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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

A METHOD TO DETERMINE NEEDS FOR MATERIALS IN UNIVERSITY LIBRARIES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

By

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Norman, Oklahoma

1978

A METHOD TO DETERMINE NEEDS FOR MATERIALS IN UNIVERSITY LIBRARIES

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ACKNOWLEDGMENTS

I am grateful to many for the support and encouragement provided me during this undertaking. The Office of Education, U. S. Department of Health, Education and Welfare provided the fellowship support which made it possible. William R. Upthegrove, Dean of the College of Engineering, University of Oklahoma, provided the necessary authority for use of the questionnaire at the College of Engineering and was instrumental in eliciting the faculty's cooperation.

I am indebted to Samuel Schrag for assistance in gathering the citation count sample data, and to Jasper G. Schad, Director of Libraries and Audiovisual Services, Wichita State University, for discussion of the many factors associated with decisions about university library collections. I am grateful to those colleagues and associates who were kind enough to contribute constructive criticism, helpful advice and much encouragement, and in this regard acknowledge particular thanks to Caroline G. Longmoor and Richard P. Boylan.

Finally, I thank the members of my advisory committee for their advice, criticism, patience and understanding which contributed so much to the completion of this investigation.

Norman, Oklahoma
1978

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CHAPTER I

OVERVIEW OF THE RESEARCH

A. Introduction. This research grew out of an examination of the Interlibrary Loan Procedure Manual published in 1970 by the American Library Association (ALA) which contains the following statement:

> It is assumed that each library will provide the resources to meet the study, instructional, informational and normal research needs of its users, and that requests for materials from another library will be limited to unusual items....(68,p.2)

That statement implies the responsibility to determine those needs and assumes that libraries have the ability to do so. But, in fact, do they? In a university, the faculty qualified to teach the various programs of study should know what materials are required. The librarians, knowledgeable about the literatures pertinent to those programs of study, should also know what is required. But once the basic collection of materials has been assembled, including the classic works, texts and journals, how does the library know that its responsibility, stated above, really has been met?

B. The Problem. The University library actually has

relatively few means of assessing use, demand, or the needs of its users for particular materials. The means generally available are analyses of statistical data routinely gathered for reporting purposes. The statistical data include counts of circulation of materials for use outside the library, requests for loans of materials from other libraries, and purchase order statistics.(2) Each of these has certain limitations as a means of assessing information needs.

Circulation statistics are limited to materials which the library already owns and which can be used outside the library. Thus the data cannot be used to assess need for materials not owned or which do not circulate. Interlibrary loan and purchase order statistics are limited to input of items which meet the criteria and restrictions of policies already in effect. Such policies may exclude from these services certain categories of users and certain types of materials.

Time delays inherent in loan and order procedures may further limit the value of these statistics in assessment of user needs. The addition of new items to the library's collection by these means entails verification, clerical, and mail procedures which can involve delays ranging from three to six weeks or more. The value to the user of some items of needed information may be diminished or entirely lost due to this delay. Because of the limita-

tions, which exclude some users and materials by policy, and others because of the delays, certain needs may never enter the system to be reflected by circulation or request types of data. The problem can be summarized as follows: the various sources on use available from library operations are limited in their capacity to show need for materials which the library does not own, which do not circulate, or which, because of procedures, policies or delays, are not reflected in the library's operating data. To augment that data, a method for determining use of materials is needed from sources other than those of the library's operations. And to show the types of needs for materials the method for determining the use should relate the use to specific criteria.

C. Objectives. The objective of the research was to develop a method using ALA's statement of the interlibrary loan code policy as the criteria for the data on use. This is a practical standard of criteria since all university libraries have either adopted the code themselves or are governed by it when they borrow from other libraries adopting it. Therefore it is nationally accepted and applicable to any specific university library.

The objectives for developing the method were to provide data on the use of materials which:

1. meet the nationally accepted standard by relating use to the study, instructional,

informational and normal research needs;

2. are obtained from sources outside the library operating system, to avoid the limitations inherent in the data collected from within the system;
3. augment data collected from within the library system;
4. relate the use of materials to the group of users of those materials, to aid the library in determining needs for material when programs, budgets, or other matters related to that group within the system change;
5. assess the needs for new forms and formats;
6. reflect the useful life of the material in relation to the users' needs, since universities tend not to collect and retain materials whose usefulness is highly ephemeral; and
7. would be widely applicable in university situations, eliminating the need for costly repetition of data collection efforts, to enhance its cost effectiveness.

D. The Research Model. To meet the research objectives a three part data-base model was developed which combines the use of a questionnaire and two citation counts. The word

"model" used here does not refer to a mathematical formula. It refers to a prototype of the data-base procedures which were designed, applied to an academic library situation, and demonstrated experimentally to test the assumptions and procedures. The word "model" is used in this sense throughout this discussion. The model requires the library to identify the material and user group on which the data are desired. This makes it possible to relate use of material to the users. The model is applied as follows:

1. A questionnaire is administered to the user group;
   a. to determine their use of the material related to academic activities, in order to relate their use to instructional, informational and normal research needs; and
   b. to determine the journals regularly read by the group. This makes it possible to use those journals as a basis for a citation count.
2. A citation count is performed on the journals read by the user group. This makes it possible to assess potential information needs of the group, based on the rationale that the users will tend to refer to such citations for information. This rationale is discussed in the

following chapters, and was tested in the course of the research.

3. Another citation count is performed sampled from a national indexing source. This makes it possible to assess needs for study and instruction. The rationale for this is derived from Gross and Gross' original development of the citation count technique for this purpose, and is discussed in later chapters.

The three data sources, the questionnaire and two citation counts from different samples of journals, in combination:

1. relate use to the national standard;
2. originate from outside the library operating system;
3. differ from data collected from circulation and other statistics within the library;
4. relate use of a specific material to a specific user group;
5. can be applied to any material, form or format capable of being cited;
6. can be manipulated to reflect useful life of materials cited, by relating the date of the material to the date of the publication citing it; and
7. can provide data capable of being

shared among universities. The national sample used for the second citation count is not related to the local faculty but only to that faculty's field of work. Therefore, that data instrument is national in source and also national in scope, with results usable anywhere. Local faculty variations can be tested among the sharing universities by applying only the questionnaire and faculty sample citation count. Two further possibilities exist:

a. that the national results can be used alone by another university as a rule-of-thumb, or national overview, of needs for the materials; and

b. universities can share responsibilities for various subject field/user group data bases. For example, use of technical reports by engineers have been examined in the experiment to test the model at the University of Oklahoma. The library at University X, elsewhere, might receive the data, and in exchange, examine use of patent literature by chemists, sending the results to the University of Oklahoma Library for examination ofthe Chemistry Department's needs. Such shared results are not limited,

of course, to a one-time or one-institution effort. Ten or more university libraries might agree to share among themselves, each supplying data on a different material/user group. A university might choose to publish results of its data collection efforts for all to use. A central clearinghouse could be established to provide pooled efforts to contributors of the data.

E. Scope of the Study. The research model is limited in scope to data on use required by university libraries to assess the needs of their users. The data-base model designed to meet the research objectives requires the specification of a group of users and a type of material. For the research experiment, the user group selected was the field of engineering. It is a field in which most universities provide at least the bachelor's degree. Many provide advanced study programs on the master's or doctoral level. Therefore, as a test field, it is widely applicable to many universities.

The type of material chosen for the test was the technical report of federally sponsored research. These reports were selected for testing the model on the following basis: (1) it was desirable that the test should demonstrate that the model could be applied to resources other than books and journals; (2) the reports are studies on a wide

variety of social and scientific problems in which the federal government has an interest; (3) the same problems are likely to be of interest to faculty members and other academic library users, and technical reports of these studies may have direct use for academic research; (4) the technical report form has been in use in limited numbers for many years but received its major impetus for wider adoption only during and since World War II. Therefore, in comparison to printed books, available since the fifteenth century, and journals, available since the seventeenth century, it can be considered a new and developing form; (5) the reports are available in microfiche format, first proposed as a convenient library information storage device by Fremont Rider in 1944 and standardized by the federal government for its agencies in the 4 x 6 size as recently as the nineteen sixties.(58) Therefore these represent a relatively new format, one which requires the use of a reading machine and hence one not usually reflected by circulation statistics.

The specific reports included for test purposes are the unclassified reports of the Atomic Energy Commission (AEC), the National Aeronautics and Space Administration (NASA), and the National Technical Information Service (NTIS). Included in NTIS are its functions, 1946 to present, accomplished by its predecessor agencies, the Publications Board, the Office of Technical Service, and the Clearing-

house for Federal Scientific and Technical Information. The scope is limited to these not because they represent the only reports of academic interest but because they represent a substantial number of available federal reports, a wide variety of research topics, and all are available to libraries by various purchasing methods.

F. Need for the Study. The increasingly interdisciplinary nature of much of the literature and the dynamics of changing disciplines tend to cause changes in the programs of study. Further, the changes occur with varying frequencies among different disciplines, and within a single discipline, and are dependent on combinations of circumstances.(17) The university is a dynamic organization with a need to adapt to changes as they occur in disciplines, in personnel, and in priorities of the internal and external environment. The library also needs to be able to adapt in order to serve this dynamic, changing organization. Therefore, it requires the means for sensing and assessing the various changes in information needs to be able to supply materials that are suitable to the current state of the organization.

The funds for purchase, space, staffing, and collection maintenance of large bodies of materials are necessarily large and any decision to adjust or alter policies or services is one to be carefully considered. It is assumed for purposes of this discussion that any such decision is not made solely by the library manager. The

university climate is such that university high-ranking administrative personnel, faculty committees, and individual faculty members normally participate in such decisions to varying degrees. The ability on the part of library management, therefore, to present data in support of recommendations for the necessary funding is often critical to the library's ability to meet its responsibility, as stated above, and to provide quality service to its users.

G. Summary. The research was designed to test a model which can be used to support recommendations for supply of materials and services, by providing data on levels of use of a particular type of material by those in a particular field. The model itself is not limited to the field and material chosen for the experiment. It was developed after a search of the literature which covered the various topics of selection, data systems in libraries, acquisition policies and procedures, the literature on technical reports, and the citation count technique. A discussion of the literature is presented in the next chapter.

CHAPTER II

LITERATURE STUDY

A. The Library Collection. The university library provides a collection of materials to support university functions. Wilson and Tauber expressed its purpose as conservation, instruction and research.(80) Carter and Bonk included support of the curriculum, provision for liberal education apart from the curriculum, and support of graduate and faculty research. They stressed that universities are more heavily committed to faculty research than are colleges.(14) Collection building in the university library historically has relied heavily on careful selection with priority given to materials deemed to have lasting value. The selection is based on: (1) actual examination of the materials themselves, or of critical reviews; and (2) knowledge of the literature, the courses of study offered by the university, and the special research interests of the faculty.(5,12,14,56,59,78)

As changes occur, informational needs shift. Therefore libraries need methods for assessment of trends and changes which may affect the use and demand for materials. The data accumulated for routine reporting procedures are

sources used for such assessment. These are discussed in the following sections.

B. Circulation Statistics. McGrath examined the correlation between materials circulated and those used in-house to establish the validity of circulation statistics as an indicator of use. His findings indicated a correlation between the subject categories of books and journals left on tables and those circulated. For purposes of his study he assumed that books reshelved by the user after a moment's examination did not constitute "use."(48) McCullough questioned this assumption and the validity of circulation statistics on the following basis: if the user considers a work as having possible pertinence, examines it, and then rejects it, this constitutes use and use with a purpose.(47)

McGrath further attempted to show that circulation data can be used for the specific purpose of developing a selection policy. He developed subject profiles of teaching programs and matched them to the books circulated, those left on tables, and the library's holdings of those subjects. He found that books which matched the profiles were more likely to be charged out than not, more likely to be charged out than left on tables, and more likely to be removed from shelves than not.(49) These findings tend to substantiate Knapp's findings and Luban's statements that student use of library materials is closely related to

course work and to faculty attitudes toward materials.(38, 39,43)

Fussler and Simon used circulation data to conclude that immediate past use is the best single predictor of future use.(27) Valuable as that is, the use of circulation statistics is questionable as a predictor for technical reports, the material selected for the research experiment. A study of circulation policies of academic libraries made by the American Library Association indicated that reports were not separately counted in circulation.(3) The only study located which included circulation statistics for technical reports was one made of the Engineering Library at Stanford University. The study examined circulation during three Autumn quarters, 1965, 1967 and 1970. Initially technical reports accounted for ten percent of total circulation. The number of reports circulated increased for each period studied, but the percentage of total circulation they represented dropped to six percent by the end of the study. During that time however the hardcopy collection of reports was replaced with microfiche. Since microfiche requires the use of reading machines this might account for the drop in the percentage of circulation. It lessened the probability that these statistics reflected actual use of the material.(6)

C. Interlibrary Loans. Interlibrary loan requests for

materials from other libraries provide another source of data which reflect the needs of the library's users.

New and Ott described several studies made of interlibrary loans, most of them limited to periodical requests. (54) The limitations of their own study were stated as follows:

> It does not attempt to evaluate the university library's collection in support of the undergraduate curriculum. It does not take into consideration those users who find the library collection lacking and go elsewhere. It makes no judgments of how much research should be going on in the various departments of a university, though it reveals some interesting indications of the wide variation of these activities. It does attempt to measure quantitatively how well the library collection serves the needs of its faculty and graduate students who find it necessary to search for material through the use of interlibrary loans.(54,pp.277-278)

Certain limitations are inherent to interlibrary loan data: (1) library policy often excludes certain materials and types of users from this service, for example the undergraduate user (35); (2) the interlibrary loan process normally includes verification of the facts of publication for the item requested, identification of a likely source, clerical procedures for typing forms, mail time to the prospective owner-library, location and pulling from the shelf, photoduplication if the item is a journal article or a few pages of a work, mail time to the requestor-library, clerical procedures for noting receipt, and notification to the requesting user.(67,68) This occupies considerable

elapsed time, often from three to six weeks. Delays can be caused by the mails, by backlogs in photoduplication laboratories, and by the necessity of repeating some of the process if the item is not available at the first prospective source. Because of this delay, requests for many items which are needed quickly, e.g., within a week or two, may never be submitted to the interlibrary loan system and therefore will never be counted.

D. Orders. The examination of library acquisitions, in toto, probably reflects established policies of the library rather than the specific needs of individuals or groups of users. Special orders, including the individual requests for use for a specific purpose, are more likely to reflect changes in trends or demands. However these are subject to the same policy restrictions and procedural delays as interlibrary loans. Therefore the same limitations as assessment devices exist in these data as in the interlibrary loan requests.

In addition to those limitations, DePew has noted that acquiring a title on request is not advantageous if the judgment of the requestor is unknown or poor and suggested that the "power base" of the requestor will affect the decision to order the requested item.(19)

No study was found which examines in detail either the interlibrary loan or special order data in terms of

reflecting changing needs of users to provide data specifically for selection decisions.

E. Library Acquisition Policies and Methods. The selection of library materials, as a dynamic process responsive to developing needs, is necessarily related to the machinery and methods of the acquisition process. In day to day library practice the desire to purchase only carefully selected materials of continuing value must somehow be balanced with the realities of current demand and the necessity of getting the material into the library without undue delays. In the last thirty years purchase plans have been developed to acquire needed materials and eliminate the expense and delay of individual item orders.(14,23,31, 45,47,59,63) Various plans, referred to as approval plans, gathering plans, the Greenaway Plan, or block buying, involve automatic receipt of materials by contract or standing order with dealers or publishers. The assumption is that, based on examination of past purchases, the majority of materials in predetermined subject groups or from specific publishers will be needed in the collection. The selection principle operates through the option to return or discard unwanted items.

Arguments against such plans have been based on: (1) the question of desirability of preselection by suppliers, i.e., which items will be sent for approval; and (2) whether

libraries will, in fact, discard books already paid for on a block buying basis but which they would not have selected otherwise.(21,59)

Those who favor such plans have pointed to: (1) the shortage of experienced personnel to keep abreast of all publication; (2) the time lag and unequal coverage of review media on which selections are based; (3) the desirability of having materials on hand and ready for use when demand occurs; and (4) the cost benefits accruing from placing a few orders instead of many individual item orders.(31,45,62,63)

The arguments for and against block buying seemed particularly pertinent to technical reports since: (1) it's unlikely that the reports received would be examined individually by library personnel, i.e., "selected" after receipt, especially if received on microfiche; (2) as a group, even those from within a single source, they cover such a wide variety of subjects that individual selection by subject specialists on the library staff might present unusual problems of overlapping responsibilities; (3) pre-selection by suppliers such as NTIS, of predetermined categories, is subject to the same criticism as other publishers' plans; (4) critical reviews of these reports seldom appear, announcement being limited usually to bibliographic identification and abstracts of content; (5) the desirability of having these items on hand to fill

potential need as it occurs assumes the library's ability to assess the extent of such need. This ability to assess need, assumed in the ALA interlibrary loan code statement quoted in Chapter I, is the crux of the problem under discussion and the basis of the research.

Nevertheless, elapsed time of several weeks between ordering and receiving a single report is a fairly strong argument for acquiring reports on a block-buy basis. The strongest argument against this method is the basic question of their value to the library collection.

The view that the library collection should contain only materials with permanent value is typified by the following statement made by Ash:

> . . . in an academic library no assignments for selection policy should be delegated to any faculty or library committee member of whatever rank. His view of future research use of even current literature is . . . frequently very limited, even blind. (Italics added) (5, p.129)

F. Review of the Literature Regarding the Value of Technical Reports. Lack of reviews, and the absence of referee examination before publication, may cause negative attitudes. Brearley noted that while the reports may not be refereed, the work being reported is subjected to initial and ongoing scrutiny where contract or grant funds are involved.(10) His statement, however, is unlikely to change negative attitudes, since those performing the ongoing scrutiny are usually the same individuals who contracted for

the research to be performed. Others who hold negative views of the value of the reports feel the publication form is ephemeral, and that those with lasting value will be issued subsequently in refereed journals. This view is open to question. The report of the President's Science Advisory Committee of 1963 (referred to by its Chairman's name as the Weinberg Report) noted that:

> In [some] cases informal reports are given no status; they are alleged to be not worth retaining as part of the permanent record unless their contents finally appear in a standard hard-copy journal. Whether this position is tenable even in the basic sciences is open to question; it certainly is no longer tenable in technological development.(74,p.19)

The National Science Foundation (NSF) also questioned the view of technical reports. Gray's discussion of that study included the findings, put here in list form for convenience:

1. The reports do include substantial amounts of significant scientific information.
2. Fewer than half the reports studied appeared as part of the published literature.
3. The publication time lag for those that did appear averaged a year and a half with lags up to four years.
4. One-fourth of all the reports studied were considered to contain publishable information which had not been published by the end of four years.

5. Among the reports not considered publishable by journal editors was potentially valuable data and negative experimental results.(30)

This last point is of particular interest. It is probably not at all unusual to fail to submit negative experimental results for journal publication. Yet such results may have a great deal of value to researchers working on similar problems, either in terms of time saved or by providing the opportunity to reevaluate a proposed method.

This and the other findings of the NSF study provide evidence that reports not republished in journals are worth retaining. Further, the time lag in such republication indicates that those republished will be unavailable for considerable time, and some of the data never available.

The persistence of attitudes associated with the technical reports may arise from three factors: (1) in the late 1940s, when World War II research was declassified, announcing and disseminating the reports was in its infancy. Many researchers previously unable to publish due to wartime restrictions published their researches in prestigious journals. This may have caused the distinction between technical reports as "unpublished" and journal articles as "published" information; (2) conditions slowly changed in dissemination procedures through the nineteen fifties and nineteen sixties. Improvement in announcement and availability of technical reports would tend to lessen the need

to republish the material in journal form; (3) the reports have been widely available in standard format, for a minimal price for the individual reports, since the nineteen sixties. Improvements in indexing and announcement however are slow, different agencies' efforts have varied, and some agencies have been very inconsistent from year to year, causing considerable confusion. Therefore it is not surprising that attitudes about technical reports still tend to reflect the situation as it was ten or twenty years ago. As recently as 1970 Gillies summarized the status of technical reports as follows:

> To the scientist . . . who feels closely identified with traditional journal literature, the technical report is a bastard form . . . . Thus it appears to be an unproper part of the scientific archive, but to research and development workers . . . the report is quite something else. It can provide such a worker with a prompt and timely announcement of significant technical developments . . . it usually provides a comprehensive treatment of an application; it is more likely to include negative results than is a journal article; and its contents, if useful to him at all, can often be immediately exploited. . . .(29,p.154)

The advantages of the form referred to in the latter part of this statement are unlikely to be realized in the academic community if the attitude of the faculty is represented by Gillies' first sentence. The library presumably would experience little if any pressure from faculty to provide materials they regard as "an unproper part of the scientific archive" whether they use them or not.

However, it is the library manager's responsibility

to change or shift priorities if changes in the materials and their use warrant it. The lack of data in the system to reflect shifting needs of faculty and others does not remove the responsibility. One way of determining shifts, changes, or continuing needs for materials is to determine their use. A method for doing this is the citation count.

G. The Citation Count. This technique was used by Gross and Gross in 1927 to examine chemistry journals.(8,76,80) The authors reasoned that to train students both to understand the science of chemistry and to be able to contribute to its progress through research one should look at the tools which those in the field of chemical research were using. By basing selection of library journals on a list made up from the composite researchers' use one could avoid the bias which might be present in a list of important chemical journals compiled by any one person. Therefore they tabulated the references cited in the latest volume (1926) of the American Chemical Society Journal, and from the tabulation drew up a list of the journal titles most used by researchers indicated by frequency of citation. Their method was applied by others over the years to study journals in other fields.(11,25,80)

1. Assumptions of the Citation Count. Brodman examined the citation count method in 1944 from the standpoint of its underlying assumptions.(13) These she stated as:

a. The value of a periodical to a professional

worker is in direct proportion to the number of times it is cited.

b. The journal or journals used as the base for the tabulation are representative of the entire field.

c. If more than one journal is used as a base, all of them can be weighted equally.(13,p.479)

To test the assumptions she hypothesized that if a periodical is valuable to professional workers in direct proportion to the number of times it is cited, then a list of periodicals actually considered valuable by professional workers in a field should approximate a list obtained by a citation count as used by Gross and Gross. Therefore, she assembled a composite list of physiology journals ranked in order of importance by the faculty members of the Department of Physiology, College of Physicians and Surgeons, Columbia University, which she called the Departmental list. For comparison she used two other ranked lists, both assembled from citation counts. One was from the Annual Review of Physiology, called the Annual Review list. The other was a composite of citations from three important national journals, one American, one British, and one German, called the National journals list. Using the Spearman Rank Correlation Coefficient to compare the eleven top-ranked journal titles from each, she obtained the following results:

a. comparison of the Annual Review list to the

Departmental list, $\rho = .573$;

b. comparison of the Annual Review list to the National journals list, $\rho = .764$;

c. comparison of the National journals list to the Departmental list, $\rho = .618$.

In her discussion of the results she stated that a correlation was ±1.00, and that a result of ±.75 would indicate a trend but not proof of correlation, citing a book on statistics by Herbert Sorenson published in 1936.(61) From this she concluded that her mathematical test of the fundamental assumptions of the Gross and Gross method had shown they were not true. Her calculations are correct but her conclusion is mistaken. Since the number of items ranked exceeded ten, the significance of the values of rho can be identified using the statistic:

$$t = \frac{r}{\sqrt{1 - r^2}} \sqrt{n-2} \quad \text{with } n-2 \text{ degrees of freedom.(22)}$$

where r represents the rank-order correlation coefficient. This tests the null hypothesis that the variables X and Y are independent, against the alternative that they are related.

The null hypothesis can be rejected for each of the three rho values as follows:

.573: $t = 2.097$, significant at $\alpha = .05$

.764: $t = 3.552$, significant at $\alpha = .005$

.618: $t = 2.358$, significant at $\alpha = .025$

A summary table of t-values provided by Edwards gives the following values for 9 degrees of freedom: (22,p.220)

α	t
.05	1.833
.025	2.262
.01	2.821
.005	3.250

Siegel provides a table of the significant correlation values for the Spearman Rank Correlation Coefficient for alpha levels of .05 and .01 for n-numbers of ranked items showing values of N of 4, 5, 6, 7, 8, 9, 10, 12, 14, etc.(60) It is possible to read the values for 10 and 12 from that table and conclude that all three rho values obtained by Brodman are significant correlations with the alpha level at least .05. In spite of the fact that such tables have been available for years, Siegel having published in 1956, authors have continued to accept Brodman's conclusion. Broadus, in his overview of citation analysis published in 1977, did state that in her comparison of lists of the eleven journal titles the same two titles were at the top of each list, and from that concluded ". . . the correlation seems reasonably high." Unfortunately, even Broadus apparently missed the real significance of Brodman's work and accepted her conclusion since on the same page as the phrase quoted above, he included an informational footnote:

> This paper is ammunition for those who oppose citation analyses . . . Dr. Brodman has published many excellent contributions, so it is ironic that this is the one which is cited so often . . . . (11, p. 316)

In a search of the literature no author was found who disagreed with her conclusion. Since Dr. Brodman's paper clearly presented the data necessary to verify her results, it is an indication of the high regard for her scholarship on the part of the many scholars who have cited this work that they did not question her conclusion.

Brodman did not examine the assumption that citation of a work is evidence of its use. Fussler discussed the point in 1949, noting that:

> Some . . . will probably cite materials that they have not used, and others may not cite material that has been used. Omissions are probably quite common for general reference works . . . . It appears reasonable to assume that the cited references will depart from true use by a modest understatement rather than overstatement. (25, p. 26)

Thus Fussler assumed citations to be a conservative estimate of materials used, and implied that such indicated works specifically applicable to the research in which they were cited. Others have differentiated betweeen the kinds of use made of cited work. (7, 11, 52) Broadus referred to the possibility of using citations to "curry favor" or "dress up the paper." (11, p. 308)

Batts differentiated types of citations used in the field of humanities, which Miller has called the "Batts' four-factor analysis" and defined as: (1) editions used;

(2) critical works about the topic; (3) background or definition; and (4) peripheral citations such as "decorative quotations." (7, 52) The second category is similar to the type of substantive citations scientists are assumed to use, and distinction of this category, in the humanities, renders that field more amenable to evaluation by citation analysis techniques. While these authorities imply that the purpose of some citations may be frivolous, none has implied that an author citing a work has not used the work cited.

2. Applications of the Citation Count to Predict Demand. Fussler applied the citation count to the fields of chemistry and physics to study both the types and titles of literature used and to examine the temporal span of literature use. (24, 25) S. C. Bradford is credited with the first use of the method for the examination of temporal span in 1934. (16, 76)

Cole plotted the temporal pattern for several groups of petroleum literature citations to predict the distribution of future journal demand. He called his result the "half-life" of journals because the rate at which usage fell as age increased was governed by the median age. He applied the half-life concept to predict the retention period of petroleum journals in libraries required to satisfy a specified percentage of demand. (15, 16)

Line argued that for practical application librarians

would need the "item half-life" for each journal rather than the grouped-subject figure Cole derived. (41, 42, 75)

Broadus reviewed the concept and concluded that:

> In general, citation analyses are capable of predicting use of publications according to age, but refinements are necessary . . . and "decay" patterns, if they exist at all, are far more irregular than had once been supposed. (11, p. 325)

Assuming that no precise prediction is required, citation counts provide a convenient method for obtaining a general idea of use by age of material. No study was found which applied the citation count to technical reports, but nothing was found in the literature which precluded such use. Using this technique to compare the date of the reports to the date of the publication in which they are cited provides a means for identifying the age of the reports used, an indicator of the "useful life" of such reports, and some indication of the temporal span of reports required to serve the users' needs. Further, a count of the technical reports, compared to journal articles, books, or other materials cited in a group of references would provide a comparative estimate of the amount of use they receive.

H. Summary. The amount of use is the one factor that appears again and again in the literature devoted to problems of library collections and selection of materials. Fussler and Simon found past use the best predicator of future

use. (27) McGrath compared use of materials circulated, those used in the library, and those used in course work, for research related to selection policy. (47, 48, 49) New and Ott examined use shown in interlibrary loan requests. (54) Ash stressed selection of materials expected to have long-term, continued use. (5) Cole and Line both devoted research to predicting the amount of use in relation to time. (15, 16, 41, 42) Therefore, the amount of use, as a factor in assessing need fc materials, is well established in the literature.

Nothing was found in the literature search, however, which provided a means for overcoming the limitations inherent in data collected from library operations. Nothing was found in the literature search which related use of materials to the specific requirements for supplying them stated in the ALA interlibrary loan code, with one exception. Determination of the study and instructional needs aspect was the basis for Gross and Gross' application of the citation count technique. Dr. Brodman's tests did supply mathematical support of the assumptions underlying the technique, although that fact has not been recognized in the literature. The way in which the citation count technique was used in the research model is discussed in Chapter III.

CHAPTER III

THE RESEARCH MODEL

A. Introduction. The research model was developed on the basis of the ALA statement that the library ". . . provide the resources to meet the study, instructional, informational and normal research needs of its users. . . ."(68,p.2) Provision for these needs implies the ability to determine what they are, and the question leading to the research was whether a university library had this ability.

Examination of the data generated from library operations, such as circulation, interlibrary loan and special orders, showed that such data sources reflected the library's collection, policies and procedures. These sources were not only limited by those matters in the ability to reflect the users' needs, but the data quantities were not capable of reflecting needs in the terms required by the ALA statement. From this it was concluded that university libraries needed another method to determine the needs of users, and needed one which determined those needs in the terms stated by the ALA interlibrary loan code adopted as a national standard. The research was undertaken to develop

and test a data-base model to serve this purpose.

The subsequent examination of the literature showed that use of materials had been established as a measure for need; that need for those materials could be inferred from such use; and that the citation count technique had been applied to show need for study and instructional materials, two of the ALA criteria. Therefore the technique was examined further to determine whether it could meet the specific objectives for the research model.

B. Research Model Objectives. The objectives for the research model were described in Chapter I. For a discussion of their relationship to the citation count it is convenient to use the distinction in terms Broadus included in his review article of citation analysis.(11) There he distinguished between the source journals or publications which contain references, and the citations, those publications which the references cite. As a further convenience to avoid long repetitious phrases, the sources of statistical data routinely gathered for reporting library operations such as circulation, interlibrary loan, and order statistics will be termed operational data.

1. Use of Citation Count to Meet the Objectives. From the nature of the citation count, it is apparent that the technique can be applied to meet most of the objectives. For example:

a. the data are obtained from sources outside the library operating system. Even if the source journals are part of the library's collection, citation counts made from them are completely distinct from the library's operational data, and therefore not subject to the same inherent limitations;
b. citation count data are different from operational data and can augment them;
c. citation counts can be developed on any material capable of being cited to assess the need for new or developing forms or formats from periodically updated counts, or retrospective comparisons;
d. comparing the publication date of citations to the publication date of the source journals provides age of the cited material as evidence of its useful life span;
e. citation counts of the type performed by Gross and Gross, using source journals applicable to a general subject field, provide data that are equally useful to any university, thus eliminating the need for duplication of data collection;
f. data from citation counts relate use to a group of users whose field is the same

as the source. For example, Gross and Gross counted citations from source journals in chemistry, the users of the citations being the chemists who cited them.(32) Brodman applied the technique to physiology, and Cole to petroleum literature.(13,15) Crane's study discussed the varying relationships of authors to the journals in which they publish. She found that within some disciplines the relationship is so direct that authors of a certain school of thought publish only in journals devoted to that point of view, whereas in other disciplines the relationship is not so rigid, but is related to the general subject field;(17) .

g. data from citation counts can meet the nationally accepted standard in part by relating use to study and instructional needs. Gross and Gross' citation count was made from a national sample of chemistry literature for the specific purpose of determining the study and instructional needs of students of chemistry. Therefore the question was whether the citation count could be applied to determine other needs. Crane's work

implied that journal readers would use materials cited by journal authors for informational purposes, but no previous research was found in the literature which satisfied the point completely.(17) Since the local faculty are specialists within their general field of study their specific informational needs might vary to some degree from the general sampling performed for study/instructional needs. And assuming that they did differ, the informational needs of the students, as opposed to the strictly study/instructional needs, would presumably be influenced to some extent by their faculty's interests, and also differ. For this reason the determination was made that the research model should include two citation counts, one performed on a general sampling, for study/instructional needs, and the second performed on a sampling of journals read by the local faculty, for informational needs. The second count was based on the assumption that the faculty would tend to utilize the references cited in the journals they read regularly to acquire further information on a subject in an article that interested them. That

assumption was tested in the research experiment. A further question was whether the citation count could be applied to determine research needs. A difficulty is that "research needs" and "information needs" are likely to overlap. The ALA criteria are stated separately, implying that they can be distinguished. However, it need not be inferred that they must be dealt with separately in order to satisfy the requirement. For practical purposes it would be satisfied if the library manager had a model for gathering use data which distinguished between the degree of need for a type of material to serve the general instructional program in a field, and the additional need, if any, to serve the more specialized local information and research purposes. Viewing the requirement in this way eliminated the necessity for examining the overlapping uses of information on the part of an individual. It makes it possible to define "normal research needs" as those (1) within the scope of the specialties of the faculty; and (2) within the scope of the normal academic activities of the faculty. Using this definition, it is possible to examine a given

faculty with respect to the member's performance of the usual academic activities of teaching, research, and its publication, and their use of the type of material of interest related to their performance of these activities. But to examine the research needs aspect another technique is required.

2. Use of a Questionnaire to Meet the Objectives.

The questionnaire/interview technique was examined for its ability to determine the normal academic activities of a university faculty, and their use of materials to meet the informational and research needs incurred by those activities. For reasons described in Chapter I, the research model was tested using the field of engineering and the use of technical reports for the experiment. The literature on interview techniques stresses the need for response to relate to a standard frame of reference with outside criteria where ever possible. (1,20,33,34,53,57) There is no available standard for comparing responses to such questions as "How much do you use technical reports?" or "Do you use technical reports for normal research purposes?" although both questions are of direct interest to library management. To avoid the ambiguity present in those questions, and to establish a criterion for use of materials, the faculty could be asked what activities were routinely performed as part of their academic appointment, and those activities with which

technical reports were routinely examined or considered for use.

By phrasing the questions in this way, the number and proportion of faculty who respond that they use technical reports could be established. Further it would establish the number and proportion who respond that they use the reports in connection with specific activities, including use for "normal research needs." Therefore, a questionnaire does meet the remaining research objective.

C. Instruments and Application of the Research Model. The questionnaire and citation count techniques, discussed above, were combined and applied to the use of technical reports by engineers as an experiment to demonstrate the results and test the assumptions of the model.

1. The Questionnaire. The questionnaire was administered to the faculty of the College of Engineering, University of Oklahoma. It is included as Appendix I.

a. The first question asked which of nine academic activities listed the respondent had performed during the prior three academic years. This time period was selected to allow inclusion of such activities as authorship of books and articles which are not routinely performed each school term, and which may require considerable elapsed time.

b. The second question was arranged opposite the first, using the same activities. It asked the respondent whether technical reports had been used in the performance of the specific activities listed. If he had performed the activity, and checked it on question one, and if he had used technical reports with the activity, then he checked it on question two.

c. The third question asked the respondent to select, from among three specified time periods, how long he would be willing to wait for a report needed for a specific activity. The times ranged from virtually no delay, to a wait of several weeks. However, only the longest time would permit interlibrary loan or special order services to fill the need. Therefore the responses were expected to give the library manager information that would be required to plan appropriate service if the decision was made to supply the reports by purchase, or some alternative means.

d. The fourth question asked the respondent to indicate the various sources from which he learned about the reports he wanted to use. Cited references was one of the sources listed

so this question provided the data to test the assumption underlying the faculty journals citation count, that citations in those journals were a potential information source.

e. The fifth question asked the respondent to indicate any of the sources from which he tended to get the reports he used. These sources included the university library, but also included other libraries, contract officers of sponsored research, and so forth. It was included to test the assumption that faculty would expect and seek needed materials from the university's library, whether or not the library could provide them.

f. The sixth question asked the respondent to rank several types of library materials, such as books, journals, etc., in order of the importance he placed on their being in the library collection. This question was included to test the assumption that technical reports, as a group, would tend to be ranked relatively low in importance to the faculty, and that the library manager would tend to receive little expressed demand for such materials.

g. The seventh question asked the respondent to list the journals which he regularly perused either in library copy or personal subscription. This last question formed the basis for a list of journals from which to make a citation count.

2. The Citation Count from Journals Read by the Faculty. The list of journals regularly read by the faculty was compiled from the responses to question seven on the questionnaire. All the titles were recorded on cards, together with a notation of each of the specific faculty members who had listed the particular title. Rather than include every journal listed by the respondents on the questionnaire, 155 titles in all, the journals were ranked in order of the number of faculty listing each title. Those listed by the most respondents were selected first and the names of those selecting the titles were struck from a list of respondents. Selection continued, in order of titles most listed, until all titles had been selected which (a) had been listed by more than one faculty member; and (b) had been listed by a faculty member who was not yet struck off the list of respondents. The selection was then completed by adding the first title listed on the questionnaire of any faculty respondent who had not been represented by a title previously selected. In this way the journals read by several faculty members were certain

to be included, and at the same time every faculty member who responded would be represented by at least one title in the sample. The resulting sample of faculty-read journals included twenty-two titles. Once the sample list of journal titles was made up, the procedure for selection was completely randomized. The entire year's publication of the journal was used as the basis for sampling. The articles were regarded as if numbered in sequence from the first article in the year's first issue to the last article in the last issue. A random number determined the number of articles sampled from the title.(37) If, for example, thirty was the number from the random table which determined the sample size, then the next thirty random numbers from the table were used to determine the specific articles to include. The result was a randomly selected sample of articles from each of the journal titles. The citation count was then made of all published references contained in the articles in the sample. Since the number of references to technical reports, alone, lacks meaning as a measure, it was desirable to determine the number of technical reports as a percentage of all published references and as a percentage of citations to material other than journal articles. To make this comparison it was necessary to define "published references" and to exclude certain citations from the definition "published." For example, citations to such things as "personal communication to the author"

were excluded since they are neither published in the usual sense, nor do they have any retrieval meaning for a library. Other citations, however, were not so clear cut, and might not have been excluded from the definition had the purpose of the count been different. An example of this problem is a citation to a paper presented at a society conference. Normally, this is considered "publication." However, issuance of such papers vary. Some conference proceedings are published together as a volume. It is the practice of some societies to publish conference papers singly as articles in journals they issue. Other conference papers are neither published as proceedings or in the society's journals, but may be submitted by the author on his own, for publication as a journal article or included in a book. Another possibility is that the paper presented resulted from sponsored research published as a technical report. Because of such variation in issuances, any reference to a paper which was cited only as presented in oral form, with no other indication of publication, was excluded from the count, since such a citation could not be identified in either the category of "journal articles" or of "other references." The citation count was totalled for the entire sample, and was totalled by source article, and by source journal, in the categories mentioned. Further, all citations to technical reports were individually captured by source (AEC,NASA,NTIS,"Other") and by date of report, for

relation to the publication date of the source journal. This sample and its results are referred to as the Faculty Engineering Sample.

3. The Citation Count from Journals in the Field of Engineering. The sample for a citation count to examine use of technical reports by the engineering field in general was selected from titles indexed in Engineering Index. The list of journals covered by Engineering Index is published.(55) It codes each title to indicate whether the title is given complete indexing coverage or not. Only titles which were indexed completely, published in English, and published in the United States or by international associations having a heavy percentage of United States authors were considered for inclusion. The titles which met these requirements were numbered in sequence on the published list. The sample titles were selected from among those titles, using a random number to determine the quantity of titles for the sample, and random numbers to determine the specific titles. The sample included twenty-three titles. Once the list of source journals included in the sample was determined, the procedure for selecting the specific articles to be sampled, and the procedure for counting the citations, was exactly the same as that used for the Faculty Engineering Sample. This sample, and its results are referred to as the National Engineering Sample.

4. The Data. The data gathered from the question-

naire described above included:

a. the number of faculty who used technical reports;
b. the academic activities for which they used them;
c. various aspects of use, such as source of information about the reports, source of supply of reports, and the amount of time faculty were willing to wait to receive reports needed for various activities;
d. the ranked importance to the faculty of technical reports in the library collection; and
e. the journals regularly read by the faculty respondents.

The data gathered from each of the two citation counts described above included:

a. the incidence of technical report citation as percentages of all the citations, and of the non-journal citations;
b. the percentage of the authors who cited reports;
c. the incidence of technical report citations from those authors' citations;
d. the publication date of the reports cited.

All of these data are given in Chapter IV, together with the statistical tests of the model and the results of those tests.

CHAPTER IV

APPLICATION OF THE RESEARCH MODEL

A. Introduction. The research model described in Chapter III was designed to give the library manager data on the use of materials which would:

1. augment the operational data already available;
2. provide evidence of need for material to assist in acquisition/selection decisions; and
3. provide the evidence in terms of standard criteria: the study, instructional, informational and normal research needs of university library users.

The way in which the model was formulated, its objectives and components, are described in detail in preceding chapters. The model was tested to determine the validity of the underlying assumptions and to demonstrate the results of its application.

B. The Questionnaire. The questionnaire was distributed in April 1973 to the eighty-one members of the full-time

teaching faculty at the University of Oklahoma College of Engineering.* It was accompanied by an explanatory cover letter and a cover letter from the Dean of the College. The questionnaire and attachments are shown in Appendix I. The questionnaire forms, coded by respondent, were addressed and sent individually through the campus mail. Completed questionnaires were collected in an envelope left for the purpose in each departmental office. Follow-up calls were made to encourage full participation and to recover all the distributed questionnaires, if possible, whether completed or blank. As a result, sixty-seven questionnaire forms were returned and fourteen were not. There is no basis for determining whether the fourteen unreturned forms indicated lack of technical report use or unwillingness to participate. Of the sixty-seven forms returned, three were blank but two of them had attached notes that the respondents didn't use technical reports. These two, plus the sixty-four completed forms, gave a total response to the questionnaire of eighty-two percent, with seventy-nine percent responding to the questions. Seventy-nine percent return is ample evidence for considering the responses to the questions representative.

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*The figures are from the Directory, 1972-73, College of Engineering; the number of faculty, given above, excludes adjunct, emeritus, visiting faculty, those on leave, special instructors, graduate assistants, administrative, clerical and technical maintenance personnel.

1. Analysis of the Data from Questions One and Two. Question One asked the respondents to check activities, from among nine listed, that they had performed during a three-year academic period. Question Two asked them to check activities for which they had used technical reports, if any. To permit respondents to consider use of technical reports in relation to the specific academic activities they had performed, the questions were arranged in parallel columns as shown in Figure 1. Because of this parallel arrangement there was a possibility that respondents would fail to make a clear distinction between the two questions. They might check both sets of boxes for the activity whether or not they intended the same answer to both Question One and Question Two.

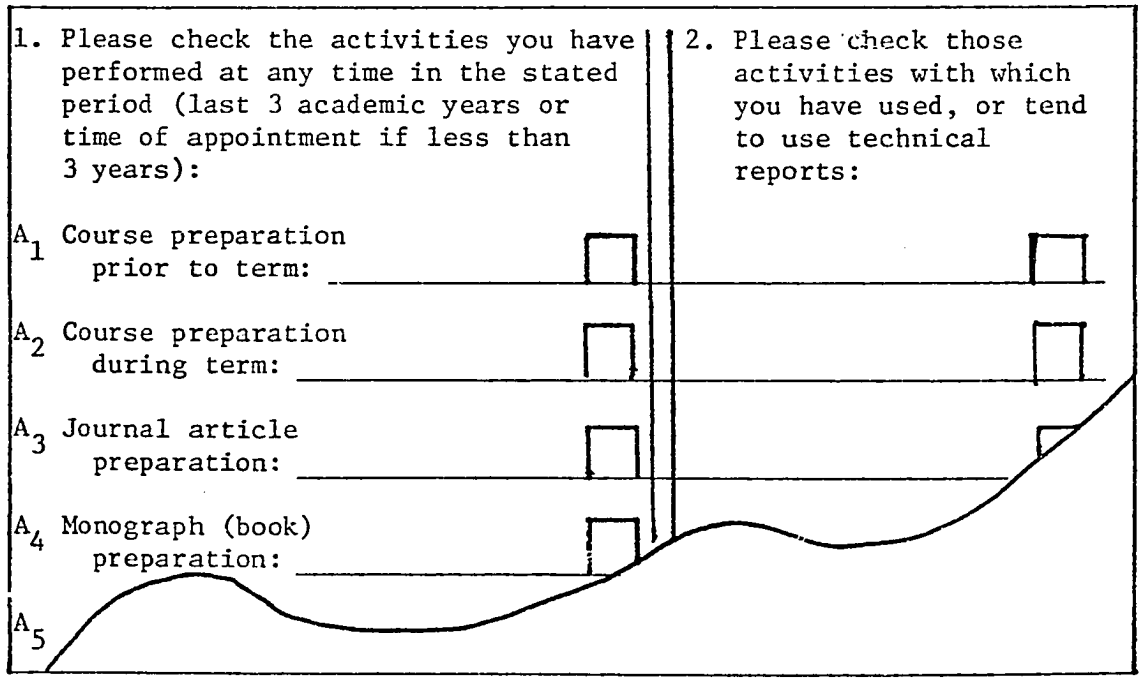

Figure 1. Parallel Column Arrangement of Question One and Two

There was also the possibility that respondents would simply scan down the columns checking responses at random. A binomial test was applied to check for these possibiliites. The assumption was made that if responses were checked at random, the proportion of those who checked the activities in Question One and Two and the proportion who did not would be approximately equal. Further, if respondents failed to distinguish between the two questions and answered them both the same, the proportion of those who responded to the two questions the same would be significantly larger than those who did not. Therefore, the test was a one-tailed test, using the hypotheses:

H_o: $P = Q = .5$ where P = the proportion answering the same to both questions for the activities performed; and

H_1: $P < Q$ Q = the proportion having fewer "yes" answers to Question Two, use of technical reports, than to Question One, activities performed. (Note that a response on Question Two that reports were used, without a response on Question One that the activity was performed would be an invalid response.)

Of the sixty-four respondents, fifty-eight of them checked use of technical reports for at least one of the activities. Therefore, the total number used for the test was fifty-eight, since inclusion of the other six who used no technical reports would inflate the results. Since the number is large, the test was made using the normal approximation

and correcting for continuity, as described by Siegel, (60) Hence the statistic is:

$$Z = \frac{(x + .5) - NP}{\sqrt{NPQ}}$$

where N = 58, total number

x = 21, number checking One and Two the same

P = Q = .5

$$Z = \frac{(21 + .5) - ((58)(.5))}{\sqrt{(58)(.5)(.5)}} = \frac{21.5 - 29}{\sqrt{14.5}} = \frac{-7.5}{3.808}$$

$$Z = -2.03$$

Using Table A in Siegel, the probability associated with a value of Z = -2.03 is .0212. Hence the null hypothesis was rejected and the conclusion drawn that respondents did not check answers at random and they responded to the two questions separately in spite of the parallel format.

Tests for correlation also were applied to Questions One and Two. These were performed to determine whether a proportionally high amount of teachnical report use for an activity bore a relationship to a proportionally high amount of performance for that activity. A test for linear correlation and the Spearman Rank Correlation Coefficient were used, and for both tests the data was the proportion of responses among the total sixty-four respondents. The data for these tests are shown in Figure 2.

Activity	Question 1: Performed Activity			Question 2: Used Technical Reports		
	Number	% of 64	Rank	Number	% of 64	Rank
1. Course preparation prior to term:	60	94%	2	31	48%	6.5
2. Course preparation during term:	63	98%	1	35	55%	3.5
3. Journal article preparation:	56	87%	4	45	70%	2
4. Monograph (book) preparation:	13	20%	9	8	12%	9
5. Short course/ Seminar preparation:	35	55%	8	17	27%	8
6. Conference/Society meeting preparation:	53	83%	5	32	50%	5
7. Research proposal preparation:	59	92%	3	50	78%	1
8. Research project unsponsored:	47	73%	6	31	48%	6.5
9. Research project sponsored:	40	62%	7	35	55%	3.5

Figure 2. Number, Percent, and Rank of Response to Questions One and Two

The test for linear correlations of the percentage of response for each activity from Questions One and Two were made using the statistic:

$$r = \frac{Sxy}{\sqrt{Sxx \cdot Syy}} \quad \text{where} \quad Sxx = n \sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i \right)^2$$

$$Syy = n \sum_{i=1}^{n} Y_i^2 - \left(\sum_{i=1}^{n} Y_i \right)^2$$

$$Sxy = n \sum_{i=1}^{n} X_i Y_i - \left(\sum_{i=1}^{n} X_i \right) \left(\sum_{i=1}^{n} Y_i \right)$$

Xi= data for
Question One
Yi= data for
Question Two
i= 1, 2, ... 9

and a test of the null hypothesis: $H_o: \rho = 0$

is made using the statistic: $Z = \frac{\sqrt{n-3}}{2} \ln \frac{1+r}{1-r}$

These tests are explained in Miller and Freund. (51, pp. 256-257). The result of the test gave a value of r = .82 and Z = 2.83. Table III of Miller and Freund shows a Z value of 2.83 is significant at the .005 level for the two-tailed test and therefore the null hypothesis is rejected.

The Spearman Rank Correlation Coefficient was calculated using the ranks of the proportions for Question One and Question Two shown in Figure 2 above as the X and Y data, respectively, and correcting the two tied ranks of Y data, Question Two. (60, p. 207) Thus the statistic used was:

$$r_s = \frac{\Sigma X^2 + \Sigma Y^2 - \Sigma d^2}{2\sqrt{\Sigma X^2 \Sigma Y^2}} \quad \text{where } \Sigma X^2 = \frac{N^3-N}{12} - \Sigma T_x$$

$$\Sigma Y^2 = \frac{N^3-N}{12} - \Sigma T_y$$

$$T = \frac{t^3-t}{12} \qquad \text{where } t = \text{the number of observations given a tied rank}$$

and: $\Sigma d^2 = 47$

X had no tied ranks therefore $\Sigma X^2 = 60$

Y had 2 tied ranks of 2 observations each therefore $\Sigma Y^2 = 59$

$$r_s = \frac{60 + 59 - 47}{2\sqrt{60 \cdot 59}} = \frac{72}{119}$$

$$r_s = .605$$

Using Table P in Siegel, the statistic is significant for nine activities at the level of $\alpha = .05$. The test is one-tailed since the positive direction of correlation is predicted. The correlation tests both show a significant correlation between the amount of performance of an activity among the sixty-four respondents and the amount of use of technical reports for the activity. Therefore the tests support the conclusion that these data from the questionnaire can be used as a predictor for this faculty, using the amount of performance of an activity as a general predictor of the use of technical reports. However, it should be noted that the predictive value is limited to the responsesof this group, and at a given time. It is a test that could be applied at any time such a questionnaire were used, to determine if, for the group and material examined, the activity was predictive of use of material.

2. Analysis of the Data from Question Three. It was assumed that faculty who used technical reports might have different requirements related to quick availability of the reports, dependent to some extent on the activity for which the reports were used. To explore this point the respondents were asked the time period which best suited their needs for each activity. From three mutually exclusive time

periods listed, they were asked to check that time they could or would wait to receive a needed report. The times stated were: (1) on hand only (hence available immediately); (2) one or two weeks (hence a slight wait for return from circulation or quick interlibrary loan service); (3) four to six weeks (hence an average time for mail inquiry and receipt from a distant source on interlibrary loan or for special purchase). The number of respondents differs for each activity. The response data for Question Three are given in Figure 3, below.

Activity	Response for each time: On hand:	1-2 weeks:	4-6 weeks:	Total
1. Course preparation, pre-term:	11	23	11	45
2. Course preparation during term:	30	15	3	48
3. Journal article preparation:	4	23	21	48
4. Book preparation:	1	6	13	20
5. Short course prep.:	8	18	6	32
6. Conference preparation:	8	30	8	46
7. Research proposal:	20	19	12	51
8. Unsponsored research:	4	12	20	36
9. Sponsored research:	4	14	19	37

Figure 3. Selection of Wait-Time Permissable for Technical Reports

A Chi square test was performed on the response for each activity to determine whether a significant difference

existed in the number of respondents selecting the most popular time-wait-allowable and the number selecting either of the other two choices. The null hypothesis was that each of the three times is equally likely to be selected by a respondent for the activity. This was tested using the statistic:

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_1 - E_i)^2}{E_i} \quad \text{for k-1 degrees of freedom}$$

and the null hypothesis was rejected at the .05 level of significance. Table C in Siegel gives the probability under H_o that $\chi^2 \geq$ Chi square for 2 degrees of freedom, as: .05 = 5.99; .01 = 9.21; .001 = 13.82. The results are summarized in Figure 4, below.

Activity	Time most selected	Significant difference	χ^2
1. Course preparation before term:	1-2 weeks	Yes	6.4
2. Course preparation during term:	On hand	Yes	22.9
3. Journal article preparation:	1-2 weeks	Yes	13.6
4. Monograph (book) preparation:	4-6 weeks	Yes	10.9
5. Short course preparation:	1-2 weeks	Yes	7.7
6. Conference preparation:	1-2 weeks	Yes	21.0
7. Research proposal:	On hand	No	2.2
8. Unsponsored research:	4-6 weeks	Yes	10.7
9. Sponsored research:	4-6 weeks	Yes	9.5

Figure 4. Test of Significant Difference for the Time Most Selected Among the Choices of the Three Time-Waits-Allowable

The test shows that the time in which a report is needed does vary by activity; that reports are needed quickly for some activities; and the library can only meet those needs if it can respond quickly. Referring back to the data on the number performing the various activities, given in Figure 2, those numbers show that:

a. more than 50 percent of the faculty performed all of the activities except book preparation;

b. more than 70 percent performed six of the activities; and

c. more than 80 percent of the faculty performed five activities:

(1) course preparation before terms, 94 percent

(2) course preparation during the term, 98 percent

(3) journal article preparation, 87 percent

(4) conference preparation, 83 percent

(5) research proposal preparation, 92 percent

The results of the test shown in Figure 4 indicate that the library would have to supply the reports immediately, or within one-to-two weeks at most, to meet the need for reports for these five activities.

3. Analysis of Data for Question Four. Question Four was designed examine an assumption: that cited references indicate the potential information needs of those who read an article citing them. In the light of scholarly tradition it might appear unnecessary to test such an assumption. The

decision to do so stemmed from information in studies such as Crane's which indicate that: (1) members of the "invisible college" within a specialty rely on informal communication among their colleagues for much information; (2) the use of formal and informal means of information transfer varies widely among specialties; and (3) the process varies among persons already established and those first entering a specialty. (17)

Since the research model utilizes a citation count sampled from source journals known to be read by the user-group specifically to indicate potential information needs of the group, the validity of the assumption underlying the use of that citation count was tested. Question Four asked respondents to state which of three sources they used to learn of potentially useful technical reports. The three sources listed were: (1) colleague or friend; (2) references cited in journal articles and other published sources; and (3) subject searches through indexes and other subject sources. The sources were not mutually exclusive. Respondents were asked to mark any sources they had used. Hence there is an equal probability of selecting: (1) all three sources; (2) two of the three sources; or (3) one of the three sources listed. The probability of selecting one of the three combinations can be further subdivided as shown in Figure 5.

Combination Selections Possible	Probability of Combination	Total Probability
1. All three sources	.3333	.3333
2. Two of the three sources		
a. Sources 1 and 2	.1111	.3333
b. Sources 2 and 3	.1111	
c. Sources 1 and 3	.1111	
3. One of the three sources		
a. Source 1	.1111	.3333
b. Source 2	.1111	
c. Source 3	.1111	

Figure 5. Probability of the Combination of Selections from Three Sets of Choices that are Not Mutually Exclusive

The selection of source 2, "references cited in journal articles and other published sources", is the only selection pertinent to establishing the assumption. From Figure 5, above, it can be seen that the combination in the left-hand column which include selection of source 2 are numbers 1, 2a, 2b, and 3b. Their combined probability is .67 and the probability of not selecting source 2 is .33.

The total number responding to question four was sixty. The responses they gave to Question Four are shown in Figure 6.

Combination	Number Responding	Number Choosing Source 2
1. All three sources	31	31
2. Two of the three sources		
a. Sources 1 and 2	5	5
b. Sources 2 and 3	15	15
c. Sources 1 and 3	0	
3. One of the three sources		
a. Source 1	0	
b. Source 2	7	7
c. Source 3	2	
Total	60	58

Figure 6. Number and Selections of Responses to Question Four

Using the data from Figures 5 and 6, the probabilities of obtaining that response, or a more extreme response, were summed, using the formula:

$$p(x) = \sum_{i}^{x} \binom{N}{i} P^{i} Q^{N-i}$$

To simplify the calculation the convention of using the smaller of the two figures, choice of source 2, or not choice of source 2, as "x" was used. Therefore:

$N = 60$

$x = 2$, not choice of source 2

$N-x = 58$, choice of source 2

hence, $i = 0, 1, 2$

$P = .33$, the probability associated with x

$Q = 1-P, .67$, the probability associated with N-x

The sum of probabilities, $p(0) + p(1) + p(2) = p(x)$, the probability of a result as extreme or more extreme than observed is:

$p(x) = .000000591$

The proportion of respondents who selected source 2 (fifty-eight of sixty, or ninety-seven percent) was compared to the proportion who could be expected to choose it (sixty-seven percent of sixty or, forty persons).

The hypothesis tested was:

H_o: $p_1 = p_2$

H_1: $p_1 > p_2$

where p_1 = the proportion from the questionnaire

p_2 = the expected distribution proportion

Using the formula:

$$Z = \frac{\frac{x_1}{n_1} - \frac{x_2}{n_2}}{\sqrt{\hat{p}\,(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \quad \text{where } \hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$

and x_1 = 58 (the actual number of respondents selecting source 2)

$n_1 = 60$

$x_2 = 40$ (the number equaling 67 percent of respondents)

$n_2 = 60$

$Z = 4.25$

Table C given by Siegel shows the probability associated with a value as extreme as Z = 4.0 is .0003. (60) The null hypothesis therefore is rejected. The conclusions were drawn that: (1) the proportion of respondents who selected sources that included the use of cited references exceeds the expected proportion to a significant degree; (2) the assumption, that cited references indicate a potential information need for those who read articles citing them, is valid; and (3) the use of the citation count in the model to determine potential information needs is justified.

4. Analysis of Data from Question Five. Question Five asked the respondents to indicate the various types of collections or sources they used to obtain technical reports. This question was posed to determine to what extent the local library collection and its interlibrary loan and special

purchase services were relied upon by the user group. If the library lacked the reports, had limited interlibrary loan borrowing capability, or limited special purchasing services, such a source, in fact, would be ineffective. Nevertheless, it was assumed that faculty would tend to rely on the local library, whatever the extent of its collection and services. This seems particularly logical in the case of new faculty members not yet fully acquainted with the extent of locally available materials and services.

The eleven sources listed were not mutually exclusive. Faculty were asked to note all sources utilized. Among the sixty respondents to this question fifty-eight percent, and fifty-seven percent, respectively, noted use of the local library collection and use of its special services, to try to get the reports. The only other sources indicated by one-third or more of the respondents were the sources related directly to sponsored research, that is, the contracting officer responsible, and the agency sponsoring the research.

The number and percentages of response for each source are shown in Figure 7. The conclusion was drawn from these data that the user group relies heavily on the local library facilities, and does not tend to seek out other specialized library collections.

Source Collection	n	Percent of N=60
C_1 O.U. Library Collection:	35	58%
C_2 O.U. Library interlibrary loan or special purchase order service:	34	57%
C_3 Other academic library locally:	2	03%
C_4 Other academic library, non-local:	6	10%
C_5 Special (company) library, locally:	0	0%
C_6 Special (company) library, non-local:	8	13%
C_7 Special (government) library, locally:	5	08%
C_8 Special (government) library, non-local:	9	15%
C_9 Contract Officer responsible for sponsored research project:	20	33%
C_{10} Directly from agency sponsoring sponsored research project:	30	50%
C_{11} Other (specify) (These responses tended to duplicate the choices above, particularly C_9 and C_{10})	16	27%

Figure 7. Sources Used to Obtain the Technical Reports Needed

5. Analysis of the Data from Question Six, Ranked Importance of Materials. In the discussion of the problem which led to the development of the model it was stated that libraries may not receive expressions of demand for materials, or be able to assess the need for materials based on lack of demand. For this reason the faculty were asked to rank five general types of materials, listed on the questionnaire in alphabetical order. Each respondent ranked each type, assigning values of one, two, three, four and five. The ranks represent the value the respondent placed on having each type in the library, a rank of one having the lowest value and five the highest.

The test examines whether the set of m rankings of n types shows any evidence of community of judgment among m individuals. The test, as explained by Kendall and Smith, is a test of preference. (36) It requires no assumption other than that ranking of the types is possible, and it does not require that the ranking be based on a distribution according to a normal variate. Hence, the test determines: (1) whether the respondents have preferences in common; and (2) if so, is there a strong degree of unanimity.

Each of the ranks are summed, and the total of all the ranks added are expressed by $mn(n+1)/2$. In the case of total agreement the sums of each type ranked show the most difference from each other. When little or no agreement is present the sums of each rank are approximately

equal. The formulas used are:

$$(1)\quad W = \frac{12\,S}{m^2\,(n^3-n)}$$

where W = the coefficient of concordance

S = the sum of squares of difference of the observed total value from the mean value $m(n+1)/2$

m = the number of rankings

n = the number of items ranked

and

$$(2)\quad \chi_r^2 = m(n-1)W$$

χ_r^2 is approximately distributed as χ^2 with (n-1) degrees of freedom.

The data are given below. The types of material, listed in alphabetical order on the questionnaire, have been arranged in order of ranked value in Figure 8.

Type	Σ of Ranks	Average Rank	Rank Order
Journal publications	264	4.4	5
Monographs (books)	257	4.28	4
Technical reports	159	2.65	3
Government publications	143	2.38	2
Product information and specifications	77	1.28	1

Figure 8. Ranked Importance of Library Material

The calculations, where

m = 60, the number of rankings performed

n = 5, the number of items ranked

gave values of:

$S = 25,404$

$W = .71$

$\chi^2_r = 169.36$

The tables for values of χ^2_r given in Friedman for n = 5, give values for m rankings as shown in Figure 9. (24, p. 89)

m	χ^2_r at: .05 level of significance	at .01 level
20	9.37	12.82
100	9.46	13.19

Figure 9. Values of Chi Square for m Rankings

The calculations indicate that the faculty have preferences in common with unanimity of preference shown to a highly significant degree. As might be expected, the ranks show strong preference for journals and monographs, with little difference between the two. Similarly, the preferences for technical reports and government publications were close in rank, but far below the level of their first two preferences. Product information and specifications appear to have little value to this faculty as a type of material to maintain in the library.

The results of the rankings tend to show that the library may experience little if any pressure to maintain collections of materials other than journals and monographs. However, it is important to note that this is contrary to the results of the previous question which showed that more

than half the faculty turn to the library for needed material including technical reports. In other words, the faculty apparently expect the library to have whatever materials they need. The experienced library manager may not find this contrast surprising. But it is important to establish these apparent discrepancies because they emphasize the need for quantifiable data to aid in evaluation of materials for selection and to support decisions.

6. Summary of the Questionnaire Data Analysis: The foregoing discussion of the questionnaire results shows that:

a. the questionnaire is a viable instrument to apply to a faculty user-group to elicit responses about use of a literature, indicated by the seventy-nine percent response;

b. a basic function of the questionnaire is to derive information from a user-group about its use of a literature. Tests applied to Questions One and Two support the view that responses reflected a reasoned judgment. Hence, the basic design of the questionnaire has been tested in the experiment and is supported by the evidence;

c. the tests demonstrated that the questionnaire can be used to determine if correlations exist between activities and uses of literature. Where correlations do exist they can be used for pre-

diction of literature use in conjunction with known amounts of performance of activities;

d. an underlying assumption of the model was that references cited in journals that are read by the user-group are a source of potential information to that group. The questionnaire was used to test the assumption and results showed it to be valid;

e. the experimental application of the questionnaire demonstrated its use to elicit additional information from the user-group related to provision of library services. For example, data on the time limit required by the user to receive needed materials, Question Three, may assist the manager in determination of both the selections and the services required to meet the users' actual needs.

f. the experimental application of the questionnaire shows that the user-group members examined tended to seek materials from their own university library. The results also indicated that the users themselves may express little or no pressure for the library to supply the materials they do use and will seek there. Hence the results tend to support the general thesis of the research: that sources of usage data from outside the library system are valuable in providing the added dimension

and objectivity necessary in making decisions about library selections and the related provision of services.

C. The Citation Count from the Faculty Engineering Sample. The source journals sampled for this citation count were drawn from those which the faculty respondents listed on the questionnaire as being titles they regularly read. The procedure used to select the sample list of twenty-two journals and the articles to be sampled from each of those titles was explained in Chapter III. The quantity of articles and the specific articles sampled from the various titles were selected by random number. This was done to avoid making any assumptions, such as those of the normal distribution, about the journals, the authors, or the references cited.

1971 volumes were used for the basic citation count. A second count, to compare changes or trends, was made for all titles in the sample which had existed ten years earlier. Of the twenty-two titles, fifteen had volumes for 1961.

To determine the amount of technical report use that the citations reflected, the citations to all publications were counted. Then the number of technical report citations was examined in relation to:

1. the total count;
2. the proportion of journal articles cited; and
3. the proportion of other materials cited.

The 1971 volumes contained a total of 3,205 articles, of which 1,106 were sampled. Of these 1,106 source articles, 1,033, or ninety-three percent, cited references. The total references in this sample numbered 16,167.

The 1961 volumes (fifteen of the twenty-two source journal titles) contained a total of 1,571 articles, of which 419 were sampled. This sample amount differs from the 1971 sample because the sample size from each title was determined by random number. Of these 419 source articles, 371, or eighty-nine percent, cited references. The total references in this sample numbered 4,580. Figure 10 shows the data from the citation count.

	1971		1961	
Category	Number	Percent	Number	Percent
Articles citing references:	1,033		371	
Number of references cited:	16,167	100%	4,580	100%
1. Journal articles, % of total:	10,050	62%	3,139	69%
2. Other, % of total:	6,117	38%	1,441	31%
3. Reports, % of total:	1,527	9%	222	5%
4. Reports, % of other:	1,527	25%	222	15%

Figure 10. References Cited in the Faculty Engineering Sample

Note that in the sample as a whole less than ten percent of all citations were to technical reports in 1971 and only five percent of the total in 1961. However, it is interesting to compare results of all the articles sampled

with the results of a sub-sample. The sub-sample is made up of those articles which cited the technical report references shown. Figure 11 shows the data from the sub-sample of the citation count.

Category	1971 Number	1971 Percent	1961 Number	1961 Percent
Articles whose authors cited technical reports, among total:	423	41%	106	29%
Number of references cited by these authors:	8,259	51% of total	1,912	42% of total
Using these references as the total:		100.%		100.%
1. Journal articles, % of total:	4,422	54%	1,218	64%
2. Other, % of total:	3,837	46%	694	36%
3. Reports, % of total:	1,527	18%	222	12%
4. Reports, % of Other:	1,527	40%	222	32%

Figure 11. References Cited in the Faculty Engineering Sample by Authors Who Cited Technical Reports

A comparison of Figures 10 and 11 shows that while technical report citations make up only nine percent of the total sampled in 1971, the authors who cite them make up two-fifths of the authors in the sample. These authors cite more than one-half of all the references in the sample, and their usage of technical reports, as a percentage of their total citations is eighteen percent, as opposed to nine percent for the total sample. The conclusion drawn from this comparison is that "usage" of technical reports shown by the

citation count differs, depending on whether you regard all references cited by all authors in the sample, or regard only the part cited by the authors who have actually shown use of reports by citing them.

D. The Citation Count From the National Engineering Sample. The procedure used to select the list of journals, and articles to be sampled, from journals indexed by Engineering Index was explained in Chapter III. The procedure was randomized to avoid any assumptions about distribution, exactly as before, for the Faculty Engineering Sample. Again, 1971 volumes were used for the basic citation count and 1961 volumes were used as a secondary count for comparison. The sample numbered twenty-three titles; in 1961 eleven of those titles had volumes which could be sampled.

The 1971 volumes contained a total of 3,412 articles of which 665 were sampled. Of these 665 source articles, 486, or seventy-three percent, cited references. The total references in this sample numbered 5,773.

The 1961 volumes (eleven of the twenty-three source journal titles) contained a total of 996 articles of which 284 were sampled. Of these 284 source articles, 220, or seventy-seven percent, cited references. The total references in this sample numbered 2,668. Figure 12 shows the data from the citation count.

Category	1971 Number	1971 Percent	1961 Number	1961 Percent
Articles citing references:	486		220	
Number of references cited:	5,773	100%	2,668	100%
1. Journal articles, % of total:	3,807	66%	1,868	70%
2. Other, % of total:	1,966	34%	800	30%
3. Reports, % of total:	187	3%	90	3%
4. Reports, % of other:	187	10%	90	11%

Figure 12. Reference Cited in the National Engineering Sample

In this sample references to technical reports are about three percent of the total. However, again the picture differs if only the sub-sample of authors who cite technical reports is examined. Those authors comprise one-fifth of the sample, they cite more than one-third of all the references, and their usage of technical reports, as a percentage of their total citations is nine percent, as opposed to three percent for the total sample. Figure 13 shows the data from the sub-sample of the citation count. Tables 1 - 7, Appendix IV also provide data from these samples.

Category	1971 Number	1971 Percent	1961 Number	1961 Percent
Articles whose authors cited technical reports, among total:	101	21%	39	18%
Number of references cited by these authors:	1,991	34% of total	1,044	39% of total
Using these references as the total:		100.%		100.%
1. Journal articles, % of total:	1,139	57%	795	76%
2. Other, % of total:	852	43%	249	24%
3. Reports, % of total:	187	9%	90	9%
4. Reports, % of Other:	187	22%	90	36%

Figure 13. References Cited in the National Engineering Sample by Authors Who Cited Technical Reports

E. Analysis of the Data from the Citation Counts. Two assumptions are inherent in the use of citation counts in the model:

1. the results of citation counts drawn from a a large field of literature, such as science, reflect the sum of all parts of that field. That sum may differ from results obtained from one part, such as engineering;
2. that results of a citation count drawn from journals in the field of engineering in general reflect the sum of the field. That sum may differ from results of a citation count drawn from journals read by a specific group of engineers.

These assumptions were tested statistically.

1. Tests of Citation Counts from General Field, Science, vs. a Particular Subset, Engineering. Garfield and Sher studied the references in science literature of 1961, accumulating 1.4 million references. (28) These averaged 13.7 references per article, of which only 2.2 references were to non-journal publications. Hence, in the 1961 science literature, 84 percent of the references cited journal articles and only 16 percent cited other materials.

As a test of the assumption, it is convenient to compare their figure for science literature in 1961 to the engineering data for 1961 to examine whether a significant difference exists in these proportions. If a difference exists, it is important to know because it establishes that the results found in the general literature (science) aren't necessarily the same as those of one of its subsets (engineering).

To make the comparison and test the null hypothesis that the proportions from these two populations are equal, against the alternative, the appropriate statistic is:

$$Z = \frac{\frac{x_1}{n_1} - \frac{x_2}{n_2}}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \qquad \text{with } \hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$

Figures for the Garfield and Sher data must be estimated to derive x since their discussion only gives the total references, 1.4 million, the average number of references

per article, 13.7, and the average number per article of non-journal references, 2.2. Dividing 2.2 by 13.7 gives .16. Multiplying 1.4 million references by that result gives the number of non-journal references as 224,818.

Of the two samples made of engineering data for 1961, the National Engineering Sample had the lower proportion of non-journal references and thus provides the most conservative test. For this sample estimating isn't required since the figures are available. The data are shown on Table 2, of Appendix IV. Using the estimates for Garfield and Sher, and the data from the National Engineering Sample, 1961, the data for the samples to be tested are:

National Engineering Sample	Garfield and Sher
$n_1 = 2668$	$n_2 = 1,400,000$
$x_1 = 800$	$x_2 = 224,818$
$p_1 = .30$	$p_2 = .16$

The hypotheses for the test are:

$H_o: p_1 = p_2$ Reject H_o if $Z > Z_\alpha$; Z at $\alpha = .05$ is 1.645

$H_1: p_1 > p_2$ $\alpha = .025$ is 1.960

$\alpha = .01$ is 2.326

$\alpha = .005$ is 2.576

Applying the data to be tested:

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2} = 0.161$$

$$Z = \frac{\frac{x_1}{n_1} - \frac{x_2}{n_2}}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{0.1392661334}{\sqrt{(0.1349764895)(0.0003755269)}}$$

$$Z = \frac{0.1392661334}{\sqrt{0.0000506873}} = \frac{0.1392661334}{0.0071195014} = 19.561$$

$Z = 19.561$

This value of Z, 19.561, is greater than Z_α for .005, 2.576. Hence, the null hypothesis, that the proportions of the two samples are equal, can be rejected at an alpha level of .005. This significant difference supports the assumption that results of a citation count drawn from a large field, such as science, differs from results obtained from one part, engineering. Hence the results obtained from the citation count of the large field cannot be used to draw conclusions about the subset.

2. Tests of Citation Counts from the General Field of Engineering Journals vs. a Particular Subset, Engineering Journals Read by a Specific Group of Engineers. The assumption was made that results of a citation count drawn from journals in the field of engineering in general may differ from results of a citation count drawn from journals read by a specific group of engineers. This assumption formed the basis for using two citation counts in the model design. One was derived from journals randomly sampled from those indexed in Engineering Index. (55) It was designed as a national overview of usage, based directly on

the original concept of the citation count, as a means of determining potential study and instructional needs of engineering students. The other count was derived from a sample of the journals read by the local engineering faculty, as a means of determining local potential informational needs. If the assumption that the two groups would differ were supported by a statistical test of the data, then the need for both citation counts would be supported. If the results of the test were to show no differences, then only one citation count would be required to show both aspects, the study/instructional, and the informational needs. Therefore, various comparisons of the results from the two engineering samples were made. In each case proportions were used, and the statistic and hypotheses for test were the same as those used to compare the Garfield and Sher data to the 1961 engineering data. Hence, the statistic used was:

$$Z = \frac{\frac{x_1}{n_1} - \frac{x_2}{n_2}}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \quad \text{with } \hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$

The hypotheses were:

H_o: $p_1 = p_2$

H_1: $p_1 > p_2$

where p_1 and p_2 represent the proportions from the two samples as shown in the following tables

and H_o is rejected if $Z > Z_\alpha$; where Z at $\alpha = .05$ is 1.645

$\alpha = .025$ is 1.960

$\alpha = .01$ is 2.326

$\alpha = .005$ is 2.576

For these tests three basic proportions were tested:

a. the proportion of non-journal references among the total references;

b. the proportion of technical report references among total references;

c. the proportion of technical report references among the total of non-journal references of which they are a subset.

A fourth proportion was also tested for comparison:

d. the proportion of authors (number of source articles (citing technical reports among the total of source articles in the sample citing any references.

Using these four proportions, comparisons were made of the data in the two samples, the Faculty Engineering Sample, and the Engineering National Sample, comparing the proportions between samples for the data years 1961 and 1971 using the data for the entire sample set. The three basic proportions also were applied using only the data from the subset of these authors in which technical reports were cited. Hence a total of seven tests were made. As stated above, these tests between samples were made to test the assumption. The data and test results are shown in Figures 14 and 15. The seven proportion tests between samples for the two

Tests Using Data From Entire Sample. Proportion Tested: where $H_o: p_1 = p_2$, $H_1: p_1 > p_2$	1961 Faculty Engineering Sample	1961 National Engineering Sample	1971 Faculty Engineering Sample	1971 National Engineering Sample
1. Proportion of non-journal references among the total references.	$n_1 = 4580$, $x_1 = 1441$, $p_1 = .31$, $Z^1 = 1.313$	$n_2 = 2668$, $x_2 = 800$, $p_2 = .30$, $Z^2 = 1.645$	$n_1 = 16167$, $x_1 = 6117$, $p_1 = .38$, $Z^1 = 5.113$	$n_2 = 5773$, $x_2 = 1966$, $p_2 = .34$, $Z^2 = 2.576$
	$Z^1 < Z^2$: No significant difference at $\alpha = .05$		$Z^1 > Z^2$: Significant difference at $\alpha = .005$	
2. Proportion of technical report references among the total references.	$n_1 = 4580$, $x_1 = 222$, $p_1 = .05$, $Z^1 = 2.982$	$n_2 = 2668$, $x_2 = 90$, $p_2 = .03$, $Z^2 = 2.576$	$n_1 = 16167$, $x_1 = 1527$, $p_1 = .09$, $Z^1 = 15.083$	$n_2 = 5773$, $x_2 = 187$, $p_2 = .03$, $Z^2 = 2.576$
	$Z^1 > Z^2$: Significant difference at $\alpha = .005$		$Z^1 > Z^2$: Significant difference at $\alpha = .005$	
3. Proportion of technical report references among the non-journal references of which they are a subset.	$n_1 = 1441$, $x_1 = 222$, $p_1 = .15$, $Z^1 = 2.723$	$n_2 = 800$, $x_2 = 90$, $p_2 = .11$, $Z^2 = 2.576$	$n_1 = 6117$, $x_1 = 1527$, $p_1 = .25$, $Z^1 = 13.784$	$n_2 = 1966$, $x_2 = 187$, $p_2 = .10$, $Z^2 = 2.576$
	$Z^1 > Z^2$: Significant difference at $\alpha = .005$		$Z^1 > Z^2$: Significant difference at $\alpha = .005$	
4. Proportion of authors (source articles) citing technical report references among all source articles citing references.	$n_1 = 371$, $x_1 = 106$, $p_1 = .29$, $Z^1 = 2.962$	$n_2 = 220$, $x_2 = 39$, $p_2 = .18$, $Z^2 = 2.576$	$n_1 = 1033$, $x_1 = 423$, $p_1 = .41$, $Z^1 = 7.713$	$n_2 = 486$, $x_2 = 101$, $p_2 = .21$, $Z^2 = 2.576$
	$Z^1 > Z^2$: Significant difference at $\alpha = .005$		$Z^1 > Z^2$: Significant difference at $\alpha = .005$	

Figure 14. Comparison of Proportions Between Samples, 1961 and 1971, Total Sample Data.

Tests Using Data from Subset, Authors Citing Technical Report References. Proportions Tested where $H_o: p_1 = p_2$, $H_2: p_1 > p_2$	1961 Faculty Engineering Sample	1961 National Engineering Sample	1971 Faculty Engineering Sample	1971 National Engineering Sample
1. Proportion of non-journal references among the total references.	$n_1 = 1912$, $x_1 = 694$, $p_1 = .36$, $Z^1 = 6.939$	$n_2 = 1044$, $x_2 = 249$, $p_2 = .24$, $Z^2 = 2.576$	$n_1 = 8259$, $x_1 = 3837$, $p_1 = .46$, $Z^1 = 2.947$	$n_2 = 1991$, $x_2 = 852$, $p_2 = .43$, $Z^2 = 2.576$
	$Z^1 > Z^2$ Significant difference at $\alpha = .005$		$Z^1 > Z^2$ Significant difference at $\alpha = .005$	
2. Proportion of technical report references among the total references.	$n_1 = 1912$, $x_1 = 222$, $p_1 = .12$, $Z^1 = 2.529$	$n_2 = 1044$, $x_2 = 90$, $p_2 = .09$, $Z^2 = 2.326$	$n_1 = 8259$, $x_1 = 1527$, $p_1 = .18$, $Z^1 = 9.764$	$n_2 = 1991$, $x_2 = 187$, $p_2 = .09$, $Z^2 = 2.576$
	$Z^1 > Z^2$ Significant difference at $\alpha = .01$		$Z^1 > Z^2$ Significant difference at $\alpha = .005$	
3. Proportion of technical report references among the non-journal references of which they are a subset.	$n_1 = 694$, $x_1 = 222$, $p_1 = .32$, $Z^1 = -1.196$	$n_2 = 249$, $x_2 = 90$, $p_2 = .36$, $Z^2 = -1.196$	$n_1 = 3837$, $x_1 = 1527$, $p_1 = .40$, $Z^1 = 9.786$	$n_2 = 852$, $x_2 = 187$, $p_2 = .22$, $Z^2 = 2.576$
	$Z^1 = Z^2$ Significant difference at $\alpha = .025$		$Z^1 > Z^2$ Significant difference at $\alpha = .005$	

Figure 15. Comparison of Proportions Between Samples, 1961 and 1971, Subset Data, References Cited by Authors of Articles Which Cited Technical Reports.

data years gave a total of fourteen tests. Of these fourteen tests there were significant differences shown in thirteen of the fourteen. Hence, the tests support the assumption and establish the need for the two citation counts in the method.

3. Comparison of Data for 1971 vs. 1961. The same statistic, hypotheses and test used for testing the assumption, above, were used to compare the data between years, to show changes in technical report usage over the ten-year period, if any. This was done for two reasons:

a. to evaluate the specific data derived in the experiment on the use of technical reports by engineers, for any changes shown; and

b. to demonstrate the capabililty of the model design, discussed above in Chapter III, for showing such changes or establishing trends in usage over a period of time.

Here again the seven comparisons between years, within each of the two samples, gave a total of fourteen tests. The results are shown in Figures 16 and 17.

The sample of journals drawn from the national index gave ambiguous results. Of the seven comparison tests made, four showed that the difference was not statistically significant. Of the three showing significant differences, the 1971 data was larger in two of the three. Hence, some differences were found but no definite

Tests Using Data From Entire Sample. Proportions Tested: where $H_o: p_1 = p_2$, $H_1: p_1 > p_2$	Faculty Engineering Sample		National Engineering Sample	
	1971	1961	1971	1961
1. Proportion of non-journal references among the total references.	$n_1 = 16167$ $x_1 = 6117$ $p_1 = .38$ $Z^1 = 7.912 > Z^2 = 2.576$ Significant difference at $\alpha = .005$	$n_2 = 4580$ $x_2 = 1441$ $p_2 = .31$	$n_1 = 5773$ $x_1 = 1996$ $p_1 = .34$ $Z^1 = 3.704 > Z^2 = 2.576$ Significant difference at $\alpha = .005$	$n_2 = 2668$ $x_2 = 800$ $p_2 = .30$
2. Proportion of technical report references among the total references.	$n_1 = 16167$ $x_1 = 1527$ $p_1 = .09$ $Z^1 = 9.887 > Z^2 = 2.576$ Significant difference at $\alpha = .005$	$n_2 = 4580$ $x_2 = 222$ $p_2 = .05$	$n_1 = 5773$ $x_1 = 187$ $p_1 = .03$ $Z^1 = -0.322 < Z^2 = -1.645$ No significant difference at $\alpha = .05$	$n_2 = 2668$ $x_2 = 90$ $p_2 = .03$
3. Proportion of technical report references among the non-journal references of which they are a subset.	$n_1 = 6117$ $x_1 = 1527$ $p_1 = .25$ $Z^1 = 7.794 > Z^2 = 2.576$ Significant difference at $\alpha = .005$	$n_2 = 1441$ $x_2 = 222$ $p_2 = .15$	$n_1 = 1996$ $x_1 = 187$ $p_1 = .10$ $Z^1 = -1.381 < Z^2 = -1.645$ No significant difference at $\alpha = .05$	$n_2 = 800$ $x_2 = 90$ $p_2 = .11$
4. Proportion of authors (source articles) citing technical report references among all source articles citing refernces.	$n_1 = 1003$ $x_1 = 423$ $p_1 = .41$ $Z^1 = 4.220 > Z^2 = 2.576$ Significant difference at $\alpha = .005$	$n_2 = 371$ $x_2 = 106$ $p_2 = .29$	$n_1 = 486$ $x_1 = 101$ $p_1 = .21$ $Z^1 = 0.943 < Z^2 = 1.645$ No significant difference at $\alpha = .05$	$n_2 = 220$ $x_2 = 39$ $p_2 = .18$

Figure 16. Comparison of Proportions Between Years, Faculty Engineering Sample and National Engineering Sample, Total Sample Data

Tests Using Data From Subset, Authors Citing Technical Report References. Proportions Tested: where $H_o: p_1 = p_2$, $H_1: p_1 > p_2$	Faculty Engineering Sample 1971	Faculty Engineering Sample 1961	National Engineering Sample 1971	National Engineering Sample 1961
1. Proportion of non-journal references among the total references.	$n_1 = 8259$, $x_1 = 3837$, $p_1 = .46$, $Z^1 = 8.056$	$n_2 = 1912$, $x_2 = 694$, $p_2 = .36$, $Z^2 = 2.576$	$n_1 = 1991$, $x_1 = 852$, $p_1 = .43$, $Z^1 = 10.310$	$n_2 = 1044$, $x_2 = 249$, $p_2 = .24$, $Z^2 = 2.576$
	$Z^1 > Z^2$ Significant difference at $\alpha = .005$		$Z^1 > Z^2$ Significant difference at $\alpha = .005$	
2. Proportion of technical report references among the total references.	$n_1 = 8259$, $x_1 = 1527$, $p_1 = .18$, $Z^1 = 7.182$	$n_2 = 1912$, $x_2 = 222$, $p_2 = .12$, $Z^2 = 2.576$	$n_1 = 1991$, $x_1 = 187$, $p_1 = .09$, $Z^1 = 0.701$	$n_2 = 1044$, $x_2 = 90$, $p_2 = .09$, $Z^2 = 1.645$
	$Z^1 > Z^2$ Significant difference at $\alpha = .005$		$Z^1 < Z^2$ No significant difference at $\alpha = .05$	
3. Proportion of technical report references among the non-journal references of which they are a subset.	$n_1 = 3837$, $x_1 = 1527$, $p_1 = .40$, $Z^1 = 3.888$	$n_2 = 694$, $x_2 = 222$, $p_2 = .32$, $Z^2 = 2.576$	$n_1 = 852$, $x_1 = 187$, $p_1 = .22$, $Z^1 = -4.541$	$n_2 = 249$, $x_2 = 90$, $p_2 = .36$, $Z^2 = -2.576$
	$Z^1 > Z^2$ Significant difference at $\alpha = .005$		$Z^1 > Z^2$ Significant difference at $\alpha = .005$	

Figure 17. Comparison of Proportions Between Years, Faculty Engineering Sample and National Engineering Sample, Subset Data, References Cited by Authors of Articles Which Cited Technical Reports.

trend was established.

The sample of journals drawn from those read by the local faculty, however, showed quite different results. A significant difference between years was found in all seven tests. In six of the seven tests the proportions for 1971 data were significantly larger than 1961. Hence, not only were definite differences found over the ten-year period, but a trend showing increased use from 1961 to 1971 was definitely established. The data and test results are shown in Figures 16 and 17.

4. Analysis of the Data on Age of the Reports Cited as an Indication of Useful-Life in Library Collections. The National Engineering Sample and the Faculty Engineering Sample exhibited different relationships of age of report versus the date of the source journal. However, both samples had instances of citations to technical reports which were twenty-five years old, or older. A summary of the data from the 1971 samples is as follows:

a. The Engineering Faculty Sample, 1971, using a cumulative percentage of technical reports cited, by age of report, showed that:

(1) twenty-one percent of demand would be satisfied with the latest three years of reports;

(2) fifty-two percent of demand would be satisfied with the latest six years of reports;

(3) seventy-three percent of demand would be satisfied by the latest ten years of reports; and

(4) the remaining percentage of total demand, shown by reports cited, is distributed over an additional thirty-year period, the oldest citation bearing a publication date of 1933.

b. The National Engineering Sample, 1971, showed that:

(1) thirty-three percent of demand would be satisfied with the latest three years of reports;

(2) fifty-two percent of demand would be satisfied by the latest four years of reports;

(3) seventy-two percent of demand would be satisfied by the latest six years of reports; and

(4) the remaining percentage of total demand, shown by reports cited, is distributed over an additional twenty-year period, the oldest citation bearing a publication date of 1943.

The dates of cited reports indicate that the total demand exhibited by the authors of the source articles could only be satisfied by a collection of reports spanning thirty to forty years. Approximately fifty to seventy-five percent

of demand would be satisfied with a collection of reports spanning five to ten years. Based on this summary data alone, without recourse to specific decisions on the amount of demand the library should satisfy, it is reasonable to conclude from the citations that technical reports do exhibit an age factor commensurate with the concept of collecting only materials having a "lasting value useful life" in university research libraries. Further, it is apparent from the data gathered in the experimental application, that the model is capable of exhibiting the age-span factor of the material being examined.

5. Summary of the Citation Count Data Analysis. Analysis of the data derived from the citation counts has shown that:

a. use of materials by a particular group such as engineers may vary considerably from use exhibited by a general group such as "all scientists";

b. use of materials shown by citation counts of random national samples may vary considerably from use shown in counts from samples of locally read sources. Hence the dual citation count used in the model is necessary to meet the objective of relating use to the local informational needs;

c. the comparison of retrospective citation counts, ten years apart, demonstrated that the model is capable of showing changes in use that occur. Therefore, the model can be expected to show trends in use, or developing forms or formats; and

d. the analysis of age of material cited demonstrated that the model meets the objective of showing useful life of the material being examined.

The reader wishing to examine the citation counts in detail will find the data provided in Appendices II, III and IV.

CHAPTER V

SUMMARY AND CONCLUSIONS

In Chapter I it was stated that the American Library Association interlibrary loan code policy is, in effect, a national standard governing loan of materials among university libraries. The ALA's loan procedure manual states the assumption that " . . . each library will provide the resources to meet the study, instructional, informational and normal research needs of its users . . . ." The statement implies that libraries have the responsibility to determine those needs, and further, assumes they have the means and ability to do so.

An examination of the literature led to the conclusion that the means available to a university library to determine the needs of its users in quantitative terms are derived from circulation, interlibrary loan, and similar descriptive statistics maintained for reporting purposes. These sources on use available from library operations are limited in their capacity to show need for materials which the library does not own, which do not circulate, or which because of procedures, policies or delays, are not reflected in the library's operating data.

Because of these limitations it was concluded that a university library does not have available within the system sufficient means to determine the materials needed by its users in terms of the categories of needs specified in the ALA statement. Therefore it lacks the ability to meet the implied responsibility. Moreover, the problem is compounded by the increasingly interdisciplinary nature of the material, the dynamics of changing disciplines which tend to cause changes in the university's programs of study, and the increasing costs of library materials and services. These factors tend to increase the need for quantitative data to support recommendations to fund library materials and services.

Hence the problem under investigation was the development of a method to provide data on use of materials which would meet the ALA's criteria for relating use to study, instructional, informational, and normal research needs, which could be obtained from sources other than the library's operating system, in order to augment data derived from the system and avoid the inherent limitations. The investigation also included objectives for provision of data which would relate the use of materials to the group which used the material in order to aid determination of needs under changing conditions in programs or budgets; provision of data which might reflect changing needs related to format of materials; provision of data which

would reflect retention period or useful life of materials used; and provision of data by a method applicable to various universities without the need for each institution to undertake costly repetition of the entire process.

Chapter III described the rationale for developing the three parts of the research model to meet the objectives for obtaining data on the use of materials, the way in which the model relates use to a specific group of users, and the way it relates use to specific types of needs. It was also noted that application of the model requires that the group of users and type of material be designated in advance, and that the research model was tested using the field of engineering and the use of technical reports for the experiment. Chapter IV described the experiment in which the model was applied, the kinds of data obtained and the statistical tests used to examine the results.

The experiment demonstrated that the questionnaire, as designed, achieved its purpose to obtain information about certain activities and use of materials from the engineering faculty. Four-fifths of the faculty responded. It was found from statistical tests applied to the results of the first two questions that faculty responses were not given at random, that faculty considered the questions individually, and responded to each in a manner indicative of considered judgment regarding their performance of activities and the use of technical reports. It was also found from statistical tests of the results

of the questionnaire that:

1. use of technical reports correlated to amount of performance of specific activities, and therefore the questionnaire design makes it possible to examine the amounts of performance of the various types of activities as predictors;
2. the amount of time in which a report was needed for use varied and depended upon the activity for which it was needed; and further that the maximum permissible wait for reports for most activities was one to two weeks;
3. the faculty would seek the materials they needed from the university library. Although they also used other sources to obtain technical reports, they would, as a group, expect the library to have them;
4. when asked to rank their preferences for materials needed in the library, this faculty did not rank technical reports high on their priorities of materials in the library. Therefore they would presumably exert little or no pressure for the library to maintain such a collection, even though, as noted above, results showed they would seek the reports from the library when needed; and
5. the statistical evidence showed that the faculty do use cited references for potential informational

needs, verifying that assumption underlying the faculty citation count.

The two citation counts of the model differed only in that the first, the faculty count, was drawn from source journals known to be regularly read by this faculty, and the second, the national count, was drawn from a general base of engineering journals, those indexed in the Engineering Index. Statistical tests applied to the results of the two citation counts showed that:

1. the results of the two counts did differ. The amount of use of technical reports, in terms of the number of authors citing them, and the proportionate amount of reports cited by them, differed to a significant degree in the two counts. This result verified the assumption that the two different counts were required to show the need for reports for study/instructional uses, from the national evidence, and the need for reports for local informational purposes, based on the evidence from locally read journal sources; and
2. there was a significant difference in the amount of technical report use over a ten-year period shown by the count from the faculty source journals. Hence the evidence indicates that the model is capable of demonstrating changes or

trends in use, and the evidence for this count indicated that the potential need for informational purposes of the faculty was increasing. Further evidence from the citation counts, based on the publication date of technical reports cited compared to the publication date of the source journals, indicated that some technical reports have a very long useful life. Some citations were noted to reports thirty years old. The amount of citation and the age of the reports cited gave an indication of the "demand" for technical reports which the authors of the source articles exhibited. The evidence from the citation counts of these samples indicates that a collection of reports spanning the last six to ten years would be required to fulfill fifty to seventy-five percent of the report-needs of these authors.

The experiment which was discussed above and in Chapter IV demonstrated the application of the research model and the data obtained from it. Statistical tests applied to the experimental data resulted in the conclusion that the questionnaire design is effective in eliciting the information from the faculty; that the assumptions underlying the faculty sample citation counts are valid, and that information relevant to library services appropriate to the material in question, can be obtained. The use of the data is not limited in time, _per se_, because the application can either be reiterated at intervals, or can

be made to compare different years, to show trends or changes in use as disciplines or material forms change.

The experiment to test the method applied the model to one technological field of study and one type of material. However there is no evidence to indicate that its application is so limited. The method requires only that the users and the material be specified in advance, and that the material be capable of being cited in published references. These requirements do not preclude application of the method to examine the interdisciplinary use of a material by a group of users drawn from several fields of study. An application of that type would be desirable for assessing need for materials in the library in the event that one of the fields of study might be discontinued following a university cutback in programs and the library required data on use of the material by those users in the related fields. This aspect of the method's application is suggested as a possibility for a future investigation.

Also, there is evidence that the method is not limited to examination of technical or scientific material. The investigations of M. S. Batts and William Miller have shown that the differing types of citations used in the humanities can be subdivided and the "substantive" citations distinguished. (7,52) Therefore the variations in citation practices in the humanities or other non-techno-

logical fields do not appear to be a deterrent to the use of this method. Such evidence suggests that future investigation of the method's application to these fields would be warranted.

The model that was used for the purpose of the present experiment to investigate the method was designed so that the citations could be identified and counted manually. However the method is not limited to manual application. The citation counts, in particular, lend themselves to computerized searches such as those made to produce the Science Citation Index (SCI) and other publications produced by the Institute for Scientific Information. This point was specifically explored during the course of the citation procedures. The publishers of SCI provided assurance that it was both possible to program for such a service, and commercially feasible to do so.* Although a cost/effectiveness analysis was beyond the scope of this study, such an analysis is a logical extension of the research. A future study might be directed toward development of a cost/effectiveness model, utilizing library input information from the present model, such as the lists of source journals, and identifying the cost variables associated with computerized searches to derive the sample data.

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*Telephone conversation with Mr. Michael E. D. Koenig, Executive Assistant to the Executive Director, Institute for Scientific Information, June 28, 1974.

A summary of the research would not be complete without noting that the data resulting from application of the model do not provide decisions. They require analysis which can lead to recommendations or decisions. However, this is also true of the present operational data available within a library system such as circulation statistics. They do not provide decisions, in themselves, but simply provide a quantitative basis for analysis.

The method designed to meet the research objectives provides library management with data on use of materials from sources unbiased by library operations. It is directly related to specific user groups and therefore applicable as needed when programs or priorities change. It is directly applicable to the four specific types of use which a university library has the responsibility to serve. Therefore it adds a new dimension to the university library director's ability to assess the library collection and the associated services. The method itself, however, is limited to the provision of data. It is hoped that this investigation will provide a stimulus for further research to develop a decision model based on this method to determine needs for materials in university libraries.

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APPENDICES

APPENDIX I: The Questionnaire

Exhibit 1

ENGINEERING FACULTY INTERVIEW
QUESTIONNAIRE, WITH COVER LETTERS

UNIVERSITY OF OKLAHOMA INTEROFFICE COMMUNICATION

COLLEGE OF ENGINEERING

OFFICE OF THE DEAN

To College of Engineering Faculty Date April 9, 1973

From Wm. R. Upthegrove W.R.U. Subject Attached Questionnaire

As you are aware, the College of Engineering has been the beneficiary of several studies of library activities that have been completed in conjunction with the library systems management program. To a very major degree, the new library facilities are a direct result of the efforts and initiative of this group.

The attached interview/survey form is part of a study that Nancy Boylan is completing under the supervision of Ray Lutz. It would be helpful to her and potentially very helpful to the College library facilities if you could take time to fill it out. Any questions regarding this should be referred to Nancy. You can contact her at 329-8508.

WRU:mr

Attachment

ENGINEERING FACULTY INTERVIEW

THE DATA REQUESTED IS BEING GATHERED PURSUANT TO RESEARCH FOR A DOCTORAL DISSERTATION IN THE LIBRARY SYSTEMS MANAGEMENT PROGRAM, SCHOOL OF INDUSTRIAL ENGINEERING. ALL INFORMATION SUPPLIED BY YOU IS CODED AND WILL BE MAINTAINED IN COMPLETE CONFIDENCE.

TO AID IN THE COMPLETION OF THE ATTACHED FORM THE FOLLOWING EXPLANATION IS PROVIDED:

ACTIVITIES PERFORMED: Please consider only the last three academic years, 1970-71, 1971-72, 1972-73 OR the time from your appointment at the University of Oklahoma, if more recent than 1970-71.

TECHNICAL REPORTS: The definition for this study is any report of federally sponsored research available from the Atomic Energy Commission (AEC), National Aeronautics and Space Administration (NASA), or National Technical Information Service (NTIS - formerly the Clearinghouse). Include in the latter reports from the Defense Documentation Center (DDC). NOTE: companies frequently supply reports which may have been sponsored by federal funds and therefore would meet the above definition. If you are unsure include all reports which you believe might be of this type in response to your use of technical reports.

PLEASE EITHER COMPLETE THE QUESTIONNAIRE AND LEAVE IT IN THE ENVELOPE HELD BY THE DEPARTMENTAL SECRETARY OR LEAVE WORD WITH HER FOR ME TO SCHEDULE AN APPOINTMENT WITH YOU IF YOU WISH ME TO BE PRESENT TO CLARIFY ANY AMBIGUITIES OR ANSWER ANY QUESTIONS YOU MAY HAVE. YOUR PARTICIPATION IN THIS STUDY IS MUCH APPRECIATED.

Thank you.
Nancy Boylan, HEW Fellow, Library Systems Management Program

College of Engineering
Department or School Code no._____ Respondent Code no._____

	1. Please check the activities you have performed at any time in the stated period (last 3 academic years or time of appointment if less than 3 years):	2. Please check those activities with which you have used, or tend to use technical reports:
A_1	Course preparation prior to term:	
A_2	Course preparation during term:	
A_3	Journal article preparation:	
A_4	Monograph (book) preparation:	
A_5	Short course/Seminar preparation:	
A_6	Conference/Society meeting preparation:	
A_7	Research Proposal:	
A_8	Research Project unsponsored by outside funding:	
A_9	Research Project sponsored by outside funding:	
A_{10}	Other (specify):	

NOTE: IF YOU HAVE NOT INDICATED USE OF TECHNICAL REPORTS IN CONNECTION WITH ANY OF THE ACTIVITIES IN QUESTION 1, PLEASE OMIT QUESTIONS 3, 4, AND 5. CONTINUE WITH QUESTION 6.

3. Please check one time box below for each of the activities for which you tend to use technical reports. Check the box in terms of the time you feel you could and would wait to receive the report. Times are mutually exclusive. Select the time period which best represents your usual need for that activity.

		L_1 If not on hand locally won't bother:	L_2 Could wait 1-2 weeks:	L_3 Could wait for inter-library loan or special order (4-6 weeks):
A_1	Course preparation prior to term:	☐	☐	☐
A_2	Course preparation during term:	☐	☐	☐
A_3	Journal article preparation:	☐	☐	☐
A_4	Monograph (book) preparation:	☐	☐	☐
A_5	Short course/Seminar preparation:	☐	☐	☐
A_6	Conference/Society meeting preparation:	☐	☐	☐
A_7	Research proposal preparation:	☐	☐	☐
A_8	Research project unsponsored by out-side funding:	☐	☐	☐
A_9	Research project sponsored by out-side funding:	☐	☐	☐
A_{10}	Other (specify):	☐	☐	☐

4. From what sources do you tend to get initial information or references to technical reports you want to use? Please check any or all of the boxes corresponding to the sources of such information which you have used to learn of technical reports:

S_1 Colleague or friend:_____ ☐

S_2 Reference cited in an article or other publication:_____ ☐

S_3 Literature searches (subject or other):_____ ☐

Examples of possible sources of such searches:

AEC'S Nuclear Science Abstracts

NASA'S STAR

"FAST" Announcements

Defense Documentation Center (DDC) search performed on request with contract user number authorization

S_4 Other (specify):_____ ☐

5. From what source(s) do you actually get the reports themselves? Please check any and all boxes relating to the sources you have used. Please limit your answer to those used while at the University of Oklahoma.

C_1 O.U. Library Collection: ☐

C_2 O.U. Library interlibrary loan or special purchase order service: ☐

C_3 Other Academic Library locally: ☐

C_4 Other Academic Library non-local: ☐

C_5 Special (company) Library locally: ☐

C_6 Special (company) Library non-local: ☐

C_7 Special (government) Library locally: ☐

C_8 Special (government) Library non-local: ☐

C_9 Contract Officer responsible for sponsored research project: ☐

C_{10} Directly from Agency supporting sponsored research project: ☐

C_{11} Other (specify): ☐

6. Please assume the library has in its collection all of the materials listed below. An unusual circumstance has caused the library to determine that it will remove all of an entire category. You are asked to specify which category should be removed first (you would miss it least), next, and so on. Use ranking numbers of 1 to 5 to indicate 1st removal (#1), 2d removal (#2), etc. Therefore these ranked numbers will increase from 1 to 5 in ascending order of the importance to you that the materials remain on hand:

Government Publications:_____

Journals:_____

Monographs(books):_____

Product information and specifications:_____

Technical reports:_____

7. Please list the research journals (articles primarily devoted to research) which you either subscribe to personally or otherwise read regularly as each issue is published. Since many journals have similar abbreviations please don't use abbreviated titles. List each as fully as possible. Use the back of this sheet if necessary.

Thank you for your cooperation. Should you wish to comment on the questionnaire please use the back of this sheet for that purpose.

EXHIBIT 2

FACULTY RESPONSE TO QUESTIONS
ONE, TWO AND THREE

Activity	Question One Activity Performance		Question Two Technical Report Use		Question Three Wait Time					
						Amount of Time Lag Willing To Wait				
						L_1 On Hand		L_2 1-2 Wks.		L_3 4-6 Wks.	
	Number	Percent	Number	Percent	Number	n	%	n	%	n	%
A_1 Course preparation prior to term:	60	94%	31	52%	45	11	24%	23	51%	11	24%
A_2 Course preparation during term:	63	98%	35	56%	48	30	63%	15	31%	3	6%
A_3 Journal article preparation:	56	88%	45	80%	48	4	8%	23	48%	21	44%
A_4 Monograph (book) preparation:	13	20%	8	62%	20	1	5%	6	30%	13	65%
A_5 Short course/seminar preparation:	35	55%	17	49%	32	8	25%	18	56%	6	19%
A_6 Conference/society meeting preparation:	53	83%	32	60%	46	8	17%	30	65%	8	17%
A_7 Research proposal preparation:	59	92%	50	85%	51	20	39%	19	37%	12	24%
A_8 Research project unsponsored by outside funding:	47	73%	31	66%	36	4	11%	12	33%	20	56%
A_9 Research project sponsored by outside funding:	40	63%	35	88%	37	4	11%	14	38%	19	51%
A_{10} Other (specify):	Only Five Responses Included Other Activities.										

EXHIBIT 3

FACULTY RESPONSE TO QUESTIONS FOUR AND FIVE

Question Four

Source(s) of initial information about technical reports needed for use:

Total number who responded = 60

Source		Number
S_1	Colleague or friend:	36
S_2	Reference cited in an article or other publication:	58
S_3	Literature searches (subject or other):	48

Question Five

Source(s) of technical reports used:

Total number who responded = 60

		Number	Percent
C_1	O.U. Library Collection:	35	58%
C_2	O.U. Library interlibrary loan or special purchase order service:	34	57%
C_3	Other Academic Library locally:	2	3%
C_4	Other Academic Library non-local:	6	10%
C_5	Special (company) Library locally:	0	0%
C_6	Special (company) Library non-local:	8	13%
C_7	Special (government) Library locally:	5	8%
C_8	Special (government) Library non-local:	9	15%
C_9	Contract Officer responsible for sponsored research project:	20	33%
C_{10}	Directly from Agency supporting sponsored research project:	30	50%
C_{11}	Other (specify): these responses tended to duplicate the choices 1-10, above.	16	27%

APPENDIX II: Faculty Engineering Sample

EXHIBIT 1

FACULTY ENGINEERING SAMPLE

LIST OF SOURCE JOURNALS

1. AIAA Journal. (American Institute of Aeronautics and Astronautics) 1971 only.

2. AIChE Journal. (American Institute of Chemical Engineers) 1971; 1961.

3. American Ceramic Society. Journal. 1971; 1961.

4. AIIE Transactions. (American Institute of Industrial Engineers) 1971 only.

5. American Scientist. 1971; 1961.

6. American Society of Mechanical Engineers (ASME). Transactions. Series E. Journal of Applied Mechanics. 1971; 1961.

7. American Statistical Association. Journal. 1971; 1961.

8. Association for Computing Machinery (ACM). Communications. 1971; 1961.

9. Association for Computing Machinery (ACM). 1971; 1961.

10. Automotive Engineering (SAE Journal). 1971; 1961.

11. Corrosion. 1971; 1961.

12. Environmental Science and Technology. 1971 only.

13. IEE Transaction on Electron Devices (IRE Transactions). 1971; 1961.

14. Institute of Electrical and Electronic Engineers (IEEE). Proceedings. (IRE Proceedings). 1971; 1961.

15. Journal of Aircraft. 1971 only.

16. Journal of Applied Meteorology. 1971 only.

17. Journal of Petroleum Technology. 1971; 1961.

18. Management Science. 1971; 1961.

19. Nuclear Science and Engineering. 1971; 1961.

20. Physical Review, 3d Series. Section A, General Physics. (Physical Review). 1971 sampled. 1961 volume, examined in four library collections lacked any table of contents or other means to determine the number of articles in the volume accurately enough to perform the random sample.

21. Transportation Research. 1971 only.

22. Water Pollution and Control Federation Journal. 1971; 1961. (Note: This title also included in the National Engineering Sample.)

EXHIBIT 2

FACULTY ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, NUMBER TOTALS

DESCRIPTION	1971	1961
1. Number of Journal Titles in Sample:	22	15
2. Number of Articles in Volumes:	3,205	1,571
3. Number of Articles in Sample:	1,106	491
4. Number of Sample Articles Citing References:	1,033	371
5. Total Number of References Cited:	16,167	4,580
6. Total Number of Citations to Journal Article References:	10,050	3,139
7. Total Number of Citations to Other Published References:	6,117	1,441
8. Total Number of Citations to Technical Report References	1,527	222
a. To AEC Reports:	285	117
b. To NASA Reports:	476	15
c. To NTIS Reports:	253	4
d. To Other Reports:	513	86
9. The Subset of Articles Citing Technical Report References in Item 8:	423	106
a. Total Number of References Cited:	8,259	1,912
b. Total Number of Citations to Journal Article References:	4,422	1,218
c. Total Number of Citations to Other Published References:	3,837	694
d. Total Number of Citations to Technical Report References: (Item 8, above)	1,527	222

EXHIBIT 3

FACULTY ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, PERCENTAGES

DESCRIPTION	1971	1961
1. Percentage of Articles in Sample Citing References:	93%	89%
2. Percentage of Citations to Journal Article References:	62%	69%
3. Percentage of Citations to Other Published References:	38%	31%
4. Percentage of Citations to Technical Reports		
a. Of Citations to Total Published References:	9%	5%
b. Of Citations to Other Published References:	25%	15%
5. The Subset of Articles Citing Technical Reports		
a. Percentage of Sample Articles Citing References:	41%	29%
b. Percentage of Citations to Journal Article References:	54%	64%
c. Percentage of Citations to Other Published References:	46%	36%
d. Percentage of Citations to Technical Report References		
(1) Of Citations to Total Published References:	18%	12%
(2) Of Citations to Other Published References:	40%	32%

EXHIBIT 4

FACULTY ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, 95% CONFIDENCE LIMITS

95% Confidence Limits For Proportions From the Citation Count Data Using:

$$p \pm Z_{\alpha/2} \sqrt{\frac{pq}{n}}$$

where p = the proportion

q = 1-p

$Z_{\alpha/2} = 1.96$

DESCRIPTION	1971 Lower	1971 < p <	1971 Upper	1961 Lower	1961 < p <	1961 Upper
1. Proportion of Other Published References Among Total References:	.3709	.3784	.3858	.3012	.3146	.3281
2. Proportion of Technical Report References Among Total References:	.0899	.0945	.0990	.0423	.0485	.0547
3. Proportion of Technical Report References Among Other Published References:	.2388	.2496	.2650	.1354	.1541	.1727
4. Proportion of Authors (source articles) Citing Technical Report References Among All Source Articles Citing References:	.3795	.4095	.4395	.2397	.2857	.3317
5. Subset: Authors Citing Technical Report References						
a. Proportion of Other Published References Among Total References:	.4538	.4646	.4753	.3414	.3630	.3845

DESCRIPTION	1971 Lower	< p <	Upper	1961 Lower	< p <	Upper
5. b. Proportion of Technical:	.1765	.1849	.1933	.1017	.1161	.1305
c. Proportion of Technical Report References Among Other Published References:	.3825	.3980	.4135	.2852	.3199	.3546

EXHIBIT 5

FACULTY ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, NUMBER OF TECHNICAL REPORTS CITED, LISTED BY DATE OF PUBLICATION, 1971 SAMPLE

YEAR	NUMBER	YEAR	NUMBER
1971	23	1951	19
1970	94	1950	11
1969	228	1949	9
1968	172	1948	5
1967	154	1947	16
1966	131	1946	4
1965	109	1945	3
1964	99	1944	6
1963	63	1943	2
1962	55	1942	6
1961	46	1941	1
1960	38	1940	0
1959	35	1939	2
1958	28	1938	1
1957	28	1937	0
1956	28	1936	0
1955	28	1935	3
1954	26	1934	1
1953	15	1933	3
1952	15	NO DATE:	20

TOTAL NUMBER OF REPORTS IN SAMPLE: 1,527

EXHIBIT 6

FACULTY ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, NUMBER OF TECHNICAL REPORTS CITED, LISTED BY DATE OF PUBLICATION,

1961 SAMPLE

YEAR	NUMBER	YEAR	NUMBER
1961	7	1946	2
1960	30	1945	0
1959	43	1944	7
1958	27	1943	1
1957	22	1942	1
1956	16	1941	0
1955	14	1940	0
1954	18	1939	0
1953	14	1938	0
1952	2	1937	0
1951	6	1936	0
1950	6	1935	0
1949	0	1934	0
1948	0	1933	1
1947	1	NO DATE:	4

TOTAL NUMBER OF REPORTS IN SAMPLE: 222

APPENDIX III: National Engineering Sample

EXHIBIT 1

NATIONAL ENGINEERING SAMPLE

LIST OF SOURCE JOURNALS

1. Accident Prevention and Analysis. 1971 only.
2. Acoustical Society of America. Journal. 1971; 1961.
3. Air Pollution Control Association. Journal. 1971; 1961.
4. American Society for Information Science. Journal. (American Documentation.) 1971; 1961.
5. American Society of Civil Engineers. Structural Division. Journal. 1971; 1961.
6. American Water Works Association. Journal. 1971; 1961.
7. Applied Physics Letters. 1971 only.
8. ChemTech. 1971 only.
9. IEEE Transactions of Communications Technology. (IRE Transactions.) 1971; 1961.
10. IEEE Transactions on Instrumentation and Measurement. (IRE Transactions.) 1971; 1961.
11. IEEE Transactions on Magnetics. 1971 only.
12. International Journal of Nondestructive Testing. 1971 only.
13. International Journal of Powder Metallurgy. 1971 only.
14. Journal of Cellular Plastics. 1971 only.
15. Metallurgical Transactions. 1971 only.
16. Photogrammetric Engineering. 1971; 1961.
17. Remote Sensing of Environment. 1971 only.
18. SAMPE (Society of Aerospace Materials and Process Engineers) Quarterly. 1971 only.
19. Society of Petroleum Engineers. Journal. 1971; 1961.
20. TAPPI (Technical Association of the Pulp and Paper Industry) 1971; 1961.

21. Telecommunications. 1971 only.

22. U.S. National Bureau of Standards. Journal of Research. Section B. Mathematical Sciences. 1971; 1961.

23. Water Pollution Control Federation. Journal. 1971; 1961. (Note: This title also included in the Faculty Engineering Sample.)

EXHIBIT 2

NATIONAL ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, NUMBER TOTALS

DESCRIPTION	1971	1961
1. Number of Journal Titles in Sample:	23	11
2. Number of Articles in Volumes:	3,412	996
3. Number of Articles in Sample:	665	284
4. Number of Sample Articles Citing References:	486	220
5. Total Number of References Cited:	5,773	2,668
6. Total Number of Citations to Journal Article References:	3,807	1,868
7. Total Number of Citations to Other Published References:	1,966	800
8. Total Number of Citations to Technical Report Refereences:	187	90
a. To AEC Reports:	16	15
b. To NASA Reports:	28	1
c. To NTIS Reports:	69	6
d. To Other Reports:	74	68
9. The Subset of Articles Citing Technical Report References in Item 8:	101	39
a. Total Number of References Cited:	1,991	1,044
b. Total Number of Citations to Journal Article References:	1,139	795
c. Total Number of Citations to Other Published References:	852	249
d. Total Number of Citations to Technical Report References: (Item 8, above)	187	90

EXHIBIT 3

NATIONAL ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, PERCENTAGES

DESCRIPTION	1971	1961
1. Percentage of Articles in Sample Citing References:	73%	77%
2. Percentage of Citations to Journal Article References:	66%	70%
3. Percentage of Citations to Other Published References:	34%	30%
4. Percentage of Citations to Technical Reports		
a. Of Citations to Total Published References:	3%	3%
b. Of Citations of Other Published References:	10%	11%
5. The Subset of Articles Citing Technical Reports		
a. Percentage of Sample Articles Citing References:	21%	18%
b. Percentage of Citations to Journal Article References:	57%	76%
c. Percentage of Citations to Other Published References:	43%	24%
d. Percentage of Citations to Technical Report References		
(1) Of Citations to Total Published References:	9%	9%
(2) Of Citations to Other Published References:	22%	36%

EXHIBIT 4

NATIONAL ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, 95% CONFIDENCE LIMITS

95% Confidence Limits For Proportions From the Citation Count Data Using:

$$p \pm Z_{\alpha/2} \sqrt{\frac{pq}{n}}$$

where p = the proportion

q = 1-p

$Z_{\alpha/2} = 1.96$

DESCRIPTION	1971 Lower < p < Upper			1961 Lower < p < Upper		
1. Proportion of Other Published References Among Total References:	.3283	.3406	.3528	.2825	.2999	.3172
2. Proportion of Technical Report References Among Total References:	.0278	.0324	.0370	.0269	.0337	.0405
3. Proportion of Technical Report References Among Other Published References:	.0821	.0951	.1081	.0906	.1125	.1344
4. Proportion of Authors (source articles) Citing Technical Report References Among All Source Articles Citing References:	.1717	.2078	.2439	.1268	.1773	.2277
5. Subset: Authors Citing Technical Report References						
a. Proportion of Other Published References Among Total References:	.4062	.4279	.4497	.2127	.2385	.2644

DESCRIPTION	1971 Lower	< p <	1971 Upper	1961 Lower	< p <	1961 Upper
5. b. Proportion of Technical Report References Among Other Published References:	.0811	.0939	.1067	.0692	.0862	.1032
c. Proportion of Technical Report References Among Other Published References:	.1917	.2195	.2473	.3018	.3614	.4211

EXHIBIT 5

NATIONAL ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, NUMBER OF TECHNICAL REPORTS CITED, LISTED BY DATE OF PUBLICATION, 1971 SAMPLE

YEAR	NUMBER	YEAR	NUMBER
1971	2	1951	0
1970	28	1950	0
1969	34	1949	0
1968	35	1948	0
1967	18	1947	0
1966	19	1946	0
1965	11	1945	0
1964	11	1944	0
1963	8	1943	2
1962	4	1942	0
1961	5	1941	0
1960	1	1940	0
1959	0	1939	0
1958	1	1938	0
1957	1	1937	0
1956	0	1936	0
1955	1	1935	0
1954	1	1934	0
1953	3	1933	0
1952	2		

TOTAL NUMBER OF REPORTS IN SAMPLE: 187

EXHIBIT 6

NATIONAL ENGINEERING SAMPLE

CITATION COUNT DATA SUMMARY, NUMBER OF TECHNICAL REPORTS CITED, LISTED BY DATE OF PUBLICATION,

1961 SAMPLE

YEAR	NUMBER	YEAR	SAMPLE
1961	0	1946	1
1960	8	1945	0
1959	15	1944	1
1958	21	1943	0
1957	9	1942	0
1956	13	1941	0
1955	6	1940	0
1954	5	1939	0
1953	3	1938	0
1952	2	1937	0
1951	3	1936	0
1950	1	1935	0
1949	1	1934	0
1948	1	1933	0
1947	0		

TOTAL NUMBER OF REPORTS IN SAMPLE: 90

APPENDIX IV: Tables Comparing the Data for the Two Citation Counts for Both 1971 and 1961

SUMMARY TOTALS OF NUMBERS OF TITLES SAMPLES, NUMBERS OF ARTICLES IN VOLUMES, NUMBERS OF ARTICLES IN SAMPLES, NUMBERS OF SAMPLED ARTICLES WHICH CITED REFERENCES, AND TOTAL NUMBERS OF REFERENCES CITED

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Number of Journal Titles in Sample	23	22	11	15
Number of Articles in Volumes	3,412	3,205	996	1,571
Number of Articles in Sample	665	1,106	284	419
Number of Sample Articles Citing References	486	1,033	220	371
Total Number of References Cited: N =	5,773	16,167	2,268	4,580

TABLE 1.

SUMMARY TOTALS OF REFERENCES CITED, TOTALS OF REFERENCES TO JOURNAL ARTICLES, TOTALS OF REFERENCES TO OTHER MATERIALS, AND TOTALS OF REFERENCES TO TECHNICAL REPORTS

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Total Number of References Cited	5,773	16,167	2,668	4,580
Total of References to Journal Articles	3,807	10,050	1,868	3,139
Total of References to Other Materials	1,996	6,117	800	1,441
Total of References to Technical Reports	187	1,527	90	222

TABLE 2.

TOTAL NUMBER OF ARTICLES CITING REFERENCES, PERCENTAGE OF ARTICLES CITING REFERENCES, NUMBER OF ARTICLES CITING TECHNICAL REPORT REFERENCES, AND PERCENT OF ARTICLES CITING TECHNICAL REPORTS THAT CITE REFERENCES

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Number of Articles Citing References	486	1,033	220	371
Percent of Articles Citing References	73%	93%	77%	89%
Number of Articles Citing Technical Reports	101	423	39	106
Among the Articles Citing References Percentage Citing Technical Reports	21%	41%	18%	29%

TABLE 3.

TECHNICAL REPORTS SHOWING TOTAL, NUMBER, AND PERCENTAGES CITED IN REFERENCES CITED FROM BOTH LISTS AND BOTH YEARS OF TITLES SAMPLES

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Total Number of References Cited N =	5,773	16,167	2,668	4,580
Technical Reports Cited: Number	187	1,527	90	222
Percent of All References:	3%	9%	3%	5%
Percent of References Other Than Journal Article References:	10%	25%	11%	15%

TABLE 4.

FROM ARTICLES CITING TECHNICAL REPORTS, TOTALS OF REFERENCES CITED, TOTALS OF REFERENCES TO JOURNAL ARTICLES, TOTALS OF REFERENCES TO OTHER MATERIALS, AND TOTALS OF REFERENCES TO TECHNICAL REPORTS

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Total Number of References Cited	1,991	8,259	1,044	1,912
Total of References to Journal Articles	1,139	4,422	795	1,218
Total of References to Other Materials	852	3,837	249	694
Total of References to Technical Reports	187	1,527	90	222

TABLE 5.

FROM ARTICLES CITING TECHNICAL REPORTS,
NUMBER AND PERCENT OF TECHNICAL REPORTS CITED

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Total Number of References Cited by Authors Citing Technical Reports	1,991	8,259	1,044	1,912
Number of References to Technical Reports	187	1,527	90	222
Technical Reports Cited:				
Percent of All References	9%	18%	9%	12%
Percent of Non-Journal Article References	22%	40%	36%	32%

TABLE 6.

COMPARISON OF THE PERCENTAGES FROM
THE TOTAL SAMPLE AND THE SUB-SAMPLE

	1971 Volumes		1961 Volumes	
	National Engineering Sample	Faculty Engineering Sample	National Engineering Sample	Faculty Engineering Sample
Percentage of Technical Reports of All References	3%	9%	3%	5%
Percentage of Technical Reports of Non-Journal References	10%	25%	11%	15%
Percentage of Articles Citing Technical Reports	21%	41%	18%	29%
Percentage of Technical Reports of All References in Articles Citing Technical Reports	9%	18%	9%	12%
Percentage of Non-Journal References in Articles Citing Technical Reports	22%	40%	36%	32%

TABLE 7.