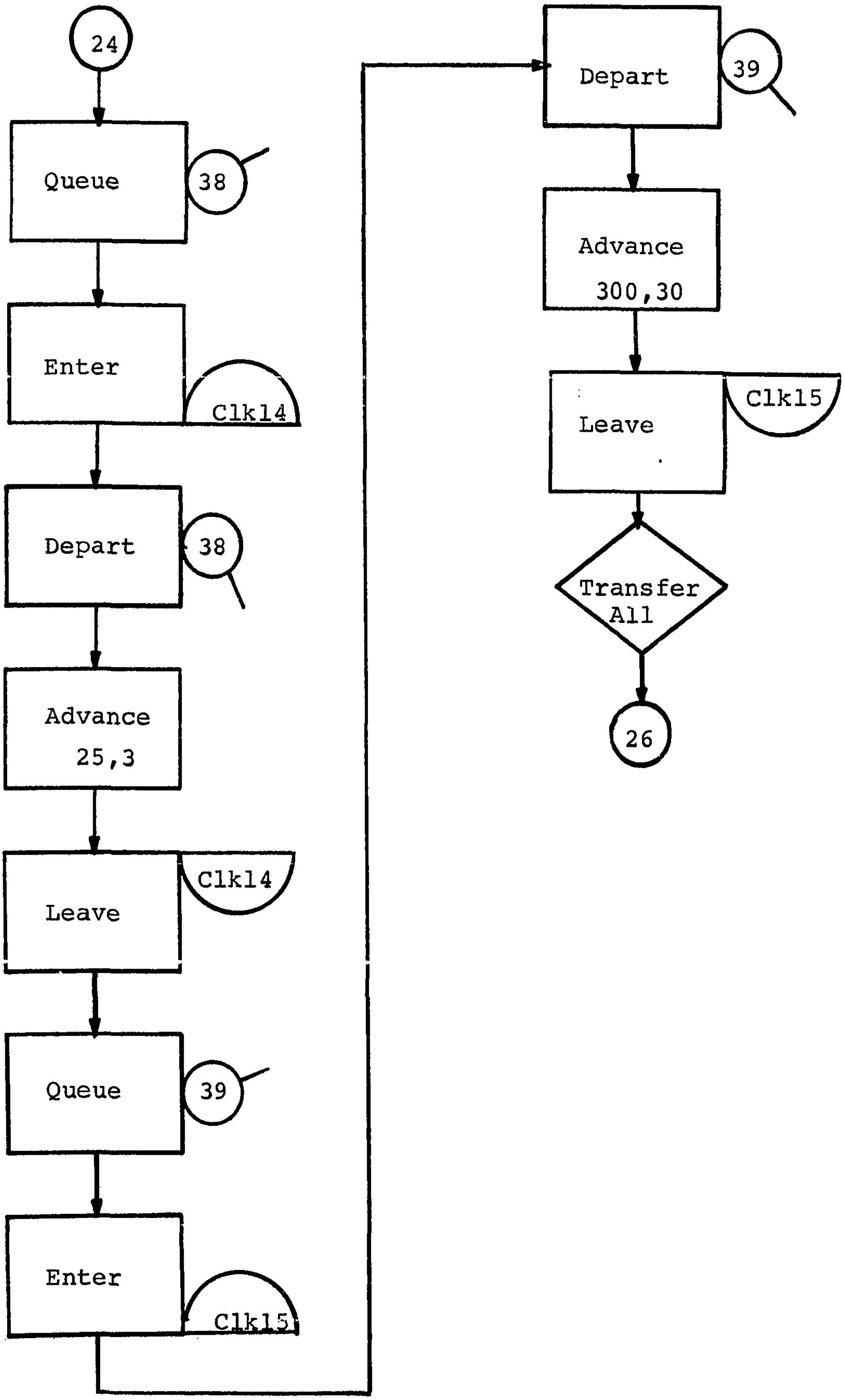


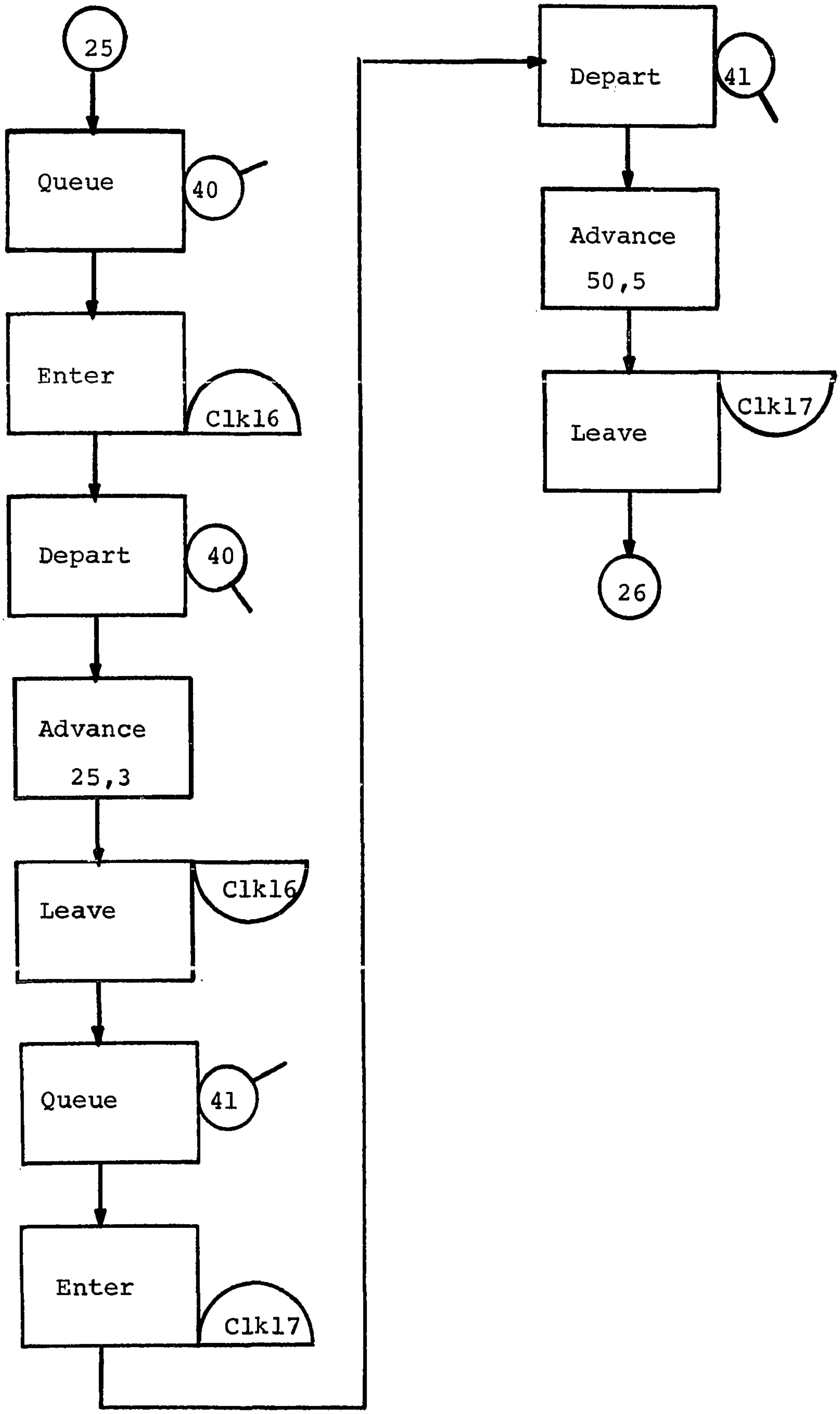
21
Queue
33
Enter
Clk10
Depart
33
Match
Item1
13
Match
Item2
20
Advance
164,16
Leave
Clk10
Queue
34
Enter
Clk11
Depart
34
Advance
45,5
Advance
15,1
Leave
Clk11
22

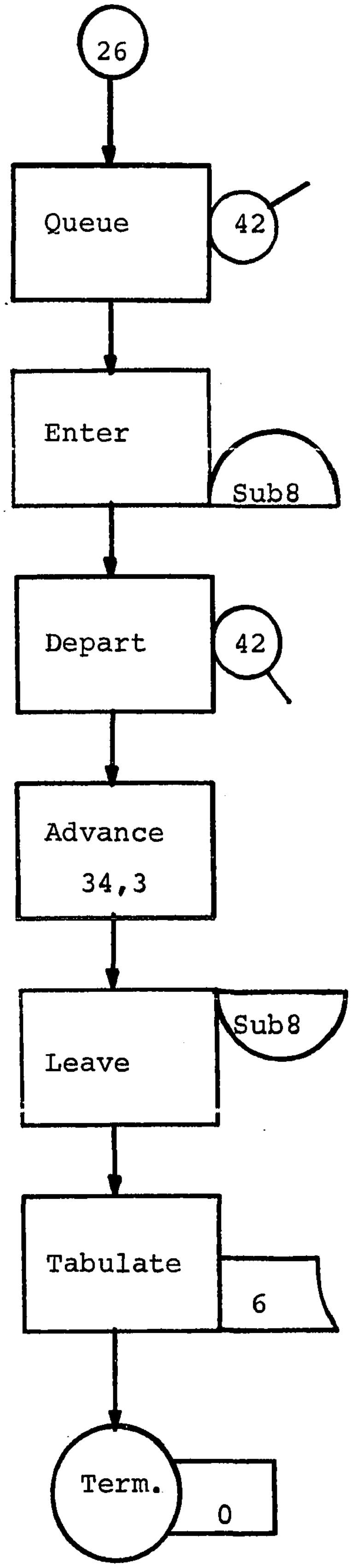

22
Queue
35
Enter
Clk12
Depart
35
Advance
79,8
Leave
Clk12
Queue
36
Enter
Sub7
Depart
36
Advance
55,6
Leave
Sub7
Tabulate
5
Term.
1



23
Queue
37
Enter
Clk13
Depart
37
Advance
3
Leave
Clk13
Split
1
24
25


24
Queue
38
Enter
Clk14
Depart
38
Advance
25,3
Leave
Clk14
Queue
39
Enter
Clk15
Depart
39
Advance
300,30
Leave
Clk15
Transfer
All
26


25
Queue
40
Enter
Clk16
Depart
40
Advance
25,3
Leave
Clk16
Queue
41
Enter
Clk17
Depart
41
Advance
50,5
Leave
Clk17
26


26
Queue
42
Enter
Sub8
Depart
42
Advance
34,3
Leave
Sub8
Tabulate
6
Term.
0

APPENDIX I

GPSS CODING AND SIMULATION RESULTS OF THE MANUAL SYSTEM

```
*LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
*       SIMULATE
*
*       SIMULATION OF A MANUAL SYSTEM/TIME IS IN SECONDS
*
        GENERATE   240,30,,,,6 GENERATE INCOMING REQUEST FORMS
        QUEUE      1
        ENTER      CLRO1
        DEPART     1
        ADVANCE    5          SORT INCOMING REQUEST FORMS
        LEAVE      CLRO1
        QUEUE      2
        ENTER      CLRO2
        DEPART     2
        ADVANCE    5,1        ALPHABETIZE REQUEST FORMS
        LEAVE      CLRO2
        TRANSFER   .050,GOOD,RET
GOOD    QUEUE      3
        ENTER      VER1
        DEPART     3
        ADVANCE    507,51     VERIFY REQUESTS IN BIBLIOGRAPHIC SOURCES
        LEAVE      VER1
        QUEUE      4
        ENTER      VER2
        DEPART     4
        ADVANCE    67,7       VERIFY PRICES AND AVAILABILITY
        LEAVE      VER2
        TRANSFER   .050,SEAR,RET
SEAR    QUEUE      5
        ENTER      SEA1
        DEPART     5
        ADVANCE    25,5       SEARCH REQUESTS IN ORDER FILE
        LEAVE      SEA1
        TRANSFER   .050,NOTF,RET
NOTF    QUEUE      6
        ENTER      SEA2
        DEPART     6
        ADVANCE    31,5       SEARCH REQUESTS IN CARD CATALOG
        LEAVE      SEA2
        TRANSFER   .050,ORDR,RET
ORDR    QUEUE      7
        ENTER      PRO1
        DEPART     7
        ADVANCE    42,4       ASSIGN VENDORS AND ORDER NUMBERS
        LEAVE      PRO1
        QUEUE      8
        ENTER      TYP1
        DEPART     8
        ADVANCE    330,24     PREPARE MULTIPLE COPY ORDER FORMS
        LEAVE      TYP1
        QUEUE      9
        ENTER      CLRO3
        DEPART     9
        ADVANCE    5          SORT ORDER FORMS
        LEAVE      CLRO3
        SPLIT      1,RET
```

```
         SPLIT     1,BOOK
         SPLIT     1,FILE
         QUEUE     10
         ENTER     TYPE
         DEPART    10
         ADVANCE   11,1       PREPARE PURCHASE REQUISITIONS
         LEAVE     TYPE
         QUEUE     11
         ENTER     CLK04
         DEPART    11
         ADVANCE   1          FORWARD ORDERS TO VENDORS
         LEAVE     CLK04
         TRANSFER  ,RECV
RC1      TABULATE  1
         TERMINATE
BOOK     QUEUE     12
         ENTER     BNK1
         DEPART    12
         ADVANCE   65,7       ENCUMBER FUNDS
         LEAVE     BNK1
FILE     QUEUE     13
         ENTER     CLK05
         DEPART    13
         ADVANCE   135,14     FILE FORMS
         LEAVE     CLK05
         TABULATE  2
         TERMINATE
RECV     QUEUE     14
         ENTER     CLK06
         DEPART    14
         ADVANCE   15,2       OPEN PACKAGES
         LEAVE     CLK06
         SPLIT     1,INV
INVOI    MATCH     COMPA
         TRANSFER  ,ACCT
INV      QUEUE     15
         ENTER     CLK07
         DEPART    15
COMPA    MATCH     INVOI
         ADVANCE   252,25     VERIFY CORRECTNESS OF ITEMS SHIPPED
         LEAVE     CLK07
         QUEUE     16
         ENTER     CLK06
         DEPART    16
         ADVANCE   54,5       CLEAR RECORDS IN ORDER FILE
         LEAVE     CLK06
         QUEUE     17
         ENTER     CLK08
         DEPART    17
         ADVANCE   60,6       CLEAR INVOICES
         LEAVE     CLK08
         QUEUE     18
         ENTER     BNK2
         DEPART    18
         ADVANCE   92,9       UPDATE ACCOUNTING REPORTS
         LEAVE     BNK2
         TABULATE  3
```

```
        TERMINATE
ACCE    QUEUE       19
        ENTER       CLK10
        DEPART      19
        ADVANCE     100,11       PLACE ACCESSION NUMBER IN ITEMS
        LEAVE       CLK10
        QUEUE       20
        ENTER       CLK11
        DEPART      20
        ADVANCE     104,10       SEARCH IN LC CARD/SLIP FILES
        LEAVE       CLK11
        TRANSFER    .500,NCCCS,CARDS
CARDS   SPLIT       1,CCSET
SET1    MATCH       ITEM1
        TRANSFER    ,MARK1
CCSET   QUEUE       21
        ENTER       SUB1
        DEPART      21
ITEM1   MATCH       SET1
        ADVANCE     251,29       CHECK LC CARDS/SLIPS FOR CORRECTNESS
        LEAVE       SUB1
        QUEUE       22
        ENTER       SUB2
        DEPART      22
        ADVANCE     146,15       CHECK SUBJECT HEADINGS
        LEAVE       SUB2
        QUEUE       23
        ENTER       SUB3
        DEPART      23
        ADVANCE     146,15       CHECK IN SHELF LIST
        LEAVE       SUB3
        TRANSFER    ,CCLC
NCCCS   QUEUE       24
        ENTER       CLK12
        DEPART      24
        ADVANCE     200,54       SEARCH IN ACC ETC FOR COPY
        LEAVE       CLK12
        TRANSFER    .250,WCOPY,[illegible]
WCOPY   SPLIT       1,WCOP1
WCOP2   MATCH       ITEM3
        TRANSFER    ,MARK1
WCOP1   QUEUE       25
        ENTER       SUB4
        DEPART      25
ITEM3   MATCH       WCOP2
        ADVANCE     61,6         CHECK WORKSLIPS FOR CORRECTNESS
        LEAVE       SUB4
        QUEUE       26
        ENTER       SUB5
        DEPART      26
        ADVANCE     146,15       CHECK SUBJECT HEADINGS
        LEAVE       SUB5
        QUEUE       27
        ENTER       SUB6
        DEPART      27
        ADVANCE     146,15       CHECK IN SHELF LIST
        LEAVE       SUB6
```

```
        TRANSFER   ,CCCC
UNIQ    SPLIT      1,WORK
WCOPS   MATCH      ITEM4
        TRANSFER   ,MARK1
WORK    QUEUE      28
        ENTER      PRO2
        DEPART     28
ITEM4   MATCH      WCOPS
        ADVANCE    200,20        COLLECT DATA ON WORKSLIPS
        LEAVE      PRO2
        QUEUE      29
        ENTER      PRO3
        DEPART     29
        ADVANCE    602,60        ESTABLISH MAIN ENTRIES
        LEAVE      PRO3
        QUEUE      30
        ENTER      PRO4
        DEPART     30
        ADVANCE    350,35        ASSIGN CLASSIFICATION NUMBERS
        LEAVE      PRO4
        QUEUE      31
        ENTER      PRO5
        DEPART     31
        ADVANCE    250,25        ASSIGN SUBJECT HEADINGS
        LEAVE      PRO5
        QUEUE      32
        ENTER      PRO6
        DEPART     32
        ADVANCE    150,15        CHECK IN SHELF LIST
        LEAVE      PRO6
        TRANSFER   ,CCCC
CCCS    TRANSFER   .500,CDS,PRSP
CDS     QUEUE      33
        ENTER      TYP3
        DEPART     33
        ADVANCE    120,12        TYPE CALL NUMBERS ON CARDS
        ADVANCE    200,20        TYPE ADDED ENTRIES ON CARDS
        ADVANCE    150,15        TYPE INFORMATION ON SHELF CARDS
        LEAVE      TYP3
        TRANSFER   ,QUAR
PRSP    QUEUE      34
        ENTER      TYP4
        DEPART     34
        ADVANCE    20,2          TYPE CALL NUMBERS ON LC PROOFSLIPS
        ADVANCE    10,1          CALCULATE AND NOTE NUMBER OF CARDS NEEDED
        LEAVE      TYP4
        TRANSFER   ,REPRO
CCCC    QUEUE      35
        ENTER      TYP5
        DEPART     35
        ADVANCE    344,34        TYPE MAIN ENTRY CARDS
        ADVANCE    10,1          CALCULATE AND NOTE NUMBER OF CARDS NEEDED
        LEAVE      TYP5
REPRO   QUEUE      36
        ENTER      CLRK3
        DEPART     36
        ADVANCE    10,1          SORT CARDS/SLIPS BY NUMBER OF CARDS NEEDE
```

```
         LEAVE       CLK13
         QUEUE       37
         ENTER       CLK14
         DEPART      37
         ADVANCE     100,10     PHOTOCOPY CARD SETS
         LEAVE       CLK14
         QUEUE       38
         ENTER       CLK15
         DEPART      38
         ADVANCE     20,2       ASSEMBLE CARD SETS
         LEAVE       CLK15
         QUEUE       39
         ENTER       TYP6
         DEPART      39
         ADVANCE     200,20     TYPE ADDED ENTRIES ON CARDS
         ADVANCE     105,19     TYPE INFORMATION ON SHELF CARDS
         LEAVE       TYP6
         TRANSFER    ,MAIN
MAIN1    QUEUE       40
         ENTER       TYP7
         DEPART      40
         ADVANCE     30,1       TYPE INFORMATION ON CIRCULATION CARDS
         LEAVE       TYP7
         QUEUE       41
         ENTER       TYP5
         DEPART      41
         ADVANCE     57,7       TYPE INFORMATION ON POCKETS
         LEAVE       TYP5
         QUEUE       42
         ENTER       CLK16
         DEPART      42
         ADVANCE     45,5       PASTE POCKETS ETC IN ITEMS
         ADVANCE     15,1       PROPERTY STAMP ITEMS
         LEAVE       CLK16
         QUEUE       43
         ENTER       CLK17
         DEPART      43
         ADVANCE     40,5       TYPE CALL NUMBERS ON LABELS
         LEAVE       CLK17
         QUEUE       44
         ENTER       CLK18
         DEPART      44
         ADVANCE     7,0        APPLY LABELS TO ITEMS
         LEAVE       CLK18
         QUEUE       45
         ENTER       SUB7
         DEPART      45
         ADVANCE     55,5       PERFORM QUALITY CHECK ON ITEMS
         LEAVE       SUB7
         TABULATE    4
         TERMINATE   1
WORK     QUEUE       46
         ENTER       CLK19
         DEPART      46
         ADVANCE     75,5       CHECK CARDS FOR ERRORS AND COMPLETENESS
         LEAVE       CLK19
         SPLIT       1,SHELF
```

```
        QUEUE      47
        ENTER      CLR20
        DEPART     47
        ADVANCE    25,5        ARRANGE CAT CARDS PRIOR TO FILING
        LEAVE      CLR20
        QUEUE      48
        ENTER      CLR21
        DEPART     48
        ADVANCE    300,30      FILE CAT CARDS
        LEAVE      CLR21
        TRANSFER   ,REV
SHELF   QUEUE      49
        ENTER      CLR22
        DEPART     49
        ADVANCE    5           ARRANGE SHELF CARDS PRIOR TO FILING
        LEAVE      CLR22
        QUEUE      50
        ENTER      CLR23
        DEPART     50
        ADVANCE    30,5        FILE SHELF CARDS
        LEAVE      CLR23
REV     QUEUE      51
        ENTER      SUB6
        DEPART     51
        ADVANCE    34,5        REVISE FILING
        LEAVE      SUB6
        TABULATE   5
        TERMINATE
CLR01   STORAGE    1
CLR02   STORAGE    1
VER1    STORAGE    2
VER2    STORAGE    1
SEA1    STORAGE    1
SEA2    STORAGE    1
PRC1    STORAGE    1
TYP1    STORAGE    2
CLR03   STORAGE    1
TYP2    STORAGE    1
CLR04   STORAGE    1
GNR1    STORAGE    1
CLR05   STORAGE    1
CLR06   STORAGE    1
CLR07   STORAGE    1
CLR08   STORAGE    1
CLR09   STORAGE    1
GNR2    STORAGE    1
CLR10   STORAGE    1
CLR11   STORAGE    1
SUB1    STORAGE    1
SUB2    STORAGE    1
SUB3    STORAGE    1
CLR12   STORAGE    2
SUB4    STORAGE    1
SUB5    STORAGE    1
SUB6    STORAGE    1
PRO2    STORAGE    1
PRO3    STORAGE    3
```

```
PRO4    STORAGE     1
PRO5    STORAGE     1
PRO6    STORAGE     1
TYP3    STORAGE     2
TYP4    STORAGE     1
TYP5    STORAGE     3
CLR13   STORAGE     1
CLR14   STORAGE     4
CLR15   STORAGE     1
TYP6    STORAGE     4
TYP7    STORAGE     1
TYP8    STORAGE     1
CLR16   STORAGE     1
CLR17   STORAGE     1
CLR18   STORAGE     1
SUB7    STORAGE     1
CLR19   STORAGE     3
CLR20   STORAGE     2
CLR21   STORAGE     4
CLR22   STORAGE     1
CLR23   STORAGE     2
SUB8    STORAGE     3
1       TABLE       M1,0,1000,25
2       TABLE       M1,0,1000,25
3       TABLE       M1,0,1000,25
4       TABLE       M1,0,1000,25
5       TABLE       M1,0,1000,25
        START       2000
        END
```

SYMBOL	NUMBER	REFERENCES				
ACCE	110	95				
BOOK	57	59				
CARDS	121	127				
CCCJ	213	173	203			
CCLC	197	147				
CDS	196	204				
COSET	124	128				
COMPA	90	92				
FILE	72	66				
GOOD	13	19				
INV	67	92				
INVO1	65	97				
ITEM1	127	129				
ITEM3	133	135				
ITEM4	173	172				
MARK1	241	130	156	170		
NOCDS	141	127				
NOTE	50	56				
ORDR	38	42				
ORIG	167	133				
PRSP	206	204				
QCHK	214	212	247			
RECV	79	71				
REPRO	219	219				
RET	65	15	56	58	42	[illegible]
REV	301	297				
SEAR	24	30				
SET1	122	134				
SHELF	291	286				
WCOPY	147	153				
WCOP1	150	154				
WCOP2	148	160				
WCOP3	162	160				
WORK	176	174				

SYMBOL	NUMBER	REFERENCES		
BKR1	12	75	78	326
BKR2	13	111	114	332
CLK01	1	10	13	315
CLK02	2	15	18	316
CLK03	9	34	37	323
CLK04	11	67	70	325
CLK05	15	80	83	327
CLK06	14	87	90	328
CLK07	18	96	99	329
CLK08	16	101	104	330
CLK09	17	106	109	331
CLK10	19	118	121	333
CLK11	20	123	126	334
CLK12	24	149	152	338
CLK13	36	227	230	350
CLK14	37	232	235	351
CLK15	38	237	240	352
CLK16	42	259	262	356
CLK17	43	265	268	357
CLK18	44	270	273	358
CLK19	46	282	285	360
CLK20	47	288	291	361
CLK21	48	293	296	362
CLK22	49	299	302	363
CLK23	50	304	307	364
PRO1	7	44	47	321
PRO2	28	178	182	342
PRO3	29	184	187	343
PRO4	30	189	192	344
PRO5	31	194	197	345
PRO6	32	199	202	346
SEA1	5	32	35	319
SEA2	6	38	41	320
SUB1	21	132	136	335
SUB2	22	138	141	336
SUB3	23	143	146	337
SUB4	25	158	162	339
SUB5	26	164	167	340
SUB6	27	169	172	341
SUB7	45	275	278	359
SUB8	51	309	312	365
TYP1	8	49	52	322
TYP2	10	62	65	324
TYP3	33	208	211	347
TYP4	34	214	216	348
TYP5	35	221	225	349
TYP6	39	242	246	353
TYP7	40	249	252	354
TYP8	41	254	257	355
VER1	3	21	24	317
VER2	4	26	29	318

STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	ENTRIES	AVERAGE TIME/UNIT	-AV. UTIL- TOTAL TIME
CEN01	1	.012	2497	[illegible]	.012
CEN02	1	.027	2497	9.009	.027
VEN1	2	1.976	2546	[illegible]	[illegible]
VEN2	2	.262	[illegible]	[illegible]	.131
SUP1	1	.092	2220	[illegible]	.092
SUP2	1	.109	2121	[illegible]	.109
PRO1	1	.146	2004	41.59	.146
TYP1	2	1.130	2004	357.9	.565
CEN03	1	.010	2003	[illegible]	.010
TYP2	1	[illegible]	2002	[illegible]	[illegible]
CEN04	1	.003	2002	1.000	.003
SAN1	1	.216	2002	64.9	.216
CEN05	2	.902	4004	135.05	.451
CEN06	1	.049	2002	14.95	.049
CEN07	1	.840	2002	[illegible]	.840
CEN08	1	.180	2001	53.9	.180
CEN09	1	.267	2001	[illegible]	.267
SAN2	1	.307	2001	[illegible]	.307
CEN10	1	.354	2002	105.9	.354
CEN11	1	.347	2002	[illegible]	.347
SUP1	1	.466	962	[illegible]	.466
SUP2	1	.255	962	[illegible]	.255
SUP3	1	.254	961	[illegible]	.254
CEN12	2	.582	1059	[illegible]	.291
SUP4	1	.000	792	[illegible]	.000
SUP5	1	.193	795	[illegible]	.193
SUP6	1	.193	795	146.557	.193
PRO2	1	.061	245	179.8	.061
PRO3	1	.306	245	750.75	.306
PRO4	1	.142	245	[illegible]	.142
PRO5	1	.101	245	[illegible]	.101
PRO6	1	.055	245	[illegible]	.055
TYP3	2	.420	500	504.091	.210
TYP4	1	.023	461	29.99	.023
TYP5	3	.612	1036	353.576	.204
CEN13	1	.023	1499	9.59	.023
CEN14	1	.099	1499	159.795	.099
CEN15	1	.049	1499	19.59	.049
TYP6	4	.901	1496	[illegible]	[illegible]
TYP7	1	.167	2000	50.143	.167
TYP8	1	.191	2000	57.231	.191
CEN16	1	.200	2000	59.941	.200
CEN17	1	.160	2000	47.935	.160
CEN18	1	.265	2000	79.603	.265
SUP7	1	.185	2000	55.117	.185
CEN19	3	.249	1995	74.8	.083
CEN20	2	.083	1995	25.001	.041
CEN21	4	.997	1995	299.503	.249
CEN22	1	.029	1995	9.000	.029
CEN23	2	.166	1995	50.050	.083
SUP8	3	.226	3969	33.904	.075

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS
1	1	.000	2597	2597	100.0	.000
2	1	.000	2597	2597	100.0	.000
3	19	6.093	2593	103	4.5	1551.609
4	1	.010	2556	[illegible]	60.5	4.745
5	1	.000	2220	2220	100.0	.000
6	1	.000	2221	2221	100.0	.000
7	1	.000	2004	2004	100.0	.000
8	1	.000	2004	2004	100.0	.000
9	1	.000	2003	2002	99.9	.001
10	1	.000	2002	1999	99.8	.010
11	1	.000	2002	2002	100.0	.000
12	1	.004	2002	1800	89.9	1.842
13	2	.002	4004	3104	72.0	5.066
14	1	.000	2002	1996	99.7	.005
15	2	.227	2002	714	35.6	68.003
16	1	.000	2001	2001	100.0	.000
17	1	.000	2001	2001	100.0	.000
18	1	.000	2001	2001	100.0	.000
19	1	.000	2002	2002	100.0	.000
20	1	.000	2002	2002	100.0	.000
21	1	.007	902	599	66.4	23.669
22	1	.000	902	902	100.0	.000
23	1	.000	901	901	100.0	.000
24	1	.000	1003	1003	100.0	.000
25	1	.000	795	795	100.0	.000
26	1	.000	795	793	99.7	.010
27	1	.000	795	791	99.7	.030
28	1	.000	245	244	99.5	.020
29	1	.000	245	245	100.0	.000
30	1	.003	245	225	91.8	7.410
31	1	.000	245	245	100.0	.000
32	1	.000	245	245	100.0	.000
33	1	.000	500	500	100.0	.000
34	1	.000	401	401	100.0	.000
35	1	.000	1058	1057	99.9	.014
36	1	.000	1499	1485	99.0	.056
37	1	.000	1499	1499	100.0	.000
38	2	.000	1499	1466	97.7	.250
39	1	.000	1498	1497	99.9	.030
40	1	.005	2000	1895	94.8	1.190
41	1	.000	2000	1924	96.2	.104
42	1	.000	2000	1922	96.1	.104
43	1	.000	2000	2000	100.0	.000
44	1	.005	2000	1796	89.7	1.556
45	1	.000	2000	2000	100.0	.000
46	1	.000	1995	1995	100.0	.000
47	1	.000	1995	1995	100.0	.000
48	1	.000	1995	1993	99.8	.051
49	1	.000	1995	1964	98.4	.072
50	1	.000	1995	1993	99.8	.017
51	1	.000	1969	1966	99.9	.004

TABLE 1
ENTRIES IN TABLE MEAN ARGUMENT 2373.063 STANDARD DEVIATION 1526.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-1.555
1000	286	11.53	11.5	88.4	.421	-.899
2000	978	39.43	50.9	49.0	.842	-.244
3000	411	16.57	67.5	32.4	1.264	.410
4000	239	9.63	77.1	22.8	1.685	1.066
5000	463	18.66	95.8	4.1	2.106	1.721
6000	103	4.15	100.0	.0	2.528	2.376

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 5885196.000 NON-WEIGHTED

TABLE 2

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
	2752.005	1446.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-1.903
1000	0	.00	.0	100.0	.363	-1.212
2000	1878	46.91	46.9	53.0	.726	-.520
3000	569	14.21	61.1	38.8	1.089	.171
4000	446	11.14	72.2	27.7	1.453	.862
5000	794	19.83	92.1	7.8	1.816	1.554
6000	316	7.89	100.0	.0	2.179	2.245

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 11016001.000 NON-WEIGHTED

TABLE 5
ENTRIES IN TABLE

MEAN ARGUMENT	STANDARD DEVIATION	
3150.401	1452.000	

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE
0	0	.00	.0
1000	0	.00	.0
2000	750	37.50	37.5
3000	284	14.19	51.6
4000	340	16.95	68.6
5000	265	13.24	81.9
6000	345	17.24	99.1
7000	15	.75	100.0

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS
6292925.000 NON-WEIGHTED

CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
100.0	-.000	-2.166
100.0	.317	-1.473
62.5	.635	-.769
48.3	.953	-.106
31.3	1.271	.567
18.6	1.589	1.276
.0	1.906	1.965
.0	2.224	2.653

TABLE 4

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
	3482.467	1464.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-2.378
1000	0	.00	.0	100.0	.287	-1.695
2000	264	13.19	13.1	86.8	.574	-1.012
3000	696	34.79	48.0	51.9	.861	-.329
4000	355	17.74	65.8	34.1	1.148	.353
5000	197	9.84	75.6	24.3	1.435	1.036
6000	405	20.24	95.9	4.0	1.722	1.719
7000	81	4.04	100.0	.0	2.010	2.402

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 6964975.000 NON-WEIGHTED

TABLE 5

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
	4801.983	1590.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE
0	0	.00	.0
1000	0	.00	.0
2000	0	.00	.0
3000	373	9.35	9.3
4000	1311	32.86	42.2
5000	705	17.67	59.8
6000	475	11.90	71.7
7000	722	18.09	89.8
8000	275	6.89	96.7
9000	123	3.08	99.9
10000	5	.12	100.0

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS	NON-WEIGHTED
19155120.000	

CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
100.0	-.000	-3.020
100.0	.208	-2.391
100.0	.416	-1.762
90.6	.624	-1.133
57.7	.832	-.504
40.1	1.041	.124
28.2	1.249	.753
10.1	1.457	1.382
3.2	1.665	2.011
.1	1.874	2.640
.0	2.082	3.269

APPENDIX J

GPSS CODING AND SIMULATION RESULTS OF THE COMPUTER-BASED SYSTEM

```
*LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
*       SIMULATE
*
*       SIMULATION OF A COMPUTER BASED SYSTEM/TIME IS IN SECONDS
*
        GENERATE   240,30,,,,6 GENERATE INCOMING REQUEST FORMS
        QUEUE      1
        ENTER      CLR01
        DEPART     1
        ADVANCE    5             SORT INCOMING REQUEST FORMS
        LEAVE      CLR01
        QUEUE      2
        ENTER      CLR02
        DEPART     2
        ADVANCE    7,1           ALPHABETIZE REQUEST FORMS
        LEAVE      CLR02
        TRANSFER   .050,GOOD,RET
GOOD    QUEUE      3
        ENTER      VER1
        DEPART     3
        ADVANCE    307,51        VERIFY REQUESTS IN BIBLIOGRAPHIC SOURCES
        LEAVE      VER1
        QUEUE      4
        ENTER      VER2
        DEPART     4
        ADVANCE    67,7          VERIFY PRICES AND AVAILABILITY
        LEAVE      VER2
        TRANSFER   .050,SEAR,RET
SEAR    QUEUE      5
        ENTER      SEA1
        DEPART     5
        ADVANCE    25,5          SEARCH REQUESTS IN ORDER LIST
        LEAVE      SEA1
        TRANSFER   .050,NOTF,RET
NOTF    QUEUE      6
        ENTER      SEA2
        DEPART     6
        ADVANCE    31,5          SEARCH REQUESTS IN CARD CATALOG
        LEAVE      SEA2
        TRANSFER   .050,ORDR,RET
ORDR    QUEUE      7
        ENTER      PRO1
        DEPART     7
        ADVANCE    42,4          ASSIGN VENDORS AND ORDER NUMBERS
        LEAVE      PRO1
        QUEUE      8
        ENTER      KEY1
        DEPART     8
        ADVANCE    538,54        TRANSFER INFO TO MACHINE READABLE FORM
        LEAVE      KEY1
        QUEUE      9
        ENTER      KEY2
        DEPART     9
        ADVANCE    538,54        VERIFY KEYING
        LEAVE      KEY2
        SPLIT      1,RET
```

```
         QUEUE      10
         ENTER      COM1
         DEPART     10
         ADVANCE    5,1          GENERATE PURCHASE ORDERS
         ADVANCE    5,1          UPDATE ORDER/PROCESSING LIST
         ADVANCE    5,1          UPDATE ACCOUNTING FILE
         ADVANCE    4            GENERATE UPDATE/NOTIFY CARDS
         LEAVE      COM1
         SPLIT      1,UPDA
         QUEUE      11
         ENTER      CLRK03
         DEPART     11
         ADVANCE    1            FORWARD ORDERS TO VENDORS
         LEAVE      CLRK03
         TRANSFER   ,RECV
RET      TABULATE   1
         TERMINATE
UPDA     QUEUE      12
         ENTER      CLRK04
         DEPART     12
         ADVANCE    1            FILE UPDATE/NOTIFY CARDS
         LEAVE      CLRK04
         TABULATE   2
         TERMINATE
RECV     QUEUE      13
         ENTER      CLRK05
         DEPART     13
         ADVANCE    15,2         OPEN PACKAGES
         LEAVE      CLRK05
         SPLIT      1,INV
INVOI    MATCH      COMPA
         TRANSFER   ,RET
INV      QUEUE      14
         ENTER      CLRK06
         DEPART     14
COMPA    MATCH      INVOI
         ADVANCE    252,25       VERIFY CORRECTNESS OF ITEMS SHIPPED
         LEAVE      CLRK06
         QUEUE      15
         ENTER      CLRK07
         DEPART     15
         ADVANCE    30,6         CLEAR INVOICES
         LEAVE      CLRK07
         SPLIT      1,NOT
         TABULATE   3
         TERMINATE
NOT      QUEUE      16
         ENTER      COM2
         DEPART     16
         ADVANCE    5,1          UPDATE ORDER/PROCESSING FILE
         ADVANCE    5,1          UPDATE ACCOUNTING FILE
         ADVANCE    5,1          MATCH RECORDS AGAINST HARD DATA BASE
         LEAVE      COM2
         QUEUE      17
         ENTER      CLRK08
         DEPART     17
         ADVANCE    3            SORT WORKSLIPS
```

```
ITEM1 MATCH     SET1
      LEAVE     CLRK8
      TRANSFER  .250,DATA,NDAT
DATA  QUEUE     18
      ENTER     SUB1
      DEPART    18
      ADVANCE   291,29        CHECK WORKSLIPS FOR CORRECTNESS
      LEAVE     SUB1
      QUEUE     19
      ENTER     SUB2
      DEPART    19
      ADVANCE   146,15        CHECK SUBJECT HEADINGS
      LEAVE     SUB2
      QUEUE     20
      ENTER     SUB3
      DEPART    20
      ADVANCE   146,15        CHECK IN SHELF LIST
      LEAVE     SUB3
      TRANSFER  ,KEY
NDAT  QUEUE     21
      ENTER     CLRK9
      DEPART    21
      ADVANCE   150,34        SEARCH IN NUC ETC FOR COPY
      LEAVE     CLRK9
      TRANSFER  .500,WCOPY,ORIG
WCOPY QUEUE     22
      ENTER     SUB4
      DEPART    22
      ADVANCE   61,6          CHECK WORKSLIPS FOR CORRECTNESS
      LEAVE     SUB4
      QUEUE     23
      ENTER     SUB5
      DEPART    23
      ADVANCE   146,15        CHECK SUBJECT HEADINGS
      LEAVE     SUB5
      QUEUE     24
      ENTER     SUB6
      DEPART    24
      ADVANCE   146,15        CHECK IN SHELF LIST
      LEAVE     SUB6
      TRANSFER  ,KEY
ORIG  QUEUE     25
      ENTER     PRO2
      DEPART    25
      ADVANCE   200,20        COLLECT DATA ON SLIPS
      LEAVE     PRO2
      QUEUE     26
      ENTER     PRO3
      DEPART    26
      ADVANCE   802,80        ESTABLISH MAIN ENTRIES
      LEAVE     PRO3
      QUEUE     27
      ENTER     PRO4
      DEPART    27
      ADVANCE   350,35        ASSIGN CLASSIFICATION NUMBERS
      LEAVE     PRO4
      QUEUE     28
```

```
         ENTER      PRO5
         DEPART     28
         ADVANCE    210,25       ASSIGN SUBJECT HEADINGS
         LEAVE      PRO5
         QUEUE      29
         ENTER      PRO6
         DEPART     29
         ADVANCE    140,15       CHECK IN SHELF LIST
         LEAVE      PRO6
KEY      QUEUE      30
         ENTER      KEY3
         DEPART     30
         ADVANCE    150,15       KEY UPDATE CARDS FOR CATALOG CARDS
         LEAVE      KEY3
         QUEUE      31
         ENTER      KEY4
         DEPART     31
         ADVANCE    150,15       VERIFY KEYING
         LEAVE      KEY4
         QUEUE      32
         ENTER      CCM5
         DEPART     32
         ADVANCE    5,1          UPDATE ORDER/PROCESSING FILE
         ADVANCE    10,1         PRINT CATALOG CARDS
         ADVANCE    4            PUNCH CIRC CARDS AND PRINT LABELS
         LEAVE      CCM5
         SPLIT      1,CCRDS
ITEM2    MATCH      SET2
         TABULATE   4
         TERMINATE
CAT      QUEUE      33
         ENTER      CLK10
         DEPART     33
SET1     MATCH      ITEM1
SET2     MATCH      ITEM2
         ADVANCE    164,16       MATCH PROCESSING MATERIALS WITH ITEMS
         LEAVE      CLK10
         QUEUE      34
         ENTER      CLK11
         DEPART     34
         ADVANCE    45,5         PASTE POCKETS ETC IN ITEMS
         ADVANCE    15,1         PROPERTY STAMP ITEMS
         LEAVE      CLK11
         QUEUE      35
         ENTER      CLK12
         DEPART     35
         ADVANCE    79,8         APPLY LABELS TO ITEMS
         LEAVE      CLK12
         QUEUE      36
         ENTER      SUB7
         DEPART     36
         ADVANCE    55,6         PERFORM QUALITY CHECK ON ITEMS
         LEAVE      SUB7
         TABULATE   5
         TERMINATE  1
CCRDS    QUEUE      37
         ENTER      CLK13
```

```
          DEPART      37
          ADVANCE     3              SORT CAT CARDS AND SHELF CARDS
          LEAVE       CLK13
          SPLIT       1,SHELF
          QUEUE       38
          ENTER       CLK14
          DEPART      38
          ADVANCE     25,5           ARRANGE CAT CARDS PRIOR TO FILING
          LEAVE       CLK14
          QUEUE       39
          ENTER       CLK15
          DEPART      39
          ADVANCE     300,50         FILE CAT CARDS
          LEAVE       CLK15
          TRANSFER    ,REV
SHELF     QUEUE       40
          ENTER       CLK16
          DEPART      40
          ADVANCE     25,5           ARRANGE SHELF CARDS PRIOR TO FILING
          LEAVE       CLK16
          QUEUE       41
          ENTER       CLK17
          DEPART      41
          ADVANCE     50,5           FILE SHELF CARDS
          LEAVE       CLK17
REV       QUEUE       42
          ENTER       SUB8
          DEPART      42
          ADVANCE     54,3           REVISE FILING
          LEAVE       SUB8
          TABULATE    6
          TERMINATE
CLK01     STORAGE     1
CLK02     STORAGE     1
VER1      STORAGE     2
VER2      STORAGE     1
SER1      STORAGE     1
SER2      STORAGE     1
PRO1      STORAGE     1
KEY1      STORAGE     2
KEY2      STORAGE     2
COM1      STORAGE     1
CLK03     STORAGE     1
CLK04     STORAGE     1
CLK05     STORAGE     1
CLK06     STORAGE     1
CLK07     STORAGE     1
COM2      STORAGE     1
CLK08     STORAGE     1
SUB1      STORAGE     2
SUB2      STORAGE     1
SUB3      STORAGE     1
CLK09     STORAGE     2
SUB4      STORAGE     1
SUB5      STORAGE     1
SUB6      STORAGE     1
PRO2      STORAGE     1
```

```
PRO3     STORAGE     2
PRO4     STORAGE     2
PRO5     STORAGE     1
PRO6     STORAGE     1
KEY3     STORAGE     2
KEY4     STORAGE     2
COM5     STORAGE     1
CLR10    STORAGE     10
CLR11    STORAGE     2
CLR12    STORAGE     2
SUB7     STORAGE     2
CLR13    STORAGE     1
CLR14    STORAGE     2
CLR15    STORAGE     3
CLR16    STORAGE     2
CLR17    STORAGE     2
SUB8     STORAGE     2
1        TABLE       M1,0,1000,25
2        TABLE       M1,0,1000,25
3        TABLE       M1,0,1000,25
4        TABLE       M1,0,1000,25
5        TABLE       M1,0,1000,25
6        TABLE       M1,0,1000,25
         START       2000
*
         END
```

SYMBOL	NUMBER	REFERENCES				
CAT	196	90				
CCRDS	221	199				
COMPA	67	69				
DATA	112	116				
GOOD	13	17				
INV	64	66				
INVOI	82	94				
ITEM1	189	206				
ITEM2	193	207				
KEY	175	154	156			
NDAT	128	116				
NOT	96	102				
NOTF	30	36				
ORDR	36	42				
ORIG	150	140				
RECV	76	73				
RET	67	19	30	36	42	56
REV	246	244				
SEAR	24	30				
SET1	199	116				
SET2	200	200				
SHELF	236	233				
UPDA	69	67				
WCOPY	134	140				

SYMBOL	NUMBER	REFERENCES		
CLK01	1	10	13	262
CLK02	2	15	18	263
CLK03	11	69	72	272
CLK04	12	77	80	273
CLK05	13	84	87	274
CLK06	14	92	96	275
CLK07	15	98	101	276
CLK08	17	113	117	278
CLK09	21	136	139	282
CLK10	33	204	209	294
CLK11	34	211	215	295
CLK12	35	217	220	296
CLK13	37	229	232	298
CLK14	38	235	238	299
CLK15	39	240	243	300
CLK16	40	246	249	301
CLK17	41	251	254	302
COM1	10	60	66	271
COM2	16	106	111	277
COM3	32	193	198	293
KEY1	8	49	52	269
KEY2	9	54	57	270
KEY3	30	183	186	291
KEY4	31	188	191	292
PRO1	7	44	47	268
PRO2	25	158	161	286
PRO3	26	163	166	287
PRO4	27	168	171	288
PRO5	28	173	176	289
PRO6	29	178	181	290
SEA1	5	32	35	266
SEA2	6	38	41	267
SUB1	18	120	123	279
SUB2	19	125	128	280
SUB3	20	130	133	281
SUB4	22	142	145	283
SUB5	23	147	150	284
SUB6	24	152	155	285
SUB7	36	222	225	297
SUB8	42	256	259	303
VER1	3	21	24	264
VER2	4	26	29	265

STORAGES

STORAGE	CAPACITY	AVERAGE CONTENTS	ENTRIES	AVERAGE TIME/UNIT	AVERAGE TOTAL TIME
CLRK01	1	.022	2400	2.000	.022
CLRK02	1	.027	2400	9.023	.027
VER1	2	1.792	2040	200.917	.791
VER2	2	.604	2040	67.105	.204
SER1	1	.090	2232	9.009	.090
SER2	1	.110	2123	20.950	.110
PRC1	1	.141	2000	41.924	.141
KEY1	2	1.120	2007	257.000	.560
KEY2	2	1.135	2006	257.27	.567
COM1	1	.077	2004	22.970	.077
CLRK03	1	.005	2004	1.000	.005
CLRK04	1	.005	2004	1.000	.005
CLRK05	1	.320	2004	141.920	.320
CLRK06	1	.042	2004	251.002	.042
CLRK07	1	.200	2004	79.990	.200
COM2	1	.050	2004	15.045	.050
CLRK08	1	.010	2004	3.000	.010
SUB1	2	.730	1501	290.207	.365
SUB2	1	.367	1500	145.970	.367
SUB3	1	.367	1499	146.[illegible]	.367
CLRK09	2	.282	503	335.194	.141
SUB4	1	.023	247	60.522	.023
SUB5	1	.000	247	141.574	.000
SUB6	1	.000	247	145.916	.000
PRC2	1	.005	250	200.294	.005
PRC3	2	.351	250	790.292	.176
PRC4	2	.149	250	546.502	.074
PRC5	1	.107	250	250.144	.107
PRC6	1	.062	250	145.246	.062
KEY3	2	.435	2001	129.972	.217
KEY4	2	.420	2001	130.124	.210
COM3	1	.065	2001	16.996	.065
CLRK10	10	5.305	2004	1576.775	.530
CLRK11	2	.201	2000	60.120	.100
CLRK12	2	.264	2000	76.964	.132
SUB7	2	.184	2000	54.927	.092
CLRK13	1	.010	2001	3.000	.010
CLRK14	2	.083	2001	24.972	.041
CLRK15	2	1.004	2001	299.527	.334
CLRK16	2	.083	2001	25.014	.041
CLRK17	2	.167	2001	49.920	.083
SUB8	2	.228	4000	34.029	.114

QUEUE

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS
1	1	.000	[illegible]	[illegible]	100.0	.000
2	1	.000	[illegible]	[illegible]	100.0	.000
3	21	10.[illegible]	[illegible]	17	.7	[illegible]
4	1	.[illegible]	[illegible]	2001	[illegible]	[illegible]
5	1	.000	[illegible]	[illegible]	100.0	.000
6	1	.000	[illegible]	[illegible]	100.0	.000
7	1	.000	[illegible]	[illegible]	100.0	.000
8	1	.000	2007	2007	100.0	.000
9	1	.000	[illegible]	2000	100.0	.000
10	1	.000	[illegible]	1972	[illegible]	.1[illegible]
11	1	.000	2004	2004	100.0	.000
12	1	.000	2004	2004	100.0	.000
13	1	.000	2004	2004	100.0	.000
14	2	.[illegible]	2004	722	36.0	[illegible]
15	1	.000	2004	2004	100.0	.000
16	1	.000	2004	2004	100.0	.000
17	1	.000	2004	2004	100.0	.000
18	1	.000	1501	1501	100.0	.000
19	1	.000	1500	1500	100.0	.000
20	1	.000	1499	1499	100.0	.000
21	1	.000	503	503	100.0	.000
22	1	.000	247	247	100.0	.000
23	1	.000	247	247	100.0	.000
24	1	.000	247	247	100.0	.000
25	1	.000	250	250	100.0	.000
26	2	.002	[illegible]	[illegible]	97.6	[illegible]
27	1	.000	250	250	100.0	.000
28	1	.000	250	240	96.0	1.[illegible]
29	1	.000	250	250	100.0	.000
30	1	.000	2001	1999	99.9	.001
31	1	.000	2001	1999	99.9	.002
32	1	.000	2001	1969	98.4	.134
33	1	.000	2004	2004	100.0	.000
34	1	.000	2000	2000	100.0	.000
35	1	.000	2000	2000	100.0	.000
36	1	.000	2000	2000	100.0	.000
37	1	.000	2001	2001	100.0	.000
38	1	.000	2001	2001	100.0	.000
39	1	.000	2001	1996	99.8	.047
40	1	.000	2001	2001	100.0	.000
41	1	.000	2001	2001	100.0	.000
42	1	.000	4000	3970	99.2	.0[illegible]7

TABLE 1

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
	3665.070	1500.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-2.443
1000	138	5.59	5.5	94.4	.272	-1.776
2000	186	7.54	13.1	86.8	.545	-1.110
3000	462	18.73	31.8	68.1	.818	-.443
4000	487	19.74	51.6	48.3	1.091	.223
5000	708	28.71	80.3	19.6	1.364	.889
6000	359	14.55	94.8	5.1	1.637	1.556
7000	126	5.10	100.0	.0	1.909	2.223

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 9038063.000 NON-WEIGHTED

TABLE 2

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
	3983.191	1262.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-3.156
1000	0	.00	.0	100.0	.251	-2.363
2000	147	7.33	7.3	92.6	.502	-1.571
3000	370	18.46	25.7	74.2	.753	-.779
4000	381	19.01	45.8	56.1	1.004	.013
5000	657	32.78	76.5	23.4	1.255	.805
6000	340	16.96	93.5	6.4	1.506	1.598
7000	129	6.43	100.0	.0	1.757	2.390

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 7982516.000 NON-WEIGHTED

TABLE 5

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
	4401.375	1275.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE
0	0	.00	.0
1000	0	.00	.0
2000	83	4.14	4.1
3000	224	11.17	15.3
4000	409	20.40	35.7
5000	685	34.16	69.9
6000	374	18.66	88.5
7000	228	11.37	99.9
8000	1	.04	100.0

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS	
6821563.000	NON-WEIGHTED

CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
100.0	-.000	-3.466
100.0	.227	-2.678
95.8	.454	-1.891
84.6	.681	-1.103
64.2	.908	-.316
30.0	1.135	.470
11.4	1.363	1.258
.0	1.590	2.045
.0	1.817	2.833

TABLE 4

ENTRIES IN TABLE | MEAN ARGUMENT 5465.250 | STANDARD DEVIATION [illegible]

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE
0	0	.00	.0
1000	0	.00	.0
2000	0	.00	.0
3000	93	4.64	4.6
4000	210	10.49	15.1
5000	367	[illegible]	[illegible]
6000	659	32.93	66.4
7000	366	18.39	84.8
8000	248	12.39	97.2
9000	45	2.24	99.4
10000	11	.54	100.0

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 1097599[illegible].000 | NON-WEIGHTED

CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
100.0	-.000	-3.974
100.0	.182	-3.250
100.0	.364	-2.525
95.3	.546	-1.800
84.8	.729	-1.076
66.5	.911	-.351
33.5	1.093	.373
15.1	1.276	1.097
2.7	1.458	1.822
.5	1.640	2.546
.0	1.823	3.271

TABLE 5

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION
[illegible]	5842.662	1380.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE
0	0	.00	.0
1000	0	.00	.0
2000	0	.00	.0
3000	9	.44	.4
4000	192	9.59	10.0
5000	400	19.99	30.0
6000	530	26.49	56.5
7000	445	22.24	78.7
8000	320	15.99	94.7
9000	82	4.09	98.9
10000	22	1.09	100.0

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 11683768.000 NON-WEIGHTED

CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
100.0	-.000	-4.233
100.0	.171	-3.509
100.0	.342	-2.784
99.5	.513	-2.060
89.9	.684	-1.335
69.9	.855	-.610
43.4	1.026	.113
21.2	1.198	.838
5.2	1.369	1.563
1.1	1.540	2.287
.0	1.711	3.012

TABLE 6
ENTRIES IN TABLE

MEAN ARGUMENT 5721.067

STANDARD DEVIATION 1386.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-4.126
1000	0	.00	.0	100.0	.174	-3.400
2000	0	.00	.0	100.0	.349	-2.685
3000	80	1.99	1.9	98.0	.524	-1.963
4000	384	9.59	11.5	88.5	.699	-1.242
5000	782	19.57	31.1	68.8	.873	-.526
6000	1164	29.05	60.2	39.7	1.048	.200
7000	821	20.52	80.7	19.2	1.223	.922
8000	597	14.92	95.7	4.2	1.398	1.645
9000	133	3.32	99.0	.9	1.572	2.365
10000	38	.94	100.0	.0	1.747	3.086

REMAINING FREQUENCIES ARE ALL ZERO

SUM OF ARGUMENTS 22857472.000

NON-WEIGHTED

APPENDIX K

SUMMARY OF PROCEDURES FOR EVALUATING ALTERNATIVE TECHNICAL SERVICES SYSTEMS

SUMMARY OF PROCEDURES FOR EVALUATING ALTERNATIVE TECHNICAL SERVICES SYSTEMS

A detailed summary of the procedures within the six phases of the methodology for evaluating alternative technical services systems is given below for use by those wishing to apply the methodology in their libraries. A more detailed description of each phase can be found in Chapters II and III.

I. Perform a systems study of each alternative technical services system to be evaluated:

   A. Identify the boundaries and parameters of each system; that is, decide exactly what functions are to be included in and excluded from each alternative system;

   B. Determine the goals and objectives of each alternative system;

   C. Divide each alternative system to be evaluated into its component parts:

      1. Separate each system into its major sub-systems; see Figure 5 for example;

      2. Separate each sub-system into its component activities; see Figures 6 and 7 for examples;

      3. Separate each activity into its component operations; see Appendices A and B for examples;

      4. Separate each operation into its component tasks; see Appendices A and B for examples.

   D. Construct a flowchart for each system, using standard block flowcharting symbols as shown in Appendix C; see Appendices D and E for examples.

II. Establish and validate evaluation criteria for all operations in each alternative system:

   A. Establish a standard time to perform each operation, using the operations and their component tasks established in the systems studies of the alternatives and one of the several methods for determining performance times described in Chapter II, preferably the time study; see Appendices A and B for examples;

B. Validate each evaluation criterion by asking supervisors of the operations if the criteria are reasonably appropriate and sound measures and, if possible, by comparing the criteria to actual or historical data;

C. Set a reasonable indicator of variation for the criteria, such as a standard deviation from their mean performance times.

III. Construct decision or system models of each alternative system to be evaluated:

A. Build a block diagram GPSS simulation model of each system, using the system flowcharts and the component operations previously established; see Appendix F for a list of some of the standard GPSS symbols which can be used, Appendices G and H for examples of system models, and references in the bibliography to this paper, particularly numbers 39 and 40;

B. Insert the performance times for operations, with the standard deviations as parameters, into the models; see Appendices A and B, for examples;

C. Transfer the models, including the performance times, to punch cards for input into the computer system; these decks become the simulation "programs." Formats and keying instructions can be found in the IBM GPSS reference manuals (references 39 and 40 in the bibliography to this paper); sample programs are in Appendices I and J;

D. Test the models by making a trial simulation run of each system on the computer;

E. Examine the output of the trial simulation runs to make certain that the models are operating as intended and that the results seem reasonable and realistic.

IV. Establish decision criteria or rules for selecting the best system:

A. Decide upon the characteristics desired for the best system, in consultation and agreement with all levels of the library's management. These decision criteria or rules usually pertain either to a system's output or to a system's costs; see Chapter III for examples;

B. Establish upper and lower or maximum and minimum parameters for each decision criterion; for example, "reject any system whose per unit processing costs exceed $10.00;" see Chapter III for examples;

C. Decide upon any other parameters which will be used in selecting the best system, particularly for determining the extent of differences between system performance.

V. Simulate the performance of each alternative system on the digital computer:

A. Simulate system performance on the computer, using the decks of punch cards prepared previously, using actual performance times in the programs;

B. Examine the outputs of the simulations to make certain that the runs were successful and that the results can be used in selecting the best system.

VI. Select the best alternative system:

A. Construct a decision matrix for use in displaying the quantitative values determined for each alternative system; see examples in Chapters II and III;

B. Analyze the output of the simulation runs and extract for each alternative system being evaluated the quantitative values which will be used as the basis for determining the best system; place the values in the decision matrix;

C. Compute any additional values needed, such as standard deviations, statistical significance tests, and so on;

D. Using the quantitative values established to indicate the performance of the alternative systems, match the values; the alternative ultimately selected as best should be the one which most closely matches the decision criteria or rules established for the best system;

E. Select the best alternative system.

The above steps would be taken in the sequence shown to evaluate alternative technical services systems. The average library manager could use this methodology, but he might wish to delegate some of the steps to specialists. He should be able to perform the systems study of each alternative system to be evaluated, to establish decision criteria or rules for selection of the best system, and to select the best alternative system. A person familiar with time and motion studies could assist the library manager to establish performance times for operations. A computer programmer could aid in the construction and testing of the decision or system models and in the simulation of the alternative systems to be evaluated on the computer. A mathematician could, if necessary, assist in the final interpretation of values in the decision matrix when the best alternative system is selected.

The library manager, of course, would share in the performance of each step and would supervise any steps delegated to other specialists. Such a shared responsibility among specialists from several fields could improve the performance of the individual steps in the methodology and the values upon which the final selection of the best system is made. Thus, the value of the methodology to the library manager in providing a quantitative basis for comparing and evaluating alternative technical services systems in libraries would be enhanced.