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CRITERIA FOR EVALUATING THE EFFECTIVENESS OF LIBRARY OPERATIONS AND SERVICES

PHASE II: DATA GATHERING AND EVALUATION

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ATLIS Report No. 19

Criteria for Evaluating The Effectiveness of Library Operations and Services

PHASE II: Data Gathering and Evaluation

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and

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Date: August 1968

Final Report on PHASE II of Contract DA-28017-AMC-3483(A) for Picatinny Arsenal, Dover, New Jersey

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ABSTRACT

This report summarizes (1) data and information collected to facilitate the development of criteria for the evaluation of the efficiency and effectiveness of Army Technical Libraries; (2) the findings on the mission and objectives of Army Technical Libraries; (3) the areas in which adequate standards for performance are feasible, and (4) presents the tentative (candidate) criteria and proposed management techniques useful in implementing them.

The criteria apply to 4 general aspects of library performance:

(1) Philosophical - criteria which relate to the enunciation of the reasons for the existence of the library.

(2) Management - criteria which relate to the influence exerted on the efficiency and effectiveness of the library by management practices.

(3) Services and products - criteria which relate to the outputs of the library and measures of service or product effectiveness.

(4) Operations - criteria which are potentially useful as a basis for developing adequate standards for performance evaluation of the staff's professional actions.

PREFACE

It is the end purpose of Contract DA-28017-AMC-3483(A) to establish criteria for evaluating Army Technical Library operations and services. The criteria are intended to cover the evaluation of all aspects of technical library operations and services, including but not limited to:

a. Library staff
b. Personnel utilization
c. Placement of library in organization it serves
d. Space and equipment requirements
e. Collections
f. Service effectiveness
g. Operations efficiency
h. Budget allocation
i. Procurement and maintenance

Because the criteria must be concepts usable for achieving the objectives of the study and will be applied pragmatically, the study must:

a. define each objective;
b. provide a method of testing the criterion with the purpose of determining library effectiveness.

The study is divided into three phases:

Phase I - State-of-the-art: conducting a literature search reflecting the current state-of-the-art, covering:

a. library standards;
b. methods of evaluating libraries;
c. data and information relating to the library performance evaluation.

Phase II - Data gathering and evaluation.

Phase III - Establishing criteria.

To introduce the reader to the work and findings of Phase II, a brief review of Phase I may prove helpful. During Phase I a detailed search was made of the literature of library and management "science" to assess the "state-of-the-art" of criteria and methods of evaluating the efficiency and effectiveness of library operations and services. More than one thousand references were located, and the documents were reviewed and evaluated. Those judged as most pertinent and contributory to the study were abstracted for inclusion in the Phase I report. Supplemental documents were included as references. Definitions of such key terms as "effectiveness," "efficiency," "criteria," "operations" and "services" were given and a glossary of management science terms was provided. A matrix was constructed depicting the possible application of various management techniques to specific library operations and services. A discussion of the findings of the investigation was presented. Generally, the existing criteria are deemed incomplete; only a few of them are useful as a basis for measuring library efficiency and

effectiveness. The quantitative measurement of the value of a library service or product such as a literature search, bibliography or current awareness service appears to be difficult to assess.

Selected suggestions were made for possible approaches to development of suitable criteria. Among these was the suggestion that a specific library criteria might be developed by analyzing to what extent the library carries out its mission.

This report discusses the investigations and findings of Phase II. The contractor was charged to collect and evaluate the data on technical libraries already available from surveys conducted by DoD, Department of the Army and others. The contractor was directed to visit a selected number of Army Technical Libraries to gather additional information on performance standards, work measurement, standard operating procedures and related items.

Although the contract states that it is the task of Phase III to establish, test and evaluate the criteria, the dividing line between Phase II and III is neither fixed nor precise. The very nature of the work is such that the form and substance of the criteria begin to take shape in Phase II. Thus, although this report will not actually state or recommend final criteria, a task that will be treated in Phase III, the analysis and evaluation of the data and information identified in Phase I and II will suggest to the readers the characteristics intended to describe these criteria. Phase II is not intended to be instructional in the application of tentative criteria or methods of implementation. Phase III will present and validate the the criteria and methods of implementation suggested in this phase and will also present detailed instructions on how to apply the tools. Phase III will also present ranks for the criteria and tools according to their relative usefulness at various types of libraries.

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DISCLAIMER

The findings of this report are not to be construed as an official Department of the Army position.

I. CANDIDATE CRITERIA AND CONCLUSIONS

The statements in this chapter represent the summarization of the findings of Phase II work. One would normally expect to find them at the end of the report. They are being presented at this point, however, so that the reader may better understand the developments in later chapters.

In reviewing the work of Phase II it became apparent that the candidate criteria fall into four general categories, depending upon the particular parameter or aspect of the library to be evaluated. These classes of criteria are:

(1) Philosophical - criteria which relate to the enunciation of the reasons for the existence of the library and the purposes it serves. The criterion here might be "the adequacy and clarity of the library mission statement is a criterion of the effectiveness of the library," for on it hinges the ability of the library staff to fulfill the purposes of the organization. It is not claimed that this class of criteria would lead to standards by which to "measure" in the usual physical sense of the term.

(2) Management - criteria which relate to the influence exerted on the effectiveness of the library by the management practices. Here we are suggesting that the effectiveness of the library is a function of how expertly the librarian (and other library supervisory staff in the larger library) chooses his staff, organizes them and directs their efforts towards producing the services which are essential to fulfilling the goals and objectives of the library.

(3) Services and Products - criteria which relate to the outputs of the library, that is, the actual services performed for a client or the products produced for the client's use. This class of criteria would relate to identification and measurement of the characteristics of the services and products and also the value of these outputs to the clients. These criteria would strive towards evaluating the effectiveness of services and products in fulfilling either individual client's needs, or statistically fulfilling the needs of populations of clients.

(4) Operations - criteria which relate to the more or less routine, but nonetheless professional actions which are carried out daily by the staff in operating a library, but which actually determine the quality, quantity, usefulness and cost of the services and products.

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PHILOSPHICAL

Criteria	Method of Implementation
1. The effectiveness of an Army Technical Library is a function of the extent to which it supports the mission of the parent organization. (a) The mission of the Army Technical Library is a derivative of the mission of the parent organization. (b) The effectiveness of an Army Technical Library is a function of the adequacy and clarity of its mission statement in enumerating concrete goals and objectives, as well as specific library services and products.	1. Organization analysis - study of the purpose for the existence of an organization, its primary and secondary functions and the extent to which it accomplishes its functions (see XXVI in glossary). 2. Research - study of missions statements at other libraries with similar types of clientele (see XXVII in glossary). 3. Human relations - studies in customer oriented planning and control (see XVII in glossary). 4. P.P.B.S. - Planning - Programming - Budgeting System aids program directors in planning, delineating objectives and analyzing costs and benefits and in budgeting to maximize benefits (see V in glossary).
2. The effectiveness of an Army Technical Library is a function of the closeness of its affiliation with the administrative level responsible for the organizational divisions served by the library. The mission of the Army Technical Library is approved at this administrative level and implemented by the library administrator.	1. Organization analysis-utilizing organization charts to identify relationships between line and staff units within an organization and to delineate areas of responsibility of each unit. Also provides a view of the distribution of responsibilities making recognition of role inconsistencies with organizational goals easier (see XXVI and IX in glossary).

MANAGEMENT

Criteria	Method of Implementation
1. The effectiveness of an Army Technical Library is a function of the extent to which the library administrator manages his resources to provide the combination of services and products which give optimum support to the library mission, goals and objectives.	1. Cost-effectiveness analysis and P.P.B.S. - utilizes a "systems approach" to quantify costs and effectiveness through system simulation models. The system model facilitates mathematical modeling which can be the basis for planning, programming and budgeting decisions (see II and V in glossary).
(a) The effectiveness of an Army Technical Library is a function of the extent to which the librarian meets quantity requirements for products and services. (b) The effectiveness of an Army Technical Library is a function of the extent to which the librarian meets quality requirements for services and products.	2. Utility analysis - utilizes managers' judgments as to the value of services and operations in supporting the library mission. Basic judgments of the relative values of each service and operation are recorded in such a way that mathematical equations can be used to unify these basic judgments and to resolve the balance between operations which gives optimum support to the library mission, goals and objectives (see IV in glossary).

SERVICES AND PRODUCTS

Criteria	Method of Implementation
4. The effectiveness of a given type of service or product is a function of the probabilities of occurrence of all events essential to that service or product.	1. This can be determined by measuring, for a population of needs, the percentage of needs which pass each event required to accomplish objectives of the services or to accomplish the production of the products.
5. The effectiveness of a given service or product is a function of the collective effectiveness values of all individual operations in accomplishing events required to produce it.	

6. The effectiveness of a given library service or product is relative to the collective indifference (of potential users, librarians and their supervisors) between that service or product and other services or products needed to meet their respective objectives.	1. This can be determined by subjective analysis of the value or utility of each service or product in supporting the mission of the library and the mission of the parent organization.

OPERATIONS

Criteria	Method of Implementation
7. The efficiency of a given library operation is a function of unit cost and quality (effectiveness) of operation outputs.	1. Where high correlations exist between operational costs and outputs within and among Army Technical Libraries it is possible to develop attainable standards of efficiency for given ranges of effectiveness. 2. Efficiency of routine operations can be measured against standard data when standard units of work are produced. Time standards for routine operations which are performed to accomplish essential events in library services can be developed for each routine operation through G.A.P. or other work sampling studies. Group efficiency can be measured against the standard and expressed as an index of staff utilization.
8. The effectiveness of a given operation is a function of the probabilities that essential events occur due to the outputs of that operation.	1. This can be determined by the relationships or correlations between certain event probabilities and the outputs of operations.

9. The effectiveness of a given operation is a function of its output contribution to the total value of library services or products.	1. This can be determined by subjective analysis of the value or utility of each operations output in adding utility to various services and products.

Criteria for the evaluation of library efficiency and effectiveness, methods of implementation and potential methods for developing efficiency-effectiveness standards are anticipated as the end product of this study in Phase III. It is anticipated that some of the final criteria which are presented in Phase III will obviously be easily supported, some will be sound, but difficult to demonstrate and still others will be of the nature of hypotheses.

A number of limits should be considered at this time in order that the contractor's intent will not be misinterpreted.

Limits:

1. The criteria are not intended to be all inclusive as a basis for management decisions concerning overall library efficiency or effectiveness.

2. The methods of implementation of these criteria are not, at this stage of the state-of-the-art of library evaluation, proposed as being purely scientific. Many areas concerning efficiency of library operations and effectiveness of library operations and services continue to elude scientific measurement or evaluation. For example: The findings of this report do not include criteria for the measurement of (a) the value of information in a collection, (b) the value of books, documents, etc., (c) the effectiveness of the library in meeting individual client needs, (d) the efficiency of nonroutine administrative operations such as staff and users training. However, the best scientific methods available in the state-of-the-art of "scientific" management have been selected by the coordinated judgments of 3 management consultants on the contractor's staff. After these methods have been tested for validity during Phase III of this effort, the feasibility of their application at various types of libraries will be determined. These validated criteria and methods of implementation are expected to be only one link in the evolution from "artistic and subjective" library evaluation to "scientific and objective" library evaluation.

3. Standards developed by means of validated criteria and methods of implementation should not be regarded as being standards which should at once be strictly enforced. Extensive testing and further development is necessary before standards of sufficient precision can be developed to control library efficiency and effectiveness within confidence limits significantly tight to justify rigid policies. However, the criteria and methods will serve as a basis for establishing adequate standards for performance evaluation.

4. The usefulness of the criteria and methods validated during this study will relate, in the final analysis, to the ability, available time, and inclination of library administrators or Army management officials to adapt and implement them. Therefore, it is recommended that a seminar and/or a training program be started to encourage further development and use of the validated criteria for measurement of efficiency and effectiveness.

II. THE NATURE OF CRITERIA

It is necessary to strive for some intellectual precision when thinking of the concepts connoted by the words "criterion" and "standard." Furthermore, there is an ever-present danger of concept confusion when we attempt to represent degrees of meeting standards in terms of "effectiveness," and then quantify this somehow in terms of "efficiency" when the factors of time and cost are introduced.

For these reasons, it is appropriate to discuss the nature of "criteria." From this, concepts of the nature of "standards" should develop, as well as ideas of how measures of "effectiveness" emerge from degree of ability to meet standards; "efficiency" values involving time and cost should then become obvious.

"Criterion" is defined in Webster's Seventh New Collegiate Dictionary as "a standard on which a judgment or decision may be based." The word "standard" as a synonym for criterion is "something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality." "Standard," "criterion," "gauge," "yardstick," "touchstone" denote a means of determining what a thing should be. "Standard" applies to any definite rule, principle or measure established by authority. "Criterion" may apply to anything used as a test of quality whether or not formulated as a rule or principle.

It would be advantageous to the progress of the work of this contract to construct a model showing the relationships between the concepts of "criterion," "standard," "effectiveness" and "efficiency." The model will be fundamental to the authors' thinking and, although some readers may disagree with it, it will be defended as the basis of the system of criteria eventually to be proposed. The model is as follows:

<u>CRITERION</u> - a requirement on which a judgment or decision may be based.

<u>STANDARD</u> - something set up or established by authority as a rule for the measure of quantity, extent, value or quality. In the sense used here, a standard is a criterion with qualification, quantification or dimensions added.

<u>EFFECTIVENESS</u> - the extent or degree to which a particular thing fulfills the mission, goal or objective for which it was performed, that is, the degree to which it meets the standard set by authority.

<u>EFFICIENCY</u> - effective operation as measured by comparing production with cost (as in energy, time and money). Efficiency is a measure of the number of units produced per unit of energy, per unit of time, per unit of money, etc.

This concept of "efficiency" assumes that the units produced are "effective" units, that is, they meet the "standard" which authority has established from the original "criterion."

To draw a general conclusion from the criterion-standard-effectiveness-efficiency model, it is not possible to establish specific levels such as efficiency without first establishing more generic levels such as effectiveness. In turn, measures of "effectiveness" cannot be established without first establishing "standards" and, more generic than standards, criteria.

Although analogies are not always satisfactory methods for proving a hypothesis, they sometimes serve as helpful examples. In this sense, consider this example. Suppose criteria are to be established for military "commandos." *By studying what commandos are expected to do, it is noted that they must often jump over fences to get to the site of their intended operation. One criterion for determining the effectiveness of commandos, therefore, could be the ability to jump fences.

In order to understand more about the importance of the fence-jumping requirement, it is necessary to study this aspect of commando tactics. Suppose a study shows that, to reduce fence-jumping to the status of a constant, it is necessary to jump the highest fences found - say a height of 20 feet. However, it is known that no man unaided can jump 20 feet high. Thus, to set a standard of ability to jump 20 feet high for commando candidates is unrealistic and would rule out all candidates. Therefore, a further study is performed where the total population of fences to be jumped is sampled and their distribution analyzed. Suppose further that this distribution curve shows that the ability to jump 6 foot fences will permit surmounting 95% of all fences encountered. An "authority" can then decide that commando candidates must be able to jump 6 foot fences and this becomes the "standard" for that requirement.

Let it be supposed that in the field we measure the actual performance of completely trained, experienced, practicing commandos with reference to jumping fences. If all commandos jump over 6 foot fences with no exception, their group effectiveness is 100% of the standard requirement, and at least 95% of the operational fence-jumping requirement. If some of the men jump fences higher than 6 feet, their operational effectiveness is higher than 95%, but less than 100%.

* The analogy has been chosen from an area remote from librarianship so that the more complex characteristics of librarianship will not complicate the issues being developed.

The efficiency of the process can then be determined in terms of the time and cost of jumping fences (costs include probable loss in casualties, energies, equipment, etc.).

The model might be stated as:

CRITERION - one of the criteria for determining the effectiveness of the commandos is the ability to jump fences.

STANDARD - in the theater of commando operations where fence heights up to six feet include 95% of all fences which are encountered, all commandos must be able to jump over fences up to six feet high.

EFFECTIVENESS MEASURE - in actual operation every commando jumped all fences up to six feet high. Some jumped higher fences. None jumped all fences more than six feet high. As a group their operational effectiveness rating for this particular criterion is at least 0.95 but less than 1.00. Effectiveness with regard to the standard is 1.00.

EFFICIENCY

Efficiency = a cost function of jumping the fences in a particular operational case.

Fence-jumping would, of course, be only one of a series (C_1, C_2, $C_3 \ldots C_n$) of commando criteria. As in the determination of effectiveness of electronic or other equipment, where overall reliability (R) is a function of the reliability of all essential component parts (assuming no shunts): $R = r_1 \times r_2 \times r_3 \ldots \times r_n$, so the overall effectiveness of the commando would be a function of all criteria which affect commando performance:

$$E_o = E_1 \times E_2 \times E_3 \ldots E_n,$$

where:

E_o = overall effectiveness of commandos in accomplishing the goals and objectives of their mission;
E_1 = effectiveness at jumping fences;
E_2 = effectiveness at demolition;
$E_{3,4,5}$ etc.= effectiveness at other essential operational tasks.

Depending upon the standards set, the ability to meet the individual standards determines the minimum effectiveness values. The actual effectiveness values will usually be higher, but not significantly so if the standards are tight.

In relating this approach to a library situation, the question may be asked: "Why do libraries exist"? The answer could be "To provide services to clients." The effectiveness of libraries would be a measure of how well the libraries provide these services to the clients. In order to be more

analytical and meaningful in discussing the effectiveness of services, the various kinds of services provided by libraries must be identified, such as, for example, (1) circulation services, (2) reference search services, (3) translation services, etc. Even this breakdown does not permit the determination of effectiveness at a meaningful level. Levels of greater definition must be sought and each individual item at that level must then be studied. Using reference search services as an example, by analysis one can identify four kinds of searches, the kind depending upon how the client requests the service:

I. Unequivocal expression of an unequivocal need.

Example: A client requests a copy of "Annual Review of Information Science and Technology," Volume I, 1966, American Documentation Institute, Carlos A. Cuadra Editor, pub. by Interscience Div. of John Wiley & Sons, New York.

II. Equivocal expression of an unequivocal need.

Example: The client wants the particular book described in Case I, but does not know the precise title or the editor's name, publisher, etc., and has to describe his need ambiguously.

III. Equivocal expression of an equivocal need.

Example: A client does not know the identity of specific books or documents. Furthermore, he does not know precisely what he is seeking. He may, for example, request information on the effect of contaminants on the properties of ruby lasers.

IV. Unequivocal expression of an equivocal need.

Example: A client knows what he is seeking, but does not know the publications which are relevant. He may, for example, request a list of all books published in Great Britain on plastics in 1965.

Type III questions are those which most require expert subject indexing,* although Type II and Type IV also require them.

In studying the effectiveness of the library in responding to Type III search questions, what are the factors involved? Among others are: (1) completeness of library collection or "data bank," (2) subject indexing of books, documents, etc., (3) skill and knowledge of reference librarians.

* Cataloging and indexing are used interchangeably in this text.

Assuming that the library collection is a constant and that the reference librarian possesses sufficient knowledge and skill to be able to locate all pertinent documents which are adequately indexed within a limiting time, indexing will be considered the only significant variable. Since indexing is the major method used to label the things stored so that they can be retrieved upon demand by library users, it is a candidate criterion of the ability to regain documents by search and thus of the effectiveness in serving client needs.

To hypothesize, let one criterion of effectiveness of search be indexing. Furthermore, assume that the only concern is with subject index terms.

Unlike the commando example, it is difficult to determine real maximum number of index terms. It cannot even be established that the maximum number corresponds, for a given document, to the number of different words in that document. Synonymy could make the maximum larger. However, it can be assumed from experience that the desired number of index terms should be in a certain range. Then it is possible by authority to specify a number of index terms and declare this to be the standard. In order for an authority to specify this number, it is necessary to perform a study of, say, the increasing probability of locating documents as a function of the number of index terms per document, as well as a function of the number of documents of that class (e.g., mathematics, L.C. Class QA; chemistry, L.C. Class QD). This probability is, of course, a function of several other factors such as time permitted for search (cost) and the skill of the searcher. The first two are significant factors and will suffice for experimental development at this point. The effect of indexing and the number of documents for the Type III questions discussed earlier - where there is an equivocal expression of an equivocal need - may be indicated by constructing a three-dimensional graph (Figure 1), utilizing data from actual searches to determine P_{j3}, X_{ij} and $\bar{Y}_{ij}$ where:

P_{j3} is the probability of finding three or more documents relevant to the client's equivocal expression of an equivocal need at a j library;

X_{ij} is the total number of documents in all subject classes searched, e.g., mathematics or chemistry, at library j for query i ;

$\bar{Y}_{ij}$ is average number of index terms per candidate document in the relevant subject classes at library j for query i .

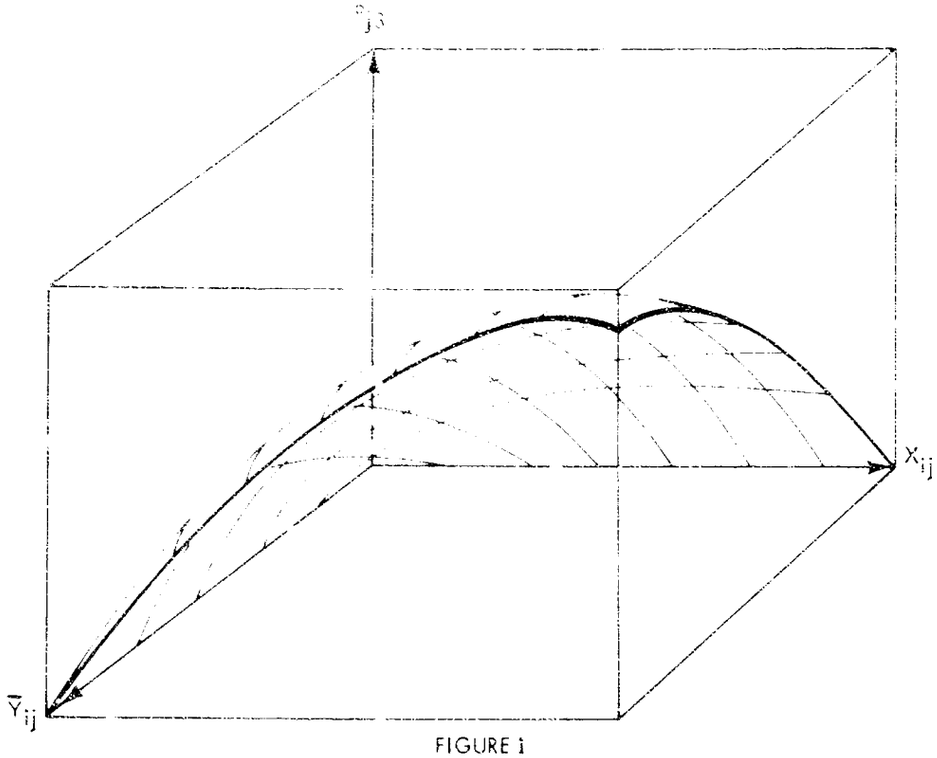


FIGURE 1

It now becomes possible to gather data based on document-finding results for a population of Type III queries, at a number of different libraries, where the mean number of index terms used on documents recalled as well as the number of relevant documents in the given subject classes can be determined. From these data equations for the probability of finding some number of documents can be constructed. For example, the probability of finding three or more documents may be some function of X_{ij} $\bar{Y}_{ij}$ and t_{ij}, i e.,:

$$P_{j3} = f\left[(X_{ij}),(\bar{Y}_{ij}),(t_{ij})\right].$$

Here the time factor "t" has been added as the third member of the equation and additional factors can be inserted. The variable of search ability will be considered constant for qualified reference librarians. However, a proficiency test could be administered to level this factor. The subscripts i and j refer to a particular query in the i family of queries at a particular library in the j family of libraries. In a group of ten libraries, j = 1,2,3...10 and an individual library, say, has 100 queries with X_{ij}, $\bar{Y}_{ij}$ and t_{ij} known; these queries are i = 1,2,3...100. The first query at the first library will have specific X_{ij}, $\bar{Y}_{ij}$ and t_{ij} values of, say X_{11} = 1000 documents, $\bar{Y}_{11}$ = 3 terms and t_{11} = 1 hr.

Having developed this probability situation the following proposition can be posed to the library administrator:

If a standard is set which requires a probability value P (perhaps 95%) that you will be able to retrieve three or more documents in response to client needs in specified subject fields, when your collection size in that subject field is a certain number of documents, and time "t" can be spent searching, it is necessary that these documents in your collection be indexed to an average depth $\bar{Y}$. If the document collection size is altered, or if "t" is altered, $\bar{Y}$ will change.

It will be possible to prepare families of graphs for P_j values for retrieving increasing numbers of documents: 1 or more; 2 or more; 3 or more; etc.

Having determined the depth of number of index terms for a set of constants, the library authority can now set a "standard" for indexing depth. While these "standard" conditions exist, meeting them will insure that the library's effectiveness in responding to client search needs of that type has the probability value chosen with a certain predetermined risk of error. Once this number of index terms is determined and set by authority as the standard number of index terms for that subject classification in that collection, adherence to that standard should achieve the probability of effectiveness indicated by the study.

In this discussion it is assumed that the index terms are selected by trained and experienced indexers on the basis of a carefully prepared thesaurus.

It must be emphasized at this point that for the most practical application of these criteria-standards-effectiveness-efficiency concepts, each situation should be regarded as dynamic. If indexing, for example, should prove to be one of the criteria of effectiveness of technical libraries, there may be different standards for various subject fields to provide tighter and more reliable standards, and it is quite possible that the standards carefully determined for today's situation in a particular subject field could be quite different at a later time. The depth of indexing suitable, say, for archeology, might not equally serve solid-state physics or oxidative enzymes and, within these fields, what holds true today might not be true later. It is likely, in an overall dynamic situation, that enforcing standards nonetheless would maintain stable effectiveness for a short run period. Periodic measurements of the effectiveness probabilities should be taken to determine if the enforcement of standards realizes the level of required (or predicted) effectiveness.

At this stage of the discussion, it should also be brought out that the criteria-standards-effectiveness-efficiency concepts are most applicable for overall library service effectiveness. These methods will measure the effectiveness of a library in responding to a population of questions, service requests or clients. The study of such populations will give data for quantifying that concept of effectiveness.

These considerations do not, however, give data for quantifying the effectiveness of a library's response to an individual client's request. The latter is a different kind of response effectiveness and the distinction between the two should be recognized. For clarity, therefore, let us distinguish:

E_{sIII} = overall search service effectiveness in responding to populations of Type III search needs,

E_{IC} = effectiveness in responding to the particular Type III search needs of individual clients.

Our study will provide data for obtaining values for E_{sIII}. It does not appear, however, that this study will give objective and quantitative values for E_{IC}. To obtain values for this measure of effectiveness it is necessary to have a more meaningful knowledge of user feedback, user satisfaction, user project progress, user project importance or something along those lines. To develop this knowledge we must study feedback--what is it, how it can be identified and how it can be quantified.

Some attempt, however, should be made to identify certain types of questions which would reduce the equivocal nature of needs, for example, questions which would establish (1) the time deadline for receipt of information, (2) the estimated number of relevant documents published, and (3) the percentage of relevant documents which should satisfy the need.*

The remaining equivocal areas of needs may be measured by subjective and qualitative criteria or empirical criteria in the judgment of an expert who would attempt to level the effectiveness of search strategy, retrieval strategy, etc., after exposure to the library operations performed and user feedback.

* Personal communication with Cyril Cleverdon.

III. DATA AND INFORMATION COLLECTION AND ORGANIZATION

As the work of this contract developed, it became apparent that there are several approaches to developing criteria for evaluating the efficiency and effectiveness of library operations and services. The various approaches lend themselves in different ways to the numerous aspects of library operations and the products or services arising out of these operations. There are undoubtedly additional approaches other than those we utilized, but attention will be directed chiefly to 5 approaches.

These 5 approaches involved the utilization of both data and information. It is the purpose of this chapter to separate these data and information into the 5 classes. For each approach the authors refer to the data or information as a "type" corresponding to the approach under discussion. Although the types are discussed separately, there will be some inevitable concept overlaps. These will be minimized as far as possible.

The word "data" is used in this report in the broadest sense. Actually, in this work the contractor is interested in gathering any type of knowledge which might be useful in recognizing and establishing criteria for evaluating effectiveness of library operations and services. It is not our purpose to launch into a lengthy discussion of the distinction between "data" and "information." Rather, for simplicity, the word "data" is used as connoting chiefly numerical, mathematical or statistical symbolic values, and the word "information" as connoting chiefly descriptive facts expressed in words.

The "data" or more properly the "information" required for approach No. 1 is simply a set of statements concerning existing criteria gathered either from the literature identified in Phase I or from statements made by librarians visited during Phase II.

The data or information for approach No. 2 comprise the existing mission statements for the libraries of the Army Technical Library complex. Shortly after the beginning of the contract, the Chief of the Scientific and Technical Information Branch of Picatinny Arsenal, Department of the Army, send a request for mission statements to 88 Army Technical Libraries. These were reviewed by that office, and a total of 72 mission statements was forwarded to us for analysis and evaluation.

The data for approach No. 3 are statistical in nature. Obtaining them was simply a matter of examining several existing reports and studies on Army Technical Libraries and extracting the data. The analysis of these data is presented in another separate section.

The gathering of "data" for approach 4 and 5 became one of the tasks to be accomplished during the library visits of Phase II. It was not the intention of the contract to visit all Army Technical Libraries, but

rather a sample of the population representing selected aspects required for study. The Army Technical Library complex is made up of approximately 107 libraries. These are widely separated geographically and differ much in character, scope, collections, staff size, location in supervisory organizations, missions, services and operations and many other charateristics. Some serve research organizations, both basic and applied. Some are for the use of developmental scientific and technical groups. Some are for test and evaluation groups. The subject contents vary widely, covering the majority of scientific and engineering disciplines and subfields. In order to make an organized and fairly logical approach to the selection of 10 libraries for visits, it was considered necessary to establish a set of requirements by which to evaluate the population of the 72 libraries. The sample chosen is based upon ten criteria and is not a completely random statistical sample. This method was used in order to accomplish the objectives of this contract with a minimal sample size.

The ten criteria for sample member selection are as follows:

1. The organization should have responded to an earlier Department of the Army in-house request for a statement of its mission. This request had been made to libraries, information analysis centers and technical information centers.

2. The organization should be a technical library within the implied definition of ATLIS Report No. 1, September, 1966, "TECHNICAL AND MEDICAL RESEARCH LIBRARIES AND INFORMATION CENTERS OF THE DEPARTMENT OF THE ARMY," and should be included in that study.

3. The library should be in the group for which data were presented in the STINFO REPORT No. 1, U.S. ARMY ON-SITE SCIENTIFIC AND TECHNICAL INFORMATION SURVEY, September, 1964.

4. The library should have been included in the Army Library Career Program Survey (except Corps of Engineer Libraries).

5. The libraries should include at least one which utilizes automatic data processing equipment for its operations or services as per "STUDY OF MECHANIZATION IN DOD LIBRARIES AND INFORMATION CENTERS," Booz-Allen Applied Research Inc., September, 1966, AD 640, 100.

6. The libraries should not be limited to those in the Washington, D.C. metropolitan area, but Army Technical Libraries in the geographical area should be utilized if they fulfill other requirements adequately.

7. The population of libraries should, if possible, represent the various Army Commands, such as CDC, AMC, CONARC, Corps of Engineers and Surgeon General's Office.

8. The libraries should include not only those serving research and development groups, but also test and evaluation groups.

9. The libraries should represent as wide a scope of collection and staff sizes as possible.

10. The libraries should represent as wide a variety of scientific and technical subject matter in their collections as possible.

All libraries chosen for visits were notified by letter by the Chief, Scientific and Technical Information Branch, Picatinny Arsenal, Department of the Army. This notification requested permission for the visits, specified that the visits would be for 1 to 2 days, named an approximate date and explained the purpose of the visit. As the scheduled date for each visit drew near, the head librarian of each chosen library was contacted to confirm the date and was sent a packet of background information to provide the library staff with some of the ideas of our research team. The packet contained a statement outlining the various criteria which we visualized for development, and a sample interview guide which the research team expected to use for obtaining the data. The interview guide was revised as a result of experience gained in the first few visits. The length of stays varied from one-half to two days. The length depended upon the extent to which the staff had prepared itself as a result of studying the literature packet, reviewing the nature of the data requested, and reviewing the data available at the library. In all visits, a tour of the library was made, and conversations held with several members of the library staff to obtain some idea of attitude toward management, clientele and fellow staff members. The major part of the visit time, however, was utilized to obtain the requested data.

In general the data sought were available or easily derived from records kept at the Army Technical Libraries or from past studies on Army Technical Libraries. However, certain classes of data were more difficult to obtain, such as user statistics (number of actual and potential users, extent of in-house use, types of users), use and extent of reference services, extent of bibliographic service, weights of library operations as they contribute to each service, and weights of each service as they contribute to the library mission and objectives. In order to get these data, ranges or estimates were accepted. The mean was estimated from the range and estimates of other parameters such as the mode and median Using these parameters the mean was estimated and was given confidence limits which were within $\pm$ 15%, 90% of the time for the data recorded. All other data sought had in general been derived from the statistics kept in each library or from statistics obtained from CEIR studies, previous ATLIS studies, library fact sheets and other previous studies. The accuracy of these data cannot be estimated by comparison, since the data represent changing situations over a period of years. However, due to the accessibility of these data, they are expected to be accurate within $\pm$ 15% 90% of the time or better.

Further investigation on the reliability of data is represented in the statistical analysis in the following chapters.

IV. TYPE 1 APPROACH EVALUATION AND ANALYSIS

The idea behind this approach is the rather obvious one of simply determining what criteria already exist, either in Army Technical Libraries, other technical libraries or other libraries. This approach was to identify these "criteria" either from the literature, (see Phase I abstracts), or from questions asked during visits to the selected Army Technical Libraries. Not all criteria may be plainly labeled "criteria"; they may also go under such other labels as "standards" or "policies" or "instructions" or a variety of other terms.

Since it is not the purpose of the present contract necessarily to invent criteria, but rather to identify or recognize as well as to originate such concepts, simply to locate such as already exist would serve the purpose equally well. If suitable criteria already exist, it will serve the task adequately, therefore, if the contractor simply identifies them and validates them. Criteria are not per se independent and adequate in a practical sense for determining effectiveness of libraries or, for that matter, of any other organization. It is necessary that they be supported by additional and more specific concepts such as are found in "standards." Effectiveness" can then be determined by measuring the degree to which the item under consideration meets the standard. If we wish to attach time and cost parameters, "efficiency" can be established. Furthermore, criteria should not be vague or ambiguous, but clearcut and capable of development into easily understood and enforceable standards.

It was the experience of the contractor, in searching the literature, that statements of criteria often did not have any organized concept in mind and were difficult to apply in a practical way. However, there are many useful standards for which there are no criteria statements. In some cases, it is not necessary to state these criteria explicitly, because they are implicit to any one knowledgeable and experienced in the field. In some cases, however, it would be helpful to every one involved, especially nonlibrarian administrators with library administration responsibilities, if the coordination of the criteria, the standards, and the measurement of effectiveness were made more clearly visible and understandable.

The following discussion of existing criteria is not exhaustive. Since it is fairly obvious that not all criteria are plainly labeled as such, and that some criteria may be enunciated in reports or other publications not included in the literature search, it is quite possible that existing important ones may have been missed. Furthermore, it is quite possible that some important criteria are so much taken for granted as to have been overlooked. It is hoped, however, that the most important ones will be taken into consideration.

The criteria gathered from the literature appear to fall into four general categories:

(1) library mission and organization-related criteria;
(2) administrative, management and general criteria;
(3) operations criteria;
(4) service criteria.

The criteria associated with the mission of the library usually are goal-related. For example, some existing criteria state: (1) the library should support the total organizational program and goal (378)*; (2) the library goals should support the goals of the parent organization (455); (3) the library goals must be explicit as to extent of service and priority requirements (455); (4) the role of the library is determined largely by requirements for library services of the laboratory served (207). In one case a criterion was subject-related: a scientific library's mission is to provide scientific information (248).

Some of the criteria statements for management personnel discuss inter-organizational expectations and some discuss more functionally what an administrator should do. This can be advantageous, when the administrator of the library is fully aware of the criteria. These statements are: (1) a college library should be directly responsible to the college president (182); (2) a library should publicize its services so that the users know they exist (345), (24); and (3) library goals must be agreed upon by management, library and users (455).

Very few criteria exist for a library budget. Both of the criteria found were in the 1964 SLA Objectives and Standards for Special Libraries(770). These were: (1) a budget for a special library should be based on recommendations of the library administrator; (2) the library administrator has the responsibility and authority for the expenditure of his budgeted funds.

The criteria for determining staff personnel were more difficult to locate precisely. These dealt mostly with professional requirements. These were for example: (1) The criterion of a profession is the existence of a systematic body of knowledge of substantial intellectual content. A member of the profession should have personal skill in the application of this knowledge to specific cases (109). (2) An adequate professional library staff is an essential component of basic research facilities (176). (3) The library staff should include persons trained in the users' fields and be familiar with their problems (225). (4) The librarians should have knowledge of sources of information and library training (381). (5) The library staff is responsible for the efficient organization of materials and for making available the catalogs and indexes for prompt access to the materials and the information by the patrons (770).

*Numbers in parentheses refer to references in Phase I report or the supplemental references in this report.

Other criteria are more specific, and might even be considered standards, as far as staffing is concerned. These are: (1) A job description should include a statement in detail of actual activities, indicating importance of each activity, the conditions under which the job is performed, and the materials needed to carry out the job (428); (2) In order to determine grade level in a government library, the knowledge requirements, scope of assignment and level of responsibility should be factors (94); and (3) To qualify as a librarian, a person should have five years of formal education beyond secondary school including graduation from library school (11).

Many more criteria statements exist for the operations or technical processes which are carried out in the library. In fact, the criteria for the acquisitions program of a library determines the nature, size and complexity of the collection. A criterion for cataloging is the comparative ease with which items can be located.

Some of the criteria statements pertinent to acquisitions are: (1) A special library should acquire materials and information for the organization's current and future needs (770) ; (2) The selection criteria should inform the library staff as to the identity of the material to be processed and also indicate to the clients what they can expect from the library (424); (3) The organization's information requirements should provide an accurate selection of all forms of information to fulfill the needs of research projects and the scientific and technical interests of group members (258); (4) Subject coverage of the collection should be intensive and extensive enough to meet the current and anticipated information requirements of the library clientele (770) ; (5) The size of the collection should depend upon the amount of material pertinent to the organization's needs (770) ; (6) The library should have as much of the needed material on hand as feasible to anticipate needs (206); and (7) The collection can be compared with published lists of key literature (261).

Much has been written about the use of relevance and recall ratios as measures of effectiveness. There is considerable controversy as to the validity of recall and relevance ratios as being measures of indexing systems effectiveness. Although criteria of this nature were not considered at this time for cataloging and classification, their validity will be discussed in Phase III of this contract. Others found to pertain to cataloging and classification were: (1) The catalog should be in enough detail for the users to be able to utilize it efficiently (211); (2) The catalog and classification should be done in such a manner as to assure the highest possible accuracy and consistency for the user (218); (3) Some criteria for a qualitative catalog listed by Oliver Lilley (244) were: cost; physical size; time to construct, maintain, search; scope by topic; ease in determining relevance; number of access points as main entry; universality of information; rate of growth per new entry; obsolescence rate; simplicity of apparatus; adaptability to reproduction and dissemination; adequacy in supplementing similar tools.

There do not seem to be as many criteria existing for library services. Criteria for circulation services include: (1) Ease in accessibility is the most desired characteristic of a system (236); (2) The physical location of the materials should be determined by the amount of use (143); (3) Success in locating library material is more significant than the number of volumes in the collection (456); (4) The ease of access or obtaining the materials is the most desired characteristic of a system (456, 236); and (5) The use of the collection by students in a college library is the ultimate test of the collection and the library (292).

The fewest criteria exist for the reference, search and bibliographic types of services. Some examples are: (1) Technical information service should be provided as a background for specific or individual projects (207); (2) The special library should provide successful reference service varying from answering miscellaneous questions to providing literature surveys and comprehensive bibliographic reports (235); and (3) The library staff should locate library materials and information promptly upon request (770).

The library visits by the research team were not fruitful sources of criteria statements or concepts. However, the subjects discussed and the data gathered during the visits have a direct or indirect relation to the effectiveness or the efficiency of the library in performing its operations or providing its services or products. Therefore, it is judged necessary to include in this report some of the observations made during the visits over and above the actual numerical data. These observations pertain for the most part to library methodology or procedural matters rather than to the more generic concepts usually thought of as constituting effectiveness criteria. Nonetheless, some of these procedural matters might constitute focal points from which to develop criteria.

Some interesting points arise with reference to management matters which have considerable bearing on both effectiveness and efficiency. One of these has to do with accountability records. It appears for the most part that accountability records are kept only for acquisitions which must be purchased. This is, of course, understandable because it is necessary to account for direct expenditure of funds. There is a tendency, however, to view "free" acquisitions as not costing anything. But there are the costs of ordering, following-up, receiving, processing, storing and retrieving these "free" documents which most often represent a larger investment in documents than the purchase price.

A second point of interest noted on the visits which would have direct bearing on library efficiency, although it would not be immediately obvious because the costs are hidden, is the necessity to respond to Army-wide or higher echelon regulations which may have little or no bearing on library operation. That is to say, in a puristic sense, there are certain

regulations which technical libraries must abide by for purposes of higher management, which do not make a positive contribution to library effectiveness but do have a negative influence on library efficiency by requiring staff time. Certain procurement requirements are examples. For instance, accountability requirements consume labor man-hours which may be utilized more effectively on other tasks. Utility Analysis, a method discussed in chapter VIII, is a tool for determining the most effective and efficient allocation of man-hours to operations. After Utility Analysis of the value of accountability operations as opposed to the value of other operations, it may be discovered that accountability requirements have a negative influence upon library efficiency and possibly upon library effectiveness.

The following observations summarize some of the findings with respect to library methods and procedures.

Activities which are a part of acquisitions and accessions:

Library contents selection - Not all libraries consider selection of new books by the user staff to be a part of acquisitions. In most libraries, the librarian selects the material with suggestions from the users and library staff. About half of the libraries can order any books and documents that they wish without further approval, as long as the materials acquired are within the scope and budget of the library. In most cases, however, there was no firm policy. The degree of librarian professionalism determined where selection of new materials for the library was initiated.

Checking - Most libraries check to see if they have the publication requested before placing the order for its acquisition.

Ordering - The biggest delay in acquisitions is in ordering. Depending upon the installation, or the overall command of the library, there are varying amounts of paper work involved.

Receipt - Good receipt records are kept at all places, in many cases in the form of the shelf list which is a matter of complying with Army regulations on accountability.

Documents - Almost all documents are received free. No accountability records are required for free documents.

Computerization - Only one library visited was using a computer for providing a record of items on order and received.

Activities performed as part of classifying and cataloging

Classification - The libraries, all technical in nature, do not all use Library of Congress Classification numbers. Some use the Dewey Decimal Classification System. No other classification systems were found to be used for books.

Cataloging - Cataloging was generally interpreted to mean using authority listings to check correct author entries, using ALA rules for subject headings, or Library of Congress subject headings. About one-half of the libraries did their own cataloging and classifying, and about one-half bought their cards from the Library of Congress. Even those which purchased cards from the Library of Congress either altered the cards or had to catalog and classify some books themselves. Collection size was not the determinant of whether the cataloging and classification was done in-house or depended on Library of Congress cards. However, the size of the staff did reflect whether or not in-house cataloging was done since additional staff were needed to perform this operation. One library was in the midst of converting from Dewey Decimal Classification to Library of Congress Classification.

Verifying - Checking to determine if books are classified the same way every time was performed in all libraries, using either authority files or the National Union Catalog.

Shelf listing - This function was performed in all libraries and provided the data for material accountability.

Catalog maintenance - All libraries attempted to keep their catalog current in order to reflect weeding and new acquisitions.

Document Indexing - A variety of documents is acquired by the various libraries. Of these documents, a large percentage originates in federal government agencies and may be acquired via government announcement bulletins. Even though such bulletins provide indexing entries, most of the libraries visited do their own indexing of the documents.

It is not common for the libraries to index journal articles, even though they may be pertinent to the particular library's collection. The one library visited which does index journal articles pertinent to its collection consequently spends a greater proportion of time on indexing than do the other libraries.

Preparation and maintenance of library materials:

This was considered to include book marking, book pocketing, weeding and card catalog maintenance. This library operation, although not obvious to the library user, takes about 5% to 10% of the library's time, according to the data gathered from these libraries. Most of the policies or standards in this area are written, but are out of date; therefore, saying that most of these standards are tradition would be more correct.

Circulation:

Circulation was considered in two ways: one, as pertaining to material circulating from a circulation desk, upon request by a user; the other, a predetermined circulation or routing of journals, reports and documents.

The total amount of time spent on both types of circulation varied from about 10% to 30% of staff time. Since the actual activities for these two types of circulation vary, questions were asked separately about each.

Circulation upon request - Some libraries required the patron to be registered. This simplified having to check lists when the user wanted some classified materials, so that he did not have to wait. Most libraries permitted browsing in the stacks. All libraries required that the documents and books be signed out. Although a staff member was located near the entrance of the library to take care of these circulation activities, this person's time was not totally taken up by signing books out. In some cases they aided in returning the books to the shelves, received the mail, answered some reference questions and scanned journals for articles of interest to other personnel. The number of units circulated per day related quite closely to the amount of time spent on this activity. All libraries had active circulation of their materials.

The policies and standards for circulation of items on request are both written and traditional. Those libraries with significant amounts of such circulation have written policies.

Charging - All books and documents should be signed out. In some cases, books are charged out without having been cataloged if there is an immediate need for them.

Overdues - The libraries generally were not very strict on overdues. Most loan periods are 30 days. When loan periods are exceeded, notices are sent out. There was no way of determining if this loan period is adequate, because renewal statistics are not kept.

Reserves - For the most part, the Army Technical Libraries did not provide reserves. However, they do have collections which do not circulate.

Interlibrary loans - All libraries practiced interlibrary loans. Depending upon the library's location and the subject field, some libraries were more involved in interlibrary loans than others.

Photocopying - The patrons are generally free to have any material copied as long as they adhere to the new copyright laws. Almost all of the libraries have photocopying equipment themselves, or equipment nearby for their use.

Routing of journals or predetermined circulation - All but one of the libraries provide extensive circulation of magazines. This library service was found to be one most usually automated, if the library is using any automatic or electronic data processing equipment.

Reference:

Reference questions can be either short, asking for an answer or a fact or even an article or pertinent item, or they can be more extensive asking for several references, a bibliography, or an analysis of information contained in the published literature. In some rare instances, the short reference questions can take longer to answer than is required for the compilation of a short bibliography. It was observed that the short reference questions are not asked to be defined by the patron nearly as often as are requests for a bibliographic type of reference search. The compilation of a bibliography almost always implies extensive work. However, if the short reference questions were defined better, probably less time could be spent responding to them. Reference is one of the few library services which brings the staff in direct contact with both the user and with library materials, books, catalogs and other library tools. Even so, it appears as though this activity takes no more than 30% of the staff time; the usual amount of time is about 20%.

Bibliographic services vary greatly from library to library because of differences in staff capabilities, extent of the collections and staff sizes. In some cases detailed bibliographic work is done within the information center or by subject specialists closely related to the library activities. Most libraries which provide bibliographies take advantage of the bibliographic services of the Defense Documentation Center, the National Library of Medicine and the National Aeronautics and Space Administration, Scientific and Technical Aerospace Report Facility. Libraries do not show partiality as to how requests for information come in, as by phone, by mail or during personal visits. The preference is determined by the person making the request.

Only two of the libraries have equipment on which they can perform reference searches automatically or index their collections. Because the most frequent bibliographic searching areas are government reports or documents, the Defense Documentation Center has automated this service and made it available. The libraries have made use of this service.

No set policies appear to exist for preparing bibliographies. When they are requested, they are prepared, if the capability exists within the library.

Translation:

Only one library prepares translations. The libraries usually accept the requests for translations and attempt to have them supplied, either by arranging for the translation or ascertaining that they already exist elsewhere. All translations requested are usually supplied since their acquisition has already been okayed.

Library Publications:

Library publications which are in the form of published accessions lists are prepared in every library. Some lists contain abstracts or annotations of selected articles. This form of publication takes little time to prepare, since it is made up from catalog cards. In some cases the document accessions are also listed. These lists are usually arranged by subject, but in some cases by the issuing agency. Document lists are not frequent, since most of the documents are classified.

These lists are circulated to the library's patrons and, to some minor extent, outside the group of immediate library users. The publications are thought to be well received, since there are always requests for the items listed.

Public Relations:

Public relations are considered as those activities which inform the users about the library either by orientation tours, preparation of brochures, reports to management or preparing various library exhibits. All libraries perform these activities; they took less than 5% of the total time.

Budget:

The libraries were found to have no set budget, for the most part. The chief librarian and the division chief, if the library is in an information center, usually prepared the budget. There was no set policy or standard evident for determining the budget, but the amount of funds available to the library depends upon the amount of money authorized for the installation or command.

Other administration activities:

Preparation of library standards - These are performed by the head librarian or by management personnel outside the library. In order to measure efficiency or effectiveness of the library, several libraries use work measurement time-standards developed by personnel outside the library.

Library committee role - About half of the libraries have library committees. The committees appear to have limited power in most cases, but provide functional review and advice to the libraries. In one case, the library committee runs the library.

Staffing policies - In some cases the head librarian is able to specify to management the job to be done and the personnel needed to do the job. The usual policy is for the comptroller's office or the manpower

office to determine the number of positions and the types of persons needed to fill them. Other libraries use patron reactions or immediate supervisor review to rate the library and staff needs.

Library space and size - In general space made available to the library is effectively used. This is usually determined by management outside the library.

Other library functions:

Of the miscellaneous remaining functions and tasks which might be performed in a technical library, the librarians queried replied that they do not perform any other operation or produce any other service which requires more than a total of 5% of their time. However, after examining the amounts of time allotted to each activity by administrators it was noted that total time added up to only about 75%. It appears that the administrators did not always include themselves in the accounts of time spent on various service-producing activities and also did not appear to realize the true magnitude of time required for administrative duties. The time of the other library staff employees was well accounted for.

V. TYPE 2 APPROACH EVALUATION AND ANALYSIS

This effort was aimed at gathering the mission statements of the Army Technical Libraries as they exist at the present time in official records. It was then the purpose to examine these to determine if out of this analysis common denominators would emerge which would constitute the basis for criteria statements

Mission statements were requested of Army Technical Libraries by the Chief of the Scientific and Technical Information Branch of Picatinny Arsenal, Department of the Army. This was done early in the contract period to permit sufficient time to receive the maximum number of statements for the analysis. The libraries were instructed to send the statements as they existed at that time, and not to prepare statements specifically in response to the request. The requests were couched in terms asking for mission statements and organization charts of the organizational group administratively responsible for the library's operations and services, and of the installation where the library is located. Out of the total population of approximately 120 libraries identified as Army Technical Libraries, requests were sent to 88 and 72 responses were received. Three of these were eliminated because they were atypical; the analysis was performed on the remaining 69 statements.

Although this discussion of Type 2 data is closely related to that of the Type 5 data, we wish to make a distinction. In this section (Type 2) we are discussing the analysis of data or information representing library situations as they existed at the time of the statement requests. In the Type 5 situation we discuss conditions which the librarian should recognize and recommendations related to these conditions.

It appears fairly common to establish for any organizational unit certain statements which give it form and purpose. They are often presented in a more or less hierarchical arrangement, expressing first the generic concepts and progressing to more and more specific statements. These statements express the policies to be followed by the organization and often the exact functions, procedures or operations of the unit. One such model of statements, which we judge provides the necessary framework for an organization, can be shown as follows:

MISSION - usually a broad and somewhat philosophical statement which expresses the reason for existence of the organizational unit. It is the unit's raison d'etre.

COALS AND OBJECTIVES - these statements tend to give form and substance to the mission statements. They classify major functions the unit is charged to accomplish.

ACTIVITIES - these statements define the actions which will convert the more generic goals and objectives, often rather static concepts at best, into dynamic and meaningful outputs.

OPERATIONS - these statements specify the fairly repetitive, although often highly professional processes which must be performed to produce the activity or service output.

It is theoretically possible to develop such a "package" of statements for any organizational unit, regardless of which echelon it occupies in an organizational management universe. In an industrial world, it can be applied to the highest corporate levels to establish corporation policies and to implement these in various subcompany products or services. In a government situation it can be applied to the executive branch, to departments, subdepartments, commands, and so on. More often than not, the more specific statements of higher level organizational units express the more generic aspects of the organizational units beneath them.

In the overall task of collecting library mission statements and analyzing them to determine their characteristics, their common denominators as well as their points of difference, their orientations and their obviously divergent interpretations of what the mission composers thought libraries are supposed to do, a fundamental rationale predominates. This basic reasoning is to the point that "effectiveness" of library services is undoubtedly some function of how well the library accomplishes the purpose for which it was established. This in turn will depend upon how well the purposes are spelled out and explained and how attainable they are in reality.

This does not mean that the missions, goals and objectives, activities or services, and operations of all libraries, or of all technical libraries, or even of all Army Technical Libraries, will be identical. But it does suggest that, for a given subpopulation of libraries such as Army Technical Libraries, there will be a common essence to mission statements as well as to the substatements under missions. The variations in the statements should be a function of the mission of the parent organization. The missions and their subordinate statements could constitute a basis for judging effectiveness.

The impression should not be gained that the contract investigators expected to find complete uniformity throughout the Army Technical Library system with regard to the location of the library in the organization it serves or with regard to the mode of expression of its mission and subordinate services and operations. It is recognized that there is much variation in size, scope, purpose, funding and other characteristics of Army Technical Libraries, due to their role in supporting the mission of their respective parent organizations. The purpose of the analysis is to seek identification of elements from which to distill principles for the establishment of the most desirable conditions by which to provide criteria for measuring effectiveness independent of the library size, scope, funding and purpose.

A few words on what are considered to be some important aspects of Army Technical Libraries will provide a little background on the author's concepts of these organizations. These can then be areas of agreement or controversy in ensuing discussions. Army Technical Libraries are "support" organizations. They are not oddities, existing simply for the sake of existence. They are meant to support the Army organizations or commands of which they are a part. The libraries are intrarelated with other activities of their own command and interrelated with other libraries in other Army commands. They are a part of an informal network and have similar reasons for existence.

Considering the Army command levels alone, each command has its own reason for existence, and each is different from its fellow commands. Thus, within Army commands, Technical Libraries should indicate obvious points of similarity, whereas the Technical Libraries of different Army commands might be expected to differ somewhat because of difference in command missions. For these reasons we might expect that an analysis of 69 Army Technical Library missions should reveal that the organizations are in many respects quite similar and in many respects uniquely different.

In order to perform an analysis of the missions statements received from these various Army Technical Libraries, and to examine the relationships of these libraries to the Army organizational groups with which they are associated, it was decided that one approach would be to adopt what might be termed a "standard" model, depicting how mission statements and their subordinate clauses might be presented and to determine how well the actual mission statements received "fit" the model. The model selected is that presented on pages 30 and 31.

By way of explanation of what might be expected for the statements of mission, goals and objectives, activities o services and operations, we assumed beforehand such examples as:

MISSION - Serve as a principal source of published and controlled information in support of the research and development programs_____ (name of organization) and of the separate commands located at the installation.

GOALS AND OBJECTIVES

(1) Collect all applicable published information.
(2) Maintain it under bibliographic control.
(3) Disseminate it, or products resulting from processing it.
(4) Conduct studies to determine needs of clients and develop plans for meeting the needs.
(5) Conduct research in new or advanced methods of librarianship and information handling. Develop plans for introduction of such methods which would be more efficient or cost-effective.
(6) Maintain liaison with related library or information organizations.
(7) Others.

ACTIVITIES (SERVICES)

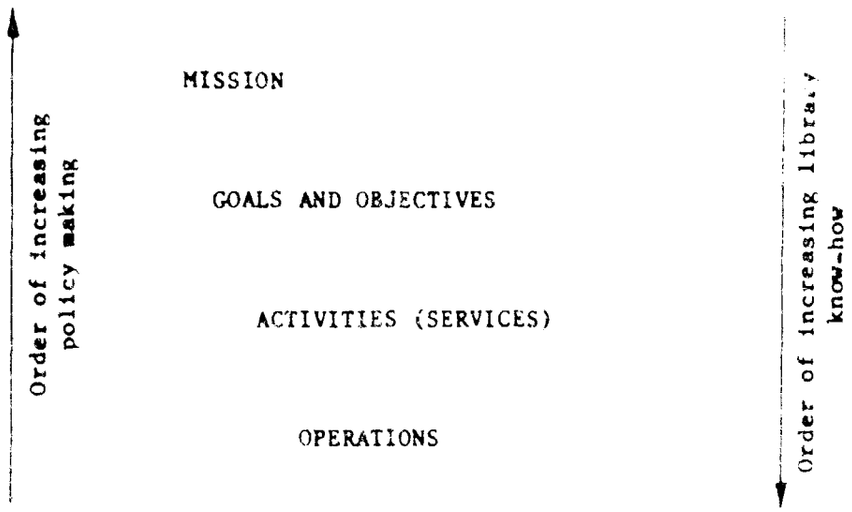
(1) Provide circulation services.
(2) Provide subject matter search services.
(3) Prepare bibliographies.
(4) Provide "current awareness" service.
(5) Provide question-answering service.
(6) Provide translation service.
(7) Provide abstracting service.
(8) Provide reference services.
(9) Provide interlibrary loan service.
(10) Others.

OPERATIONS

(1) Acquisition of books, documents, etc.
(2) Catalog books, documents, etc.
(3) Prepare materials for shelving.
(4) Perform weeding.
(5) Store and retrieve books, documents, etc.
(6) Maintain shelf list.
(7) Maintain property accountability records.
(8) Maintain records of journal subscriptions, holdings, etc.
(9) Maintain binding operations.
(10) Others.

As we study this model, it becomes quite obvious that the responsibility and, for that matter, the capability for establishment of statements at the different levels of specificity shift considerably. For example, at the generic level the responsibility for preparation and establishment of the mission statement quite possibly belongs one or more level above the library itself. Thus, if the library is situated in the Research and Development Directorate of an organization, the library mission statement responsibility quite properly belongs to the head of this directorate. The goals and objectives statements can quite properly and adequately be prepared by the directorate with the cooperation of the head librarian. The activities statements, however, are the direct responsibility of the head librarian. The operations statements are functions of librarianship and the responsibility of the librarian or lower echelon professional personnel on his staff.

We may say then, as shown on page 32, that responsibility for preparation of the various levels of statements should be consonant with levels of policy-making, and with levels of library "know-how."



These matters appear to be rather obvious and their importance may tend to be overlooked. They play an important part in the overall concept of library effectiveness and efficiency, however, in that misplacement of responsibility for establishment and carrying out what these statements connote can result in striving for misunderstood ends and thus a low order of effectiveness. It may not be at all sensible for the head librarian to establish his own library's mission, for he may not have a complete or sufficiently deep understanding of the higher echelon purposes. Yet, it is not sensible for the higher echelon authorities to tell the librarian what operations he should carry out to accomplish the production of certain services, for in doing so they are weakening his ability to carry out fully the expert librarianship capabilities for which he was engaged.

This aspect of library effectiveness is also tied in intimately to the placement of the Technical Library in its parent organization. It is essential that the library be located such that the next higher echelon of authority has the capability of appreciating and understanding completely the technical aspects of the library's work and is not in such a position that he has conflicts of interest between the groups served by the library. Otherwise, there should be a willingness to delegate technical authority either impartially to the technical groups the library serves, or even to the library itself. If certain groups, individuals or projects are to have priority, the mission statement should reflect the degree of priority. Technical understanding and cooperation goes far to lubricate the discussion by which to determine kinds and degrees of services to be provided to each group served, directions to take, and budgets required. All these considerations are criteria for evaluating the effectiveness of the technical library.

An examination of the mission statements returned by the libraries, with reference to location or placement of the library within the parent organization it serves, gave evidence of considerable variation. The responses indicated, as would be expected, that the installations differ considerably. The mission statements of the parent organizations reflected the differences, and thus the supporting elements for the installations, as for example, the libraries, showed considerable difference in missions. Perhaps as a consequence of this the level within which the libraries are situated varied. Although this was most noticeable between commands, it was evident even within the same command. The technical libraries associated with the Army schools of CONARC exhibited uniformity of placement, being administered by the school secretary. This office is usually charged with administrative services, personal services, security and the library.

In the Army Materiel Command there appears to be no set pattern. Even in those cases where the effort is concerned with basic and applied research on assigned materiel, the libraries do not appear to be uniformly placed. The most common locations were in the Technical Services Directorate, the Administrative Services and the Research and Development Command. The Administrative Services Division or office is usually concerned with mail, records, records management, reproduction and publishing. In very few instances are the technical libraries directly under the administration of the research laboratory organization.

Most of the technical libraries in the Surgeon General's Office are hospital libraries, serving the general staff as well as hospital research. These libraries are most often placed in the Administrative Services Division of the organization. Several of the Surgeon General libraries not at hospitals are those in the Research and Development Command. These are located in the Support Division.

The technical libraries of the Corps of Engineers are commonly found in the Office of Administrative Services. If, however, the library is in a research facility, it appears to be directed by the research center or facility management.

The Combat Development Command, like others studied, appeared most commonly to assign its technical libraries to the Administrative Services Division. The examination of the other commands revealed that there appears to be no set pattern as to where the technical libraries are located in relation to the groups they serve most closely.

The mission statement packages returned by the 69 libraries were examined to determine if the statements contain the elements set out in the "model" previously devised for comparison. Of the packages returned, 13 Army Technical Libraries provided statements containing all 4 elements of the "model." Thirty-nine libraries set forth "mission" statements. It

appeared that these statements for the library were provided not only in the library statements, but occasionally in the statement of the organizational group administratively responsible for the library.

The statements most commonly found for the libraries might be termed more appropriately "activity" or "service" statements, rather than "mission" statements. It may be that this is explainable by the fact that the mission statement exists elsewhere and that the libraries are concerned solely with the services they are charged with providing. There may, of course, be some misinterpretation of what a library mission statement should be. Forty-five of the libraries provided activities statements. Of these, 11 were mentioned outside of the library statements. Thirty-four of the libraries showed "goals and objectives" type statements. Of these, 7 appeared outside the library statements. The "operations" the library is expected to perform were found in statements for 33 libraries. In 6 cases these statements of library operations were found outside the library statements. This location of "operations" statements is unusual, because it would appear that the library staff would be most aware of the best operational techniques for accomplishing activities or services and that these statements would appropriately appear in statements by the library.

From the data provided, it is difficult to determine if there is any difference from command to command in insuring that the technical libraries concerned have mission statements, and if the mission statements and their corollaries provide all elements necessary to give adequate and clear guidance for library management.

VI. TYPE 3 APPROACH EVALUATION AND ANALYSIS

The approach visualized here is to examine data which may show possible relationships between library statistics and efficiency and effectiveness either (1) already available in government-sponsored contract or in-house reports,* and (2) data which may be collected to respond to questions in greater depth.

In the case of (1), one of the purposes of the library visits by the research team was to validate some of the data in such reports. For example, some of the questions asked in one of these studies included queries on whether or not the Army Technical Libraries provide services such as loans, selective dissemination of information, shelving/filing/reshelving, circulation, inventory control, abstracting, translations, etc. The validation of such "yes or no" data could make it possible to develop criteria for Army Technical Libraries pertinent to selected services or operations.

With respect to (2), the research team wished to collect additional numerical data, cost data, "yes or no" data, or other qualitative or quantitative data. For example, depending upon the development of the subject, it becomes desirable to seek information or data on such items as the following:

(A) Number of items in the library collection

(1) Books
(2) Journals
(3) Reports
(4) etc.

(B) Number of items in

(1) Chemistry
(2) Physics
(3) Biology
(4) etc.

(C) Clientele

(1) Chemist
(2) Physicist
(3) Biologist
(4) etc.
(5) PhD
(6) MS
(7) BS
(8) etc.

* REPORT NUMBER STINFO 1, U.S. ARMY, ON-SITE SCIENTIFIC AND TECHNICAL INFORMATION SURVEY, September, 1964, Contract No. DA 49-092-ARO-23, CEIR, or ATLIS Report No. 1, TECHNICAL AND MEDICAL RESEARCH LIBRARIES AND INFORMATION CENTERS OF THE DEPARTMENT OF THE ARMY, September, 1966.

(B) Programs or projects of parent organization

(1) Chemistry
(2) Physics
(3) Biology
(4) Materials
(5) Missiles
(6) etc.

From these data a sufficiently detailed picture of library missions, staff size, collection size, number of users, services use, operations outputs, operations costs and other parameters could be obtained from which to draw some conclusions about relationships of efficiency and effectiveness in developing criteria for Army Technical Libraries.

The surveys and reports examined include:

1. "FEDERAL DEPARTMENTAL LIBRARIES: A SUMMARY REPORT OF A SURVEY AND A CONFERENCE," Luther H. Evans et al., Washington: Brookings Institute, 1963. The data for this survey, the first federal library survey made since 1876, were initially collected in 1959-1960 and included all federal libraries, both general and special. The survey was performed with a three-part questionnaire. Part A was filled out by the administrative officer of the department or agency or by a representative designated by him. It dealt with overall policy and administrative problems involved in the operation of the library or libraries by the agencies. The questions included the general subjects: I. [illegible]sion of the agency; II. Agencies' libraries; III. Functions performed by agency headquarters for the field libraries; IV. Budget of the agency; V. Future development.

Part B was filled out by any library designated as reference and technical. The questions for this part were presented under the following headings: I. Purpose, scope and coverage of the library; II. Organization of the library, III. Size and nature of present collection; IV. Acquisitions policies and procedures; V. Binding; VI. Cataloging and classification; VII. Reference and bibliographic service; VIII. Lending service; IX. Library space; X. Budget; XI. Personnel; XII. Reporting of statistics; XIII. Cooperative arrangement with other libraries; XIV. Service on Committee and relations with associations; XV. Future development; XVI. Mechanical and electronic devices; XVII. Miscellaneous. Part C was intended for general libraries and the questions fell in the same areas as Part B.

Of the libraries designated as Army Technical Libraries, about half had been included in the Brookings survey. For the purposes of the present John I. Thompson & Company contract, the Brookings survey data were compared, therefore, with present mission statements for libraries included in library visits in our research to determine if any major changes had taken place or if their missions had changed since 1959. In the intervening

time, however, the DoD has undergone several reorganizations. Some libraries are no longer in the same command or have the same administration. However, the primary subject missions appear to have stayed the same. This was determined by examining the data supplied concerning the major subject areas of the collection and the type of usage.

2. "U.S. ARMY ON-SITE SCIENTIFIC AND TECHNICAL INFORMATION SURVEY" Report Number STINFO 1, performed by CEIR, Inc., Arlington, Virginia, for the Director of Army Technical Information, Department of the Army. Contract DA 49-092-ARO-23, Final Report September, 1964, AD 445-800. The purpose of this study was to identify by means of an on-site survey the personnel, facilities and funding (for FY 1964) involved in the performance of scientific and technical information functions. The objective was to determine what was being done in the areas of originating, processing, storing and disseminating scientific and technical information. Processing includes all functions, processes and activities to which this information is subjected, except for the origination of rough draft and the use made of the information after the ultimate user has received it. In addition to inventorying the activities to which the Army subjects its scientific and technical information, the survey aimed at locating significant depositories or collections of items containing data or information about numerous scientific and technical subjects of interest to the Army.

The objective of our research team in analyzing the data of the CEIR report was to determine what trends could be detected in certain selected functions. It was judged that the establishment of trends by a statistically supported population of libraries might in itself provide a basis for consideration as criteria. The activities, services, functions and other library or information-center-related items included in the CEIR survey are reflected in the following listing.

ITEMS IN CEIR SURVEY

Code	Activity Name	Group
01	Managing STINFO activities	STINFO Administration
02*	Education of STINFO users	STINFO Administration
03*	Coordinating STINFO activities	STINFO Administration
04*	R&D in Information Sciences	STINFO Administration
05*	Planned technical visits	STINFO Administration
06	Analyzing results of meetings	STINFO Administration
07*	Selection of items	Acquisition of STINFO Items
08*	Dollar procurement	Acquisition of STINFO Items

09*	Exchange agreement	Acquisition of STINFO Items
10*	Loans	Acquisition of STINFO Items
11*	Non-dollar procurement	Acquisition of STINFO Items
12	Technical writing	Primary Report Preparation
13	Technical editing	Primary Report Preparation
14	Technical review	Primary Report Preparation
15	Preparation of format	Primary Report Preparation
16	Printing	Report Production
17	"Dummy" master preparation	Report Production
18	Folding/collating	Report Production
19	Binding/stitching	Report Production
20	Still photography	Visual and Audio Arts
21	Motion picture photography	Visual and Audio Arts
22	Illustrating/charting	Visual and Audio Arts
23	Drafting	Visual and Audio Arts
24	Model/sculpting/exhibit-making	Visual and Audio Arts
25	Mapping	Visual and Audio Arts
26	Sound recording	Visual and Audio Arts
27	Photographic copying	Reproduction
28	Microphotography	Reproduction
29	Xerography	Reproduction
30*	Disseminating new STINFO	Dissemination
31*	Disseminating info re: STINFO	Dissemination
32*	Selective dissemination	Dissemination
33*	Use of displays	Dissemination
34*	Secondary distribution	Dissemination

35*	Prep. for storing/handling	Storing Handling of STINFO Items
36*	Shelving/filing/reshelving	Storing Handling of STINFO Items
37*	Circulation	Storing Handling of STINFO Items
38*	Inventory control	Storing Handling of STINFO Items
39*	Weeding	Storing Handling of STINFO Items
40*	Descriptive cataloging	Cataloging
41*	Subject classification/indexing	Cataloging
42*	Indicative abstracting	Abstracting Translating
43*	Informative abstracting	Abstracting Translating
44*	Translation	Abstracting Translating
45*	"Ready reference"	Reference
46*	Noncritical searches	Reference
47*	Critical searches	Reference
48*	Noncritical summaries	Reference
49*	State-of-the-art	State-of-the Art Review
50	Card/tape punching	Punch Card and EDPM Processing
51	EDPM Systems design	Punch Card and EDPM Processing
52	EDPM programming	Punch Card and EDPM Processing
53	Plugboard layout/wiring	Punch Card and EDPM Processing
54	EAM/EDPM operation	Punch Card and EDPM Processing

Of these items, 29 were selected as appearing to be common to technical libraries. These are: 02, 03, 04, 05, 07, 08, 09, 10, 11, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48 and 49 (see asterisks).

Some difficulty was encountered in extracting the desired data. The survey often dealt with entire information centers or other information organizations and not only with libraries. It was, therefore, necessary to determine which of the chosen activities were being performed in the library when the desired library was part of an information center. (One observation made with reference to the survey was that, although it very directly concerned libraries, library personnel often had only a minor part in supplying the data.) In order to obtain the desired information regarding the selected functions, it was necessary to examine carefully the data presented in CEIR Table 1 (Organizational Elements by Code), Table 2 (Organization by Installation Directory) and Table 7 (Elements within Organizations performing Activities). These tables are presented in Appendix A of the Final CEIR Report.

Of the 69 Army Technical Libraries which replied to the requests for information concerning their missions, organization and staffing, 42 had also been a part of the CEIR study. Our investigators, therefore, extracted from the survey information on the 29 functions listed by their CEIR code numbers, as they had been replied to by the 42 libraries. The resulting data are displayed in the bar chart in Figure 2. The height of the bars depicts the number of libraries in the total population of 42 which perform the activity or function listed.

3. "STUDY OF MECHANIZATION IN DoD LIBRARIES AND INFORMATION CENTERS." Booz-Allen Applied Research, Inc., Contract DSA-7-15489, performed for Defense Supply Agency, Department of the Army, Bethesda, Maryland, 1966. The report summarizes an on-site survey of mechanization as it appeared to be in 1966. Presentations are included on thesaurus building, file structure, input processing, serial control, selective dissemination of information, circulation control, equipment, recommendations on information retrieval systems, observations on organization, operation and application, and summaries on mechanization status, scope and size of collections, and COSATI subject area breakdowns. The survey covered 76 facilities and individual reports were prepared for 35. Among other uses, this survey could be used to show some relationships between the mission of t organizations, the number of persons required to carry out the services and operations performed, and whether an important service or operation had been mechanized to provide more efficient service and reduce the required number of manhours.

Although the Booz-Allen study contained an insufficient number of the Army Technical Libraries to make the information adequately comparable, many interesting data on collections of books, periodicals and reports, classified according to particular subject categories, were presented.

4. "TECHNICAL AND MEDICAL RESEARCH LIBRARIES AND INFORMATION CENTERS OF THE DEPARTMENT OF THE ARMY," Army Technical Library Improvement Studies (ATLIS) Report No. 1, Washington, 1966, collected information on the size

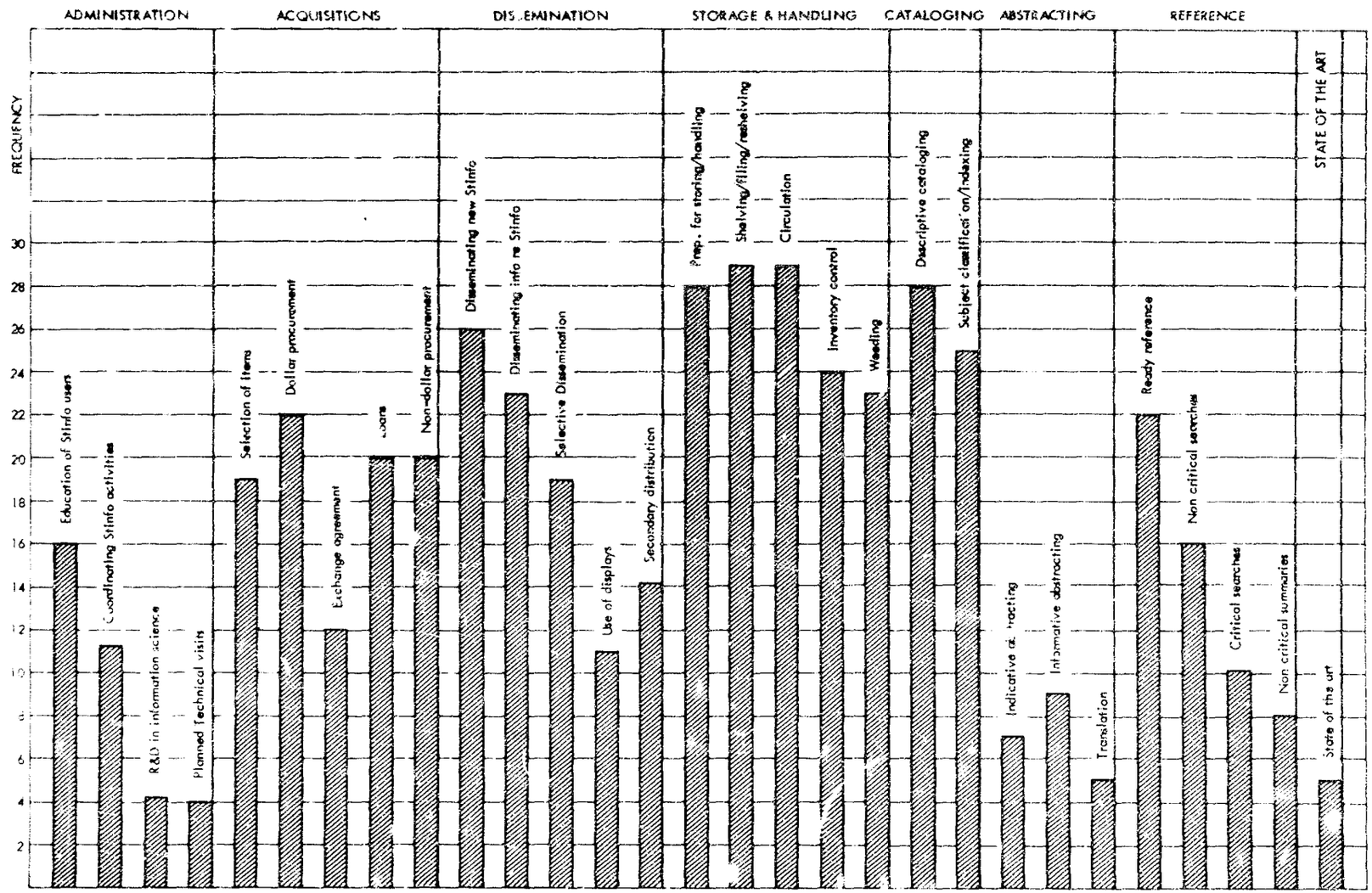


FIGURE 2. CEIR STUDY

and makeup of Army Technical Library staffs, as well as the composition and size of the collections at each installation. As will be discussed later, the data from this survey were examined in our study to note any changes in size from the more recently collected data as well as that collected during the 10 library visits.

5. "ARMY CIVILIAN CAREER PROGRAM FOR LIBRARIANS. LIBRARY FACT SHEET," Office of the Adjutant General, Department of the Army, Washington, 1966, provides the following information regarding Army libraries: number and type of resources, number and type of full time personnel, and the library services made available. Because the libraries of the Army Corps of Engineers were not included, it was not possible to make comparisons of this important facet. As will be discussed later, the data included in this fact sheet were employed in some of the correlation studies as part of the present study.

6. "SURVEY OF SPECIAL LIBRARIES SERVING THE FEDERAL GOVERNMENT, 1965," Frank Schick, Federal Library Committee, Washington, 1967, Contract No. OEG-4-7-001913-1913, 1967, presents detailed data on the special libraries serving the Federal Government. Included are data concerning organizational patterns, library clientele and activities, resources of library materials and staff and expenditures. Data are also given for the primary subject areas of the collections and the primary occupations of their users. Library functions performed traditionally and by automated means were tabulated. The information sought in this survey were quite similar to that of our library visit interview guide. For the purposes of the correlations made in our study, the Schick data were included.

Tables 1 through 6 summarize some of the data extracted from several of these referenced surveys, as well as some of the data collected by our investigators on the 10 library visits. Although the identities of the 10 libraries surveyed in all 5 studies are not revealed, the data are, of course, directly comparable. Data are shown for staff, analyzed according to professional, library assistants, clerical and total. Data are also shown for collections, classified according to whether or not the items are books, volumes, pamphlets, reports and so on, according to the word usage in the various survey reports. Because it was judged that the weeding policies of the various libraries would have an influence on the data presented on collection size, Table 7 is included, tabulating whether or not a weeding step is performed. Table 8 notes the observations taken from the CEIR report regarding whether or not the various coded items are included in the same population of the 10 libraries, as well as observations made by our investigators.

Before discussing the treatment of some of the data used for studying correlations, it is thought appropriate to make a few observations concerning the data in general. When we examine the data from the past studies, as well as those gathered during the present study, the lack of

Table 1 – Staff Profile

LIBRARY NO.	BROOKINGS 1959				ATLIS I 1964				FLC 1965				FACTSHEET 1966				VISIT 1967			
	Professionals	Library Assistants	Clerks	Total	Professionals	Library Assistants	Clerks	Total	Professionals	Library Assistants	Clerks	Total	Professionals	Library Assistants	Clerks	Total	Professionals	Library Assistants	Clerks	Total
1	4	3	1	8	6	1	5	12									6			12
2	1	2	3	7	0	1	3	4					0		6	6	0			4
3	9	7	5	22	9		17	26					10	9	9	28				
4	21	2	6	33	25		20	45	35	6	1	56	26	12	2	40	26	12	2	40
5					7	5	11	23					4	11	5	21	3	4	11	18
6	2	1	4	10	6		9	15					4	3	5	13	5			17
7	6	3	1	13	6	6	4	16					6	4	8	19	6			15
8					1			1					1			1	1			1
9					4		6	10					4		3	7	1			6
10					1		1	2					1	1	1	3	1			3

Table 2 - Volumes (Excluding bound serials)

LIBRARY NO.	BROOKINGS 1959	ATLIS I 1964	FLC 1965	FACTSHEET 1966	VISIT 1967
1	3,450				
2	2,190	10,000		13,000	12,115
3	18,550	26,150		26,765	
4	40,369	85,000	80,000		85,593
5		48,000		47,000	50,000
6	5,000	50,000		45,000	21,000
7	21,146	30,000		37,200	45,000
8		2,000		2,500	2,500
9		20,000		20,716	20,000
10		1,300		1,500	1,000

Table 3 - Volumes (Bound serials)

LIBRARY NO.	BROOKINGS 1959	ATLIS I 1964	FLC 1965	FACTSHEET 1966	VISIT 1967
1			5,900		
2		11			11 titles 10,000
3		120,000			
4	10,700	26,000	26,000		28,085
5		25,000			20,000
6	15,000	25,000			25,000
7	7,190	13,000			400 titles 2,000
8		500			35 titles
9		18,000			
10					

Table 4 - Serial Subscriptions

LIBRARY NO.	BROOKINGS 1959	ATLIS I 1964	FLC 1965	FACTSHEET 1966	VISIT 1967
1					
2				375	471 titles 726
3				1,071	
4				4,559	4,150
5				1,000	1,000
6				1,100	1,000
7				1,200	1,200
8				95	105
9				156	175 titles 250
10				100	125 titles

Table 5 - Pamphlets, Reports and/or Documents

LIBRARY NO.	BROOKINGS 1959	ATLIS I 1964	FLC 1965	FACTSHEET 1966	VISIT 1967
1					
2	7,000	8,000		10,000	11,000
3	12,650	608,800		660,000	
4	120,000	740,000	700,000	303,742	311,782
5		300,000		330,000	360,000
6	30,000	50,000		46,000	46,000
7	67,000	40,000			30,000
8		6,100		6,200	6,200
9		58,000		20,000	
10		7,000		8,000	12,500

Table 6 - Microforms

LIBRARY NO.	BROOKINGS 1959	ATLIS I 1964	FLC 1965	FACTSHEET 1966	VISIT 1967
1			8,252		
2					34,323
3				27,303	
4			440,000	507,344	571,963
5				10,000	15,000
6				500	500
7		10,000		10,000	2,350
8					
9					
10					

TABLE 7

Summary of Observations on Weeding Policies*

Library Number	Brookings	CEIR	Visit
1	X		X
2	X	X	X
3	X	X	X
4	X	X	X
5			X
6	X	X	X
7	X	X	X
8			X
9		X	X
10		X	

* X's indicate performance of weeding

TABLE 8

Activities

	CEIR	VISIT
1	03, 37, 40	Now doing more coordination (03). Felt the questionnaire too complicated.
2	02, 07, 08, 10, 11, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 45, 46	No longer 42. Those involved are no longer around.
3	02, 07, 08, 09, 10, 11, 30, 31, 32, 35, 36, 37, 38, 39, 40, 41, 43, 45, 46, 47	Did not return this part of the interview guide.
4	07, 08, 09, 10, 11, 30, 35, 36, 37, 38, 39, 40, 41, 43, 45, 47	Did all the same.
5	43	Although listed in the CEIR study, all of their data were not included.
6	02, 03, 04, 07, 08, 10, 11, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41, 44, 45, 46, 48	Felt there was no change in what they had reported previously.
7	02, 07, 08, 10, 11, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 45, 48	Now doing 34 more.
8	Nothing recorded for any of these activities	Did not have anything to do with it.
9	02, 03, 05, 07, 08, 10, 11, 30, 31, 32, 34, 35, 36, 37, 38, 39, 40, 41, 42, 45, 46	Validation not considered applicable.
10	02, 03, 07, 10, 11, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 45, 46	No data. The original guide was lost.

Note: For activity names see corresponding code numbers on page 37.

constancy becomes apparent. This probably should have been expected in view of the fact that as far as staff size and composition and collection size and composition are concerned, the situation is dynamic. The figures are marked by change rather than stability. Thus, it is difficult to judge the accuracy of the data, even with on-site inspection. The dates of collection and the manner of collecting, reporting and interpreting the data can cause variations. The values shown in the tables bear out this observation.

The effort to validate the data presented in the CEIR report during our visits was difficult. Most of the people interviewed were vague about what they had reported in the prior survey. Even when the data reported for them were shown again to them, there was considerable ambiguity and few were either willing or able to provide revisions. It was also noted that, although one of the libraries had completely related activities it was performing, the study did not show this.

One of the anomalies interesting to note was that some of the smaller libraries, with less professional staff and less complete collections and facilities, checked more activities as being performed by their library than some of the larger, much more complete and professionally staffed organizations. This would suggest that there was considerable latitude in interpreting questions as to function definition and performance. It was also found that even on-site visits could not validate all the claimed activities and functions. However, it is reasonable to state that it was easier to validate the information on libraries which had claimed fewer activities and functions than those which had claimed a higher number.

As a check on validating some of the policy statements, the example of "weeding" was chosen. As can be seen in Figure 2, almost all libraries profess to be performing weeding. The investigators could not, however, determine how extensive the weeding performed actually is. Furthermore, this particular policy matter, as with most others, was not a formal, written matter, but rather was informal and unwritten.

Data Correlation Considerations

In discussing the analysis of the data to determine the presence or absence of correlations between such factors as staff size, document collections, number of searches and similar elements, the investigators wish to develop the situation in two steps: A. Determination of the population and aspects for which correlations will be developed; and B. Usefulness of correlations in developing criteria for measurement of efficiency and effectiveness. The following sections develop [illegible] concepts for sample cases. It should be noted that the details are not included in this report for all the correlations attempted, but are available if required. Should the methods used prove valuable in criteria development, the details for given cases can then be utilized in later stages not included in the present contract work, but more properly to be done under a separate arrangement by a contractor or performed by an Army in-house effort.

A. Determination of the population and aspects for which correlations will be developed.

The population under study for the development of tentative criteria include Army Technical Libraries which have submitted data and information which will permit computations and determinations of certain library parameters in regards to staff size and positions; and the number of books, documents and technical reports, subscriptions and microforms in the collection. The data were statistically interpreted to determine the distribution of the population. Sixty-one libraries constitute the population in this aspect of the study. The population identified is not homogeneous. This implies that subpopulations can be identified.

A histogram was used to show the distribution of the various parameters. Five histograms are represented in Figures 3, 4, 5, 6 and 8. There are 61 blocks on each histogram, one for each library. The blocks filled in with cross-hatching are those libraries which were visited by our team. Although 10 libraries were visited, not all of the data needed was provided by each library. Therefore, some of the charts and tables will present data for fewer than 10 libraries. The data from these libraries will be statistically manipulated to draw inferences about the whole population of Army Technical Libraries.

The distribution of staff size among the population studied is shown in Figure 3. This histogram identifies 15 classes of libraries according to staff size. The classes are:

Class 1 -- libraries having 1 to 4 staff members;
Class 2 -- libraries having 4 to 7 staff members, etc.

The histogram shows a skewed distribution in terms of staff size, which is characteristic of crowding at one end and a gradual taper to the opposite end of a scale.

The distribution in Figure 3 shows crowding of libraries in the smallest staff size class and a sharp drop over the next two classes. There is a gradual drop over the next 12 classes. This population distribution shows a trend which is reflected by the sample.

Skewed distributions were also found for the number of documents and technical reports in library collections, Figure 4, and the number of documents, technical reports and books in the collection, Figure 5. There does not appear to be any trend in the population in terms of the percent of books in library collections as shown in Figure 6. In all cases the sample reflected the population trends. However, Figures 3 through 6 indicate that the sample means do not always closely estimate the population means. The fact that population means are usually lower than sample means shows that the sample is biased in that the larger libraries had more than an equal chance of being represented in the sample. This bias occurs due to criteria 5, 9 and 10 p.16 and p. 17. The conclusions drawn in this analysis will take the bias into account.

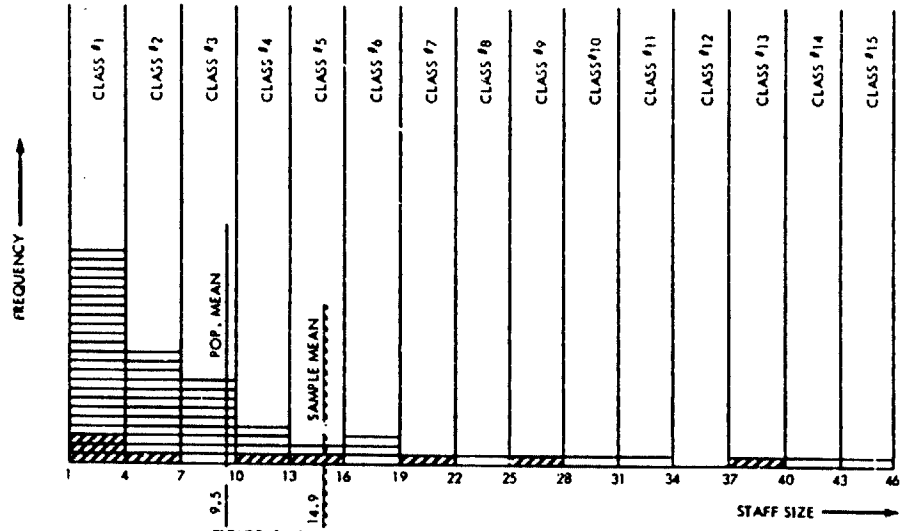


FIGURE 3. POPULATION HISTOGRAM OF NO. OF STAFF

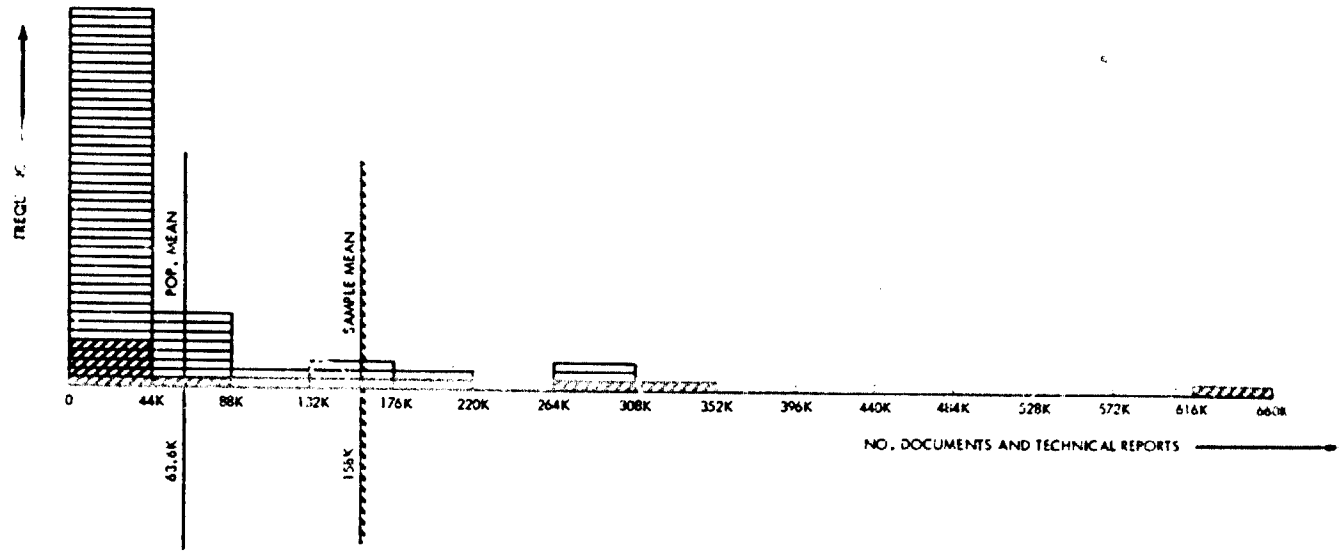


FIGURE 4. POPULATION HISTOGRAM OF NO. OF DOCUMENTS & TECHNICAL REPORTS IN COLLECTION

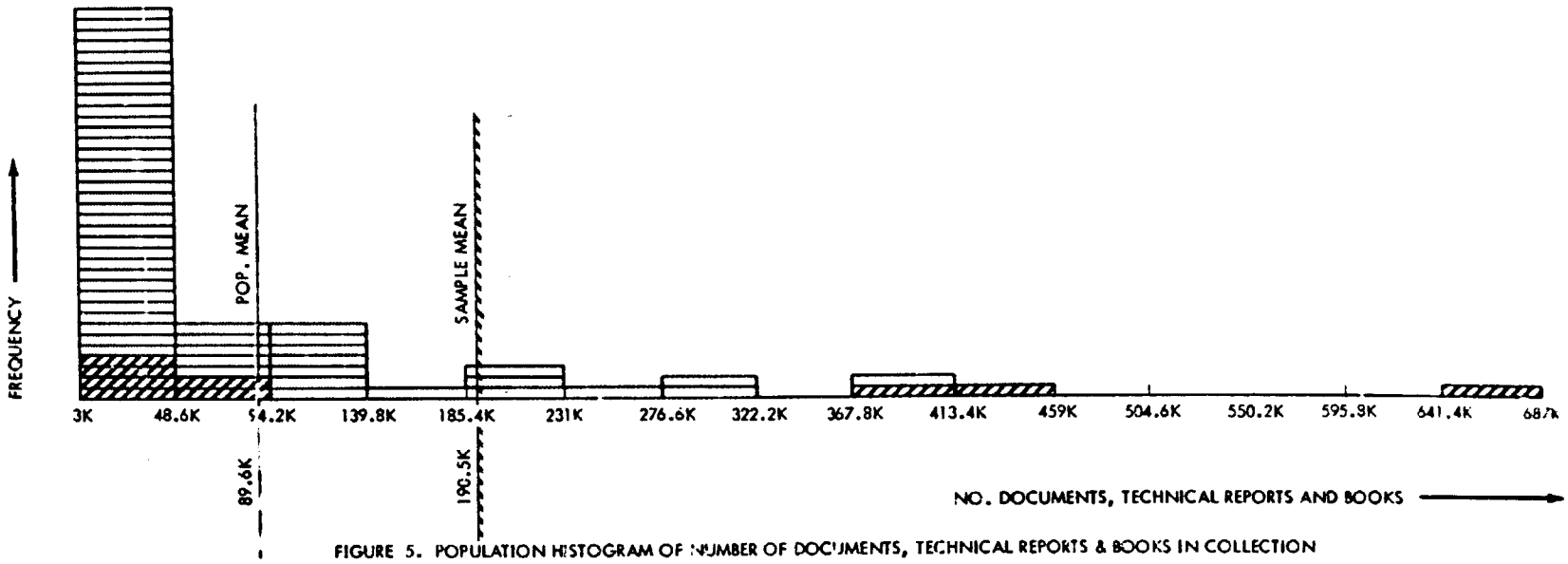


FIGURE 5. POPULATION HISTOGRAM OF NUMBER OF DOCUMENTS, TECHNICAL REPORTS & BOOKS IN COLLECTION

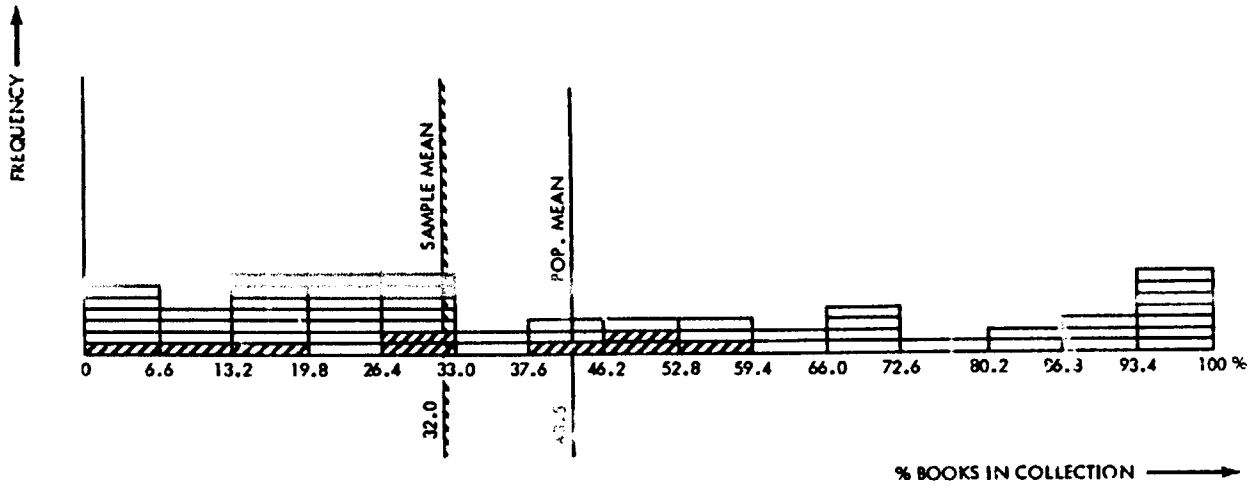
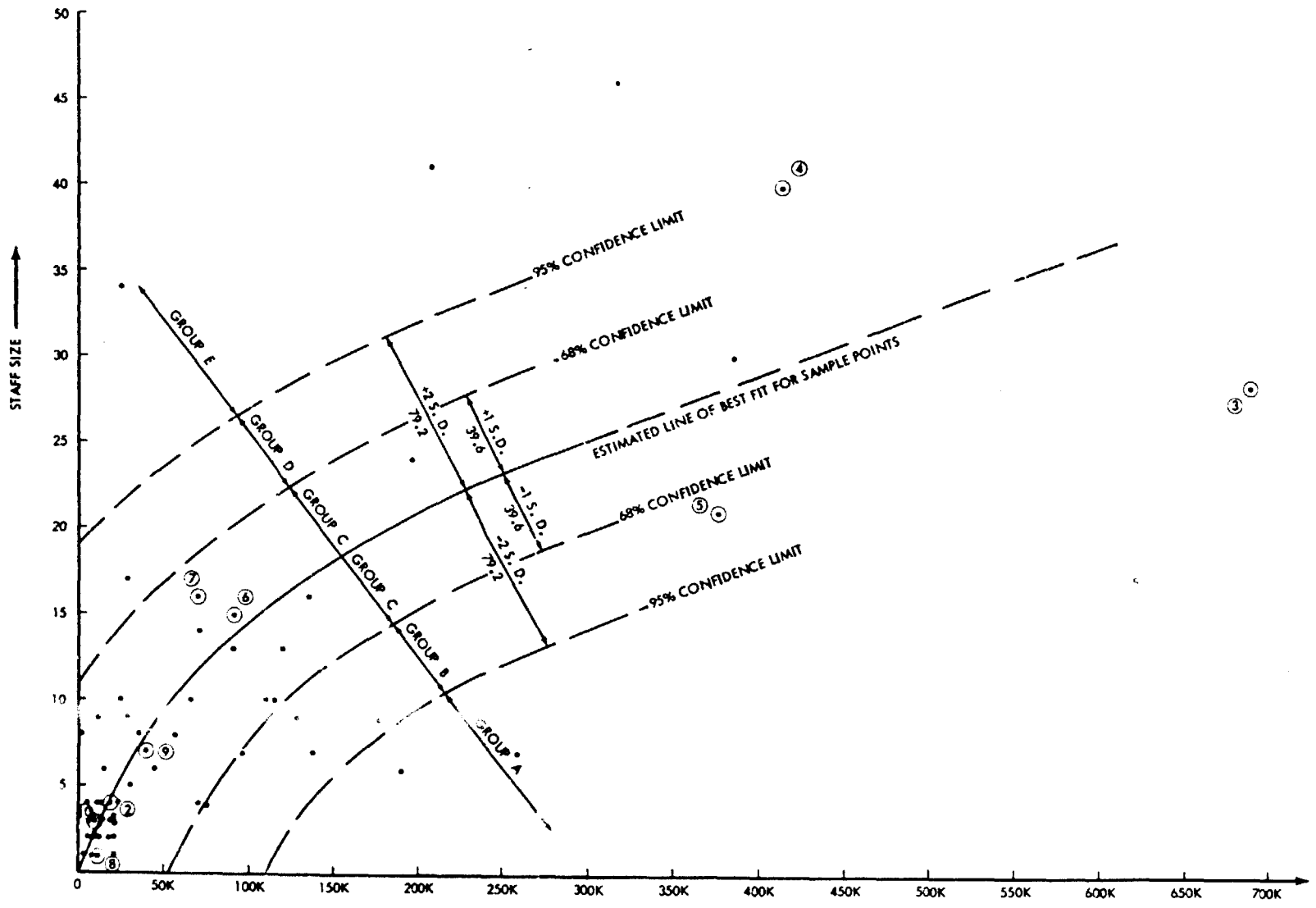
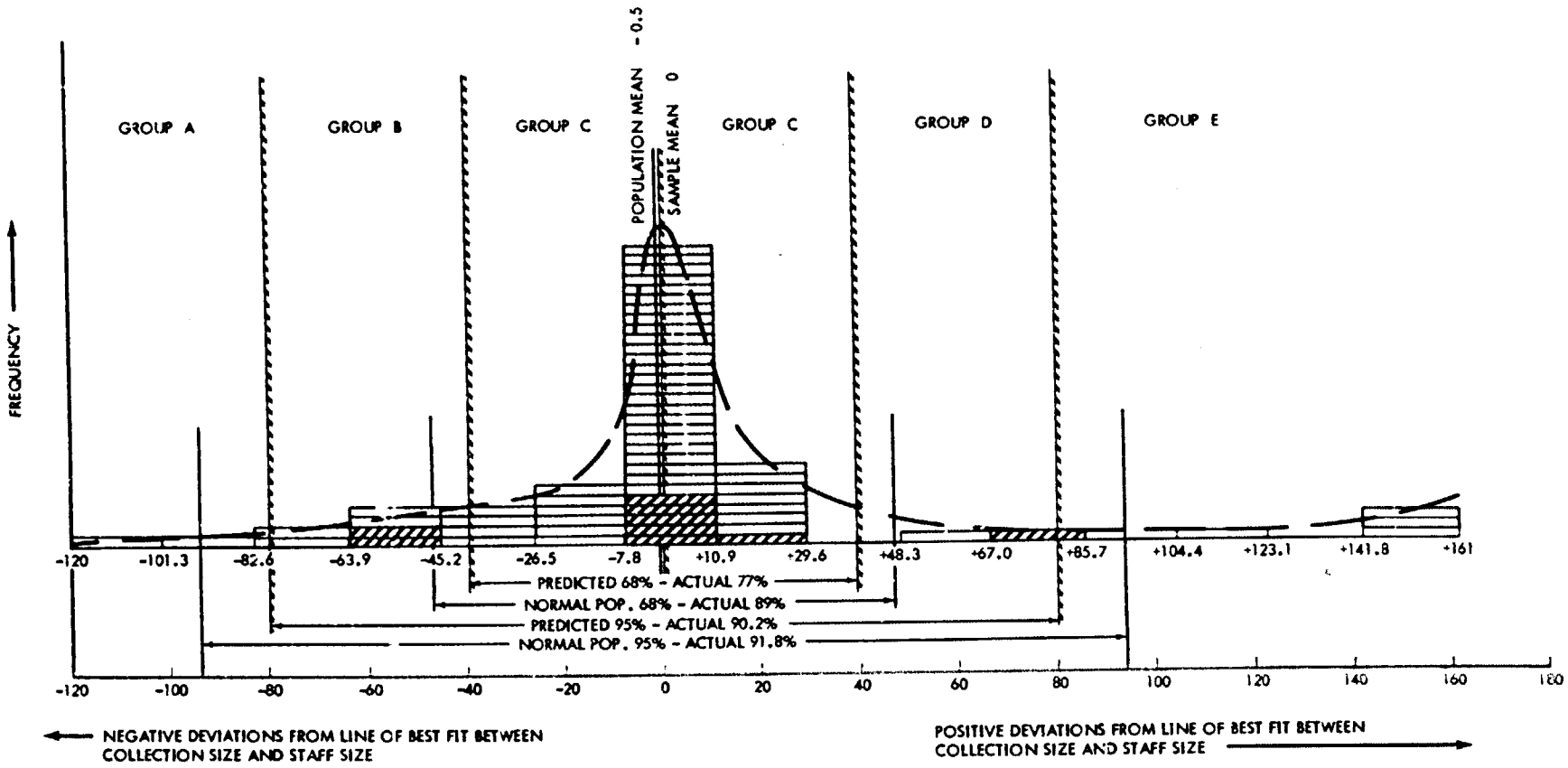


FIGURE 6. POPULATION HISTOGRAM OF % BOOKS IN COLLECTION



NOTE: THE LINE OF BEST FIT IS DISCONTINUED AT 300K COLLECTION SIZE DUE TO THE SIGNIFICANT INFLUENCE OF MICROFORMS ON THE COLLECTION SIZE OF TYPICAL LARGE ARMY TECHNICAL LIBRARIES AND DUE TO INABILITY TO DEFINE MEANINGFUL CONFIDENCE LIMITS FOR THE SMALL NUMBER OF LARGE LIBRARIES.

FIGURE 7. CORRELATION OF STAFF SIZE VS. NUMBER OF DOCUMENTS, TECHNICAL REPORTS & BOOKS IN COLLECTION



NOTE: LARGE LIBRARIES (OVER 300K COLLECTION SIZE) CANNOT BE JUDGED ACCORDING TO THEIR DEVIATION FROM THE MEAN OF THE POPULATION DESCRIBED BY THIS HISTOGRAM.

FIGURE 8. POPULATION HISTOGRAM OF VARIATIONS FROM SAMPLES ESTIMATED LINE OF BEST FIT

When data classes with similar trends such as number of staff and number of documents, technical reports and books in the collection are correlated, we may see a relationship between the two. Figure 7 is a plot of the libraries in the population in terms of staff size vs. the number of documents, technical reports and books in the collections. The libraries visited are identified by the circled points. The circled numbers refer to the library numbers in Tables 1 through 7. A line estimated best to fit the 9 circled points is shown on the chart (Figure 7). The libraries are expected to be scattered about this line in normal distribution. This means that 68% of the libraries are expected to lie within one standard deviation from this line and 95% of the libraries are expected to lie within two standard deviations from this line. Standard deviations are both plus and minus values from the line of best fit.

One standard deviation (1 S.D.) for the sample libraries was computed to be 39.6 units from the line of best fit, on an arbitrary scale. The one standard deviation lines are represented by the dashed lines, called 68% confidence limits. The two standard deviations are represented by the dashed lines, called 95% confidence limits. The sample statistically predicts that 68% of all libraries will fall with ± 1 S.D. and that 95% of the libraries fall with ± 2 S.D., assuming that the population is normal and that the sample is representative.

A histogram was made of the deviations from the estimated line of best fit of the sample. This histogram (Figure 8) shows that the total population approaches a normal population. A normal population is recognized by a characteristic bell shaped curve similar to the dashed curve in Figure 8. The actual mean deviation of the population from the line of best fit was computed to be 0.5 below the line of best fit. This calculation used the same arbitrary scale as was used for the sample deviations. Figure 8 shows the sample mean and the actual population mean. It can be observed that the error in the estimate was negligible.

The sample predicts that 68% of the libraries in the population fall within ± 1 S.D. A count of the libraries within ± 1 S.D. shows that actually 77% of the points fall within this range. The error in the estimate is 13.3%. The sample also predicts that 95% of the libraries in the population fall within ± 2 S.D. A count of the libraries within ± 2 S.D. shows that actually 90.2% of the libraries fall within this range. The error in the estimate is 5.3%.

Therefore, reliable (less than 15% error) correlations can be drawn between the data classes collected from the sample of libraries. These correlations can be assigned confidence limits and each library can be classified according to its deviation from the norm. Any library within ± 1 S.D. can be classified as a group C library. Any library between +1 S.D. and + 2 S.D. can be classified as a group D library. Any of the libraries

higher than +2 S.D. can be classified as group E libraries. Any library between -1 S.D. and -2 S.D. can be classified as a group B library. Any library lower than -2 S.D. can be classified as a group A library.

Since there may be errors in the sample's predictions of the parameters of the population, those libraries which are close to the margin between groups cannot be classified with high confidence.

Correlation analyses were conducted between a variety of data classes where correlations may be meaningful. The line of best fit method was used for these analyses.

Significant positive correlations were found between the following classes of data by visual inspection of scatter diagrams.

a. The number of items acquired per week and

   1. Cost of acquisitions per week.
   2. Number of titles cataloged and classified per week.
   3. Cost of cataloging and classifying per week.
   4. Cost of preparation and maintenance of materials per week.

b. The number of documents and periodicals acquired per user per week and items circulated upon request per user per week.

c. The number of titles cataloged and classified per week and the cost of cataloging and classifying per week.

d. The circulation of items upon request per week and

   1. Cost of circulation upon request per week.
   2. Number of documents, reports, theses and bound volumes per user.

e. The circulation of items upon request per user per week and the number of items circulated by predetermined routing per user per week.

f. The number of items circulated by predetermined routing per week and

   1. Cost of predetermined routing per week.
   2. The number of subscriptions in the collection per user.

g. Total circulation of items per user per week and the number of documents, reports, theses, bound volumes and subscriptions per user.

h. The number of reference searches per week and the cost of reference searches per week.

i. The number of bibliographic citations compiled per week and the cost to compile these references per week.

j. The number of documents, technical reports and books in the collection and the staff size.

Correlations were tried between the following classes of data and no significant or meaningful correlations were found:

a. The number of items acquired per week and

1. The number of items circulated upon request per user per week.
2. The total number of items circulated per user per week.

b. The number of items circulated upon request per week and the total number of actual users.*

c. The number of items circulated upon request per user per week and

1. Percent of B.S. degrees among users.
2. Percent of M.S. degrees among users.
3. Percent of Ph.D. degrees among users.

d. The total number of actual users* and

1. The staff size.
2. The number of documents, reports and theses in the collection.
3. The number of volumes in the collection.
4. The number of titles in the collection.
5. The number of periodical titles in the collection.
6. The number of bound journals in the collection.
7. The number of journals in the collection.
8. The number of subscriptions in the collection.
9. The number of microforms in the collection.
10. The total number of items in the collection.

e. The number of documents, reports, theses & bound volumes per user and

1. The number of items circulated by interlibrary loan to the library per week.
2. The number of items circulated by interlibrary loan from the library per week.

8. Usefulness of correlations in developing criteria for measurement of efficiency and effectiveness.

* Note: The total number of actual users does not seem to correlate highly with any of the parameters tested. This can be partially accounted for by the high variability in the average frequency of use by identified users of variant libraries.

The data classes identified in Section A which had meaningful correlations with other data classes are potential areas for development of standards (4,310). These standards, if developed after Phase III of this contract, could be used for measuring efficiency of library operations. For example, if there is a close linear correlation between cost of cataloging and classifying and the number of titles cataloged and classified, a standard unit cost may be derived (20, 125, 11, 51, 74, 118, 382). If there is a close curvilinear correlation between cost and number of titles cataloged, then a conditional standard can be derived. This can be in the form of cost = some function of the number of titles cataloged and classified. Such standards could be used to indicate relative efficiency among libraries.

If unit cost of cataloging and classifying are above the standard cost, we would expect effectiveness to be higher or would expect some other justification for higher costs such as higher wage rates. If it cannot be shown that effectiveness is higher, or that wage rates, etc. extenuate deviation from the standard, the extra cost cannot be justified. If reliable effectiveness measures can be determined, deviations from the norm may be justified when additional effectiveness is realized from higher unit costs.

In order to have useful and enforceable standards, not only must the standards be realistic and attainable, but also we must be able to justify or reject any costly deviations from the standard.

This report later discusses effectiveness measures in Type 4 and 5 approaches. After some of these measures are taken in Phase III of this contract, correlations between effectiveness and unit costs may be determined. If high correlations exist, criteria can be developed which relate operation output or unit costs of operations to effectiveness (141, 159). Correlations such as that described in Figure 1 p. 12 were intended for consideration under Type 3 approach. However, some criteria developed in Type 4 approach must first be validated. Therefore, these correlations and further analysis will be performed in Phase III.

Standards developed by correlations are potentially useful. The data so far gathered reflect that the standards would be "loose." That is to say, such standards would be based on averages and may in some cases be standards of mediocrity. However they would, nonetheless, be points from which to measure. This looseness is due to a number of possible factors, including:

1. Lack of standard operational procedures among the Army Technical Libraries.
2. Lack of consideration of quality and effectiveness of the work units produced.
3. Lack of clearly defined operations and services.
4. Variability of wage rates for similar operations among and within the Army Technical Libraries.
5. Variability of efficiency in operational procedures among and within the Army Technical Libraries.
6. Errors in estimates of work performed, costs, number of users, number of volumes, etc.

In order to develop "tighter" and more useful standards, it will be necessary to quantify or eliminate some or all of these factors.

In an effort to demonstrate that these factors can be quantified or eliminated by the use of selected management techniques, Phase III of this contract will be dedicated primarily to developing Group Attainment Program, cost effectiveness analysis and utility analysis. The choice of these techniques is discussed in Chapter VII, Type 4 approach.

Factors 1, 2 and 3 can be quantified or eliminated in utility analysis or cost-effectiveness analysis utilizing a "systems" approach through modeling to define boundaries of operations and services and to identify the activities, costs, objectives and effectiveness of services (768).

Factors 4, 5 and 6 can be taken into account through Group Attainment Program utilizing work-sampling studies on some routine operations.

After standards of efficiency and measures of effectiveness are established by these management techniques, criteria may be developed from correlations which relate standard unit costs of operations to effectiveness. Standard unit costs are total unit costs minus avoidable costs per unit. Avoidable costs include costs due to slow work pace and costs due to work delays in excess of allowances.

VII. TYPE 4 APPROACH EVALUATION AND ANALYSIS

This approach explores the possibility of developing criteria from various "Management Techniques." These techniques were presented in ATLIS REPORT NO. 10, CRITERIA FOR EVALUATING THE EFFECTIVENESS OF LIBRARY OPERATIONS AND SERVICES. PHASE I: LITERATURE SEARCH AND STATE OF THE ART, AD-649 468. These techniques were presented in the form of a matrix. The definitions were given in an appendix and discussed throughout the text. For example, reference to the matrix shows that "cost effectiveness" was judged applicable for studying "bibliographic services." The data collected for a cost effectiveness assessment of this service may permit the development of criteria statements. The kind of data required for this approach included (a) statistics on library work measurement programs; (b) operating cost data such as weekly costs of acquisitions and accessions, cataloging and classifying and circulation activities; (c) operations output data such as the weekly number of titles cataloged and classified, number of units (books, documents, reports) acquired; (d) budget data; (e) layout charts; (f) other statistics on the library such as number of items (books, documents, reports), staff size and grades, number of actual and potential users and (g) standard data. Other information of this type concerned: (a) organizational facts such as missions, structure, and distribution of functions, responsibilities and control; (b) methods of library performance evaluation; (c) value of user surveys; (d) validity of various measures of effectiveness; and (e) methods and equipment to perform operations and services.

Because there are so many techniques available, it was thought reasonable to reduce the number to a few for actual consideration. The techniques listed in the matrix of the Phase I Report were, therefore, analyzed for their usefulness in indicating efficiency and/or effectiveness or for controlling performance of certain library operations and services. Before this was done, however, the library functions were classified according to the contractor's concepts of high and low priority.

The analytical method employed for selecting management techniques for further consideration in the contract is the "paired comparison" method. Three consultants on the contractor's staff, trained and experienced in management techniques, performed analyses independently. Each was supplied with definitions of the library functions and the glossary of the management techniques presented in the Phase I Report with some revisions and new considerations. The three consultants were instructed identically as to the methods they were to use in making the comparisons. They were not informed about the priority ratings assigned to the functions.

In actual use, the paired comparison method employed a type chart for each individual library function. Figure 9 illustrates the method, in this particular case used for selecting management techniques for evaluating circulation service. All management techniques identified

TECHNIQUES	COMPARISON FACTORS	II	XII	X[illegible]	XXX	XXII	XV	XVI	XX	III	XXVII				RATING	RANK	REFERENCES
II Cost Effectiveness	Indicator of Efficiency		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				9	1	155, 20*, 147
	Indicator of Effectiveness		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				9	1	
	Controller of Performance		No	No	No	Yes	Yes	Yes	No	Yes	Yes				5	5	
XII Standardization	Indicator of Efficiency	No		No	No	No	No	No	No	No	No				0	-	355*, 58*, 74*, 11*, 265*,
	Indicator of Effectiveness	No		No	No	No	No	No	No	No	No				0	-	296*, 382*, 481*, 760*,
	Controller of Performance	Yes		Yes	Yes	Yes	Yes	Yes	No	Yes	Yes				8	2	760*
[illegible] Methods Study	Indicator of Efficiency	No	Yes		No	No	No	No	Yes	Yes	Yes				4	6	65*, 228, 61[illegible], 760*, 164
	Indicator of Effectiveness	No	No		No	No	No	No	No	No	No				0	-	
	Controller of Performance	Yes	No		Yes	Yes	Yes	Yes	No	No	Yes				6	3.5	
XXX Motion & Time Study	Indicator of Efficiency	↑	Yes	Yes		No	Yes		Yes	Yes	Yes				6	4	761, 760*, 32, 315, 255*
	Indicator of Effectiveness	No	No	No		No	No	No	No	No	No				0	-	
	Controller of Performance	No	No	No		No	No	No	No	No	No				0	-	
XXII Data Processing Techniques Evaluation	Indicator of Efficiency	↑	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes				8	2	230, 760*
	Indicator of Effectiveness	↑	No	No	No		No	No	No	No	No				0	-	
	Controller of Performance	No	No	No	Yes		No	No	No	No	No				1	6	
XV Work Sampling	Indicator of Efficiency	↑	Yes	Yes	↑	No			Yes	Yes	Yes				5	5	761, 32, 3[illegible], 465*, 760*,
	Indicator of Effectiveness	No	No	No	No	No		No	No	No	No				0	-	587, 63*
	Controller of Performance	No	No	No	No	No		No	No	No	No				0	-	
XVI Group Attainment Program	Indicator of Efficiency	No	Yes	Yes	Yes	No	Yes		Yes	Yes	Yes				7	3	251
	Indicator of Effectiveness	No	No	No	No	No	No		No	No	No				0	-	
	Controller of Performance	No	No	No	No	No	No		No	No	No				0	-	
XX Budgeting	Indicator of Efficiency	↑	No	No	No	No	No	No		No	No				0	-	226, 77, 136, 111, 63*, 338,
	Indicator of Effectiveness	No	No	No	No	No	No	No		No	No				0	-	29*, 231, 274*
	Controller of Performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes				9	1	
III Cost Accounting	Indicator of Efficiency	↑	Yes	No	No	No	No	No	Yes		Yes				3	7	311, 231, 226, 111, 62*,
	Indicator of Effectiveness	No	No	No	No	No	No	No	No		No				0	-	63*, 367, 760*
	Controller of Performance	No	No	Yes	Yes	Yes	Yes	Yes	No		Yes				6	3.5	
XXVII Research	Indicator of Efficiency	↑	Yes	No	No	No	No	No	Yes	No					2	8	71*, 31*, 211*,
	Indicator of Effectiveness	↑	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes					7	2	432*
	Controller of Performance	No	No	No	No	No	No	No	No	No					0	-	
	Indicator of Efficiency																
	Indicator of Effectiveness																
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	Controller of Performance																

*Previously Used or Proposed For Library Applications

FIGURE 9. CIRCULATION SERVICE

either in Phase Report or added during the Phase II work, for the library function under consideration, were reviewed. Those chosen as potentially useful for circulation service evaluation or control are listed in both the left-hand vertical column and the horizontal top row of the chart. Although the title of the technique is provided only in the left-hand vertical column, the Roman numerals used in both columns and rows indicate identical techniques. The references shown in the right-hand vertical column represent abstracts in the Phase I Report, or publications identified in the Supplemental Management Science References in the present report.

In the second left-hand vertical column, 3 comparison factors are repeated for each technique compared:

1. Indicator of efficiency;
2. Indicator of effectiveness;
3. Controller of performance.

Each management technique can thus be compared with all other techniques listed for that particular library function. The judgments of the management consultants who performed the comparisons were indicated by "yes" or "no" notations in the spaces provided on the charts. A "yes" notation indicates that the technique in the vertical column is a better indicator or controller than the technique with which it is being compared in the top horizontal row for the particular library function. An arrow indicates that the technique in the vertical column is or can be a subtechnique of the more generic technique represented in the top horizontal row.

After all judgments were performed, the "yes" notations were totaled to obtain a rating figure for each technique. These ratings were then converted to ranks for each technique on each comparison factor. The ranks among the 3 judges were averaged to determine the final rank for each technique. The highest ranked techniques for each library function on each comparison factor are summarized in Figures 10 and 11.

As will be recalled from the Phase I Report, certain management techniques are referred to usually as "analytical" and others as "operative." Thus, those techniques or tools assigned the letter "A" in the bottom rows of Figures 10 and 11 are analytical, and can be used to study, develop and justify criteria. Those tools assigned the letter "O" are regarded as operative techniques which, if applicable, can be used to implement criteria or develop standards of effectiveness or efficiency of library functions.

Due to time limitations on this particular data type effort, only 3 techniques will be used as examples to develop criteria. These are GAP (Group Attainment Program), Cost-Effectiveness Analysis and P.P.B.S. (Planning-Programming-Budgeting System). These techniques are to be used formally in developing criteria as discussed in subsequent sections. It

MANAGEMENT TECHNIQUES

LIBRARY FUNCTION (High Priority)	COMPARISON FACTORS	II Cost-Effectiveness	XX Budgeting	XXIV Quality Control	XXIII Cybernetics	XVI G. A. P.	XII Standardization	XIII Standard Data	XI Methods Study	IV Utility Analysis	XIV Performance Evaluation	V P. P. B. S.	XXVI Organization Analysis		REFERENCES
Information Retrieval Service	Indicator of Efficiency	1													155, 14, 56, 112, 125, 86, 141,
	Indicator of Effectiveness	1													303, 336, 8[illegible]
	Controller of Performance				1										518, 521, 7[illegible]5
Translation Service	Indicator of Efficiency	1													155, 20, 141
	Indicator of Effectiveness	1													
	Controller of Performance			1											583, 588, 760
Bibliographic Service	Indicator of Efficiency	1													155, 20, 14
	Indicator of Effectiveness	1													
	Controller of Performance		1												226, 77, 136, 111, 63, 338, 274
Circulation Service	Indicator of Efficiency	1													155, 20, 141
	Indicator of Effectiveness	1													
	Controller of Performance		1												226, 77, 136, 111, 63, 338, 274
Reference Services	Indicator of Efficiency	1								1					155, 20, 141
	Indicator of Effectiveness	1													
	Controller of Performance		1												226, 77, 136, 111, 63, 338, 274
Library Mission and Orientation to Organization	Indicator of Efficiency												1		394, 79, 236
	Indicator of Effectiveness												1		146, 126, 204, 227
	Controller of Performance											1			437, 317
Staff Utilization	Indicator of Efficiency					1									251
	Indicator of Effectiveness									1					394
	Controller of Performance							1							760, 761, 32, 315, 41
Cataloging and Classifying	Indicator of Efficiency					1									251
	Indicator of Effectiveness N/A														
	Controller of Performance						1								481, 58, 74, 242, 11, 269, 362, 760, 296
Abstracting	Indicator of Efficiency					1									251
	Indicator of Effectiveness			1											
	Controller of Performance						1								
Acquisitions and Accessions	Indicator of Efficiency					1									251
	Indicator of Effectiveness N/A														
	Controller of Performance								1						618, 760, 764
Reference Work	Indicator of Efficiency					1									251
	Indicator of Effectiveness N/A														
	Controller of Performance								1						618, 760, 764
Preparation Maintenance of Library Materials	Indicator of Efficiency					1									251
	Indicator of Effectiveness N/A														
	Controller of Performance								1						19, 228, 618, 760, 754
Budget-Allocation for Services and Operations	Indicator of Efficiency											1			652, 115, 231
	Indicator of Effectiveness	1													20, 155, 184
	Controller of Performance											1			437, 317, 226, 111, 338, 274, 136
Staff Salary	Indicator of Efficiency										1				462, 80, 324, 162, 120
	Indicator of Effectiveness										1				289, 760
	Controller of Performance N/A														
Contents Composition and Extent	Indicator of Efficiency N/A														
	Indicator of Effectiveness									1					184, 113, 763, 372
	Controller of Performance		1												226, 77, 136, 111, 231
		A	O	O	O	O	O	O	A	A	A	O	A		

FIGURE 10. TENTATIVE TOOLS CHART

MANAGEMENT TECHNIQUES

LIBRARY FUNCTION (Low Priority)	COMPARISON FACTORS	V P. P. B. S.	XIV Performance Evaluation	XXVII Research	XVII Human Relations	II Cost-Effectiveness	XII Standard-ization	XXIV Quality Control	XXV Plant Layou. Analysis	X Layout Chart	XXXIII Cybernetics					REFERENCES
Contract Performance	Indicator of Efficiency	1														652, 711, 231, 62
	Indicator of Effectiveness		1													80, 462, 162, 120
	Controller of Performance	1														439, 294, 371, 436
Services Orientation to Various Types of Clientele	Indicator of Efficiency			1												24, 80, 386
	Indicator of Effectiveness			1												71, 42, 396, 397, 421
	Controller of Performance				1											765, 133
Research in Library Operations	Indicator of Efficiency					1										71, 68, 92, 240, 31, 211, 421
	Indicator of Effectiveness					1										
	Controller of Performance	1														437, 317
Incentive Programs	Indicator of Efficiency					1										155, 63, 338, 274
	Indicator of Effectiveness					1										109, 765, 264
	Controller of Performance N/A															
Editorial Assistance	Indicator of Efficiency		1													462, 111, 63, 338, 274
	Indicator of Effectiveness		1													120, 289
	Controller of Performance							1								588, 760
Budget-Allocation for Materials	Indicator of Efficiency					1										155, 111, 311
	Indicator of Effectiveness					1										141, 184, 763
	Controller of Performance	1														231, 274, 136
Space and Size Arrangement	Indicator of Efficiency								1							19, 263, 760
	Indicator of Effectiveness								1							762, 279
	Controller of Performance															761
Geographical Location	Indicator of Efficiency					1				1						155, 760
	Indicator of Effectiveness					1										260
	Controller of Performance N/A															
Automation Application to Operational Procedures	Indicator of Efficiency					1										155, 111, 311, 425, 56, 200, 112, 51
	Indicator of Effectiveness					1										141, 49, 23
	Controller of Performance										1					523
Staff Professional Activities	Indicator of Efficiency					1										226
	Indicator of Effectiveness					1										428, 344
	Controller of Performance						1									583, 224, 233, 382, 400
Clientele and Staff Training Programs	Indicator of Efficiency					1										155, 136
	Indicator of Effectiveness				1											24, 47, 428
	Controller of Performance						1									74, 233, 296, 381, 90
Equipment-Cost Type and Amount	Indicator of Efficiency					1										155, 111, 311
	Indicator of Effectiveness					1										141, 184
	Controller of Performance	1														63, 136, 231, 274
	Indicator of Efficiency															
	Indicator of Effectiveness															
	Controller of Performance															
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	Indicator of Effectiveness															
	Controller of Performance															
		O	A	A	A	A	O	O	A	A	O					

FIGURE 11. TENTATIVE TOOLS CHART

should be kept in mind, however, that elements of several other management techniques are used in other sections of this work and report, but in a more informal sense. For example, systems analysis and utility analysis techniques are used freely, probability methods are involved, correlations are made, and elements of cost-accounting, models, charting techniques, personnel administration, management analysis and several others are touched upon. GAP and Cost-Effectiveness techniques will, however, be discussed in some detail.

METHOD OF DEVELOPING CRITERIA WITH OPERATIVE TECHNIQUES

Group Attainment Program (see GAP XVI in Figure 10) was judged the most useful tool for indicating efficiency of routine library operations, such as cataloging and classifying, abstracting, indexing, acquisitions, preparation and maintenance of library materials, and overall staff utilization. Using proven measurement techniques such as work sampling, standard data and motion and time study, GAP objectively determines attainment factors for the jobs in a group. These attainment factors represent the time that it should take a competent employee, using prescribed methods and working at a normal pace, to perform one operation successfully and completely. Having determined the "should take" time for all operations, it is applied to present or planned volumes of operations to determine total labor requirements for the entire volume of work. Attainment factors or "should take" times are recorded as specific standard data (Standard Data, XIII in Appendix A).

GAP indicates efficiency of groups by comparing actual time spent to "should take" time. The measure of efficiency is expressed as the index of productivity. This index is computed by dividing "should take" time by actual time. An index of productivity can be computed for each group performing given operations or for the whole staff giving an overall measure of staff utilization. The operative criterion of GAP is its end product--unit cost or unit time standards for each significant operation.

METHODS OF DEVELOPING CRITERIA WITH ANALYTICAL TECHNIQUES

Cost-Effectiveness Analysis (Cost Effectiveness, II, Figure 10), has been judged the best technique for indicating efficiency and effectiveness of typical library services, such as circulation service, information retrieval service, translation service, bibliographic service and reference service. Cost-Effectiveness Analysis measures cost and effectiveness of each service to provide a means of judging overall performance of each service or for all services. For example, let us make the assumption that there are 3 possible methods for providing predetermined circulation, methods #1, #2 and #3. Hypothetically, the costs are $1.00, $1.50 and $2.00, respectively, per item circulated, and the effectiveness measures of meeting the objectives of the service are 50%, 40% and 70%, respectively.

A plot of the methods represents a cost-effectiveness diagram (Figure 12) and shows the relative cost-effectiveness of each method. The choices of methods which appear most practical are circled. Method #2 is impractical because it is more costly and less effective than method #1. The two choices left are evaluated in terms of the librarian's preference: being 20% more effective or spending only $1.00 per item circulated. The library should have a well developed mission statement and budget to facilitate deciding the most practical choice between methods.

In order to make a Cost-Effectiveness Analysis of services possible, it is necessary to: (1) define each significant service, (2) define all significant activities and operations, (3) provide meaningful cost data for each activity and operation, (4) provide meaningful effectiveness data for each operation and service. After this has been accomplished, criteria for effectiveness of operations and services can be derived. For example, the extent and efficiency of cataloging and classifying may show a correlation with effectiveness of certain services. Such criteria can be drawn from real world situations at each library. The task at hand, therefore, is to simulate real world situations as closely as possible. In doing so, the criteria are expected to become apparent (Phase I Report, References 4, 14, 23, 46, 51, 55, 310, 410, 415; this report, References 766, 767).

Such a simulation has been attempted by a generalized model of services and operations in a typical Army Technical Library. This has been done by representing real world situations in chains of events joined by activities performed to actuate each progressive event. The simulation of 4 typical services is shown in Figures 13, 14, 15 and 16.

Each service chain has one or more entry points. All entries from event 1 are origins of library service needs. All entries from other events are continuations of needs which have required previous library services. In test cases in Phase III, or in actual use, event blocks critical to service effectiveness will be assigned probabilities that the event will occur. These probabilities will be based upon past experience using statistical and/or subjective analysis or by statistical sampling. Each activity is represented by the connecting line between events. Activities which accrue significant costs will be assigned standard cost data. These standard cost data will be derived from past experience or can be generated by work sampling, motion and time study, GAP and cost accounting techniques. The standard cost data will be expressed as average unit cost per need or as expected cost per 100 needs or some similar representation of cost standardization.

Measures of efficiency may be the standard cost data from which an index of productivity can be calculated for given work periods. Measures of effectiveness may be derived from factors which influence the probabilities that events will occur when a number of needs are processed.

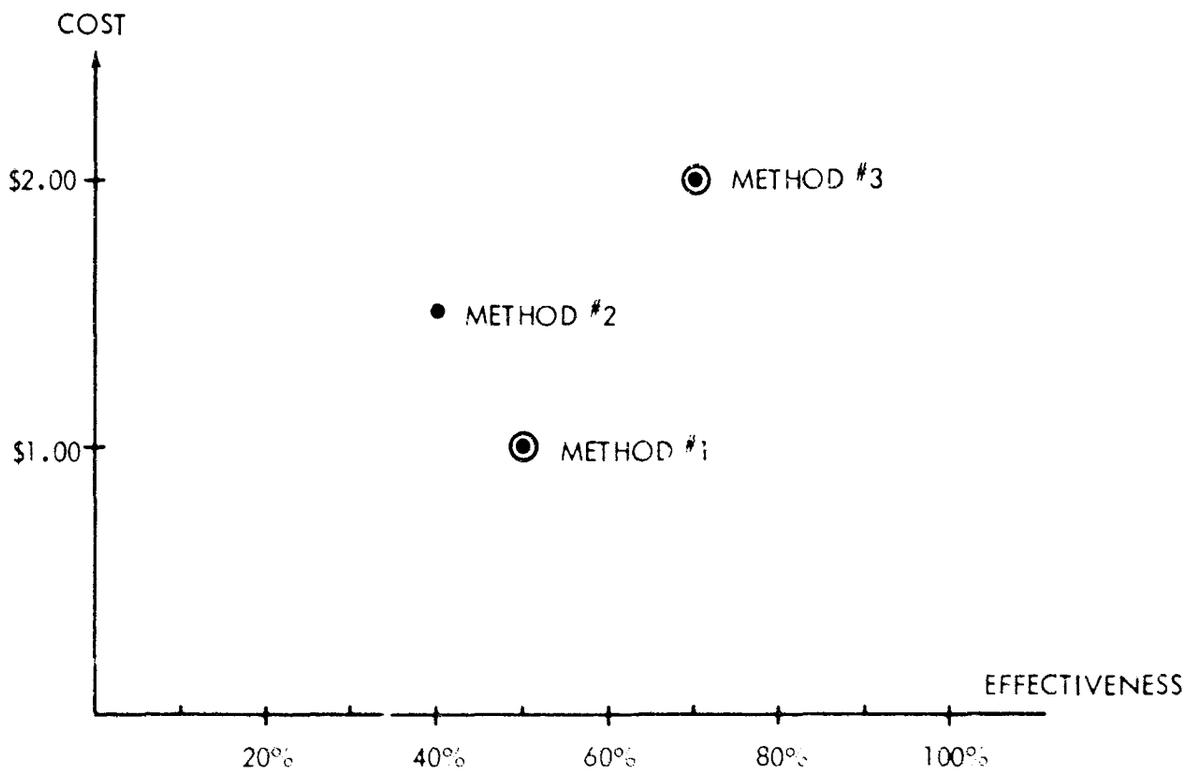


FIGURE 12 - COST EFFECTIVENESS CHART

Certain event blocks separate and identify factors which influence effectiveness. For example, in Figure 13 event 3 (the librarian begins a search), two possible reasons which could explain why a reference librarian would not process a need further are (a) the need is not within the scope of the library's mission and (b) the priority of other tasks. Indicators of the percent cause of failure to accomplish the event represented by subprobabilities will help identify the reason for low probabilities of effectiveness. These causal identifiers can indicate criteria for effectiveness. Effectiveness causal factors may be any identifiers which reflect a responsiveness of effectiveness to the extent of the factor present. (Reference 768, p.13)

Another effectiveness causal factor is the direct labor operation preceding each event block. For example, in Figure 13, event 4 (some candidate documents are identified) is preceded by the activity of the librarian conducting a reference search. This activity lying between event 3 and event 4 will be referred to as activity 3-4. The effectiveness probability of event 4 depends upon the performance of activity 3-4. Mathematically expressed, event 4 = f (activity 3-4), i.e., event 4 is a function of activity 3-4. The effectiveness of activity 3-4 can be measured to some extent by the probability of event 4 occurring. Conversely, the occurrence of event 4 is partially dependent upon the time, effort and facilities allocated in activity 3-4. Therefore, performance of activity 3-4 may be recognized as a causal factor influencing the effectiveness probability of event 4. The unit cost per need of activity 3-4 may show a correlation with the effectiveness probability of event 4. Where high correlation is found to exist, the unit cost of activities becomes a causal factor of effectiveness.

Another effectiveness causal factor is the cost of indirect library functions. These functions may contribute to effectiveness in the same manner as direct cost activities. Indirect costs to services are those which contribute to long range effectiveness, such as costs of acquisitions and accessions, preparation and maintenance of library material, cataloging, classifying, indexing, and setting up of systems for information retrieval and for selective dissemination of information. These costs must be prorated over their effective use period. The costs assigned in the indirect factors blocks (Figure 13) may be based on costs prorated per user, per 100 users, per unit time or other units. As in the case of direct activity performance and unit costs, indirect function performance and unit costs may show a correlation with effectiveness probabilities. Where high correlations are found to exist, unit cost or extent of indirect functions can become a criterion of effectiveness.

The total cost of a service can be computed by summing the direct and indirect unit costs. The total effectiveness of a service can be determined by the number of needs which meet the objectives of the service relative to the number of needs entering the service. Along any chain of events and activities, effectiveness E can be computed by the product of the effectiveness probabilities or by the formula:

$$E = \frac{\text{No. of needs processed through services' final objective} \times 100\%}{\text{No. of entry needs}}$$

The intrinsic effectiveness of a service to a user may not necessarily be represented by event probabilities. The probabilities are, however, indicators of the effectiveness of library expenditures in actuating essential events. The effectiveness of search service, for example, depends on the objectives of the service. The objectives can be represented generally by the possible events in a service chain. For example, one objective of reference service or search service may be only to identify some candidate documents for an informational need. The effectiveness of this service in meeting this objective can be measured by the product of probabilities of communication of needs, of the librarian beginning a search and of the librarian identifying some candidate documents. Another objective of search service may be to determine, perhaps by examination, the documents relevant to a given informational need. The effectiveness of the service in meeting this objective can be measured by the product of the probabilities of communication of needs, of the librarian beginning a search, of the librarian identifying some candidate documents, of these documents being retrieved and of the documents containing some relevant information. The effectiveness of the library in meeting client needs is predicated upon the goals and objectives of each service and ultimately upon the library mission. Before a meaningful measure of effectiveness to the user can be derived, it is necessary to determine the service or services needed by the user. For example, one class of users may communicate a need for information on a given subject. To meet this need it may be necessary to provide search service (Figure 13) through events 1, 2, 3, 4, 6 and 7, and then circulation service (Figure 16) through events 8, 10 and 11. After event 11 has occurred, the services are completed. The completion of each event represents progressing in steps to a final objective. The final objective in the chain of events 1, 2, 3, 4, 6, 7, 8, 10 and 11 is event 11--user gains possession of relevant material. The overall effectiveness probability of meeting this objective for a population of users is the product of the probabilities of events* 2, 3, 4, 6, 7, 8, 10 and 11. Other measures of effectiveness of the service in meeting the mission of the library or the client needs can be determined from user feedback (Figure 17). If the user reads the documents, event 16 occurs, so that the next activity would be user feedback. The feedback would permit: (1) evaluating the adequacy of the source(s) in meeting the mission of the library (activity 17-18), (2) evaluating the adequacy of the source(s) in meeting the clients needs (activity 18-19). (3)**evaluating the effect of recall, retrieval, and relevance upon meeting the mission and/or meeting the users informational need. The probability of meeting the mission of the library can be determined by the percent of needs which are considered satisfied relative to the conditions of the mission statement. The mission-related effectiveness (EM) of the service is the product of the probabilities of events 2, 3b, 4, 6, 7, 8, 10, 11, 16 and 18. The effectiveness of the service to the users is the product of probabilities 2, 3, 4, 6, 7, 8, 10, 11, 16, 18 and 19.

* The probability of event 1 occurrence will not be included in the discussions of effectiveness measures in Phase II.

** The effect of recall, retrieval and relevance and the use of recall and relevance ratios as measurements of effectiveness will be discussed in Phase III of this contract.

The measure of mission-related effectiveness is not necessarily a measure of the total effectiveness to the user of the services or to the parent organization. The measure of mission-related effectiveness will more closely approximate the measure of effectiveness to the user or parent organization as the goals, objectives and mission of the library approach the goals and objectives of the user and support the mission of the parent organization. Therefore, the importance of well-formulated library missions, goals and objectives in deriving a meaningful measure of effectiveness of the library cannot be overemphasized.

In order to explain further, the applicability of this technique to real world situations, an attempt to organize various cases of search service into type categories, has led to the following breakdown of 4 service types and 12 service cases:

Type I. Unequivocally expressed, unequivocal need.

- Case I(a). Search conducted by librarian.
- Case I(b). Search conducted by user with assistance from a librarian or library assistance.
- Case I(c). Search conducted by user.

Type II. Equivocally expressed, unequivocal need.

- Case II(a). Search conducted by librarian.
- Case II(b). Search conducted by user with assistance from a librarian.
- Case II(c). Search conducted by user.

Type III. Equivocally expressed, equivocal need.

- Case III(a). Search conducted by librarian.
- Case III(b). Search conducted by user with assistance from a librarian.
- Case III(c). Search conducted by user.

Type IV. Unequivocally expressed, equivocal need.

- Case IV(a). Search conducted by librarian.
- Case IV(b). Search conducted by user with assistance from a librarian.
- Case IV(c). Search conducted by user.

Each of the 12 cases will be handled differently in computing costs and effectiveness. The probable paths taken in cases I(a) through III(c)* are marked in Figure 13. An example of an equivocally expressed, equivocal need, case IIIa follows:

* The paths of cases IV(a), IV(b), and IV(c) are not marked in figure 13 because of the rarity of their occurrence.

Case IIIa. Client contacts a reference Librarian seeking some information on a given subject. This case will be referred to as an equivocally expressed, equivocal need. The following activities and events ensue (Figure 18):

Activity 1-2. The client communicates his need for information on the effect of contaminants on ruby lasers.

Event 2. The need is adequately communicated (understood) by the librarian to process the need further.

Activity 2-3. The reference librarian reviews the need in order to determine if service will be given.

Event 3. The reference librarian considers the need as within the mission of the library and as having significant priority to begin a search.

Activity 3-4. The librarian conducts a search.

Event 4. Some candidate documents are identified by the librarian. At this point (event 4), a request for a bibliography may begin activity 4-5. However, the client may not require a bibliography, but instead may ask for some of the candidate documents. If this is the case, activity 4-6 begins.

Activity 4-5 (alternate). A bibliography is prepared.

Event 5 (alternate). A bibliography is provided and the user reviews the listings.

Activity 5-6 (alternate). The user orders and the librarian retrieves some of the documents listed in the bibliography.

Activity 4-6 (alternate). The librarian retrieves some of the candidate documents.

Event 6. Some of the candidate documents are retrieved within the required time.

Activity 6-7. The client reviews the documents to determine relevance.

Event 7. Some of the documents are relevant. Event 7 ends the search service. At this point the client may request circulation service and exit to event 8 (Figure 16).

If 100 similar needs were processed and all needs were met, the effectiveness probabilities of all events would be 100%. If only 70 needs have passed event 3 out of 100 which passed event 2, the effectiveness probability of event 3 would be 70%. This may indicate that the mission statement should be revised to encompass more of the needs or that additional reference librarians are needed because many needs could not be met due to priority of other tasks. Such needs should be met if costs are not prohibitive.

Contamination of the measurements of effectiveness may arise from (1) poorly developed library missions statements which are not clear or compatible with the users' departmental missions, (2) poor interpretation of user feedback, and (3) inadequacy of feedback to express the true utility of the information in meeting the objectives of the user.

In summary, and in spite of the errors inherent in the measurements of effectiveness, this systematic approach is potentially useful in resolving the probabilities that the services will meet the needs of its users to the extent that criteria of cost-effectiveness can be established objectively.

Planning-Programming-Budgeting Systems (See P.P.B.S., V in Figure 10) was judged the most useful tool for controlling performance of budget allocations for services and operations.

From the models developed by Cost-Effectiveness Analysis expressing effectiveness as a function of event probabilities, it is expected that each probability can be expressed as a function of the amount of certain factors present. For example, the probability that some candidate documents are identified by searching a card catalog may be a function of several independent variables, such as amount of time (t), the depth of indexing (I), and the number of documents (D) in the relevant subject classes. The relationship between the dependent variable P (the probability of finding some candidates) and the independent variables t, I and D may be found to fit some general equation, where $P = f(t, I, D)$. The general equation (mathematical model) which best represents the real world relationships may be logarithmic, for example: $P = a + b \ln t + c \ln I + d \ln D$ may be the general equation which best describes the relationships between P, t, I&D, where a, b, c and d are some given constants and ln t, ln I and ln D are the natural logarithms of t, I and D, respectively.

With such general equations it is possible to determine the change in P with the change in any independent variable.

For example: $\delta P / \delta I = c / I$

that is, the change in P with respect to the change in I is equal to c/I.

Cost parameters can be added to derive the change in P with the change in the cost of I.

For example:

Let: cost of I = C_I

since: $C_I = f(I)$, say $C_I = g(I)$

where: $g(I)$ is the exact function

then: $\delta C_I / \delta I = \delta g(I) / \delta I$ or $\delta I / \delta C_I = \delta I / \delta g(I)$

therefore: $$\frac{\delta P}{\delta C_I} = \left(\frac{\delta P}{\delta I}\right)\left(\frac{\delta I}{\delta C_I}\right) = \left(\frac{c}{I}\right)\left[\frac{\delta I}{\delta g(I)}\right] = \frac{c}{(I)\left[g'(I)\right]}$$

where $\delta g(I) / \delta I = g'(I)$

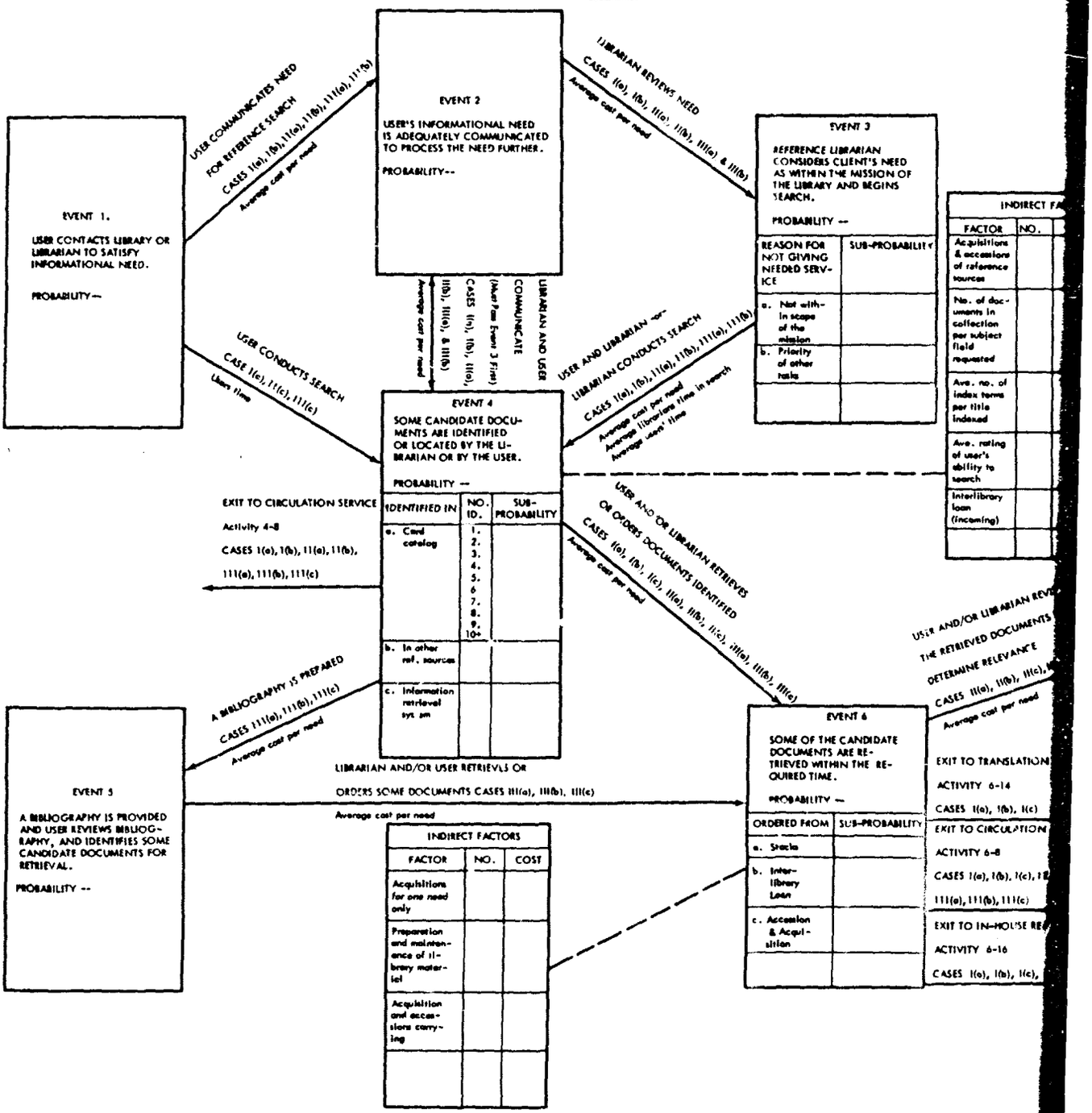
The equation $\frac{\delta P}{\delta C_I} = \frac{c}{(I)\left[g'(I)\right]}$ can be used to measure the effect of funds allocated to indexing in increasing the probability of finding some candidate documents.

Equations of this type may prove to be useful criteria for budgeting funds. Since resources should be added to operations to maximize the probability of essential event occurrence, then funds should be added where $\frac{\delta P}{\delta C_j}$ is the largest, where C_j = cost of I, cost of t, or cost of D, etc., in a "j" family of independent variables any one of which would affect event probability.

In real library situations it may be desirable to maximize other values such as the satisfaction of executive officers served or other such values based upon subjectivity. If values other than maximization of total within-mission needs met extenuate, then general formulas based upon these services models are not necessarily valid as tools for budgeting criteria. Further discussion on subjective effectiveness values to be measured and maximized is discussed in Chapter VIII under the utility analysis approach.

SEARCH SERVICE

These activities leading to and including searches for specific factual information or for selected references and those follow-up activities requested which are essential to determining relevance of candidate documents.



A

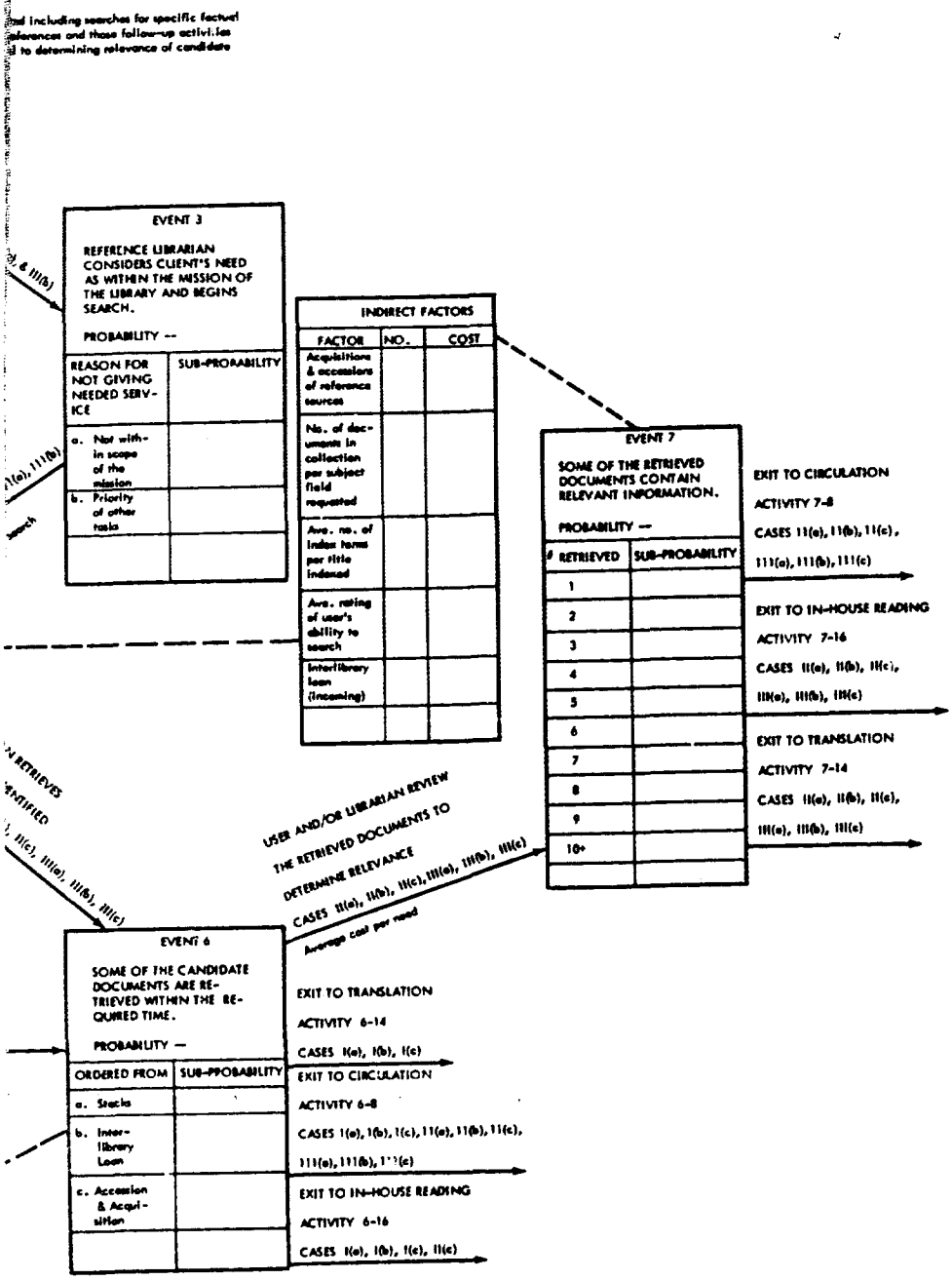
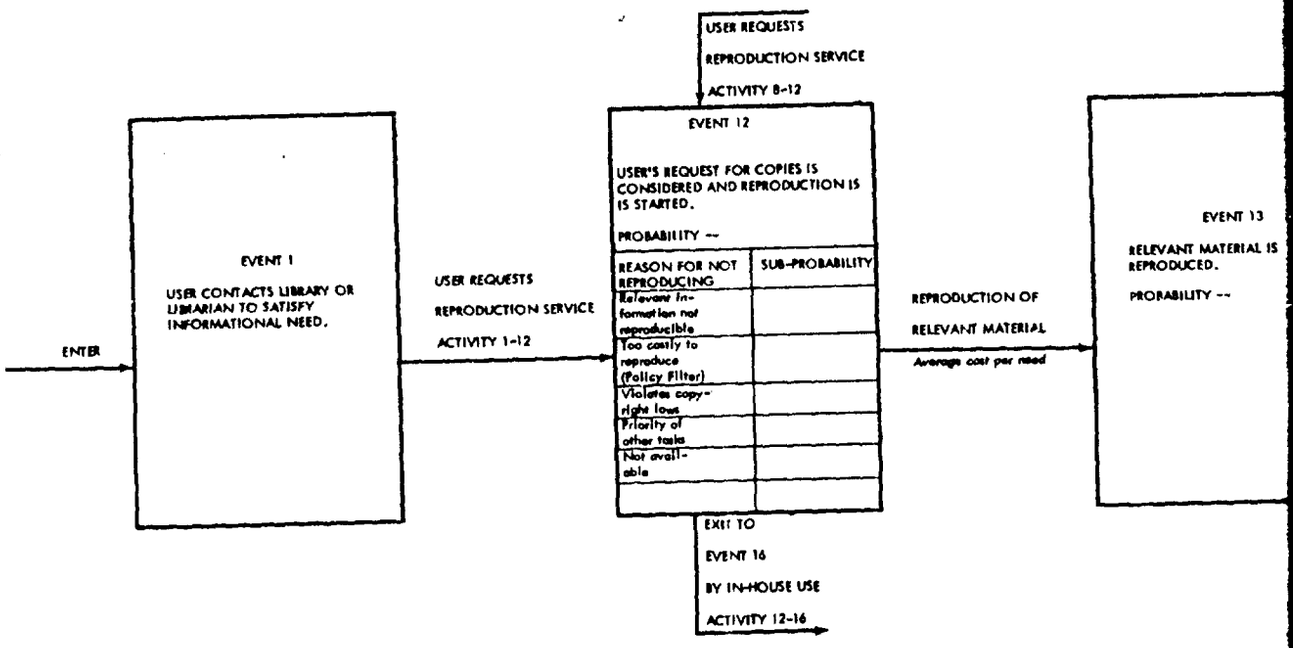

EVENT 3
REFERENCE LIBRARIAN CONSIDERS CLIENT'S NEED AS WITHIN THE MISSION OF THE LIBRARY AND BEGINS SEARCH.
PROBABILITY --
REASON FOR NOT GIVING NEEDED SERVICE
SUB-PROBABILITY
a. Not within scope of the mission
b. Priority of other tasks
INDIRECT FACTORS
FACTOR
NO.
COST
Acquisitions & accessions of reference sources
No. of documents in collection per subject field requested
Ave. no. of index terms per title indexed
Ave. rating of user's ability to search
Interlibrary loan (incoming)
EVENT 7
SOME OF THE RETRIEVED DOCUMENTS CONTAIN RELEVANT INFORMATION.
PROBABILITY --
RETRIEVED
SUB-PROBABILITY
1
2
3
4
5
6
7
8
9
10+
EXIT TO CIRCULATION
ACTIVITY 7-8
CASES II(a), II(b), II(c), III(a), III(b), III(c)
EXIT TO IN-HOUSE READING
ACTIVITY 7-16
CASES II(a), II(b), II(c), III(a), III(b), III(c)
EXIT TO TRANSLATION
ACTIVITY 7-14
CASES II(a), II(b), II(c), III(a), III(b), III(c)
USER AND/OR LIBRARIAN REVIEW THE RETRIEVED DOCUMENTS TO DETERMINE RELEVANCE
CASES II(a), II(b), II(c), III(a), III(b), III(c)
Average cost per read
EVENT 6
SOME OF THE CANDIDATE DOCUMENTS ARE RETRIEVED WITHIN THE REQUIRED TIME.
PROBABILITY --
ORDERED FROM
SUB-PROBABILITY
a. Stacks
b. Inter-library Loan
c. Accession & Acquisition
EXIT TO TRANSLATION
ACTIVITY 6-14
CASES I(a), I(b), I(c)
EXIT TO CIRCULATION
ACTIVITY 6-8
CASES I(a), I(b), I(c), II(a), II(b), II(c), III(a), III(b), III(c)
EXIT TO IN-HOUSE READING
ACTIVITY 6-16
CASES I(a), I(b), I(c), II(c)

FIGURE 13

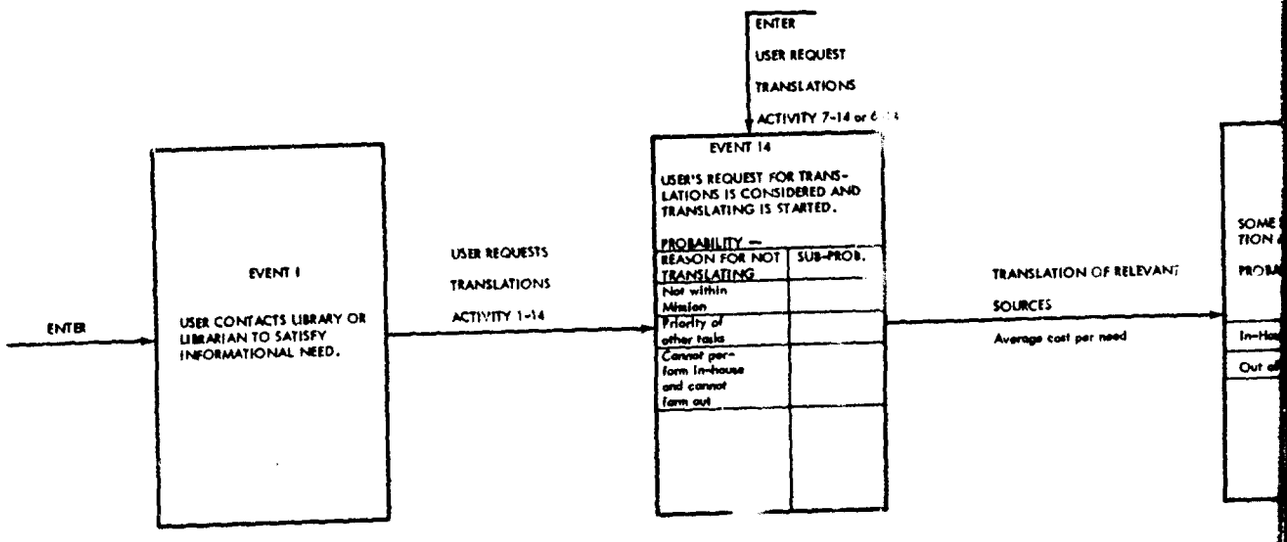
REPRODUCTION SERVICE

A service within the library or provided by the library for the purpose of preparing copies of library material. The service includes direct labor and facilities allocation to actuate the events below.



TRANSLATION SERVICE

That service including the operations identified below which actuates those events respectively following each operation. Those activities leading to translations requested by a client.



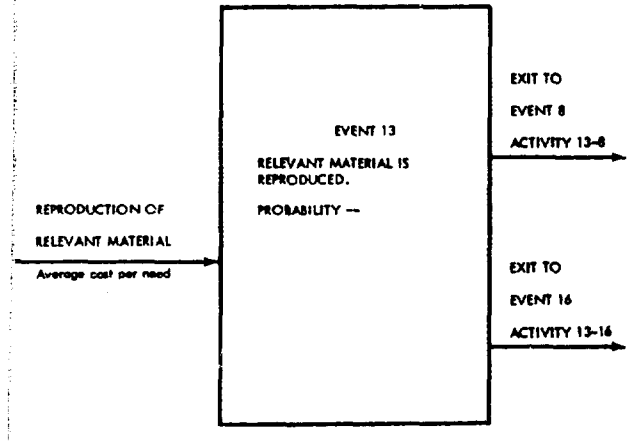


FIGURE 14

dentified below which
owing each operation.
requested by a client.

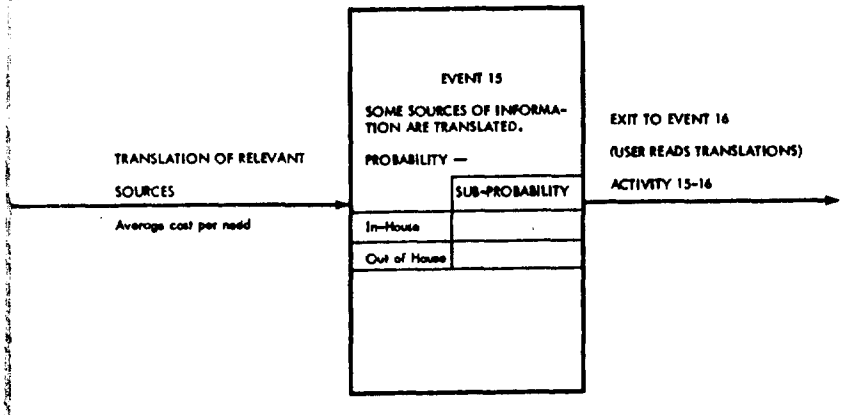
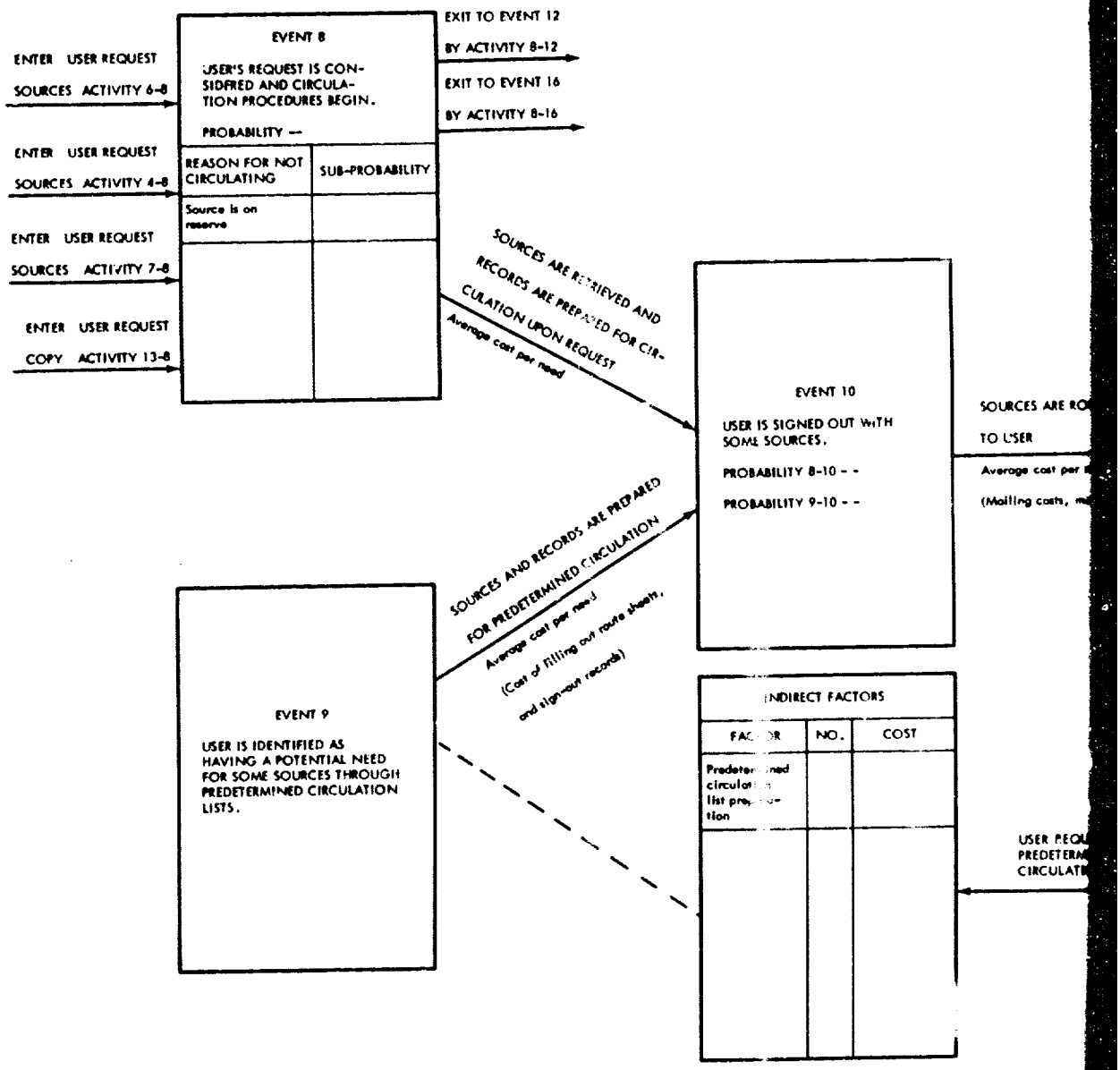


FIGURE 15

JB

CIRCULATION SERVICE
PREDETERMINED AND UPON REQUEST

That service including the operations identified below which actuate the events respectively following each operation. Those [illegible] operations which lead to the circulation of materials to a user.



CIRCULATION SERVICE
PREDETERMINED AND UPON REQUEST

That service including the operations identified below which actuates the events respectively following each operation. Those labor operations which lead to the circulation of materials to a user.

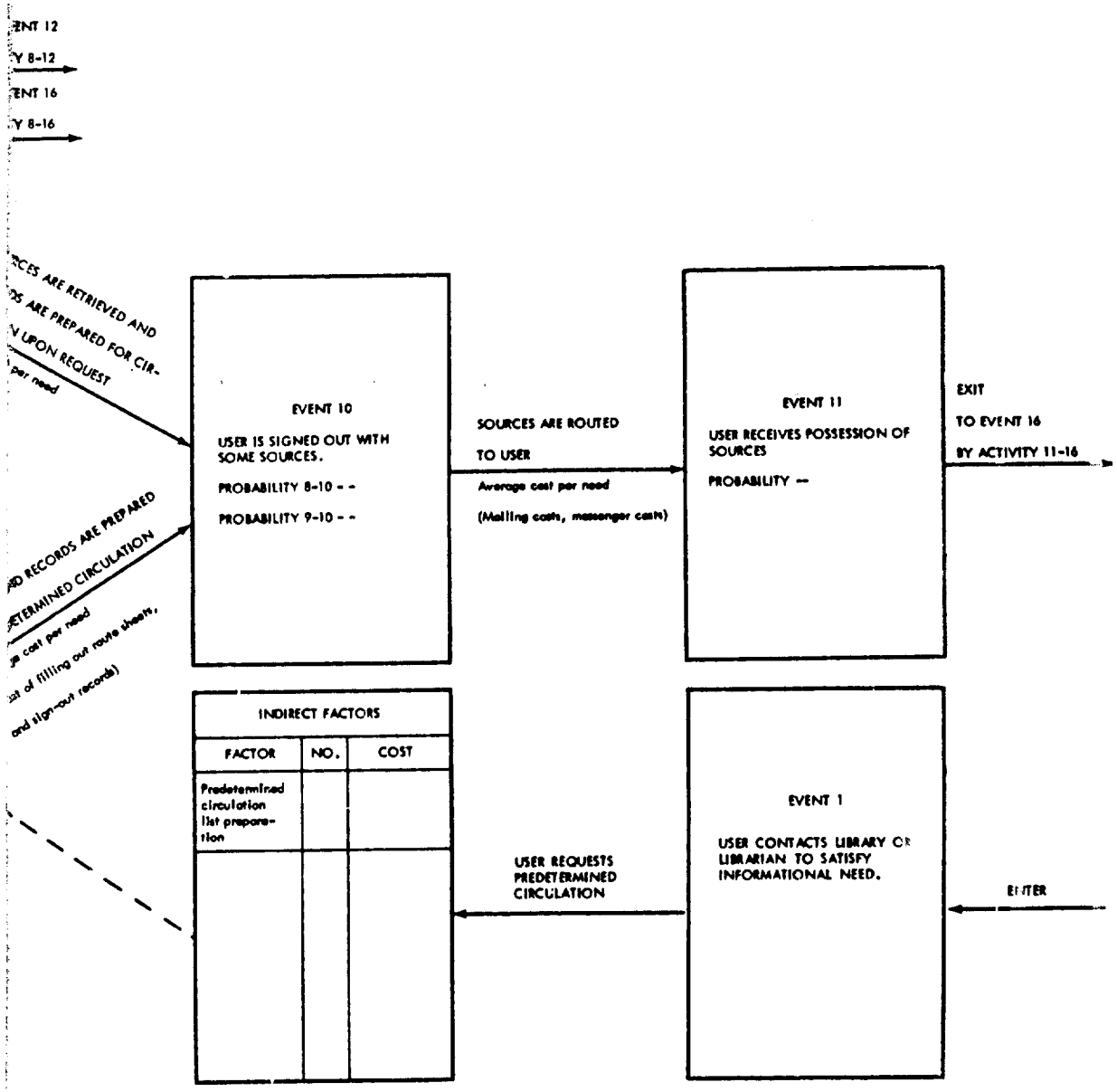
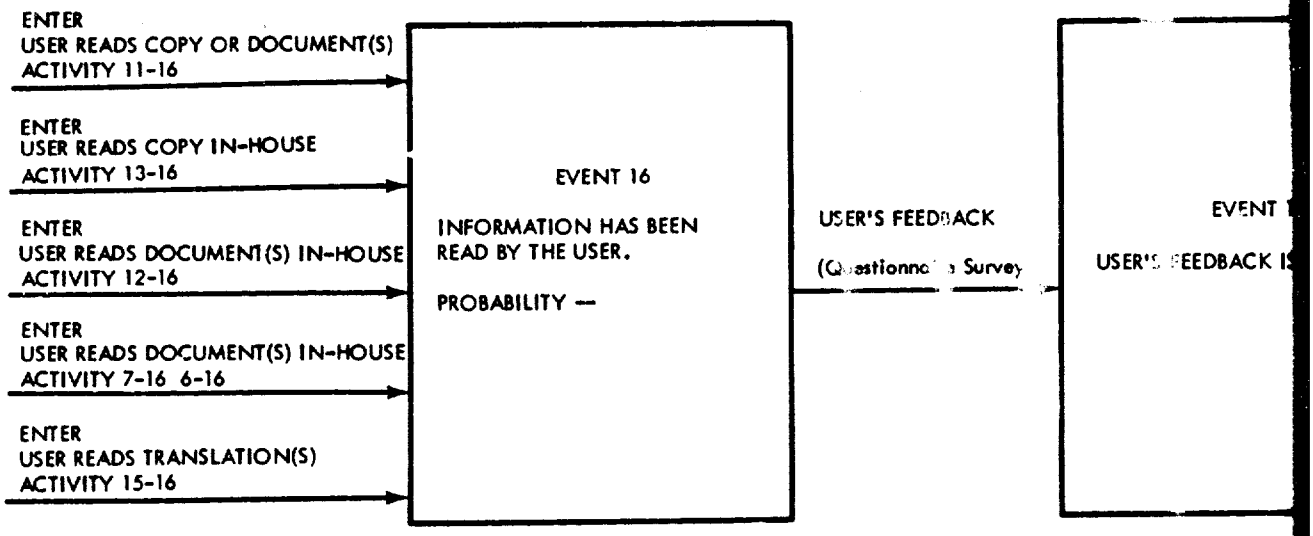


FIGURE 16

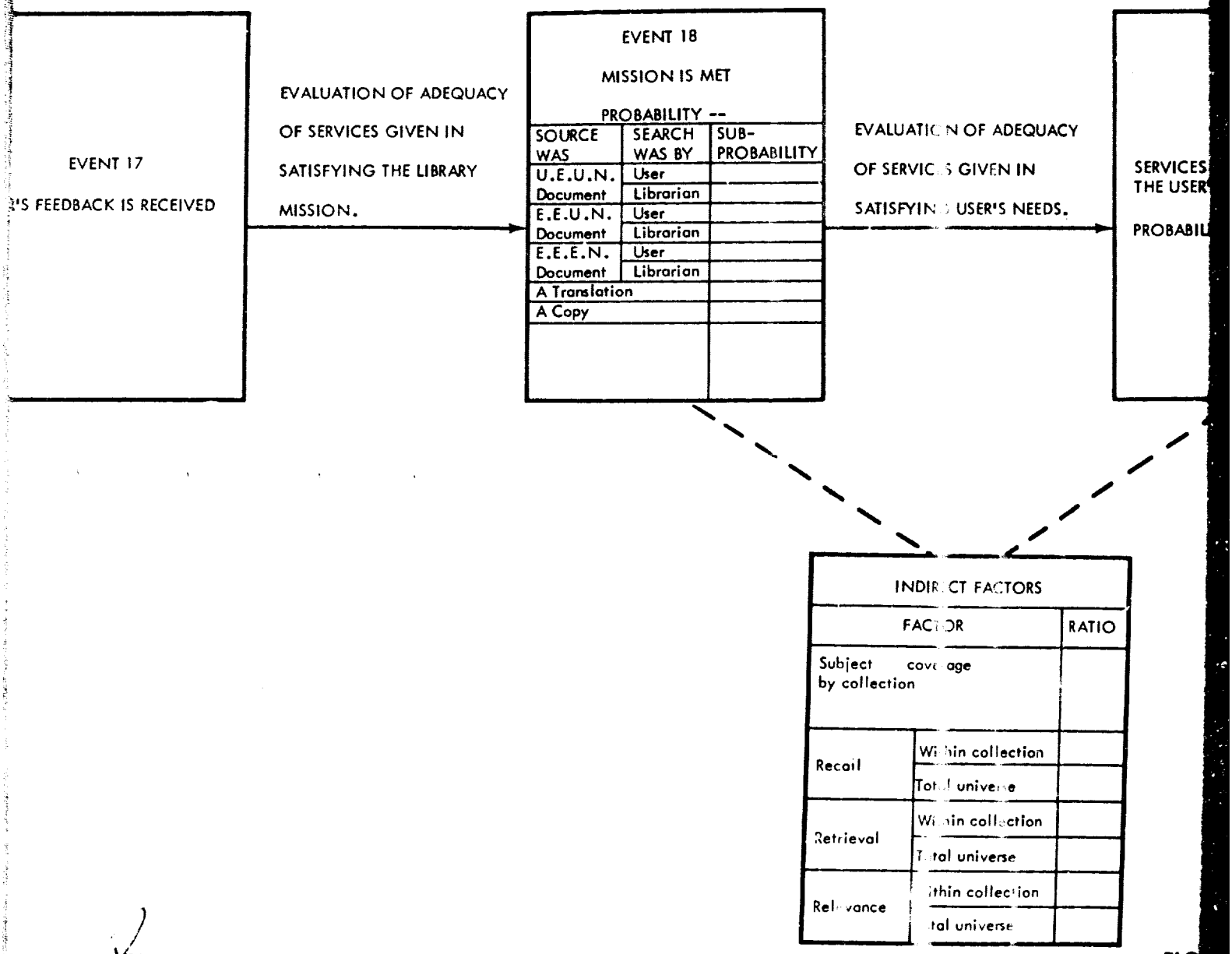
B


ENTER
USER READS COPY OR DOCUMENT(S)
ACTIVITY 11-16
ENTER
USER READS COPY IN-HOUSE
ACTIVITY 13-16
ENTER
USER READS DOCUMENT(S) IN-HOUSE
ACTIVITY 12-16
ENTER
USER READS DOCUMENT(S) IN-HOUSE
ACTIVITY 7-16 6-16
ENTER
USER READS TRANSLATION(S)
ACTIVITY 15-16
EVENT 16
INFORMATION HAS BEEN READ BY THE USER.
PROBABILITY —
USER'S FEEDBACK
(Questionnaire Survey
EVENT
USER'S FEEDBACK IS

A

USER'S FEEDBACK CYCLE

Represented below is the chain of events and activities which lead to, include, and evaluate effectiveness of information in meeting the mission of the library or the needs of the client.



FIG

EVENT 18

MISSION IS MET

PROBABILITY --

SOURCE WAS	SEARCH WAS BY	SUB-PROBABILITY
U.E.U.N. Document	User	
	Librarian	
E.E.U.N. Document	User	
	Librarian	
E.E.E.N. Document	User	
	Librarian	
A Translation		
A Copy		

EVALUATION OF ADEQUACY OF SERVICES GIVEN IN SATISFYING USER'S NEEDS.

EVENT 19

SERVICES PROVIDED SATISFY THE USER'S NEED.

PROBABILITY --

INDIRECT FACTORS

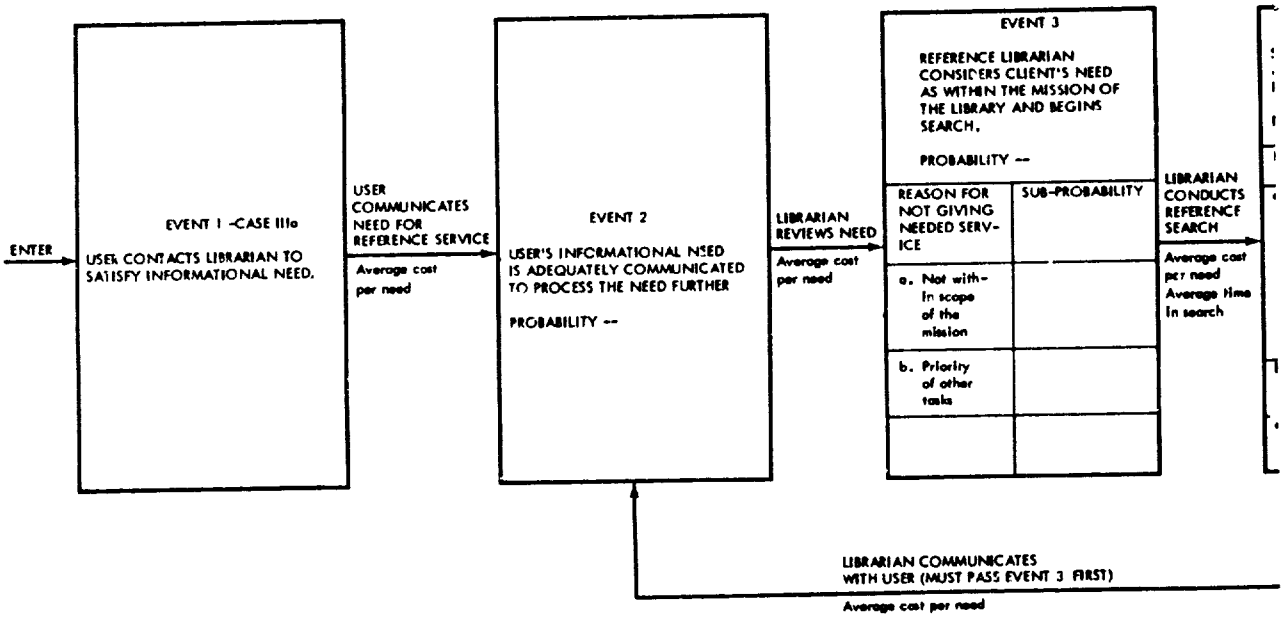
FACTOR		RATIO
Subject coverage by collection		
Recall	Within collection	
	Total universe	
Retrieval	Within collection	
	Total universe	
Relevance	Within collection	
	Total universe	

FIGURE 17

SEARCH SERVICE (LIBRARIAN CO

EQUIVOCAL EXPRESSION OF EQ

CASE IIIa



A

SEARCH : RVICE (LIBRARIAN CONDUCTS SEARCH)

EQUIVO AL EXPRESSION OF EQUIVOCAL NEED

CASE IIIa

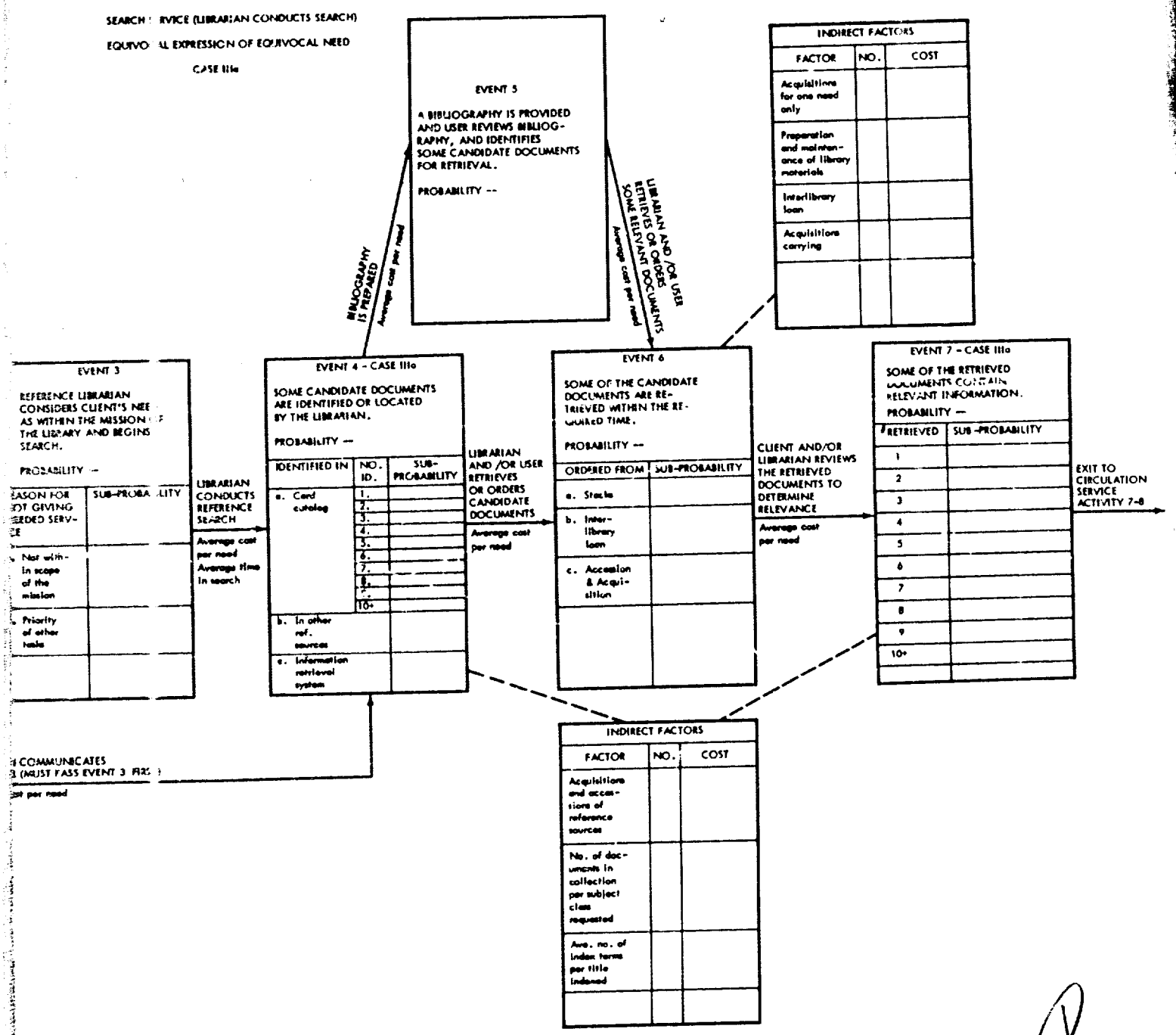


FIGURE 18

B

VIII. TYPE 5 APPROACH EVALUATION AND ANALYSIS

Approach 5 is explained in part in the Phase I report of this contract, (ATLIS Report No. 10), beginning on p. 6 and illustrated by Figure 1 on p. 9. The purpose is to formalize in the mind of the librarian that all operations performed in his library and all services the library produces serve the goals and objectives which either he or his superiors have set as implementing the overall mission of his library. This mission is subservient to the higher mission of the organization within which the library operates.

This approach, therefore, provides the format and procedures which the librarian may use in formalizing (1) his library mission statement, (2) the goals and objectives which give form and substance to that mission, (3) the particular activities or services his library should produce to implement those goals and objectives, and finally (4) those operations which he and his staff must perform.

On the basis of training and experience, it then becomes possible, using the matrix provided, for the librarian to assign weights to the various services which describe their relative importance in achieving the mission, goals and objectives. The librarian can then estimate how much of each operation is necessary to produce the activities and services required. It is then possible for him to compare this situation with the real-life situation in the library and assess the effectiveness of overall operations.

This approach would be expected to produce a "management" criterion. That is, the effectiveness of a given library is a function of the organization and management ability of the head librarian. It is highly judgmental and proximate. In the hands of a well-organized head librarian it is a tool which assesses his own effectiveness and demonstrates to superiors that by organizing activities and services to optimize mission fulfillment he is effectively fulfilling his management responsibilities.

This approach, or perhaps the methods and procedures involved, permit periodic adjustment to changing situations. That is, with assignments of new tasks, or alteration in services, or other changes, the librarian is able to re-assess his situation and to make the management decisions required to meet the new set of requirements. In that sense this approach recognizes that library situations are dynamic.

This approach makes a number of assumptions. The major assumption is that a well delineated mission statement is available for the library organization and that this statement supports the higher mission organization (command, department, division, research group, and so on) that the library serves. The subsequent assumptions are based on that major assumption.

For example, the more specific goals and objectives provide definition of generalized entities which must be provided to fulfill the mission. The actual services or products to be produced by the library are determined from the goals and objectives statements. The operations statements define the actions the library staff performs to produce the services or products.

In applying this method the mission statement must be provided first. It can, for example, be prepared by the director of the research laboratory. It is desirable, however, for the librarian to review the statement to insure it is in terms he can understand. The goals and objectives statement, however, should be prepared jointly by the higher authority and the librarian. Identification of the particular services and products should be performed by the librarian who by training and experience is best fitted to determine which services and products of the library fill the specifications of the goals and objectives. When these 3 levels of statements have been decided upon, the librarian is ready to test this particular approach.

The librarian, from the background of his knowledge of the overall situation, must then assign weights or values to the various services and products his organization produces. These can be arbitrary numbers which have little or no meaning per se, but which by comparison, each with the others, give the relative importance of the services and products as they support the goals and objectives. For purposes of simplicity in this exercise, the total sum of these arbitrary values is equated to the total "utils"* of the library, as will be discussed later. The librarian would then also assign values for each operation according to its effect in adding value to services or products.

Type 5 data were sought from some of the libraries visited during the Phase II data gathering survey. This data type is expected to reflect the relative values of operational outputs toward providing given services and the relative values of services in supporting the mission of the libraries. As discussed in the Phase I report, a matrix was developed to facilitate a test of the librarians' ability to assign relative values for operations and services (see pp. 6-10, Phase I Report).

Some of the librarians asked to provide these data were not responsive. This indicates that: (1) the values sought were not clearly communicated or understood, (2) the librarians are often not able to quantify the values of operations in supporting services** or values of services in supporting missions.

From the data submitted it was apparent that all librarians do not assign the same values to given operations and services. However, there was some general agreement in the rank order of values assigned. This rank

* Utils, an arbitrary unit which represents the amount of utility or value.

** In this discussion the term "services" includes "products."

order is from highest to lowest of 5 services: reference search, circulation, bibliographic, publications, translations. The data indicated that even though libraries have different missions, goals and objectives, the relative values of operations and services do not diverge completely, although values can be expected to be affected by missions and the kinds and degrees of operations performed.

In evaluation of the responses received during the data collection effort it was deduced that some librarians do have the ability to assess the comparative values of their services and operations. However, it is considered necessary to develop the concept further in order that more meaningful and complete value data may be collected to determine and validate criteria from Type 4 data. With this objective in mind, the test described in the following section will be conducted in Phase III of this contract to collect additional and more comprehensive Type 5 data.

Test procedure for developing and validating criteria by utility analysis (see Utility Analysis in the Glossary, p. 97)

The procedures outlined here investigate the applicability of utility criteria for measuring the value of services and products, and for making determinations of equilibrium conditions which maximize utility within given budget constraints. The application of utility analysis used here is not based upon the users judgments of utility as in the classical approach. The measurements of utility applied here are based upon the judgments of a librarian as to the utility of the services and operations in meeting the mission of his library. For each library tested, it will be necessary to have statements prepared by the librarian and/or the next higher echelon which define:

(1) The library mission.
(2) The library goals and objectives supporting the mission.
(3) The particular services and products of the library which implement the goals and objectives.

In the course of the tests, a number of determinations must be made. These will be:

(1) Determination of inputs and outputs of each service and the relationships between inputs and outputs.
(2) Determination of the factors to be maximized for each service relative to the purpose of the library. For example, most private industries have a central purpose of maximizing profits. A library may also have a central purpose which may be to maximize the percentage of within-mission needs met or to maximize the value of library services and products in supporting research and development activities of the users.
(3) Determination of a means of measuring the utility of the factors to be maximized.

(4) Determination of the operations to be performed in the effort to maximize utility of each service or product.

(5) Determination of standard output* units per man-hour for each operation.

(6) Determination of the change in utility (ΔU_i) of each service (i) with respect to the change in each operational output unit (ΔO_j), where $\Delta U_i/\Delta O_j$ = marginal utility of service (i) with respect to operation (j). To determine the marginal utility of a given operational output, it is necessary to describe a utility curve such as shown in Figure 19. This curve is described by plotting points on utility-output coordinates. Various operational output quantities are plotted against their utility. The output quantities may be arbitrarily chosen to deviate from existing outputs. In Table 9 the existing output is 80 standard man-hours of work. The deviations are in 10 man-hour increments above and below the existing output. Judgments are then made of the utility of each service derived from the various outputs. The marginal utility of the existing output can be represented by the average slope of the utility curve between points 3 and 4 (P_3 & P_4) or $\Delta U_{i3}/\Delta O_{j3}$ = 30/10 = 3.0, (or ideally at P_3).

(7) Determination of the total change of utility ΔTU_j of operation (j) with respect to the change in operational output ΔO_j where $\Delta TU_j/\Delta O_j = MU_j$ = marginal utility of respective operations outputs.

(8) Determination of the cost per man-hour at 100% utilization for each operation.

If these determinations can be made, it will be possible to establish criteria for allocation of man-hours in such a way that overall utility of operations and services may be maximized. The equilibrium condition for maximum utility exists when total budget for operations (I); amount of each operational output (A,B,C,...N); price of each operational unit (P_a, P_b, P_c,...P_n) and marginal utility of each operational unit MUa, MUb, MUc,... MUn satisfy the following equations:

(1) $$I = AP_a + BP_b + CP_c + \ldots + NP_n;$$

(2) $$\frac{MUa}{P_a} = \frac{MUb}{P_b} = \frac{MUc}{P_c} = \ldots = \frac{MUn}{P_n}.$$

* The term "output" has different meanings, depending on the part of the system to which it refers. In this chapter, unless otherwise stated, the term means a measure of operational actions, not a measure of number or quality of services or products. In this sense operational outputs are inputs toward producing services or products.

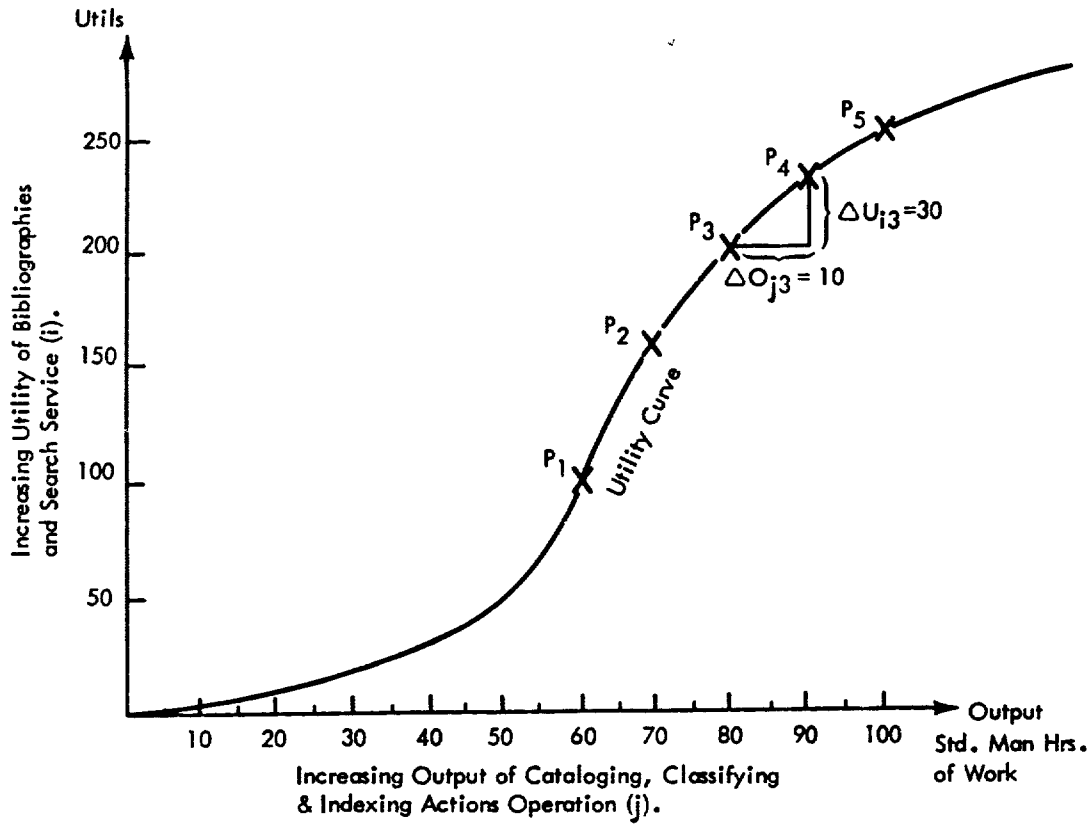


FIGURE 19

Point	Operational Output	Utility of Service Derived From Operation	Marginal Utility $\Delta U_i/\Delta O_j$
1	60 man hrs.	100 Utils	$\frac{160-100}{70-60} = \frac{60}{10} = 6.0$
2	70 man hrs.	160 Utils	$\frac{200-160}{80-70} = \frac{40}{10} = 4.0$
3	80 man hrs.	200 Utils	$\frac{230-200}{90-80} = \frac{30}{10} = 3.0$
4	90 man hrs.	230 Utils	$\frac{250-230}{100-90} = \frac{20}{10} = 2.0$
5	100 man hrs.	250 Utils	

TABLE 9

If these equations cannot be satisfied, it may be possible to optimize manpower allocation to approach utility maximization. If there are constraints other than budget constraints, such as manpower constraints, it may not be possible to maximize utility. Regardless of constraints and barriers to utility maximization at the point of equilibrium, criteria may be developed to indicate the optimum balance between budget allocation and utility.

The following example will serve to demonstrate the utility analysis approach.

Example:

Figure 20 is a hypothetical total and marginal utility schedule for estimates of long run utility of operations and services. Only 8 services and 11 operations are considered as the significant operations and services at a hypothetical library. The value to be maximized is the utility of the services in meeting the within-mission needs of the users. The outputs units being measured as contributing to utility are standard work units expressed in terms of standard man-hours of work (Figure 20, third column from right).

The numbers underlined in the schedule are existing output (standard man-hours of work) and utility (utils) measures for each operation. The standard man-hours of work produced (in the output column) is the same number as the man-hours worked (in the operation input column), when the operator is working at 100% utilization. This concept and the criteria for standards will be discussed further in the Phase III development of the Group Attainment Program. For our present example we will assume that all operators are working at 100% utilization. The other numbers in the schedule represent utility and marginal utility changes at various output changes.

If the library is operating at a point of maximum utility within budget constraints, the following conditions must be satisfied:

(1) $I = APa + BPb + CPc + DPd + EPe + FPf + GPg + HPh + IPi + JPj + KPk;$

say: $Pa = \$3.00$, $Pb = \$5.00$, $Pc = \$4.00$, $Pd = \$3.00$, $Pe = \$3.00$, $Pf = \$2.00$, $Pg = \$5.00$, $Ph = \$4.00$, $Pi = \$4.00$, $Pj = \$2.50$, $Pk = \$6.00$.

(2) $$\frac{MUa}{Pa} = \frac{MUb}{Pb} = \frac{MUc}{Pc} = \frac{MUd}{Pd} = \frac{MUe}{Pe} = \frac{MUf}{Pf} = \frac{MUg}{Pg} = \frac{MUh}{Ph} = \frac{MUi}{Pi} = \frac{MUj}{Pj} = \frac{MUk}{Pk}.$$

Estimates of Long Run Utility

SERVICE OR PRODUCT			S.D.I.	TRANSLATIONS	BIBLIOGRAPHIES & REFERENCE SEARCH	CIRCULATION UPON REQUEST	CIRCULATION PREDETERMINED	ABSTRACTS
Existing Utility of Each Service or Product in Meeting within-Mission Needs of the Users.			100	50	500	500	50	50
Operation Output Symbol	Operation	Operation Input - Man Hrs.	Utility	Utility	Utility	Utility	Utility	Utility
A	Cataloging Classifying & Indexing Actions	60	65		100			
		70	80		160			
		80	90		200			
		90	93		230			
		100	95		250			
B	Performance of Searches	20			20			
		30			40			
		40			50			
		50			60			
		60			70			
C	Bibliographic Listing Actions	10			10			
		20			20			
		30			25			
		40			30			
		50			30			
D	Circulation Upon Request Actions	50				50		
		75				85		
		100				100		
		125				110		
		150				115		
E	Circulation by Predetermined Listings Actions	5					13	
		10					20	
		20					25	
		30					28	
		40					30	
F	Preparation & Maintenance of Collection	5	3		3	24		
		10	5		5	40		
		20	10		10	80		
		30	12		12	95		
		40	13		13	100		
G	Translating Actions	10		25				
		15		40				
		20		50				
		25		56				
		30		60				
H	Users' Education Actions	5			11	11		
		10			12	12		
		20			15	15		
		30			20	20		
		40			30	30		
I	Abstracting Actions	10						15
		20						20
		30						25
		40						30
		50						35
J	Reproduction Actions	10				1		
		20				3		
		30				5		
		40				6		
		50				7		
K	Acquisitions Actions	50			100	75	10	20
		75			150	200	15	23
		100			200	300	25	25
		125			250	375	32	26
		150			300	400	35	27
L	Staff Training Actions							
M	Inter Library Loan							

FIGURE 20. TOTAL & MARGINAL UTILITY SCHEDULE

Estimates of Long Run Utility

BIBLIOGRAPHIES & REFERENCE SEARCH	CIRCULATION UPON REQUEST	CIRCULATION PREDETERMINED	ABSTRACTS	REPRODUCTIONS	USERS SEARCH	Total & Marginal Utility of Operations		
500	500	50	50	50	1000			
Utility	Utility	Utility	Utility	Utility	Utility	Output-Std. Man Hrs. of Work.	Total Utility	Marginal Utility.
100					100	60	265	20.0
160					225	70	465	12.5
200					300	80	590	8.3
230					350	90	(675)	4.7
250					375	100	720	
20						20	20	2.0
40						30	40	1.0
50						40	(50)	1.0
60						50	60	1.0
70						60	70	
10						10	10	1.0
20						20	20	.5
25						30	(25)	.5
30						40	30	.0
30						50	30	
	50					50	50	1.4
	85					75	85	.6
	100					100	(100)	.4
	110					125	110	.2
	115					150	115	
		13				5	13	.6
		20				10	(20)	.5
		25				20	25	.3
		28				30	28	.2
		30				40	30	
3	24				35	5	65	4.2
5	40				50	10	100	3.0
10	80				75	20	(175)	2.0
12	95				100	30	220	.6
13	100				115	40	241	
						10	25	3.0
						15	40	2.0
						20	(50)	1.2
						25	56	.8
						30	60	
11	11				130	5	152	4.4
12	12				150	10	174	5.6
15	15				200	20	(230)	7.0
20	20				260	30	300	9.0
30	30				310	40	370	
			15		10	10	25	1.0
			20		15	20	35	1.5
			25		25	30	(50)	1.5
			30		35	40	65	2.0
			35		50	50	85	
	1			30		10	31	1.2
	3			40		20	43	1.2
	5			50		30	(55)	1.1
	6			60		40	66	1.1
	7			70		50	77	
100	75	10	20		200	50	405	11.3
150	200	15	23		300	75	688	10.5
200	300	25	25		400	100	(950)	9.3
250	375	32	26		500	125	1183	7.2
300	400	35	27		600	150	1362	

FIGURE 20. TOTAL & MARGINAL UTILITY SCHEDULE

B

Utilizing the output data in the 3rd column from the right, when the total budget for operations is \$2200/week, condition (1) requires that:

$$\$2200.00 = (80)\ (\$3.00) + (40)\ (\$5.00) + (30)\ (\$4.00)$$
$$+ (100)\ (\$3.00) + (100)\ (\$3.00) + (20)\ (\$2.00)$$
$$+ (20)\ (\$5.00) + (20)\ (\$4.00)$$
$$+ (30)\ (\$4.00) + (30)\ (\$2.50) + (100)\ (\$6.00)$$

This reduces to:

$$\$2200.00 = \$2175.00.$$

It can be seen that the library does closely approximate the first condition.

Utilizing the marginal utility data in the 1st column from the right and the prices of respective output units condition (2) requires that:

$$\frac{8.3}{3.00} = \frac{1.0}{5.00} = \frac{.5}{4.00} = \frac{.4}{3.00} = \frac{.3}{3.00} = \frac{2.0}{2.00}$$

$$= \frac{1.2}{5.00} = \frac{7.0}{4.00} = \frac{1.5}{4.00} = \frac{1.1}{2.50} = \frac{9.3}{6.00}.$$

This reduces to:

$$2.80 = .20 = .13 = .13 = .10 = 1.00 = .24 = 1.75 = .38 = .44 = 1.55.$$

It can be seen that the library does not closely approximate the second condition. Therefore, in order to maximize utility it will be necessary to add output to operations where MU_j/P_j = the largest positive number. Since $\frac{MU_a}{P_a} = 2.80$ and 2.80 is the largest MU_j/P_j, we should add output (A) to cataloging, classifying and indexing and reduce output from operations where MU_j/P_j = the smallest number. Since $\frac{MU_e}{P_e}$ = the smallest number = .10, we shall remove 10 units of E (10 man-hours) and allocate the cost of 10 man-hours of E (10 x \$3.00 = \$30.00) to A. If we add \$30.00 to A we will add 10 man-hours to A, since the Pa = \$3.00/man-hour.

The change in allocation of funds causes a change in total utility. The sum of the numbers in the total utility column which are underlined represent the total utility of operations before the change. The sum of the numbers in the total utility column which are in parenthesis represent the total utility after the change. Because of the reallocation of funds the utility of E drops 5 utils, and the utility of A increases by 83 utils. Therefore, a net long run gain of 78 utils is anticipated by spending \$30.00 less on predetermined circulation and \$30.00 more on cataloging, classifying and indexing.

At this point, before the change is made, the purpose for the change and the effect of the change must be reviewed. The purpose is to maximize utility of total operations in meeting the within-mission needs of users.

The effect would be decreased predetermined circulation and increased cataloging, classifying and indexing. If there are no obvious constraints upon reducing predetermined circulation or increasing cataloging, classifying and indexing, the change should be recommended, reviewed by top management and implemented if approved. Disapproval would constitute a constraint and, therefore, may be a barrier to maximizing utility of the operations in meeting the within-mission needs of the users. On the other hand, disapproval may indicate poor value judgments in the analysis which should be revised to improve the measure of utility. If there are barriers such as (1) no additional qualified catalogers are available or (2) top executives insist that predetermined circulation should not be reduced regardless of a lower predicted benefit per dollar invested, then it will be necessary to optimize service utility by seeking other changes which will resolve greater total utility. Perhaps adding man-hours to H and reducing man-hours of C or D may be accomplished.

Operation D is circulation actions. Assuming that the personnel performing circulation actions are fully utilized in serving clients, the man-hours reduced must be accomplished by improving methods of circulation operations, otherwise reduction in man-hours could cause a bottleneck which reduces user satisfaction.

The utility approach, therefore, is useful in pointing out the operations which should be concentrated upon first to improve methods and efficiency in order to free labor for more effective and utility maximizing operations.

In the case of increased total manpower for operations the additional man-hours should be added where MU_j/P_j is largest. In the case of staff cuts the man-hours should be reduced where MU_j/P_j is smallest.

APPENDIX A

GLOSSARY OF MANAGEMENT SCIENCE TECHNIQUES

Although a glossary of management science terms was presented as Appendix E of the Phase I Report, a revision of several of the glosses is required. This revised version, therefore, provides modified explanations of several of the management techniques of the original glossary. However, it does not present or define terms which do not represent formalized management techniques per se, such as the word "budget."

The purpose here is to reorganize the major techniques considered in Phase I, to add some new considerations and to provide reference numbers to selected articles which discuss the techniques. Reference numbers through 758 represent either abstracts or simply references to articles as shown in the Phase I Report. Numbers above 758 represent references included in Appendix B to this Phase II Report.

The references refer to publications which relate to the techniques in one or more of the following respects:

(1) Methodology.
(2) Possible application to industry, government and/or libraries.
(3) Previous application in industry, government and/or libraries.
(4) General discussion--advantages, disadvantages, philosophy, etc.

Following the references are parameters explaining what each technique indicates or controls.

The statements and parameters are not intended to be criteria for measurement but are presented here as hypothetical tools for measurement. These hypothetical tools which have been selected as tentative tools (see paired comparison experiment page 60) are identified in the tentative tools charts, Figures 10 and 11. In these charts each tool (technique) is identified with the library operation or service which it measures or controls.

Each of these tentative tools is potentially useful for developing criteria for measuring or controlling the efficiency and effectiveness of library services and operations. In light of the data gathered and the observations made during the Phase II library survey, certain of these tentative tools will be selected to develop criteria in Phase III of this contract.

I. Systems Analysis

Systems Analysis is a functional process responsible for the development of policies and objectives for the planning, acquisition and utilizations of library resources and requirements as affected by the operators, users and designers of library information systems

at various levels and mission assignments considering political, social and economic factors. This basic approach could be useful to segregate and delineate the individual functions of the library. Systems analysis will show the interfaces between functions and their relationship to the overall objectives and goals of the library. This concept has been expanded to include the relationship of the library to the users and to the parent organization and the mission of that organization. In this sense the system is "a set of organized operations to satisfy a definable user requirement." (References: 38, 46, 49, 126, 155, 157, 146, 282, 327, 410, 416.)

Indicates efficiency of individual operations of the library by determination of the ability of the various operations to work together. The total efficiency of an organization or a system is a function of the efficiencies of each operational unit and the efficiency of the interactions between the operational units. Systems analysis can be used to facilitate measuring the efficiency of and between operational units by models, charts, etc., which simulate an on-going system. This simulation may be used in cost-effectiveness analysis, P.P.B.S. or other systems techniques which indicate, measure or predict parameters of a system.

Indicates effectiveness by identifying the individual functional units of the library and delineating the roles and goals of each with regard to the overall mission of the library. After this role and goal assigning has been accomplished, simulations which identify probabilistic and deterministic variables can be made. The simulations facilitate judgments as to each unit's effectiveness in attaining goals. Even though all functional units are effective in their roles, organizational effectiveness is not insured. The outputs of each unit must merge into the system in an effective manner. Systems analysis should also determine the effectiveness of the coordination between goal directed roles and user needs through user feedback.

II. Cost-Effectiveness Analysis

This is an economic analysis applied to resource allocation. It relates tangible costs to meaningful and utility-maximizing missions or programs, instead of to the cost of individual segments. In economic analysis, the concern is with objectives rather than objects. Cost-effectiveness can be determined by identifying the performance or accomplishments of a program needed to achieve objectives, and evaluating all resources associated with the program in relation to the benefits anticipated from the program. (References: 14, 20, 53, 86, 112, 115, 125, 130, 141, 155, 232, 260, 303, 325, 429.)

Indicates efficency-effectiveness (Performance) level by correlating efficiency (expressed in terms of cost) and effectiveness (expressed in terms of probabilities of meeting objectives or in terms of qualitative judgments of effectiveness). Cost-effectiveness analysis helps resolve the optimum cost-effective system and thereby helps to maximize performance. Optimum cost-effectiveness can be indicated after assigning weights to cost by cost accounting (see Cost Accounting, III) and effectiveness by qualitative or quantitative measures. Graphs, computer programs (Linear Programming, VII) or models (Models, XIX) can be used to indicate the relative cost-effective level of alternate methods or systems.

III. Cost Accounting

Cost accounting is an excellent control device, commonly used in industry, which allocates the various costs of doing business to the units produced or sold. Cost accounting serves a need for communication and control between sources of money and management concerning the use of capital invested. As used in the library, cost accounting could develop a cost figure for each operation performed and each product or service given by utilizing cost data derived from accounting records, standard data (Standard Data, XIII) or tailored techniques such as the systems generalized models which have been developed in this study for each library service. (Reference: 62, 63, 111, 226, 231, 311, 367, 760.)

Indicates efficiency by identifying costs of each service or operation in terms of dollars. Efficiency of a service or operation can be measured in terms of dollars when the outputs are constant in terms of quality or effectiveness. If outputs vary, the costs must be prorated to indicate efficiency.

Controls Performance by periodic checking of expenditures with budget allocations and automatic feedback control when costs become inconsistent with budgets (Budgeting, XXXI).

IV. Utility Analysis

Utility analysis depends upon the concept that the consumer not only knows that he prefers A to B, but he can give numerical expression to his desires which permits him to say he prefers A, say, twice as much as B, giving A twice the utility of B. (References: 102, 183, 184, 303, 361, 362, 372, 763.)

Indicates effectiveness by evaluating a product or service in terms of how much one is willing to sacrifice in order to get that product or service. This sacrifice may be manifested as a trade off of money, time, effort or other products or services. The cardinal utility of the desired product or service can be measured by dollars or time units and by other com-

parative units such as weights of the relative preference for one product or service over another. Care must be taken not to assume utility can be measured by any absolute value of what one is willing to sacrifice. Ordinal utility of a commodity for one individual can be measured by his relative indifference between having various commodities. If a population of scientists has the same indifference between having Chemical Abstracts or Current Contents, the utility of the two is constant for the group. However, if 40% of the scientists prefer one and 60% prefer the other, the utility of each depends on the user indifference. Utility of various items in a collection can be rated by comparison with each other. For instance, rating or ranking techniques, such as paired comparisons (Figure 9), can be made between a number of journals to determine the utility rank of each journal for each scientist. The ratings or ranks given to each journal can be averaged to give a mean utility rank for each.

V. P.P.B.S.: Planning-Programming-Budgeting System

P.P.B.S. is a set of procedures receiving increasing use and importance in the preparation of government agency budgets, which specify program objectives in quantitative terms, measure benefits and seek least cost solutions of meeting objectives and which impose controls by a budgeting process. The Planning-Programming-Budgeting System requires management to think and plan further into the future, to delineate objectives, analyze costs and benefits of existing programs (costs of activities, equipment, etc.: benefits from probabilities of accomplishing goal-directed events and objectives); and find better and cheaper ways to accomplish objectives. P.P.B.S. is founded on 3 major concepts:

1. Each agency possesses in-house analytical capability for determining the objectives and programs which they should support.

2. A multiyear planning and programming process incorporating and using a systems approach which classifies and presents essential data required for decision-making (such essential data can be utilized in Mathematical & Econometric Models, XIX, or Systems Models).

3. A budgeting process which can refine broad program decisions for subsequent review and action (Budgeting, XXXI).

(References: 437, 317.)

Controls performance by budgeting. Budget allocations are determined by: (1) planning, (2) programming essential data about resources required for decision-making and (3) processing these data to develop base lines of resource limits as criteria for budgeting. This technique was primarily designed for long-run control by budgeting, requiring periodic review and analysis of programs and budgets, and revising resource allocation where necessary.

VI. Statistical Sampling

A method of selecting a sample from a population to insure its being random and consequently representative of the entire population. The sample reflects inferences about the parameters of the whole population according to statistical theories.

Statistics is a general term for a large group of mathematical tools based on laws of probability, used to collect, analyze and interpret numerical data. The purpose of statistical analysis is to provide methods of treating data so that the maximum information can be obtained with a predetermined risk of drawing false conclusions. No method of analysis can extract more information from a set of data than is contained therein, and no method, statistical or otherwise, can draw conclusions from experimental data with zero risk of error. (References: 4, 386, 759.)

Indicates efficiency and effectiveness by presupposing that information about effectiveness, efficiency or performance can be extracted from critical data. It further assumes that it is not necessary to study all data, but it is possible to examine a representative sample of the data to make inferences about efficiency, effectiveness, performance or any other parameter of the population reflected by the sample.

VII. Linear Programming

Any problem concerned with minimizing or maximizing linear objective functions, such as total costs or net profit, and subject to a set of linear equations or inequalities in the form of constraints due to limitations of men, materials, capital or other resources, is a linear programming problem. The two most common types of linear programming are the graphic and simplex methods. The analytical procedure in all instances consists of 4 parts:

1. Arranging the alternative possible goals to be sought.
2. Defining the assumptions to be employed.
3. Determining the balance of net advantages and disadvantages in selecting the optimum solution.
4. Modifying selection by relating the alternatives to the organization's overall objectives.

(References: 220, 538; also pp. 53 and 54, Phase I Report.)

Indicates efficiency and effectiveness by resolving optimum efficiency - effectiveness from data containing many interrelated factors which can be expressed in linear equations or inequalities. Actual efficiency, effectiveness and/or performance values can be compared to the optimum values to indicate the differential between actual and optimum "attainable" accomplishments.

VIII. Correlation Analysis

The coefficient of correlation provides a measure of the degree of relationship between variables. Linear correlations have a possible range of -1.00 to +1.00. Curvilinear correlations have a range of 0 to +1.00. If one variable increases while the other decreases, the result will be a negative coefficient in linear correlations. If there is no relationship between the variables, the coefficient will be zero. In general, the closer the coefficient of correlation comes to equaling $\pm$ 1, the better the relationship is for forecasting purposes. Correlation analysis has been extended in this definition to include regression analysis--a method for computing lines of best fit or formulas showing relationships between variables. (References: 4, 16, 23, 212, 310, 768.)

Indicates factors contributing to efficiency and effectiveness by disclosing relationships between variable factors and efficiency, effectiveness or performance. For example, if high correlation exists between effectiveness and the number of books in a library collection, it can be assumed that effectiveness is a function of the extent of the collection. Furthermore, if linear relationships exist between effectiveness and extent of collection within a range, effectiveness can be predicted by the number of volumes within that range. However, the number of volumes must be taken as only one component of a measure of total effectiveness. If it were possible to establish all variables which determine effectiveness and all correlations between these variables, total effectiveness could be predicted by weighting the correlation values of the variables, according to their power to contribute, and summing the weighted values.

IX. Organization Chart

Graphically identifies bureaucratic relationships between functional and staff units within an organization and delineates areas of responsibility of each unit. (References: 79, 537.)

Indicates efficiency by providing a view of the distribution of responsibilities making recognition of role inconsistencies with organizational goals easier.

Controls performance by providing a means to communicate proper relationships between and proper roles of the line and staff units.

X. Layout Chart

Usually a floor plan of a facility locating the items in the physical layout. Three types of layout charts are plant layout, department layout and workplace diagrams. (Reference: 761.)

XI. Methods Study

Method study is a systematic analysis of work to:

1. Eliminate unnecessary work.
2. Arrange the remaining work in the best possible order.
3. Standardize usage of proper work methods.
4. Establish accurate time standards for the work.

(References: 32, 255, 315, 761.)

Indicates efficiency relative to standardized methods and times for elements of work such as basic motions or operations. These standards are developed by coordination of motion studies and time studies. The standardized methods and times are compiled and presented in various forms such as general standard data (basic motion times) and specific standard data (basic operation times) (Standard Data, XIII). Standard data are time values and the end product of motion and time studies.

XII. Standardization

An authority or rule for the measure of quantity, extent, value or quality, denoting the establishment of practices, policies and rules. Also connotes simplification (reduction of diversification) and denotes establishment of standard equipment and standard methods. (References: 11, 51, 58, 74, 81, 83, 94, 118, 135, 170, 171, 183, 185, 196, 224, 233, 242, 269, 296, 382, 355, 400, 481.)

Controls performance by establishment of practices, policies, rules, standard equipment and standard methods.

XIII. Standard Data

Standard data are predetermined time values, tabularized or reduced to simplest terms, and compiled to largest time values consistent with accuracy, flexibility and speed required for the establishment of time standards for operations. The work factor system divides standard data into 2 classes, general and specific. General standard data are time values developed for a relatively small work segment, such as basic motions and usually applicable to several classes of work. Specific standard data are usually developed for larger work segments occurring in specific operations or classes of operations. The time values in specific standard data are often developed from combinations of values selected from a general system. (References: 32, 41, 315, 449, 761.)

Indicates efficiency by relative comparison of actual time to standard time to indicate the index of productivity or percent utilization.

Controls performance by setting an attainable, expected and enforceable standard of efficiency.

XIV. Performance Evaluation

Gathering of performance information (such as qualitative and quantitative measures of efficiency and effectiveness) and appraisal of this information and managerial philosophy. (References: 80, 120, 132, 162, 166, 289, 324, 462.)

Indicates efficiency and effectiveness by subjective appraisal of qualifying factors of behavior and abilities of individuals, supported by objective appraisal of quantitative statistics such as index of utilization, job description analysis data (Job Description Analysis, XVIII) and degree of effectiveness of the individuals in meeting organizational goals. Appraisals should be made by trained evaluators.

XV. Work Sampling

A method for analyzing work to find delay allowances applicable to a given job, to determine percentages of machine and operator utilization and to establish production standards (Standard Data, XIII and Standardization, XII). It utilizes random observation of operators to determine statistically the amount of time spent on each activity (work or non-work) and the pace at which the operators work. (References: 32, 315, 465, 587, 761.)

Indicates efficiency by determining the utilization of the operators studied. This utilization can be measured in terms of percent time spent working at 100% pace. Work time is defined as the time on the job minus non-work time, avoidable rework time and unnecessary work time. During work time the operator is rated according to pace. The operator's percent utilization will be his work time multiplied by his average pace rating divided by the total time on the job.

NOTE: All work sampling techniques do not require pace measurements; however, utilization percentage figured without pace consideration cannot be expected to be as good a measure of efficiency as utilization percentage including pace leveling.

XVI. Group Attainment Program (GAP)

Using proven measurement techniques (such as Work Sampling, XIV and Standard Data, XIII), GAP objectively determines attainment factors for the jobs in a group. These attainment factors represent the time, including allowances, that it should take a reasonably competent employee using prescribed methods, and working at a normal pace, to perform one operation successfully and fully. Having determined the "should take" time for all operations, it is applied

to the present or planned volume of operations to determine the total labor requirements for the entire volume of services or for any given type of service. Attainment factors or "should take" times are recorded as specific standard data (Standard Data, XIII). (Reference: 251.)

Indicates efficiency of groups by comparison of actual time spent to "should take" time. The measure of efficiency is expressed in terms of an index of productivity which is computed by dividing "should take" time by actual time.

XVII. Human Relations

The study of the kinds and degrees of interactions, and reactions between people and their orientation to groups and institutions and the reasons for such interactions, reactions and orientations. Studies are based on the social sciences, psychology and economics. Human relations is primarily an analytical technique; however, public relations will be considered an application of human relations as an operative technique which applies knowledge of human relations to control interactions, reactions and orientations. (References: 24, 47, 80, 108, 551.)

Indicates effectiveness by determination of how well staff members are suited for their roles and how well clients orient to library resources. For example: Observations before and after clientele and staff training or public relations programs can indicate how effective the programs or the library services were relative to increased interest and ability to utilize library resources.

Controls performance by creating conditions conducive to efficient and effective interaction between clients and staff. Also controls performance by determination of client and staff needs and the means to meet these. For example: By accommodating staff and clientele needs by improving library facilities and working conditions, by reducing boredom and fatigue, and by creating interest and other such incentives conducive to efficient and effective work in and use of the library.

XVIII. Job Description Analysis

An analysis of each job in terms of the duties of the job, amount of skill, effort and responsibility required and the working conditions, leading to decisions in selection, placement and assignments, training, transfer, upgrading and promotion, and in making wage surveys and adjustments. (References: 264, 344, 428, 467.)

Indicates efficiency and effectiveness by identifying the requirements of each job such that staff abilities, training, education, experience and other job factors can be weighted and utilized to the greatest advantage. This advantage is realized by optimum usage of staff qualifications in matching people with jobs. After optimum matching is accomplished, jobs with underqualified workers may be recognized, indicating a need for training programs to increase performance. Jobs with overqualified and high-salaried workers performing routine tasks may also be recognized, indicating a need to assign them to more strategic operations. Job description analysis indicates efficiency of allocation and utilization of staff qualifications and wages

XIX. Models - Mathematical and Econometric

Mathematical - In mathematical analysis, the word "model" is used to mean a mathematical description of an operation which represents the relationships among various elements with sufficient accuracy to predict the actual outcome under any expected set of circumstances. The advantage of a model is that it, instead of the organization it simulates, can be manipulated in a variety of ways until the best solution is found. The disadvantage is that no model can duplicate reality completely.

Econometric - A "model" based on the idea that changes in economic activity can be explained by a set of relationships among economic variables. It explains the past and predicts future economic activity by mathematical equations that express the most profitable interrelationships within a set of economic variables. The best mathematical arrangement is a model which takes the form of an equation or system of equations that best describes the past set of relationships according to economic theory and statistical analysis. The model, in other words, is a simplified abstraction of a real situation expressed in equation form and applied as a system which will yield numerical data reflecting the probable outcomes of a real economic situation when certain inputs are varied. (References: 14, 23, 46, 51, 55, 64, 83, 237, 410, 415, 766, 767.)

Indicates efficiency and effectiveness by manipulating variables within the model to resolve the efficiency maximizing, effectiveness maximizing, or efficiency-effectiveness optimizing conditions and by comparing the maximum or optimum conditions to the actual.

XX. Budgeting

Developing of a budget by considering organizational needs and most efficient and effective allocation of resources. A budget is a plan for authorization of resources, which can be expressed in terms of people or money. Generally a budget converts resources into money. Authorization by means of the budget may be made to a

function , a division or the total organization. The budget should be correlated to planning for efficient and effective accomplishment of objectives. It should represent a decision on the utilization of resources after alternative courses of action are evaluated. The budget gives management a quantitative base for measurement and evaluation. It represents delegation and delineation of responsibility and promotes organizational stability and continuity. (References: 20, 63, 77, 111, 136, 226, 231, 274, 338.)

Controls performance by allocating resources in such a way as to limit waste while allowing enough resource for each function to maintain optimum cost-effectiveness of the services and operations.

XXI. PERT (Program Evaluation and Review Technique)

PERT is a development, planning and control concept designed to focus managerial attention on key program parts, point up potential problem areas which could disrupt program goals, evaluate progress toward the attainment of program objectives, give management a prompt mechanical reporting device, and facilitate decision-making. In the accomplishment of these objectives, PERT uses time units as a common denominator to reflect 3 categories of factors which influence success--progress, resource applications and required performance specifications. Some of the important PERT terms are given below.

Activity - An activity is a time-consuming physical and/or mental process. It is the work in process between 2 points or events in time. An activity is represented by an arrow in PERT network systems.

Activity time - Estimate of the time required to complete an activity in a specified manner. There are 2 types of estimates:

1. Single estimates.

2. Three time estimates: Expected time = $\frac{a + 4b + c}{6}$, where

   a = Optimistic time = the shortest time in which an activity can be completed if there are no problems.

   b = most likely time = the estimated time to complete the activity under normal working conditions. This is the model estimate of time that would occur most often if the activity were repeated under exactly the same conditions many times.

c = pessimistic time = the longest time an activity would take if major changes in approach or design were required; for example, if the product were more difficult than it first appeared.

Event - A specific accomplishment recognizable by a particular instant in time.

Network or flow plan - A diagram or topological representation of a project made up of one or more series of sequential events joined by activity lines to show the time and relationships among events.

Slack - The difference between the latest allowable date and the expected date (T_L minus T_E). Slack may be positive, zero or negative.

Milestones - The significant events or selected points on which progress information is needed in order to evaluate performance with regard to meeting final project objective.

Critical path - the path within the PERT network that contains the algebraically least amount of slack. (References: 163, 294, 371, 436, 439, 452.)

Indicates efficiency by providing view of key program development parts and their labor and time r arements with bench marks to measure progress.

Controls performance by providing a schedule representing ranges of time within which each event is expected to be satisfactorily completed and by providing mechanisms to facilitate decisionmaking when milestones are not falling in chronological sequence as planned.

XXII. Data Processing Techniques Evaluation

Evaluation of methods of storing and retrieving information and performing operations to obtain a desired output.

Indicates efficiency of data processing by objective analysis of existing systems. Evaluation of data processing techniques should be conducted by persons familiar with the sciences of data processing and familiar with various systematic approaches to evaluation of data processing techniques. (1, 23, 46, 48, 49, 52, 54, 55, 56, 85, 112, 160, 173, 181, 195, 200, 267, 376, 380, 415, 434.)

Controls performance by objective evaluation of existing systems, recognition of potential areas for improvement and by systematic development of proposals for change. (1, 46, 48, 49, 54, 56, 72, 144, 160, 173, 181, 194, 195, 200, 201, 230, 267, 312, 376, 391, 425, 434.)

XXIII. Cybernetics

Cybernetics is the study of control principles applicable to mechanical, electrical, biological, organizational and economic systems and the similarities among all of these systems. Efficient control normally works with a low expenditure of energy, exerting just enough influence to effect the degree or kind of output desired. (References: 518, 521, 755.)

Controls performance by the study of an implementation of sound control principles. Cybernetics can play an important part in increasing efficiency and effectiveness on all systems levels from coordination of inputs to quality control of outputs. Cybernetic principles can be used in controlling performance of automated systems. For our purpose in this phase it is not feasible to propose how cybernetics should be utilized to control library automated systems. It is, however, reasonable to hypothesize that the use of feedback mechanisms will facilitate control to the extent that automated operations can monitor themselves or provide check points for management follow-up and evaluation of performance.

XXIV. Quality Control

Control of quality by inspection and rejection, repair, correction or acceptance according to a predetermined standard. (References: 583, 588.)

Indicates effectiveness by statistical computations which reflect the effectiveness of a volume of work according to findings made while inspecting, either by sample inspection or 100% inspection (Statistical Sampling, VI) of that work.

Controls performance by inspection of a volume of work (either sample inspection or 100% inspection) and rejection, repair, correction or acceptance according to a predetermined standard.

XXV. Plant Layout Analysis

Plant layout analysis deals with the study of the arrangement of facilities. Effective layout calls for a minimum of movement of both materials and personnel, and effective placement of lighting, heating and other environmental control devices. Plant layout analysis may also be defined as planning and integrating the path of the component parts or activities of a product or service to obtain the most effective and economical relationship between man and equipment. Principles to be considered in planning a layout are:

1. Overall integration.
2. Minimum distance moved.
3. Flow.
4. Cubic space utilization.
5. Safety
6. Flexibility.
7. Aesthetics.
8. Lighting.
9. Heating and Air conditioning.
10. Noise
11. Comfort.

(References: 19, 263.)

Indicates efficiency and effectiveness relative to the amount of improvements which can be made to obtain more effective and economical relationships between people (working with or using the facilities) and the plant's physical facilities. Layout charts can be utilized to judge feasibility of alternate arrangements (Layout Chart, X).

XXVI. Organizational Analysis

Study of the purpose for the existence of an organization, its functions and the extent to which it accomplishes its functions. Uses organization charts to delineate functional areas of organization (Organization Chart, IX). (References: 96, 126, 146, 204, 205, 206, 227, 265, 394.)

Indicates efficiency and effectiveness of an organization by one or more of a variety of systematic approaches (for example, abstracts 96, 126, 146, 204, 206, 227, 394, Phase I). These studies measure efficiency, effectiveness and performance by considering the completeness of and the degree of consistency between missions, goals, roles and outputs of each unit and stratum within the bureaucracy.

XXVII. Research

Methods of gathering information by interviews, questionnaires, observation and surveys and utilizing this information to draw objective conclusions. This technique is intended to include a wide variety of methods of gathering information not included elsewhere in the glossary of techniques, but represented in the following abstracts: 6, 24, 25, 27, 31, 42, 68, 71, 80, 92, 183, 211, 240, 386, 396, 397, 421, 432, Phase I.

Indicates efficiency and effectiveness by a wide variety of techniques incorporating questionnaires, observations and surveys to gather performance data and by incorporating various techniques to process these data in order to draw conclusions about efficiency, effectiveness and performance.

APPENDIX B

SUPPLEMENTAL MANAGEMENT
SCIENCE REFERENCES

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13. ABSTRACT

This report summarizes (1) data and information collected to facilitate the development of criteria for the evaluation of the efficiency and effectiveness of Army Technical Libraries; (2) the findings on the mission and objectives of Army Technical Libraries; (3) the areas in which adequate standards for performance are feasible, and (4) presents the tentative (candidate) criteria and proposed management techniques useful in implementing them.

The criteria apply to 4 general aspects of library performance:

(1) Philosophical - criteria which relate to the enunciation of the reasons for the existence of the library.

(2) Management - criteria which relate to the influence exerted on the efficiency and effectiveness of the library by management practices.

(3) Services and products - criteria which relate to the outputs of the library and measures of service or product effectiveness.

(4) Operations - criteria which are potentially useful as a basis for developing adequate standards for performance evaluation of the staff's professional actions.

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