THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION: A CITATION STUDY TO DETERMINE THE CORE LITERATURE

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ABSTRACT

THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION: A CITATION STUDY TO DETERMINE THE CORE LITERATURE

Michael Afolabi

Several papers and journals may be useful to students of bibliographical classification, but library science libraries, for economic reasons cannot acquire all the published papers and journals in the subject. They could, however, acquire the papers and journals that are most likely to be useful.

The purpose of this study is to determine and identify the following in the literature of bibliographical classification published between 1960 and 1980: (a) the core journals cited; (b) the core papers cited; (c) the core authors cited; and (d) the characteristics of the cited literature by bibliographic format, language, subject, and age.

The methodology employed was the documentary approach. Data were gathered using the technique of citation analysis. A total of 4,631 citations were gathered. The statistical techniques applied to the citation data were Price Index and Bradford's distribution.

The findings revealed that (a) monographs were the most cited form of publication (57.2 percent), followed by journals (31.1 percent); (b) English was the most cited language (89.8 percent); (c) psychology and computer technology and its application were the frequently cited subjects; (d) the

analysis of the citations by age using Price Index indicated that the literature was a 'research front' subject; (e) the six core journals were: Journal of Documentation/ Library Resources and Technical Services/ American Society for Information Science Journal/ Library Association Record/ Aslib Proceedings/ and Library Science with Slant to Documentation; (f) the two core papers were: Prolegomena to Library Classification/ 3rd ed. 1967, by S. R. Ranganathan, and Classification and Indexing in Science/ 2nd ed. 1958, B. C. Vickery; (g) the only core author was S. R. Ranganathan; the highly cited authors were found to be socially linked to the two most active national classification research groups: the Documentation Research Group (India), and the British Classification Research Group; (h) the application of Bradford's distribution to the data of this study showed that the data on the cited journal titles and authors conformed to the law, while there was less conformity in the data on the cited papers.

It was determined in this study that there exist a strong number of core journals but a weak core literature in bibliographical classification. The lack of a strong core literature suggests that the knowledge base in the field is spread over many titles.

CHAPTER ONE

INTRODUCTION

Sayers defined classification as "the intellectual process by which our mental concepts or pictures of things are recognized to have likeness or unity and by this likeness or unity are set in relation to one another. This is the logical and real meaning."[1] The focus of this study is not classification in general, however, but rather "bibliographical classification" which is generally understood as the arrangement by subject of books and other materials on library shelves or in catalogs in an order that will be most useful to readers looking for information. Bibliographical classification is thus a tool for achieving an important objective, that is, providing a helpful order of books and documents to information seekers and library patrons. It occupies an important position in the organization of information.

Like many other areas in library and information science, the literary output regarding bibliographical classification has been on a steady increase. Previous research efforts have provided us with information on such aspects of bibliographical classification as its history, as in the works by Comaromi on the history of the Dewey Decimal Classification,[2] LaMontagne's history of American library classification,[3]

and Metcalfe's work on the history of information retrieval in Britain and America from 1876 to 1976;[4] its notable personalities as in the works by Campbell on Bliss,[5] Vann's edited work on Melvil Dewey's enduring presence in librarianship,[6] Miksa's edited work on Charles Cutter, the library systematizer,[7] and Matthews' study of the influence of Ranganathan on faceted classification;[8] individual classification schemes shown in studies by Hoage on the Library of Congress classification,[9] and Shepherd's study on the possible use of the Colon classification in automated text retrieval;[10] and its theory as in Buchanan's theory of classification,[11] and Maltby's edition of Sayers' Manual of Classification.[12]

Explaining the diverse possible approaches to a subject field, Saracevic and Perk observed that:

> There are numerous ways by which a subject field can be analyzed: the history of the subject; the problems towards which it is or was oriented; the content of accumulated knowledge; its arts, practices and methodologies; the social and cultural context, the environment; the philosophy, the ethics; the people in the subject; the education; the communication means, channels, media, patterns and processes, etc.[13]

Literature is the primary means of communication in a subject, and therefore its analysis has the significance of contributing to our understanding of an insight into the subject.

One area of bibliographical classification still unexplored is the analysis of the characteristics of the literature cited in its published sources. The cited literature of a subject is a mirror of the communication

patterns in that field. Many citation studies have been conducted in different subjects with the purpose of determining if analyses of their citations will reveal anything useful about the importance of individual journals, authors, papers, or the "hardness" or "softness" of a subject field. The findings of some studies generally have implications for libraries' acquisition procedures, for instance, recommending a few core journals established from a citation study for acquisition. The results of other studies are, however, communication-oriented, revealing such patterns as the citation behavior of writings in different languages, of a group of researchers working in a special area of a subject, or of writings by authors in different geographical regions. Citation studies therefore attempt, in most cases, to determine the patterns that exist in subject literature.

Statement of the Problem

Many research libraries in the past have attempted to collect most published material, regardless of its usefulness to the user. The increase in publication output, the cost of published materials, and the economic realities of modern times have made it increasingly difficult for libraries to continue such efforts. It is even more difficult for smaller libraries and for libraries operating on low budgets.

Most libraries have thus abandoned the idea of acquiring every publication and have instead begun dealing with the problem of identifying the most useful literature for

acquisition. From the library patron's point of view, a large number of works published are useful, but the increase in the number of these publications, their rising cost, and limited library budgets in recent years have made it necessary for libraries to identify and acquire only the most useful publications, thus providing maximum service with the minimum amount of resources available.

Determining which publications would be most useful to users has thus been a problem of growing concern to librarians. As far back as 1934, Bradford, a British librarian, while studying the number of articles published on applied physics and lubrication by journals, observed that a small number of journals were more useful than a large number of others, in terms of the articles they published.[14] This subsequently led him to formulate his theory which is often referred to as Bradford's law. It is based on the idea that a small number of journals will publish more useful articles on a subject than the larger number of journals. Fairthorne described Bradford's law as "the root of techniques for solving a particular problem."[15] Donohue saw Bradford's method as promising to be a "useful tool in increasing the effectiveness of library acquisition procedures."[16] Brookes commented upon the theory as follows:

> It seems to offer the only means discernible at present of reducing the present quantitative untidiness of scientific documentation, information systems, and library services to a more orderly state of affairs capable of being rationally and economically planned and organized.[17]

Although the law was based on the productivity of journals, its usefulness has been found to apply to citation analysis--a technique of measuring literature usage through citations. A number of studies that have employed this technique are reviewed in the next chapter.

By applying the theory to citations, a core literature can be determined. The availability of a list of core publications on a specific subject not only points out to librarians the most useful and important publications in that subject, but also saves libraries the expense of having to acquire publications that are less useful. While discussing the need for libraries to determine the most useful publications for acquisition, Kent observed that "the problem is exacerbated by the increasing quantity of materials available for acquisition which makes the selection process even more difficult."[18] This, according to him, leads the librarian to (1) increase continuously the quantity of material that is acquired, (2) have the materials in close proximity, and (3) have complete "runs" of materials, especially journals.[19]

Writers of subject literatures cite a variety of publications in different formats, languages, and subjects. They cite articles published in a variety of journals that belong to many subject fields. They also cite publications published in different years; while some of these publications may be recent in terms of the date in which they were published, others may be old publications. Most library patrons, however, expect libraries to meet their information needs by

acquiring works that are likely to be useful to them. This information need would require the acquisition of a large number of works in patrons subject fields. In practical terms, this may not be possible for many libraries because of limited budgets. They would rather prefer to acquire the segment of literature and journals most likely to be useful, and rely on inter-library loans for other publications that are less sought. Suggesting a solution to the problem of selecting library materials, Donohue observed:

> A trivial solution to the selection problem would be to obtain all of the periodicals published, or alternately, to obtain all of those in a given subject area defined. The first of these solutions is an impossibility and the second an absurdity in economic terms. It is apparent that there exists a point at which it is preferable to obtain a copy of an article upon demand, rather than to subscribe to the publishing journal on a permanent basis. Present trends in the direction of interlibrary cooperation, as well as improvements in the techniques for making and transmitting copies, make this point very clear.[20]

Bradford's distribution makes it possible for the identification of the most useful literature and journals through its nucleus zone, which is the zone having the highest concentration of citations. In quantitative terms, the distribution divides the cited publications into zones which range from the zone with the highest concentration of citations to the zone with the lowest citations. Thus, for a library school library to which this study is addressed, an effective acquisition policy should be based on the identification and acquisition of the literature and journals

most likely to be useful.

On the average, there were 54 papers estimated to have been published on bibliographical classification for each of the eleven years covered by this study. The estimated figures, based on the papers indexed by Library Literature are provided as follows: 1960 (52 papers), 1962 (53 papers), 1964 (40 papers), 1966 (31 papers), 1968 (52 papers), 1970 (60 papers), 1972 (70 papers), 1974 (63 papers), 1976 (69 papers), 1978 (77 papers), and 1980 (29 papers). There were also ninety-three journals that published articles on the subject of bibliographical classification. It is the contention of this study that all of these publications, as well as those published in the years not covered in this study, are potentially useful to library users, but because of limited budgets, space, increasing number and cost of publications, libraries, particularly library school libraries, may not be in a position to acquire them all. Library school libraries can only acquire those publications that are of the greatest potential use.

The question then for librarians faced with this problem is: What is the segment of this literature and journals that will most likely be useful? It is this segment of most useful literature and journals (termed "core literature" and "core journals" respectively) that this study is attempting to identify for libraries, particularly library school libraries, that are acquiring publications on bibliographical classification. The research question for this

study, therefore, is: Are there core literature and core journals in the literature of bibliographical classification that would be more useful in library school libraries than would the rest of the literature?

Determining such a list of core literature and core journals in bibliographical classification, it is suggested here, would fill the present vacuum which results from the lack of such knowledge; it would be based moreover on an objective method of citation analysis instead of relying on subjective judgment as has been done in the past.

Statement of Purpose

The primary purpose of the study is to analyze the citations gathered in order to determine and identify the core literature as represented by the most cited journals in the literature of bibliographical classification. The papers that will be identified as "core" will be the ones with the highest concentration of citations. These papers, within the context of this study, are the more significant and more useful from the library patron's point of view than other papers with lower citations. By identifying these core papers, this study is drawing the attention of librarians of library school libraries to them, for the purpose of their being acquired, if they have not yet been acquired. After identifying these papers, the study will examine their subject contents to determine whether they deal with topics on traditional enumerative classification or on modern

classification based on facet analysis.[21]

The journals determined as 'core' will be the ones having the highest concentration of citations. They are considered by this study to be the more significant and more useful than other journals with lower citations. It is the contention of this study that the core journals are the ones that must be given top priority in the acquisition of journals on bibliographical classification.

The second purpose of this study is to analyze the citations by authorship to determine and identify the core authors cited in the literature of bibliographical classification. The existence of core authors in bibliographical classification would suggest that there exist a group of authors who could be regarded as "leaders" in the field in terms of their significant contributions to the field through the generation of original ideas which may impact the field. Information about leaders in a subject field is therefore improtant from the theoretical point of view. Information about core authors in a field could also be valuable to the librarian acquiring publications in that field. He could use his judgment to include some of the published writings of the core authors in his collection.

The third purpose of this study is to examine the patterns of citations according to the following characteristics: format, language, subject, and age. The findings on these characteristics are meant to provide a better understanding of literature use in the field. It is the contention of

this study that in addressing the problem of core literature and core journals in bibliographical classification, it would be useful to include other features of the literature of the field. These other features or characteristics are discussed in terms of their usefulness to the librarian acquiring publications on the subject.

The purpose of the distribution of citations by format of publications is to determine the various formats in which the publications cited in bibliographical classification were published. The finding arising from this analysis will provide the essential information on the more frequently cited publication format for the purpose of drawing the attention of librarians to them so that they can be emphasized in the acquisition of publications on the subject. For instance, if monographs were found to be the more frequently cited publication format, the implication will be that, the acquisiton of monographs in bibliographical classification should be strongly emphasized.

The purpose of the distribution of citations by language is to determine the more frequently cited languages in bibliographic classification and draw attention to them. For instance, if English was the dominant language cited, the implication for acquisition is that the acquisition of English language publications should be emphasized in the process of acquiring publications on bibliographical classification. Information about the more frequently cited languages in bibliographical classification would be useful in the

acquisition process.

The purpose of the distribution of citation by subject is to determine the extent to which the literature of subjects other than library and information science have been cited in the literature of bibliographical classification. It will then identify the non-library science subjects cited; from these, it will identify the more frequently cited subjects and discuss how they are related to the field of bibliographical classification. The acquisition implication of this characteristic is that there is need for the acquisition of publications on other subjects that are frequently cited in the literature of bibliographical classification.

The purpose of the distribution of citations by age is to determine whether the literature cited in a particular year is largely made up of current or retrospective publications.

If the citations for a particular year revealed that current publications were more frequently cited than retrospective ones, the indication, using Price Index, which is to be described later, is that the literature for that year was a research front subject. In other words, much research activities took place that year. If on the other hand, the citations made in a particular year revealed that retrospective publications were more frequently cited than current ones, the indication, again according to Price Index is that, the literature was 'archival.' If, however, there were more years belonging to the former category, it would

be inferred that much research activities took place in bibliographical classification during the period studied.

Assumptions

The following two assumptions are made in this study:

(1) citation is an indicator of literature use;

(2) the number of works that cite a given paper is an indicator of the significance of the work cited.

Scope

The investigation is an attempt to determine a core literature in bibliographical classification by analyzing the cited literature of the subject from 1960 to 1980 at two year intervals. The rationale for the selection of this particular period is provided in Chapter 3 under "Sample." It covers the languages of the publications that are indexed in Library Literature during that period. It also covers monographs, journals, and dissertations published during the same period.

Definition of Terms

The following terms are defined within the context of this study:

1. Age of a citation refers to the year in which a cited paper was published.
2. Author refers to the writer(s) of a cited paper.
3. Bibliographical Classification is used in the sense that it serves as a heading in Library Literature, Library Science Abstracts, and Library and Information

Science Abstracts, where it embraces works about the organization of knowledge that employs schemes of document classification based on notational symbols. Although masters theses are embraced by this definition, they were excluded from the study because they were mostly not available. Eight of them were published during the years covered by this study. It was, however, felt that their non-inclusion would not seriously affect the results of the study; also excluded were the following which were considered to be not specifically on bibliographical classification: "thesaurus," "indexing," "subject headings," and "automatic classification." They are meant for producing alphabetical subject indexes whereas bibliographical classification is designed to arrange publications on library shelves. Some of the papers indexed under these "see also" headings, however, no doubt contain sections that were relevant to bibliographical classification. Indeed it is because of their relatedness in subject content that the device of "see also" was employed. By eliminating the "see also" references from this study, some useful materials related to bibliographical classification may have been excluded. Although the inclusion of some of these items might in some ways have strengthened the study, it was felt that the subject field under consideration

would have sprawled beyond the specific domain and into the broader field of indexing. Since this study is a citation study specifically of the literature of bibliographical classification and not of indexing, it was decided that the entries under the "see also" references would be eliminated.

4. Citation in this study is an item referred to in the body of a written text, as a footnote or at the end of a paper. Citation frequency for journals, authors, and papers represents the number of papers that cited them.

5. Core publications: There is no standard definition in the literature for the terms "core literature," "core journals," and "core authors" which are used in this study. They are, however, defined in the sense in which they were used in the bibliometric works cited after each of the following definitions:

   a. Core literature refers to the cited papers identified in the nucleus zone of Bradford's distribution.[22]

   b. Core journals refer to the cited journals identified in the nucleus zone of Bradford's distribution.[23-26]

   c. Core authors refer to the cited authors identified in the nucleus zone of Bradford's distribution.[27]

6. Item (citing) is a published writing on bibliogra-

phical classification. This could be a journal article, a dissertation, or a monograph. Where separate contributions have been made in a monograph, each contribution was taken as a unit or item. Each edition of a publication was treated as an item.

7. Language refers to the language in which a cited paper was written.
8. Paper refers to a journal article, monograph, technical report, conference publication, thesis, or dissertation cited.
9. Significance is used in this study to indicate the zones in Bradford distribution. Zone 1 is defined as most significant. Zone 2 is less significant than Zone 1, Zone 3 being less significant than Zone 2, and so on. The term significance is used interchangeably with importance.
10. Format as used herein refers to the physical appearance of a cited item. It might be a journal article, monograph, dissertation, conference proceeding, technical report, etc.

Organization of the Study

This study is organized into the following six chapters: Chapter One introduces the study by stating its problem, purpose, assumptions, scope, and the definition of terms used.

Chapter Two reviews some previous studies on citation analysis. Chapter Three describes the procedures of collecting and analyzing the data for the study and the statistical technique employed to determine a core literature, core journals and core authors. Chapter Four tests for the existence of a core literature, core journals and core authors using the Bradford's distribution. Chapter Five describes the characteristics of the cited literature by bibliographic format, subject, age, and language of publication. Chapter Six summarizes the findings, discusses its limitations, concludes the study, states its significance, interprets the findings, and suggests areas for further studies.

Notes for Chapter One

[1]W. C. B. Sayers, Quoted by J. Farradane, "Fundamental Fallacies and New Needs in Classification," in The Sayers Memorial Volume, edited by D. J. Foskett and B. I. Palmer (London, The Library Association, 1961), p. 120.

[2]J. P. Comaromi, Eighteen Editions of the Dewey Decimal Classification (Albany, Forest Press, 1976), 678p. (rev. version of Ph.D. thesis, University of Michigan)

[3]L. E. LaMontagne, American Library Classification, with Special Reference to the Library of Congress (Hamden, Conn., Shoe String Press, 1961), 433p.

[4]J. W. Metcalfe, Information Retrieval, British & American, 1876-1976 (Metuchen, N. J., Scarecrow, 1976), 243p.

[5]D. J. Campbell, "Short Biography of Henry Evelyn Bliss (1870-1955)," Journal of Documentation 32 (1976): 134.

[6]S. K. Vann, ed., Melvil Dewey, His Enduring Presence in Librarianship (Littleton, Colo., Libraries Unlimited, (1978), 278p.

[7]F. L. Miksa, Charles Ammi Cutter, Library Systematizer (Littleton, Colo., Libraries Unlimited, 1977), 344p.

[8]G. O. Matthews, "Influence of Ranganathan on Faceted Classification" (Ph.D. thesis, Case Western Reserve University, 1980), 197p.

[9]A. A. L. Hoage, "The Library of Congress Classification in the United States: A Survey of Opinions and Practices, with Attention to Problems of Structure and Application" (D.L.S. thesis, Columbia University, 1961) 245p.

[10]M. A. Shepherd, "Colon Classification As a Basis for Automated Full Text Retrieval" (Ph.D. thesis, University of Western Ontario, 1978), 281p.

[11]B. Buchanan, Theory of Library Classification (London, Bingley, 1979)

[12]A. Maltby, Sayers' Manual of Classification for Librarians, 5th ed. (London, Deutsch, 1975)

[13]T. Saracevic and L. J. Perk, "Ascertaining Activities in a Subject Area through Bibliometrics Analysis," American Society for Information Science Journal 24 (1973): 120.

[14]Samuel Clement Bradford, "Sources of Information on Specific Subjects," Engineering 137 (1934): 85.

[15]Robert A. Fairthorne, Preface to Understanding Scientific Literatures, by Joseph C. Donohue (Cambridge, Mass.: The M.I.T. Press, 1973), p. xi.

[16]Joseph C. Donohue, Understanding Scientific Literatures: A Bibliometric Approach (Cambridge, Mass.: The M.I.T. Press, 1973), p. 23.

[17]B. C. Brookes, "Bradford's Law and the Bibliography of Science," Nature 224 (1969): 953.

[18]Allen Kent et al., Use of Library Materials: The University of Pittsburgh Study (New York: Marcel Dekker, 1979), p. 2.

[19]Ibid., p. 3.

[20]Donohue, Understanding Scientific Literatures, p. 19.

[21]S. R. Ranganathan, "Library Classification Through a Century," in Classification Research: Proceedings of the Second International Study Conference held at Hotel Prins Hamlet, Elsinore, Denmark, 14th to 18th September, 1964, ed. Pauline Atherton (Copenhagen: Munksgaard, 1965), p. 18.

[22]William A. Brace, "A Citation Analysis of Doctoral Dissertations in Library and Information Science, 1961-1970" (Ph.D. dissertation, Case Western Reserve University, 1975), p. 85.

[23]Ibid.

[24]G. S. Cline, "Application of Bradford's Law to Citation Data," College & Research Libraries 42 (1981): 53.

[25]James C. Baughman, "A Structural Analysis of the Literature of Sociology," Library Quarterly 44 (1974): 293.

[26]Donohue, Understanding Scientific Literatures, p. 82.

[27]Brace, "A Citation Analysis of Doctoral Dissertations in Library and Information Science," p. 85.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Most documents rely to a large extent on previously published information sources. A scholarly paper is usually considered as one that links the paper with previous work done. Infact, one of the important criteria for publishing in scholarly journals is the provision of citations in articles for publication. The literature cited by writers contain patterns which are of interest to bibliometricians. By exploring the full ramifications of the patterns existing in the literature cited by writers, they are shedding light on the features of a subject and such information offers the librarian, the student, the teacher, and the sociologist of knowledge a type of statistic not yet considered, but which can complement the traditional approaches to the study of collection development and communication. Citation analysis can be applied to any subject area so long as large data can be gathered.

The literature on the use of citation analysis for examining the communication patterns and literature use is very extensive. It has been applied in previous studies to gain a better understanding of the literature cited in many subjects in the humanities, natural and social sciences. It has also been applied to determine and identify a body of

writings that will be most useful from the library patron's view because of the high citations they received. This chapter will review some important writings on the following characteristics: bibliographic format, language, age, subject of citations and the core authors, papers and journals cited.

Age of Citations

The age of publications cited is one common characteristic often measured by citation analysts. For instance, it is generally believed that scientists make less use of older literature, whereas the reverse is the case for the humanities. These observations came from citation studies. Line and Sandison's study, however, showed that the present interpretation of citation studies must be modified with particular regard to the age of literature. In their paper, they attacked the concept of "half-life" and pointed out that such a measurement over-simplifies literature use. The concept of exponential decay or decrease in literature use is also attacked by them with the argument that the process is not smooth and that important papers continue to be cited. Supporting their case, they traced the latter references made to articles in the first number of Physical Review for 1960.[1] Line found that those articles cited heavily during the years immediately after their publication were also cited more heavily during the following twelve years. On the other hand, those with few citations in the early years were also cited less frequently as time passed.[2] A measure that was proposed

by Price enables one to demarcate the current literature from the retrospective literature. The measure is based on the proportion between the citations to the last five years and the total citations made in a given year. If a proportion of 42 percent or more is obtained, this is an indication that a substantial amount of current papers may have been used. Percentage figures lower than 42 percent suggest that a large amount of older publications were used.[3]

Language of Citations

Cited publications are also often analyzed by language. Citation studies in the western world have indicated that English-language writers refer mostly to materials in that language.

Batts, working on modern-language studies, concluded that languages other than those of the author and his topic are virtually ignored.[4] Louttit discovered that in psychology, references made to writers in English-language journals were 92.5 percent to English-language works; in German journals, 91.1 percent to German, in French journals, 64.6 percent to French. Citation studies in the English language indicate that about 90 percent of citations are to English-language materials and 10 percent to foreign languages.[5] Laosunthara's study on geology also indicated that less use is made of foreign-language materials.[6] Forster reported that only 7.4 percent of the total references in library science periodicals were to items published outside the United States and that those were mostly English.[7] A study

by Salton on information science literature revealed that of the top thirty-nine authors cited, thirty-five were Americans and four were British.[8] One unusual exception is the study by Simonton who discovered that in two English-language source journals in the fine arts, more than half of the references were to materials in foreign languages.[9]

The problem of less use of or non-usage of foreign-language materials could stem from ignorance of the language concerned. One seldom cites publications in languages that one cannot read. The communication gap can be bridged only if one knows other languages or has relevant papers translated.

Formats of Citations

Penner reported that serial and non-serial items in library and information science are cited almost equally, with the non-serial category including 93 percent monographs and 7 percent reports.[10] Brace, La Borie, and Halperin studied dissertations to reveal the literature characteristics in the subjects they studied. Brace found an almost equal distribution between book and journal literature (monographs 38.9 percent, and journals 33.0 percent)[11] while La Borie and Halperin reported that 43 percent of all citations were to books, 23 percent were to journals, and a very large percentage (21 percent) were to unpublished materials (which was largely due to historical dissertations).[12] Fenichel, in an earlier investigation on information science literature, (based on Annual Review of Information Science Technology)

showed that journals and reports were the most important sources in that field.[13] Stewart's study of the literature of political science revealed that 66 percent of citations were to monographs while 23 percent were to journals.[14] In some physical science subjects, however, there are more citations to journals than monographs. Fussler, for instance, obtained 92.7 percent for journals and 5.2 percent for monographs in chemistry and 91.8 percent for journals and 7.7 percent for monographs in a citation study of physics literature.[15]

Subject of Citations

Pope reported the proximity of the two fields of library science and information science in that they had two core journals in common: Library Journal and Special Libraries. Nine other journals overlapped the two fields. He concluded that although information science is a broader field in terms of subject breadth than library science, it is narrower than science.[16] Saracevic and Perk found education to be the largest single "other area" contributing to the literature of librarianship. The next closely related subject area was administration-- the management of people, resources and systems.[17] Cline and Barnard reported that the subjects closely related to library science were: history, sociology, education, literature, and technology.[18-19]

Core Literature

Most of the citation studies in Library and information

science are aimed at identifying "core" literature, either core journals or classic papers central to the subject field. In 1950, Hart undertook the first citation analysis in library science. He studied the periodicals of professional librarianship and identified the twenty most cited library science periodicals, with Library Journal ranking first. His sources of reference were the 1945-1949 volumes of six library science periodicals.[20] Reviewing Hart's study five years later, Harvey observed that "Hart's study confirmed the fact that a few periodicals carry the bulk of the profession's important articles."[21] Two years after Harvey's article was published, further data on citation characteristics of library periodical literature were provided by Barnard, who based his reference analysis on seven professional periodicals and produced a list of the ten most cited periodicals, with Library Journal again leading.[22] Nine years later, Gilchrist sought to identify key documentation journals by analyzing the periodical titles most frequently cited in articles in nine prominent source journals from 1960 to 1964; he produced a list of the ten most frequently cited periodicals in the 1960-1964 articles that accounted for 52.3 percent of all citations.[23]

Two years later, Little, using a blend of citation and content analysis on use and users of library literature, produced a list of the twenty most cited journals.[24] In the same year, Forster studied the development of library school periodical resources for graduate programs specifically in the area of foreign and international journals. Counting

references in non-United States library journals in the 1963-1965 issues of five American journals, he found that 7.4 percent of total references were to library science periodicals published outside the United States, 51.0 percent of these being in English; he also identified the twenty most cited journals of which the Unesco Bulletin for Libraries was highest followed by Zentralblatt fur Bibliothekswesen.[25]

Of concern to Sumner were the citation patterns in the broad field of library science on an international basis. Analyzing references in the 1950-1961 issues of Libri (excluding the 1954 issues) in terms of their form, title dispersion, language distribution, time span, and subject dispersion, she provided a list of the eighteen most cited journals accounting for 50.4 percent of the total citations. Zentralblatt fur Bibliothekswesen was first, Libri was second, and Library Journal was third.[26]

While Sumner was interested in the broad field of library science, Lehnus was more interested in the sub-fields of the subject. In 1971, he studied education for librarianship. By analyzing citations in the 1960 to 1970 issues of Journal of Education for Librarianship (JEL), he found that the ten library science periodicals most frequently cited in JEL represented 79.8 percent of the 210 citations, whilst the other 20.2 percent were distributed among twenty-six periodicals.[27] In a doctoral dissertation in 1973, he analyzed references to subject cataloging and identified the significant authors and writings. He identified 184 frequently

cited works in cataloging, 82 (44 percent) works of which were monographs, 73 (40 percent) were periodical articles, and 29 (16 percent) were other contributions.[28]

Dansey, in the same year, undertook a citation analysis of some English-language information science journals and found that a few journals provided most of the citations. These were: Journal of the American Society for Information Science (106 citations), Journal of Documentation (59 citations), Aslib Proceedings (34 citations), and Information Storage and Retrieval (23 citations).[29]

Two years later, Brace, using 202 dissertations written between 1961 and 1970 in American library schools, analyzed 20,298 citations and reported the absence of a core literature, although he noted the existence of a weak core of significant authors in the literature of library and information science.[30]

Other writers who have identified core journals in the subjects they studied are Lawani on the literature of agriculture,[31] Saracevic and Perk on the literature of library and information science,[32] and Brookes on science.[33] Perhaps, the writer who has most extensively studied the phenomenon of "high-concentration" of citations is Garfield, who has published many papers on the most cited papers, authors, and journals in different subject fields, most notably in the natural sciences.[34]

Most studies that utilized the Bradford's distribution to determine a core literature, authors, and journals have

based their findings on one of two formulations--the so-called "verbal" and "graphical" formulations, but the latter has been the most commonly applied using a mathematical method of formulation developed by Brookes.[35] Leimkuhler, who developed a model based on Bradford's verbal formulation and who tested his model against empirical data, found close agreement between the observed and the theoretical distributions.[36] Baughman also applied the verbal formulation of Bradford's law to the cited journals in sociology and reported that the data used conformed to the law.[37] However, few studies have applied the verbal formulation of Bradford's law to corroborate the formulation. This could possibly be due to what Wilkinson described as "the difficulty in this case of establishing the nucleus and hence the starting point of the geometric progression."[38] Her study introduced two formulae which enable the two Bradford's formulations to be tested to determine which conforms more to Bradford's law. Praunlich and Kroll proposed a new formulation based on Wilkinson's formulations and claimed that theirs was an improvement over Wilkinson's in terms of accuracy of prediction.[39] Cline applied Wilkinson's formulae to citation data in library science and reported the appropriateness of applying Bradford's law as a test of the data she used.[40]

In recent years, significant advances have been made in the area of model formulations, all in an attempt to build on the Bradford's distribution and law. Some recent models by Bookstein, Pratt, and Price[41,42,43] have contributed to

our understanding of the Bradford's distribution. Of these models, the one that attracted the attention of some bibliometricians is that of Price, which is still at the experimental stage. Price proposed a general bibliometric theory based on a hyperbolic curve, which he called the Cumulative Advantage Distribution. The theory unifies the diverse phenomena as article scatter, wealth distribution, scientific authorship, and an article's citation accumulation. Price described his theory as having a single-edged Matthew effect, that is, success is rewarded but failure has no consequences.[44]

Despite the models proposed in recent years, most studies continue to apply Bradford's distribution either in the verbal form as it was originally stated or use the graphical formulation based on the study by Brookes and Groos, improved on the earlier graphical formulation of Bradford.[45,46]

From the foregoing review, two important conclusions can be drawn. First, there is no doubt that citation analysis has been shown to be a useful objective alternative technique of analyzing the use of publications. Secondly, the number of studies focusing on the problem of most cited literature and journals is increasing. This may be attributed to the growing concern of librarians for the selection problem. With the proliferation of publications in most subject fields, such studies become necessary since many libraries may not be able to acquire all that is published in a subject field. The technique of citation analysis, however, has thus far not been

applied to the literature of bibliographical classification to identify a core literature and core journals, if they do indeed exist.

Notes for Chapter Two

[1]Maurice B. Line and A. Sandison, "Obsolescence and Changes in the Use of Literature with Time," Journal of Documentation 30 (1974): 306.

[2]Maurice B. Line, "The Half-Life of Periodical Literature," Journal of Documentation 26 (1970): 266.

[3]Derek J. de Solla Price, "Citation Measures of Hard Science, Soft Science, Technology, and Non Science," Communication among Scientists and Engineers, in ed. Carnot E. Nelson and Donald Pollock, (Lexington, Mass.: Heath, 1970), p. 15.

[4]M. S. Batts, "Citations in the Humanities: A Study of Citation Patterns in Literary Criticism in English, French, and German," Institute of Professional Librarians Quarterly 14 (1972): 20.

[5]C. M. Louttit, "The Use of Foreign Languages by Psychologists, Chemists, and Physicists," American Journal of Psychology 70 (1957): 314.

[6]M. E. Lao Sunthara, "Some Bibliographical Characteristics of Serial Literature in the Field of Geology " (Ph.D. Indiana University, 1956), p. 67.

[7]D. Forster, "Magazines in the Library School," Journal of Education for Librarianship 9 (1969): 145.

[8]Gerald Salton, "On the Development of Information Science," American Society for Information Science Journal 24 (1973): 219.

[9]W. C. Simonton, "Characteristics of the Research Literature of the Fine Arts During the period 1948-1957" (Ph.D. University of Illinois, 1960).

[10]R. Penner, "Measuring a Library's Capability," Journal of Education for Librarianship 13 (1972): 26.

[11]William A. Brace, "A Citation Analysis of Doctoral Dissertations in Library and Information Science, 1961-1970" (Ph.D. dissertation, Case Western Reserve University, 1975), p. 39.

[12]T. La Borie and M. Halperin, "Citation Patterns in Library Science Dissertations," Journal of Education for Librarianship 16 (1976): 278.

[13]Carol J. Fenichel, "Citation Patterns in Information Science" (Masters thesis, Drexel Institute of Technology, 1969).

[14]June L. Stewart, "The Literature of Politics: A Citation Analysis,"International Library Review 2 (1970); 331.

[15]Herman H. Fussler, "Characteristics of the Research Literature: Pt. II," Library Quarterly 19 (April 1949): 127.

[16]Andrew Pope, "Bradford's Law and the Periodical Literature of Information Science," Journal of the American Society for Information Science 26 (1975): 210.

[17]Saracevic and Perk, "Ascertaining Activities in a Subject Area through Bibliometric Analysis," p. 134.

[18]Gloria S. Cline, "College & Research Libraries: Its First Forty Years," College &Research Libraries 43 (1982): 224.

[19]Walter Monroe Barnard, "Characteristics of the Literature Used by American Authors of Journal Articles in Library Science" (Masters thesis, University of North Carolina, 1957), 62p.

[20]P. W. Hart, "Periodicals for Professional Librarianship" (Unpublished Masters thesis, Catholic University of America, Washington, D.C., 1950), 52p.

[21]J. F. Harvey, "Periodicals for Professional Librarianship: A Summary and Review Article," LPRT Newsletter 2 (1955): 28.

[22]Barnard, "Characteristics of the Literature Used by American Authors."

[23]Alan Gilchrist, "Documentation of Documentation: A Survey of Leading Abstract Services in Documentation and an Identification of Key Journals," Aslib Proceedings 18 (1966): 69.

[24]T. M. Little, Use and Users of Library Literature: Pre-print of a Paper Presented at the Conference on the Bibliographical Control of Library Science Literature (State University of New York at Albany, April 19-20, 1968), p. 30.

[25]Forster, "Magazines in the Library School," p. 146.

[26]F. B. Sumner, "Some Characteristics of the Literature Used by Authors of Articles in Libri: International Library Science Review, 1950-1961" (Masters thesis, Kent State University, Ohio, 1967), 51p.

[27]Donald J. Lehnus, "JEL, 1960-1970: An Analytical Study," Journal of Education for Librarianship 12 (1971): 77.

[28]Donald J. Lehnus, "Milestones in Cataloging, 1835-1969: An Attempt at an Objective Approach to the Growth of a Subject Literature" (Ph.D. Case Western Reserve University, 1973), p. 225.

[29]P. Dansey, "A Bibliometric Survey of Primary and Secondary Information Science Literature," Aslib Proceedings 25 (1973): 252.

[30]Brace, "A Citation Analysis of Doctoral Dissertations in Library and Information Science," p. 85.

[31]S. M. Lawani, "Bradford's Law and the Literature of Agriculture," International Library Review 5 (1973): 346.

[32]Saracevic and Perk, "Ascertaining Activities in a Subject Area through Bibliometric Analysis," p. 127.

[33]Brookes, "Bradford's Law and the Bibliography of Science," p. 954.

[34]Eugene Garfield, Essays of an Information Scientist, vols. 2-4 (Philadelphia: ISI Press, 1974-1981)

[35]B. C. Brookes, "The Derivation and Application of the Bradford-Zipf Distribution," Journal of Documentation 24 (1968): 247.

[36]F. F. Leimkuhler, "The Bradford Distribution," Journal of Documentation 23 (1967): 197.

[37]James C. Baughman, "A Structural Analysis of the Literature of Sociology," Library Quarterly 44 (1974): 299.

[38]Elizabeth A. Wilkinson, "The Ambiguity of Bradford's Law," Journal of Documentation 28 (1972): 126.

[39]P. Praunlich and M. Kroll, "Bradford's Distribution: A New Formulation," American Society for Information Science Journal 29 (1978): 55.

[40]G. S. Cline, "Application of Bradford's Law to Citation Data," College & Research Libraries 42 (1981): 57.

[41]A. Bookstein, "Explanations of the Bibliometric Laws," Collection Management 3 (1979): 151.

[42]A. D. Pratt, "A Measure of Class Concentration in Bibliometrics," American Society for Information Science Journal 27 (1977): 285.

[43]D. J. D. Price, "A General Theory of Bibliometrics and Other Cumulative Advantage Processes," American Society for Information Science Journal 27 (1976): 292.

[44]Ibid.

[45]Brookes, "The Derivation and Application of the Bradford-Zipf Distribution," p. 247.

[46]Ole V. Groos, "Bradford's Law and the Keenan-Atherton Data," American Documentation 8 (1967): 46.

CHAPTER THREE

METHODOLOGY

This chapter discusses the methodology that was employed in this study, the justification for the period chosen, the operational definition of the citation characteristics and procedures adopted, the statistical techniques ultimately selected and employed, and the rationale for employing them.

The method that offers the greatest promise of objectivity in this inquiry is citation analysis. This method involves the analyses of citations at the end of papers with the objective of identifying the characteristics of literature usage through those citations. Commenting on the need to cite fellow scientists who have made previous contributions, Merton observed:

> We know that he will be under pressure to make his contribution to knowledge known to other scientists and that they, in turn, will be under pressure to acknowledge his right to intellectual property.[1]

The number of times a work or an author is cited should be an indication of the influence of that work or author compared to others. These thoughts on the significance of a frequently cited work were expressed by Garfield when he observed:

> High citation counts reflect impact but may not reflect intrinsic worth. The data obtained from citation analysis are always

relative rather than absolute.[2]

Similar observations were made by Price who noted that:

> Clearly the citing of a paper does not necessarily imply it has been read and even more certainly not all papers read are cited, but there is some significance to such citation.[3]

One limitation of citation analysis is that not all papers cited are read and not all papers read are cited. An author might not have actually used the paper cited although the citation of that paper gives an impression that it was actually used. It is also possible that an author might have cited only a part of the papers read. This may be due to the unavailability of the relevant papers, forgetting to record the source from which information was obtained and failure to acknowledge writings of others when information in these writings had been used.

Another limitation of citation analysis is its restriction to documents examined, particularly to journals. This obviously does not provide a clear picture of the total communication system in the field. Although sampling is essential in research, the strength of citation analysis rests on the size of the sample. This therefore calls for the analysis of a large part of the literature if valid conclusions are to be made. Citation analysis does not involve the analysis of the subject content of the documents cited; therefore, it is necessary to gather large quantities of data before conclusions are made.

Despite these limitations, citation analysis is the one

bibliometric method that has been used extensively, particularly in the sciences, to study communication patterns and seek the most useful literatures. Some reasons adduced for the popularity of the method are: (1) citation analysis does not require the active cooperation and participation of the individual scholars: (2) citation analysis does not limit the investigator to subjects as they exist within limited geographical areas or institutional settings, since what is actually being analyzed are artifacts of research and development; and (3) citation analysis can be accomplished without the assistance of highly-trained subject specialists.[4]

Sample

With the publication in 1933 of the first edition of Colon Classification by S. R. Ranganathan, bibliographical classification entered a new period which was described by Ranganathan in a paper at the Elsinore Conference on Classification Research as the Faceted Period.[5] Through the early editions of the Colon Classification and the first and second editions of the Prolegomena to Library Classification, Ranganathan expounded his concept of facet analysis. The use of the Colon Classification, however, was largely confined to India, its country of origin. It was not adopted by libraries in the western world because they were already using traditional classification schemes like Dewey Decimal Classification and Library of Congress Classification and found it expensive and disruptive to change to a

new system. Furthermore, the Colon Classification was considered to be inclined towards oriental philosophy and culture.[6] This lack of enthusiasm for the Colon Classification in the western world perhaps accounted for the slow advance of facet analysis in classification.

In 1955, a memorandum was published by UNESCO on the need for a faceted classification as the basis of all methods of information retrieval.[7] The following observations were made by the Classification Research Group (England) in the memorandum:

> The Classification Research Group is convinced that many weaknesses of existing classification and other methods of information retrieval are due to an insufficiently searching consideration of principles on the part of their makers. Other weaknesses are due to the failure of an actual classification to conform with its stated principles.[8]

The Classification Research Group embarked on research into facet classification. It was, however, not until 1960 when Brian Vickery, an eminent British librarian and a member of the Group published the first textbook for the Classification Research Group on the construction and use of faceted classification schemes.[9]

The earliest faceted scheme to be published after Vickery's publication was the faceted classification for engineering brought out in 1961 by Binns and Bagley.[10] Other faceted classification schemes began to emerge in the early sixties.[11-16] Summarizing the progress made at the time, Mills reported that:

> ... it is hardly an exaggeration to say that the major problems of compiling special classifications had been mastered by the end of the 1960s, although numerous improvements in detail and in method of application are obviously possible.[17]

It is perhaps in recognition of the work of the Classification Research Group (England), and Vickery in particular, on facet classification that he was invited to deliver a paper on facet classification at the fifth of a series of seminars on Systems for the Intellectual Organization of Information conducted by the Rutgers University Graduate School of Library Service in 1965.[18]

Essentially, the basic difference between the older enumerative classification schedules and the new faceted schemes according to Mills is that:

> The former are inconsistent in their method of division, unconscious of the need for a preferred citation order in any one class, and inconsistent and unpredictable in their provision, positionally and notationally, for compound subjects (whether this is by enumeration or by synthesis). Faceted classification introduces consistency, conscious pattern and predictability.[19]

The choice of the year 1960 to begin the study is therefore important in that it is the culmination of the Classification Research Group's (England) years of work which led to the appearance of the publication that would guide librarians in the construction of special subject classification schemes based on facet analysis. Prior to this publication, research in bibliographical classification had largely been individual efforts, but this publication is significant in that it is the outcome of years of research

by the first research group to be founded in bibliographical classification. Librarians of special libraries who had become dissatisfied with the application of the traditional enumerative classification schemes, now have at their disposal a guidebook for constructing classification schemes suitable for organizing their library collections. They have at their disposal principles that could guide them in constructing detailed subject classification which the general enumerative classification schemes lacked. Referring to the significance of the publication, Salvan observed that "le guide pratique qu'il à récemment élaboré sont de nature à apporter une aide aux constructeurs de systèmes spéciaux." [that Vickery's practical guide has proved useful to constructors of special classification systems] [20]

Vickery's publication, together with papers published in the early sixties probably accounted for the creation of a sub-heading for facet classification beginning from the 1961-1963 issue of Library Literature. It is probably because of the significance of Vickery's publication that it was translated for use in Norwegian in 1962, French in 1963, German in 1969, and Italian in 1972. The publication is therefore a landmark in the history of bibliographical classification, and its publication likely influenced the faceted classification schemes published soon afterwards, thus marking an important sub-period in the fifty years of the Facet Period.

Two year intervals were established from 1960 to 1980

as the years from which citation data would be collected. It is the contention of this study that such a sample would be sufficient to achieve the objectives of the study. A wider year interval was not chosen because it might not yield sufficient citations on which to base the study.

The sample for this study comprised 4,631 citations obtained from the literature of bibliographical classification published at two-year intervals-- i.e., every other year-- between 1960 and 1980. The two-year intervals were decided upon because it was felt that over such a long period, any possible skewing resulting from use of only partial data would be ameliorated, while at the same time the body of data would be reduced to a manageable size.

Data Collection

The following steps were taken in collecting the relevant data:

1) From under the term "Classification" in Library Literature, Library Science Abstracts, and Library and Information Science Abstracts, the references listed were copied to 5 x 3 inch cards, with the exception of entries on the following see also references: "Thesaurus," "Subject headings," and "Indexing," entries on automatic classification were also excluded because, as pointed out in Chapter One, they are used in alphabetical subject indexing systems rather than for classifying publications and arranging them on the shelves. Some citations to documents treated classifi-

cation and indexing together. This was usually determined through the the title of the documents as given in the citation information. In the case of monographs, the chapters on bibliographical classification were determined through the chapter headings in the table of contents. A good example is Bakewell's Classification and Indexing Practice where the table of contents revealed some chapters on bibliographical classification and others on indexing. In the case of journal articles also, the titles provided by the citations were used to determine whether classification and indexing were treated together. Since journal articles do not have table of contents as in monographs, and since there was usually one sequential list of references to the two subjects in one article, it was therefore not possible to distinguish citations on bibliographical classification from those on indexing. Their citations were, however, included in the study.

2) The citations in the following publication formats were analyzed: journals, monographs and dissertations. Technical reports and conference proceedings were also analyzed for their citations, but because they were published in monographic form, they were classified as monographs. As pointed out in the opening definition of bibliographical classification, masters theses were excluded because of their unavailability.

3) The citations were recorded with one cited item on one card. An entry for each document was followed by the

citation entries. Citations to conference proceedings and technical reports that were not published as a monograph were classified under the headings, "Conference Proceedings" and "Technical Reports." Those that were published in monographic form were treated as monographs. The bibliographic information on the citing publication was copied onto the card containing the information on the cited item.

4) A total of 596 items were compiled on the subject of bibliographical classification from the sources mentioned in step 1 above for the following years in the two-decade period studied: 1960, 1962, 1964, 1966, 1968, 1970, 1972, 1974, 1976, 1978, and 1980. A breakdown of these items showed that 505 (84.7 percent) were journal articles, 85 (14.3 percent) were monographs, while 6 (1 percent) were doctoral dissertations. Of the 596 items listed, 334 items were analyzed for the study because they were found to contain citations. Of these, 268 items were journal articles, 60 were monographs, while 6 were dissertations (Appendix 4). Of the 596 items, 93 (15 percent) were not available for analysis, and 169 (28 percent) had no citations. A total of 4,631 citations were collected in the 334 items, and these constitute the data base for the study.

Data Analyses

The characteristics examined in this study and the procedures adopted are described as follows:

Author

The entire citations were arranged in one alphabetical sequence. The citations made to each author (including corporate authors) were counted and recorded. Where a cited work had more than one author, each named author received one recording. For instance, in a work by A. Neelameghan and M. A. Gopinath, each author was assigned one score. Works that lacked indication of authorship were not included in the analysis. The authors were then ranked by the citations they received ranging from the highest to the lowest in a frequency distribution table. The verbal and graphical formulations of Bradford's law were then applied to the authorship data to determine the core authors. The procedure in the application of the two formulations on the data is discussed later in this chapter.

Format

The bibliographical information for each citation was examined to determine if it was a monograph, journal, thesis, technical report, or of some other format. The bases for this determination were as follows: imprint was used to identify monographs; numbering sequence of a publication identified journals; the word "report" represented a technical report; conference proceeding was identified by the word proceeding; thesis was identified by the word thesis or dissertation; the word mimeograph identified mimeograph copies; the words letters or personal communication identified correspondence;

while the abbreviation A-V followed by words like filmstrip, identified audio-visual materials. The distribution of citations by form of publication was then converted to percentages to determine their distribution. An alternative procedure was to examine the cited documents physically, but since these were scattered in many libraries, this approach was considered unfeasible for this study.

The approach taken by this study is valid in the sense that in searching bibliographic devices such as catalogs and bibliographies, library patrons can, in most cases, determine the publication formats from the bibliographic information provided. By the nature of their training, librarians are even in a better position to determine the bibliographic format of a publication based on the information provided in a bibliographic citation.

Subject

Citation information is generally limited to the titles of the cited papers. This, however, poses a problem to an investigator who wants to determine their subject contents.

The contents of documents need to be examined in order to determine their subject contents. Attempting to determine the subject of documents from their titles alone is an unreliable procedure. Searching for all of the documents in this study, just in order to analyze their contents, could not be attempted because the 4,631 citations were geographically scattered and could not be easily reached. Instead, an alternative method was adopted. This approach involved the

distribution by subject of the journals cited. This approach, although a limitation, is based on the principal statistical technique applied in this study, Bradford distribution, which is described later in this chapter. Its application here is based on the notion that authors will cite papers published in journals that are specifically devoted to the citing subject, and to papers published in several other subjects. Since bibliographical classification is a sub-field of library and information science, the citing subject is therefore considered to be library and information science. What needs to be known is the distribution of the number of cited journals by subject.

The method adopted in determining the subjects of the cited journals was to base the analysis on Ulrich's International Directory of Periodicals (1981), an approach employed in Baughman's study of the cited literature of sociology.[21] The index of this publication was consulted for each of the cited journals for a reference to the classified list of journals. In many cases, journals dealt with only one subject area, but in quite a few other cases, more than one subject was ascribed to a journal.

The alternative approach has the advantage of basing the subject distribution on a physical examination of the subject of the documents. The approach of determining the subjects of the cited journals has the strength of having the subject distribution on an existing publication such as Ulrich International Directory of Periodicals which has determined the

subject of journals. Its weakness is that it does not deal with the documents themselves and is limited to only an analysis of journals.

Language

The procedure for the distribution of citations by language used in this study is as follows: The bibliographic information for each citation was read and where necessary translators were employed to determine their languages. The number of citations made to a language represented the total score of that language. The scores for each language together with the corresponding percentage was then presented in a tabular form. The group contained no citations to translations of documents from one language to another.

Journal Citation

In this study, the citations to each journal were recorded, and the figures were ranked from the highest citation figure to the lowest. A frequency table was produced from the ranked figures, and the Bradford's verbal and graphical formulations were then applied to identify the core journals. A discussion of Bradford's verbal and graphical formulations is found in the section on Bradford's distribution in this chapter, while their application to the data on journal citation is presented in Chapter Four.

Age

The Price Index was chosen as the statistical technique to analyze the distribution because it is the only technique to analyze the age distribution because it is the only

technique devised so far that measures the "hardness" or "softness" of a subject field based on the age of citations.

Apart from Price, two other authors have provided definitions for the hardness and softness of a subject. Storer viewed the concept of hardness and softness as a continuum. He saw "hardness" as implying tough, brittle, strong, unyielding, impersonal, difficult, and aggressive, and "softness" as implying gentleness, adapting, weakness, malleability, sympathy, warmth, informality, and ease. Using nine disciplines, he measured their differences in terms of hardness and softness by (1) the percent of articles in journals which used author's initials (instead of full names) in references and footnotes which he described as a measure of impersonal and social relations, and (2) the percent of articles using equations and tables which he felt were a measure of rigor.[22]

McGrath regarded the hardness and softness of a subject as based on the number of books charged on a subject. The harder a subject, the fewer the books that will be charged; the softer a subject, the more books that will be charged out of the library by library patrons.[23]

The Price Index offered the best approach to this study because this study is measuring the use of literature in terms of the age of citations. It measures the hardness and softness of bibliographical classification in terms of the age of citations as defined in Price Index, rather than in terms of authors' initials and the use of equations and

tables as defined by Storer and the number of books that were charged out as used by McGrath.

Price suggested that an index which he named after himself as Price Index can be employed to advantage in establishing the "scientific" nature of a subject. This Index is based on the proportion of all cited references which were dated within the previous five years. The citations of a subject can be placed on a scale which ranges from what he termed hard science through soft science and technology, and finally to what he called non-science. According to Price, if a subject has 42 percent or more of its citations dated within the previous five years, it is a hard science; if between 42 percent and 21 percent, it is a soft science, and a subject that has less than 21 percent is a non-science subject. In the present study, the citations for each of the years studied were analyzed to determine what proportion of them cited the previous five years as compared to those that cited earlier years. The Price Index was then used to determine if the citations in a given year indicated a hard, soft, or a non-science subject. If the analysis for one year indicated a hard science, the implication was that a large percentage of the literature used in that year was current, meaning that it had appeared within the previous five years. If a large proportion of retrospective materials was used, a soft science subject was indicated. If a substantial amount of very old materials was used, this indicated that the subject was a non-science.[24]

The validity of the Price Index lies in the fact that it is based on citation studies of 154 journals from various subjects and dates. The Index level for certain subject fields tends to fall consistently within a certain range. Subjects in the humanities tend to have a low Price Index (i.e. they have a low percentage of citations to publications written within the previous five years), whereas the natural science and technology have a high Index.[25]

The terms "hard," "soft," "non-science" were used by Price in the context of the use of publications and not on the basis of how difficult a subject is. It is the contention of this study that Price's categorizations are valid in that they are based on the results of studies of literature use. In subjects like history and fine arts, for instance, there is a heavy use of old documents. This is, however, not the case with natural science subjects like chemistry and physics where information is frequently updated and requires that researchers constantly keep abreast with the literature, hence much use is made of current documents.

Price also introduced a graph which is based on the Index. The graph, presented as Fig. 1 enables one to have a better view of how citations to papers are distributed by age. He plotted a graph of references to papers on the vertical axis against the percentage of references dated in the previous five years on the horizontal axis. He then divided the graph into three columns. Papers with an index below 21 percent were described as "archival", that is, based

largely upon old papers. Those papers with an index between 21 and 42 percent were described as "normal", while those with 42 percent and above were described as "research front".[26] These categorizations correspond to those that Price established for subject disciplines. A hard science subject would be at the "research front" column; a soft science subject would be located in the column labeled "normal"; while a non-science subject would lie in the "archival" column. The graph described below will also be used to describe the distribution of the cited papers by the categories of "archival", "normal", and "research front" in Chapter Five.

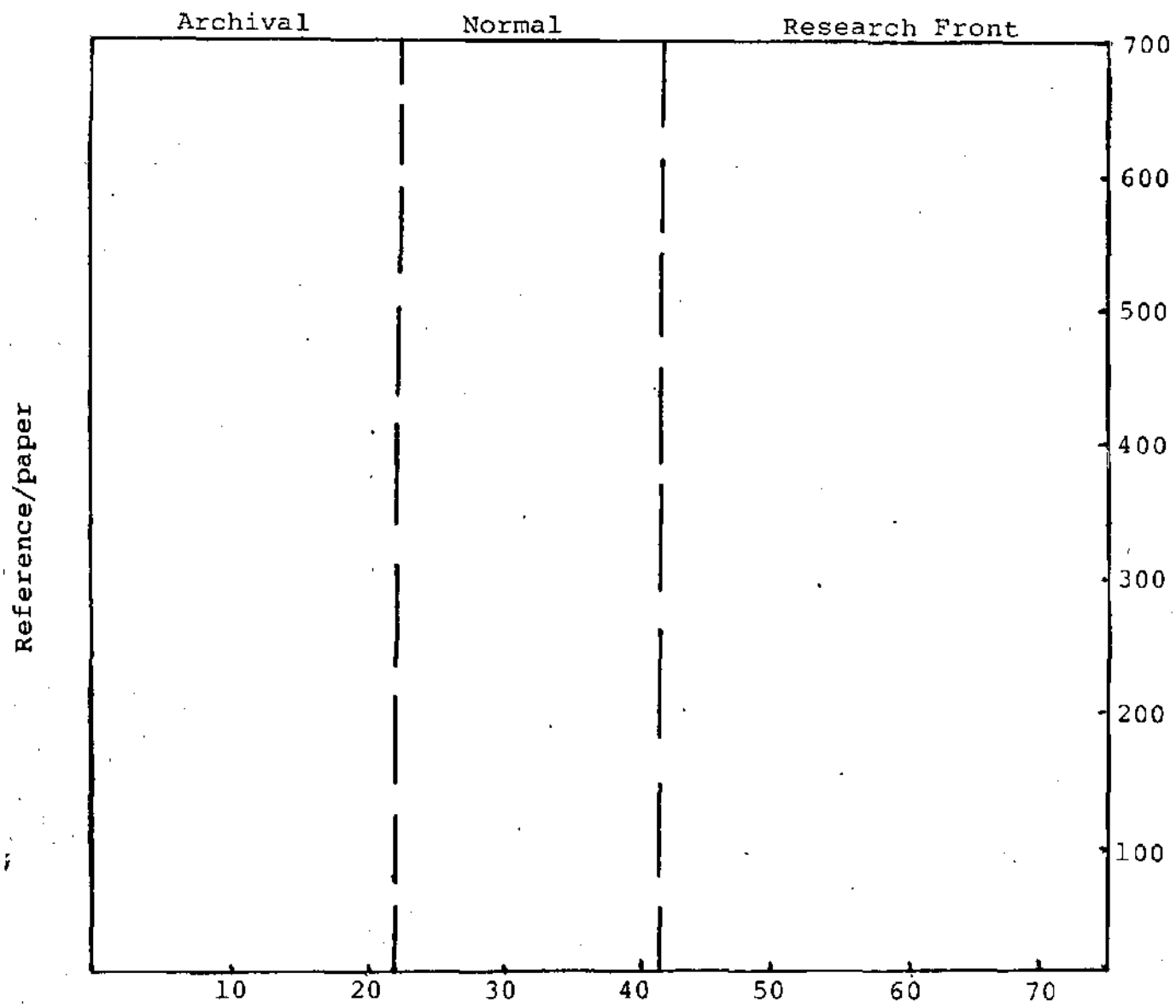
Papers Cited

The total citations in this category were arranged in one alphabetical sequence by authors' last names. Anonymous works were arranged by the first words of the titles (articles excluded). Different editions of a work were separately scored. The citations made to each author's paper were examined and recorded to determine the number of citations received by the paper. A frequency distribution table based on the citations received by papers was then produced, and Bradford's verbal and graphical formulations were applied to the tabulated data to determine core papers. This application is discussed in Chapter Four.

The Bradford Distribution

The Bradford distribution was considered the most

FIG. 1 THE GRAPHICAL ILLUSTRATION OF PRICE INDEX



Price Index = % Reference dated in last 5 years.

appropriate statistical technique for this inquiry because it is the most widely used technique for studying similar

problems, and thus far, no better technique has been devised for such application. It was therefore chosen for use here because of its long historical, and mathematical foundations, its successful application, and its widespread use.

Bradford's law is based on the theory of scattering of articles on a given subject in several periodicals. It was formulated by Samuel Clement Bradford, a British librarian and documentalist while studying the periodicals that would be useful to his clientele in the fields of applied geophysics and lubrication. He first termed the regularity of their distribution a "law of scattering" in an article entitled "Sources of Information on Specific Subjects" which he first published in the January 1934 issue of Engineering (London). The article later constituted a chapter in his book Documentation, published in 1950.[27,28] He stated the law verbally as follows:

> If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into nucleus of periodicals more particularly devoted to the subject, and several groups of zones containing the same number of periodicals in the nucleus and succeeding zones will be as in $1:a:a^2....$[29]

Because the frequency distribution predicted by Bradford's law so closely resembles Zipf's law of word frequency, it is often referred to as the Bradford-Zipf distribution.[30]

Bradford also formulated the law graphically as in Fig. 2. He plotted R(n) against log n as defined below and noticed that the resultant graph was a rising curve that ran into a

straight line after some critical point, followed by a deviation.

Several studies have shown that there is a deviation in this so-called "Bradford-Zipf bibliograph." The deviation which was not shown in Bradford's original graph is usually downwards, though in a few cases upward deviations have been reported. The deviation has been termed the Groos droop, because it was first identified by Groos in 1967 while working on the Keenan-Atherton data for physics, and because he was the first to report the deviation from the linear prediction of Bradford's law.[31]

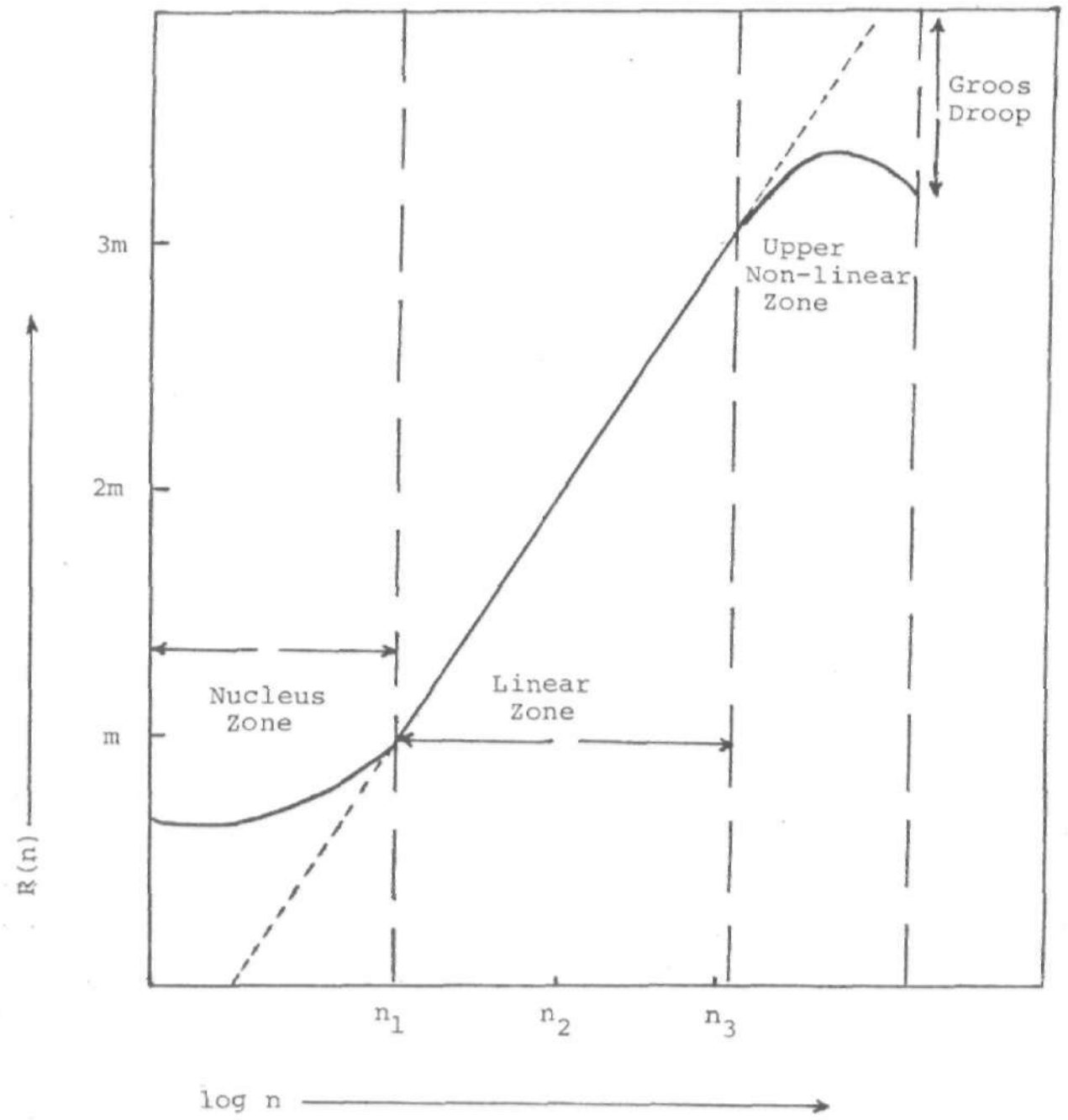
Two types of explanations have so far been given for the droop. These are:

(a) that all phenomena conform to simple mathematical laws and the deviation of the plotted graph from the linear ideal indicates that the search was not complete and that further searching would eventually restore the sagging empirical graph to strict linearity.

(b) that Bradford's law is correct as far as it goes and that no matter how painstakingly and exhaustively one searches, the Groos droop can never be completely eliminated.[32]

Since its formulation, the law has been widely used by several investigators in subjects in the physical sciences, social sciences, and the humanities. In Figure 2 below, m

FIG. 2 BRADFORD-ZIPF BIBLIOGRAPH



represents the number of articles published by the n_1 journals that fell in the nucleus zone or Zone 1 of the distribution. The total number of articles 2m published by n_2 journals represents Zone 2, while the total number of articles 3m were published by n_3 journals and represents Zone 3 of the graphical distribution.

The mathematical formulation of the law was not, however, available until 1968 when its expression with practical significance to library and documentation work was formulated by Brookes.[33]

If all journals that publish papers on a given subject are collected for a specified period, and their number is counted, the journals can be arranged in order of their decreasing productivity. If R(n) is the total number of relevant papers in the first n of the ranked journals (i.e., R1 is the total in the journals ranked 1, R2 is the total in the journals ranked 1 and 2, and so on), and Rn is plotted against n on semi-logarithmic paper, a graph similar to that of Figure 3 will be obtained. The graph is in two parts, and is based on Brookes' mathematical formulae: a rising curve which represents the 'core' journals and a straight line which represents the tail. The equation of the rising curve is

$$R(n) = an^b$$

The equation of the straight line is

$$R(n) = N \log n/s$$

where

R(n) is the cumulative sum of journal articles published

within a given period (i.e., 1 to n);

a is the number of journal articles contributed by the most productive journal (i.e., the journal of rank 1). Its value increases as the period considered increases;

n is the rank of journals arranged in decreasing order of the number of articles they contribute to a given subject;

b is a constant if the publications considered cover a short time-span (i.e., 2-6 years); otherwise it increases as time increases. Its value is always less than 1.

N is the total number of journal titles that would be expected (predicted value) to publish articles on the subject. It is given by the slope of the linear portion of the Bradford-Zipf bibliograph;

s is the value of n at the intersection of the straight portion of the bibliograph with the log n axis; and

c is the value of n at the point where the curve runs smoothly into the straight line portion of the bibliograph. Journals ranked 1-c constitute the "nucleus" of journals publishing articles on the subject.[34,35]

If enough data are collected, a graph of their distribution is drawn, and a straight line is then drawn through the curve as in Fig. 2, the highest value of R(n) and n and the

value obtained for s can be substituted in the equation to give N.

$$N = \frac{R(n)}{\log \frac{n}{s}}$$

After finding the value of N, the total number of articles R(N) published can then be calculated, since

$$R(N) = N \log \frac{N}{s}$$

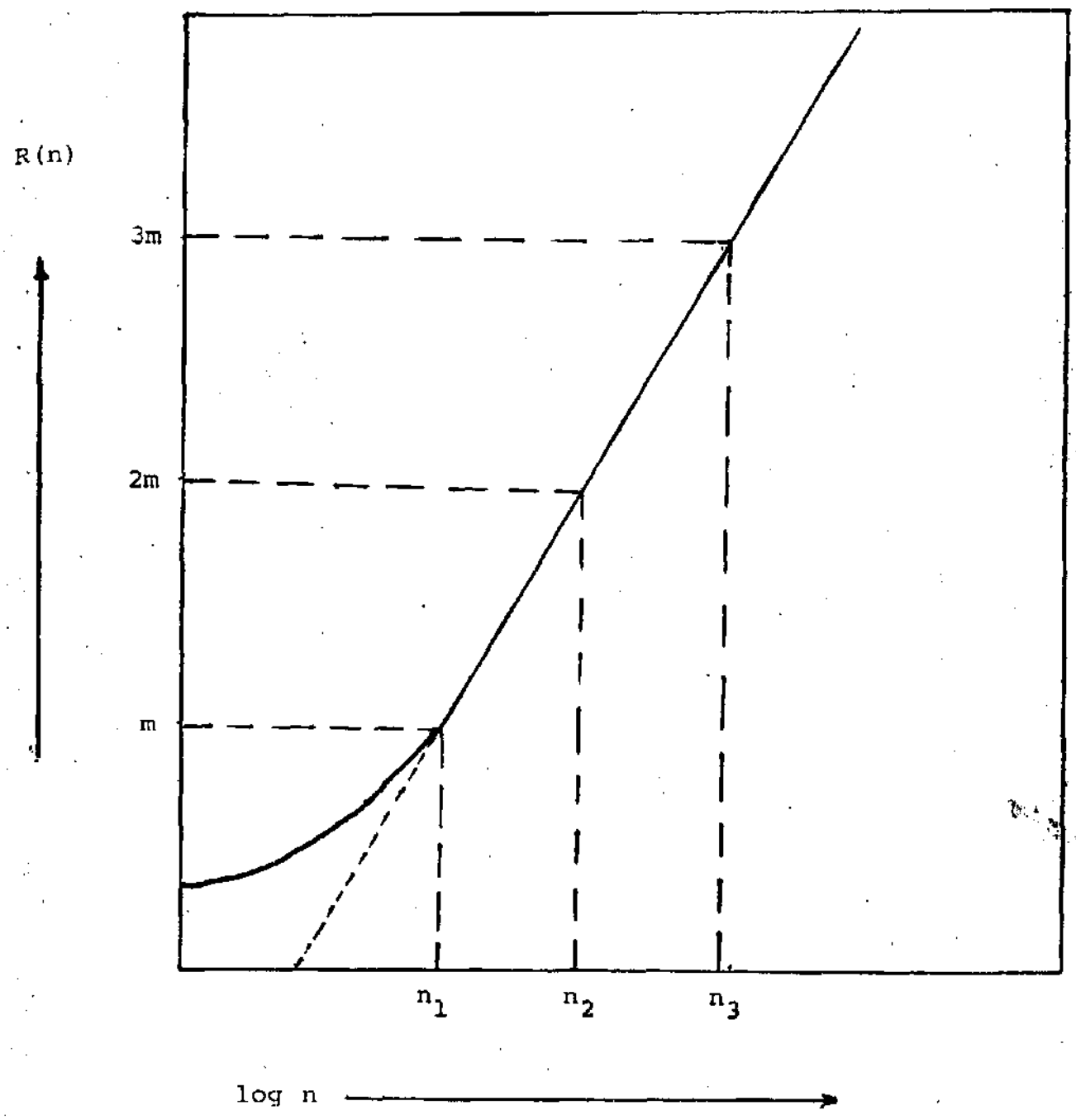
It is thus possible to estimate from this curve the number of journals that must be acquired to cover X% of the total number of cited articles published.

Although Bradford's law was formulated to apply to the productivity of journals in a subject field, it has also been applied to the citations made to papers, authors, and journals in some of the studies reviewed in Chapter Two. The present study is not applying the law to the productivity of journals or authors but rather to the citations made to journals, publications, and authors.

Bradford developed his theory of the distribution of articles in journals by considering the range of journals as "a family of successive generations of diminishing kinship."[36] He expressed this theory first in the verbal form which was stated earlier in this chapter, then he wanted to substantiate this verbal formulation from empirical data. By plotting empirical data on a graph, he observed a straight line as shown in Fig. 3 below.[37]

Fig. 3 is similar to Fig. 2 except for the deviation from the straight line (Groos droop) which was absent in

FIG. 3 THE GRAPHICAL FORMULATION OF BRADFORD'S LAW



Bradford's graph. Vickery, who had pointed out the disparity between the two formulations, noted that Bradford mistakenly assumed his graphical formulation to be a restatement of the verbal formulation. He showed that if n_m journals contributed a cumulative m papers, where n_m is larger than the nucleus, the verbal formulation is equivalent to the expression:

$$n_m : n_{2m} - nm : n_{3m} - n2m : \ldots : : I : a_m : a_m 2 \ldots,$$

while the graphical formulation is equivalent to the expression:

$$n_m : n_{2m} : n_{3m} : \ldots : : I : bm : bm^2 \ldots$$ [38]

Bradford's verbal formulation therefore expressed his theory, while the graphical formulation expressed his observations. [39]

Subsequent interpretations of Bradford's law have been based on one or the other of Bradford's two formulations. Brookes' study that was mentioned earlier, enables the 'nucleus' of journals to be calculated and the estimation made of the total number of contributing journals and papers on a particular topic using the graphical formulation. [40]

Leimkuhler developed a model that was based on the Bradford's verbal formulation. When he tested his model against empirical data, he found that there was a close agreement between the observed and theoretical distributions. [41]

Studies that tested either of Bradford's formulations used different data. In a comparative study of the two formulations of Bradford's law using the same data, Wilkinson noted a difference in the results obtained and proposed two formulae

for determining which formulation more closely reflects the practical situation. Her bibliographic data covered four subjects (agricultural economics, muscle fiber, schistosomiasis, and mast cells).[42]

The test utilized simple formulae for calculating N (the estimated total number of journals containing articles relevant to the subject of the search) and R(N) (the estimated total number of papers produced by N). Only p (number of journals) and S (the corresponding cumulative number of papers) need to be known to apply the formulae. Both p and S were derived from a plot of the empirical data on semi-log paper. The value of p can be determined at any point in the linear portion of the bibliograph. It represents the number of journals on the horizontal axis of the bibliograph in Figure 2. The corresponding value of S could then be determined from the value of p. After identifying S, 2S can be identified. The corresponding number of journals required to produce 2S, called q, was determined. The values derived for S, p, and q were then used to calculate N and R(N) for both the verbal and graphical expressions of Bradford's law (equations 1-4). Wilkinson revealed that, for the data she considered in her test, the graphical formulation was more consistent with the practical situation than the verbal. The two formulae that Wilkinson proposed and applied to the study are stated as follows:

Verbal Formulation

$$N = \frac{S}{\log \alpha} - \frac{p}{\alpha - 1} \qquad (1)$$

where $\alpha = \frac{q - p}{p}$

$$R(N) = \frac{S}{\log \alpha} \cdot \log\left[\frac{S}{\log \alpha} \cdot \frac{(\alpha - 1)}{p}\right] \qquad (2)$$

Graphical Formulation

$$N = \frac{S}{\log \beta} \qquad (3)$$

where $\beta = \frac{q}{p}$

$$R(N) = \frac{S}{\log \beta} \cdot \log\left[\frac{S}{\log \beta} \cdot \frac{\beta}{p}\right] \qquad (4)$$

These two formulae for testing Bradford's verbal and graphical formulations are provided here since they will be applied in this study to determine which formulation better conforms to Bradford's law.

Wilkinson's study differs from the present one in two respects. First, whereas the Wilkinson study used a bibliography, the present one used citations similar to Cline's study.[43] The implication of this is that the physical significance of N which represents the exhaustive search of a complete bibliography does not apply in this study since no restriction can be made on the cumulative sum of the

citations. Secondly, the citations in this study were drawn from journals, books, and dissertations rather than from journals alone.

This chapter has described the general methods that could be applied to this kind of investigation. After reviewing these methods, the citation analysis method was considered best for this investigation. The variables considered in the study are operationally described, and the procedures adopted are also explained as well as the statistical techniques employed.

Notes for Chapter Three

[1]R. K. Merton, "Priorities in Scientific Discovery: A Chapter in the Sociology of Science," American Sociological Review 22 (1957): 640.

[2]Eugene Garfield, The Use of Citation Data in Writing the History of Science (Philadelphia, Institute for Scientific Information, 1964), p. 1.

[3]Derek J. de Solla Price, "Is Technology Historically Independent of Science? A Study in Statistical Historiography," Technology and Culture 6 (1965): 556.

[4]Thomas J. Waldhart, "The Relationship of the Citation of Scientific Literature and the Institutional Affiliation of Engineers" (Ph.D. Indiana University, 1973), p. 71.

[5]S. R. Ranganathan, "Library Classification through a Century," in Classification Research: Proceedings of the Second International Study Conference Held at Hotel Prins Hamlet, Elsinore, Denmark, 14th to 18th September, 1964, ed. Pauline Atherton (Copenhagen: Munksgaard, 1965), p. 18.

[6]B. I. Palmer, "Shiyali Ramamrita Ranganathan Ayer, 1892-1972," Library Association Record 74 (1972): 228.

[7]The need for a Faceted Classification As the Basis of All Methods of Information Retrieval (UNESCO I.A.C. Doc. Ter. P.A.S. memo 320/5515), Library Association Record 57 (1955): 262.

[8]Ibid., p. 268.

[9]B. C. Vickery, Faceted Classification: A Guide to the the Construction and Use of Special Schemes (London, Aslib, 1960)

[10]English Electric Co. Ltd., A Faceted Subject Classification for Engineering, Compiled by Jean Binns and David Bagley (English Electric Co., 1961).

[11]W. G. Buick, "Classification of English Literature: A Faceted Classification Compatible with D.C.," Library Journal 16 (1967): 174-7.

[12]K. D. C. Vernon and V. Lang, London Classification of Business Studies (London, Graduate School of Business Studies, 1970), 132.

[13]M. A. Greaves, Librarianship: A Faceted Classification Scheme As a Teaching Aid (University of Ibadan, Institute of

Librarianship, 1970), 19p.

[14]J. E. L. Farradane, "Diamond Technology [Faceted Classification Scheme]," Journal of Documentation 18 (1962): 77-9.

[15]K. Coyle, "Faceted Classification for Occupational Safety and Health," Special Libraries 66 (1975): 256-9.

[16]Classification Research Group, Classification of Library Science: Preliminary Draft Edition (London, Aslib, for the Classification Research Group, 1965)

[17]Jack Mills, "Classification," in Five Years Work in Librarianship, 1956-1960, ed. P. H. Sewell (London: Library Association, 1963), p. 239.

[18]"Vickery Leads Seminar on Faceted Classification," Special Libraries 56 (1965): 228.

[19]Mills, "Classification," p. 239.

[20]Paule Salvan, "Les Progress de la Classification a Facettes," Bulletin des Bibliotheques de France 7 (1962): 10.

[21]J. C. Baughman, "A Structural Analysis of the Literature of Sociology," Library Quarterly 44 (1974): 302.

[22]Norman W. Storer, "The Hard Sciences and the Soft: Some Sociological Observations," Bulletin of the Medical Library Association 55 (1967): 76.

[23]William E. McGrath, "Relationships between Hard/Soft, Pure/Applied, and Life/Non-Life Disciplines and Subject Book Use in a University Library," Information Processing & Management 14 (1978): 17.

[24]D. J. de Solla Price, "Citation Measures of Hard Science, Soft Science, Technology and Non-science," in Communication Among Scientists and Engineers, ed. Carnot E. Nelson and Donald K. Pollock. Lexington, Mass.: Heath Lexington Books, 1970), p. 10.

[25]Ibid., p. 10.

[26]Ibid., p. 11.

[27]S. C. Bradford, "Sources of Information on Specific Subjects," Engineering 137 (1934): 85.

[28]S. C. Bradford, Documentation (Washington: Public Affairs Press, 1950)

[29]Ibid.

[30]G. K. Zipf, Human Behavior and the Principle of Least Effort (Cambridge, Mass.: Addison-Wesley Publishing Co., 1949)

[31]Ole V. Groos, "Bradford's Law and the Keenan-Atherton Data," American Documentation 8 (1967): 46.

[32]B. C. Brookes, "Bradford's Law and the Bibliography of Science," Nature 224 (1969): 953.

[33]B. C. Brookes, "The Derivation and Application of the Bradford-Zipf Distribution," Journal of Documentation 24 (1968): 217.

[34]Brookes, "Bradford's Law and the Bibliography of Science," p. 953.

[35]S. M. Lawani, "Bradford's Law and the Literature of Agriculture," International Library Review 5 (1973): 342.

[36]Bradford, Documentation, p. 116.

[37]Ibid., p. 116.

[38]B. C. Vickery, "Bradford's Law of Scattering," Journal of Documentation 4 (1948): 200.

[39]Elizabeth A. Wilkinson, "The Ambiguity of Bradford's Law," Journal of Documentation 28 (1972): 125.

[40]Brookes, "The Derivation and Application of the Bradford-Zipf Distribution," p. 253.

[41]F. F. Leimkuhler, "The Bradford Distribution," Journal of Documentation 23 (1967): 197.

[42]Wilkinson, "The Ambiguity of Bradford's Law," p. 126.

[43]Gloria S. Cline, "Application of Bradford's Law to Citation Data," College & Research Libraries 42 (1981): 56.

CHAPTER FOUR

TEST FOR A CORE LITERATURE, CORE JOURNALS, AND CORE AUTHORS IN BIBLIOGRAPHICAL CLASSIFICATION

The purpose of this chapter is to test for the existence of (a) a core literature as represented by the most frequently cited journals in the literature of bibliographical classification; (b) core journals as represented by the most frequently cited journals in the literature of bibliographical classification; and (c) the core authors as represented by the most frequently cited authors in the literature of bibliographical classification. The determination of core zones through the application of the Bradford-Zipf bibliograph on the data for journals, papers, and authors in this study would be positive indications of the existence of core journals and a core literature in bibliographical classification.

To achieve this purpose, the two formulations of Bradford's law--verbal and graphical--will be applied to the data on journals, papers, and authors while Wilkinson's formulae which were stated earlier in Chapter Two, will also be used to determine which formulation to base the conclusions of the study on. In attempting to determine core journals, core papers, and core authors, the data for these are handled and reported separately. The analyses for journals will be presented first, followed by those for papers, and then authors.

Journal Title Citation

The purpose of this section is to apply the Bradford distribution to the citation of journal titles in order to determine which journals would fall in the core zone. It would also determine whether the citation data for this study conform to the verbal and graphical formulation of Bradford's law.

The distribution of citations by journal titles is presented in Table 1. This table is used to determine the Bradford verbal and graphical formulations.

TABLE 1

FREQUENCY TABLE OF CITATIONS TO JOURNALS IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION

(N = 230)

No. of Titles (A)	No. of Citations (B)	(AB)	Cumulation of Titles (C)	Cumulation of Citations (D)
1	148	148	1	148
1	135	135	2	283
1	93	93	3	376
1	65	65	4	441
1	57	57	5	498
1	55	55	6	553
1	39	39	7	592
3	35	105	10	697

TABLE 1--Continued

No. of Titles (A)	No. of Citations (B)	(AB)	Cumulation of Titles (C)	Cumulation of Citations (D)
2	28	**56**	**12**	753
1	24	**24**	**13**	777
2	23	46	**15**	823
1	22	22	**16**	845
3	20	60	**19**	905
1	17	17	**20**	922
2	16	32	**22**	954
1	15	15	**23**	969
1	14	14	**24**	983
2	13	26	**26**	1,009
1	11	11	27	1,020
2	10	20	29	1,040
5	9	45	34	1,085
5	8	40	39	1,125
3	7	21	42	1,146
4	6	24	46	1,170
11	4	44	57	1,214
8	3	24	65	1,238
38	2	76	103	1,314
127	1	127	230	1,441

Verbal Formulation

Table 1 shows that two journal titles can be determined as the most frequently cited and most used. They therefore constitute Zone 1 of the Bradford distribution. These two journals alone accounted for 283 citations. This number was then used to determine subsequent zones, establishing a total of six zones. Zone 2 contained 4 journals which accounted for 270 citations; Zone 3 contained 9 journals which also accounted for 270 citations; Zone 4 contained 19 journals which accounted for 262 citations; Zone 5 contained 69 journals which accounted for 229 citations, while Zone 6 contained 127 titles which accounted for 127 citations (Table 2).

TABLE 2

ZONING OF JOURNALS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION

(VERBAL FORMULATION)

Zone	Citations	No. of Journal Titles	Braford Multiplier (b)
1	283	2	...
2	270	4	2
3	270	9	2.25
4	262	19	2.1
5	229	69	3.6
6	127	127	1.8
Total	1,441	230	2.35*

*Average

While the Bradford multiplier appears fairly constant from Zone 1 to Zone 4, the multipliers obtained for Zones 5 and 6 are not constant with those in earlier zones. In other words, they do not exhibit the regularity that characterized the Bradford multipliers in Zones 1 to 4. Despite this irregularity, this verbal formulation can be described as having conformed to Bradford's law.

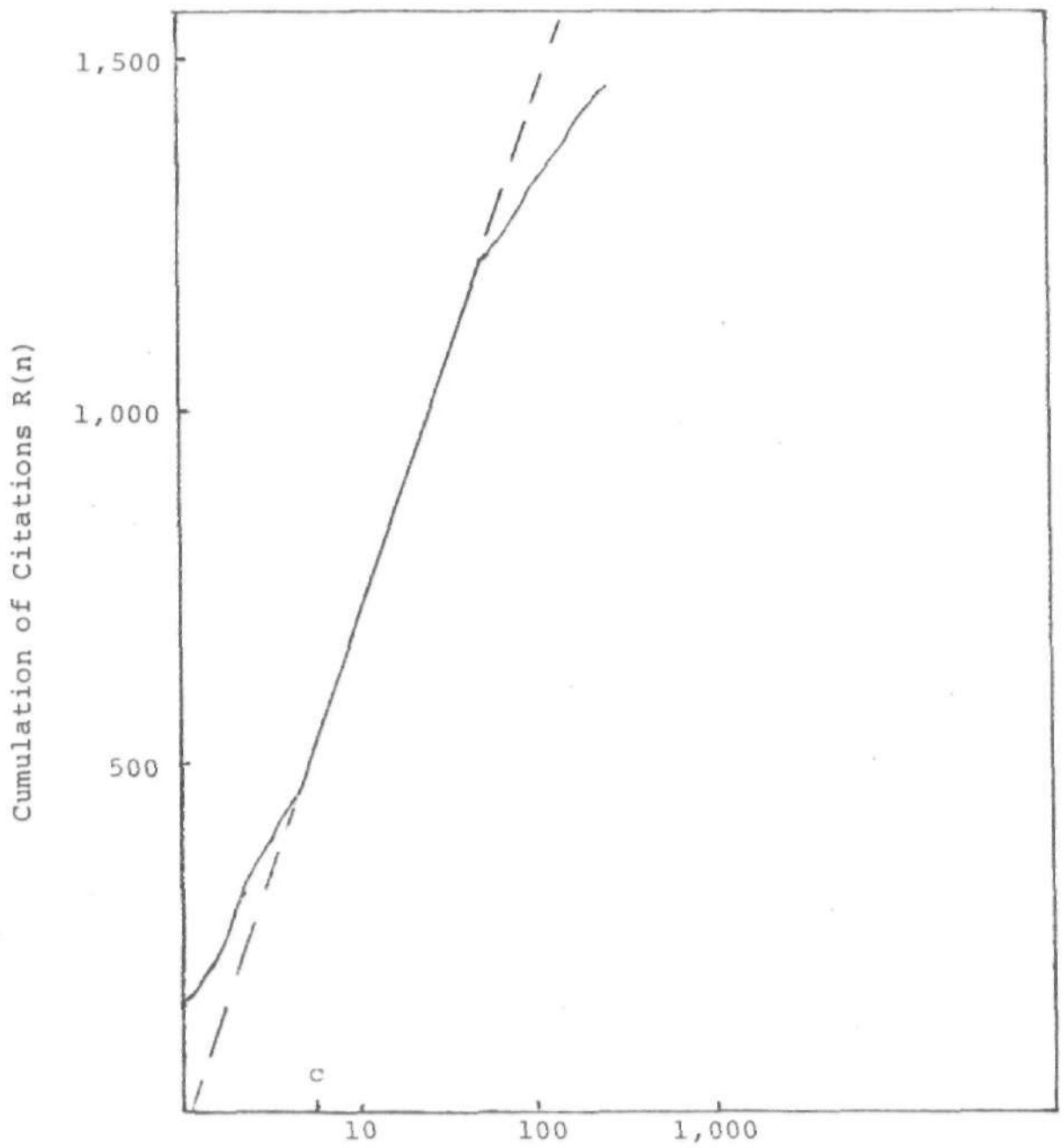
The two journals that were determined to constitute Zone 1 are: Journal of Documentation and Library Resources and Technical Services. These journals are therefore described as the most significant journals in bibliographical classification.

Graphical Formulation

Fig. 4 is the Bradford-Zipf bibliograph of the journal citation data. It is the graphical formulation of Bradford's law, and was drawn from the figures in Table 1. Those in the columns labeled "Cumulation of Titles" were used for computing the horizontal axis, and those in the column labeled "Cumulation of Citations" were used to compute the vertical axis.

The graph revealed that six journal titles could be identified in the nucleus or core zone (the point at which the concave part of the graph runs into the straight line). These six journals accounted for 553 citations, thus constituting Zone 1 of the distribution. Twenty-eight journals with 532 citations constituted Zone 2, while 196 journals accounted for the remaining 356 citations. The

FIG. 4 BRADFORD-ZIPF BIBLIOGRAPH FOR JOURNAL CITATIONS IN BIBLIOGRAPHICAL CLASSIFICATION



zoning of the journals based on this graphical formulation is presented in Table 3.

It can be deduced from table 3 that the Bradford multiplier is not constant. When the graphical formulation is compared with the verbal formulation, there are three important differences. Firstly, two journals were established for zone 1 (core) whereas six journals were established in the zone 1 of the graphical formulation. Secondly, six zones were established in the verbal formulation whereas three zones were computed from the graphical formulation. Thirdly, the Bradford multiplier exhibited a fair degree of constancy whereas this was not evident in the graphical formulation.

TABLE 3

ZONING OF JOURNALS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (GRAPHICAL FORMULATION)

Zone	Citations	No. of Journals	Bradford Multiplier
1	553	6	...
2	532	28	4.7
3	356	196	7.0
Total	1,441	230	5.85*

*Average

Since both formulations have produced different results in terms both of zoning and the number of journals in the nucleus or zone 1, it would not be justifiable to accept the

results of one formulation and reject the other without further examination. Wilkinson's formulae are therefore applied to test the two formulations to determine which one is closer to Bradford's law. The one with fewer errors is considered closer to the law than the one with more errors. The calculations now follow:

First, the verbal formulation will be calculated to determine N, the estimated number of cited journals and R(N), the estimated number of citations.

S = 592 (Citations produced by p or 7 journals)

p = 7 (Number of journals producing S citations)

q = 46 (Number of journals with 2S citations or 1,184 citations)

Both p and q were two points taken from the linear portion of the bibliograph in Figure 4. The point p was first chosen and this was equivalent to seven journals which accounted for 592 citations. The second point was obtained by multiplying S or 592 by 2, yielding 1,184 citations. Since there was no journal with this number of citations in Table 1, the nearest citation figure is 1,170, produced by 46 journals. The second point, q, is represented by 46.

Next, the formula for determining the estimated number of cited journals given below is used to determine N:

$$N = \frac{S}{\log \alpha} - \frac{p}{\alpha - 1}$$

where $\alpha = \frac{q - p}{p}$

Substituting the values for q and p to the above

formula,

$$\alpha = \frac{46 - 7}{7}$$

$$= 5.57$$

By substituting 592, log 5.57, 5.57, and 7 to the formula for estimating N, the value of N can be determined.

$$N = \frac{592}{0.7459} - \frac{7}{5.57-1}$$

$$= 793.67 - 1.53$$

$$= 792 \text{ (Estimated number of cited journals)}$$

Next, the estimated number of citations will be determined from the following formula:

$$R(N) = \frac{S}{\log \alpha} \cdot \log \left[\frac{S}{\log \alpha} \cdot \frac{(\alpha - 1)}{p} \right]$$

$$= \frac{592}{0.7459} \cdot \log \left[\frac{592}{0.7459} \cdot \frac{(5.57 - 1)}{7} \right]$$

$$= 793.67 \times \log (793.67 \times 0.65)$$

$$= 793.67 \times \log 518$$

$$= 793.67 \times 2.7143$$

$$= 2,154 \text{ (Estimated number of citations)}$$

Next, the percentage error will be calculated using the following formula:

$$\text{Percentage error} = \frac{\text{Estimated - Observed}}{\text{Observed}} \times 100 \text{ (at corresponding N)}$$

The percentage error is obtained by subtracting the observed value of 1,441 citations from the estimated value of 2,154, then the result is divided by the observed value of 1,441, and finally multiplied by 100 to determine the percentage.

$$= \frac{2,154 - 1,441}{1,441} \times 100$$

= 49.48 percent (Percentage error for the verbal formulation)

Having determined the estimated number of citations and the percentage error, a similar exercise will be applied to the graphical formulation.

S = 592, p = 7, q = 46 (these are the same as those determined in the verbal formulation above)

To determine N, the estimated number of journals cited, the following formula will be used:

$$N = \frac{S}{\log \beta}$$

where $\beta = \frac{q}{p}$

Substituting q = 46, and p = 7 to the above formula

$$\beta = \frac{46}{7}$$

$$= 6.57$$

Substituting S = 592 and log of 6.57 to the formula for determining the value of N produces the following:

$$N = \frac{592}{\log 6.57}$$

$$= \frac{592}{0.8176}$$

= 724 (Estimated number of cited journals)

The formula for estimating number of citations made will next be applied. It is given below as

$$R(N) = \frac{S}{\log \beta} \cdot \log \left[\frac{S}{\log \beta} \cdot \frac{\beta}{p} \right]$$

Substituting S = 592, β = 6.57, p = 7 to the above formula, the estimated number of citations R(N) can be determined.

$$R(N) = \frac{592}{0.8176} \cdot \log\left[\frac{592}{0.8176} \cdot \frac{6.57}{7}\right]$$

$$= 724 \times \log 724 \times 0.9385$$

$$= 724 \times 2.8319$$

$$= 2{,}050 \quad \text{(Estimated number of citations)}$$

The next step is to determine the percentage error of the above estimated number of citations. This is obtained by subtracting the observed number of citations (i.e. 1,441) from the estimated value (i.e. 2,050), then divide the result by the observed value (i.e. 1,441), and finally multiplying the result by 100 to obtain the percentage. The calculations now follows:

$$\text{Percentage error} = \frac{\text{Estimated - Observed}}{\text{Observed}} \times 100 \quad \text{(at corresponding N)}$$

$$= \frac{2{,}050 - 1{,}441}{1{,}441} \times 100$$

$$= 42.26 \text{ percent (percentage error)}$$

The results of the above calculations reveal that the graphical formulation had 42.26 percentage error, whereas that of verbal was 49.48 percent. Since the percentage error of the graphical formulation was significantly lower than that of the verbal, the graphical formulation is therefore accepted. Although the 42.26 percentage error obtained for the graphical formulation is still large, it is likely that the predictive strength of Wilkinson's formulae may be more suited to a bibliography than to citations which this study used. It is also likely that estimating the number of citations and journals may not apply

to citations since there is no limit to the number of citations that can be made by authors. Cline's citation study of College & Research Libraries for the period 1940-1944, for instance, revealed percentage errors of 67.1 for the graphical formulation and 144 for the verbal formulation.[1] As Brookes pointed out, "citations are not bibliographically homogeneous."[2]

The six core journals determined in the graphical formulation are briefly described as follows:

1. Journal of Documentation: this is a quarterly British journal that is devoted to the recording, organization, and dissemination of specialized knowledge.
2. Library Resources and Technical Services: this is a quarterly American journal that is devoted to the technical processes in a library and includes classification.
3. American Society for Information Science Journal: published bi-monthly, this American publication which superseded American Documentation is the official journal of the American Society for Information Science. It is devoted to the various fields of documentation and information science and serves as a forum for discussion and experimentation.
4. Library Association Record: a monthly publication of the Library Association, this British journal is

devoted to all aspects of librarianship.

5. Library Science with Slant to Documentation: a quarterly publication published in India, this journal, founded by S. R. Ranganathan is devoted to cataloging, classification, documentation, organization, reprography, and training of librarians and documentalists.
6. Aslib Proceedings: a monthly publication of Aslib, this British journal publishes articles of a practical nature and which are related to library problems; operation of library and information units or services, and the introduction of new systems, techniques, or equipments.

In general, three journals accounted for 25 percent of citations, 10 journals accounted for 50 percent of citations, while 29 journals accounted for 75 percent of all citations. The implication of these findings to library acquisition procedures is that depending on a library's financial strength, the number of journals that can be subscribed to could range from as low as three (if all the six core journals cannot be purchased for libraries on low budgets) to twenty-nine for those on large budgets. The latter is an ambitious step to take. It would even be discovered that many of these journals are not specifically devoted to classification but are journals that cover many aspects of library and information science. Even of the six journals determined as being the core, two are more general in their

subject coverage than the other four. These are: Aslib Proceedings and Library Association Record. These are general library science journals that should probably be acquired by any library operating an acquisition program. If a library has already subscribed to these two journals, then it is left with only four journals that could be described as specifically devoted to bibliographical classification. Their acquisition would be required.

This study therefore recommends that the six journals identified as "core" should be acquired. The next section will examine the citations to papers to determine if a core literature exists.

Papers Cited

The procedure for determining core papers is similar to that of journals discussed above. The data on the cited papers are summarized in Table 4. As in the journal analysis, the two Bradford formulations-- verbal and graphical-- were applied here to determine the more acceptable of the two findings.

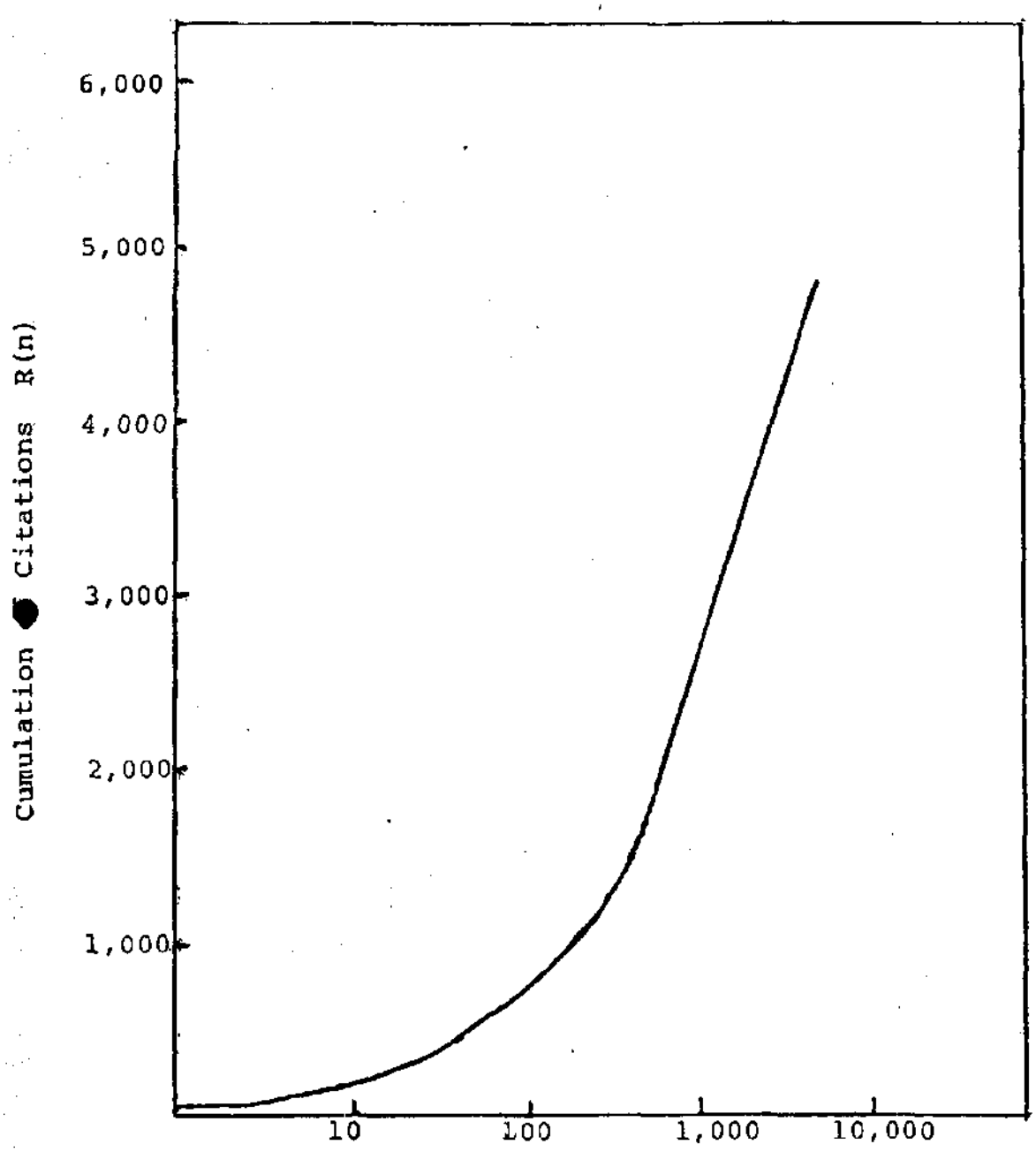
When the verbal formulation was applied to the figures in Table 4, two papers were determined as core. These two papers constituted 0.06 percent of all cited papers and accounted for 57 (1.2 percent) of total citations. These papers are: S. R. Ranganathan's Prolegomena to Library Classification, 3rd edition, 1967, and B. C. Vickery's Classification and Indexing in Science, 2nd edition, 1958.

TABLE 4

FREQUENCY TABLE OF PAPERS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION

No. of Citations (A)	No. of Papers (B)	(AB)	Cumulation of Citation (C)	Cumulation of Papers (D)
33	1	33	33	1
24	1	24	57	2
21	1	21	78	3
19	1	19	97	4
18	2	36	133	6
17	4	68	201	10
14	1	14	215	11
13	3	39	254	14
12	3	36	290	17
11	2	22	312	19
10	4	40	352	23
9	3	27	379	26
8	5	40	419	31
7	19	133	552	50
6	13	78	630	63
5	26	130	760	89
4	48	192	952	137
3	78	234	1,186	215
2	174	348	1,534	389
1	3,097	3,097	4,631	3,486

FIG. 5 BRADFORD-ZIPF BIBLIOGRAPH OF PAPERS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION



A total of 14 zones were determined ranging from Zone 1 which constituted the core with 2 papers and accounted for 57 citations, to Zone 14 with 3,097 papers which accounted for 3,097 citations. These findings are summarized in Table 5. The papers cited in the first seven zones are listed in Appendix III.

When the graphical formulation was applied to the figures in Table 4, however, there was an absence of the linear region which was necessary for determining the nucleus or core zone. The graph produced was a curve instead of the typical Bradford's bibliograph that has an initial concave or curve, a linear portion, and a droop, similar to Fig. 2 in Chapter 3. Because it was not possible to establish a nucleus zone from the graph drawn in Fig. 5, core papers could therefore not be determined by this formulation. Wilkinson's comparison of verbal and graphical formulations cannot be applied in this case because the graph does not exhibit the typical Bradford-Zipf bibliograph with an initial concave region, a linear middle region and a Groos droop. In the absence of a positive result from the graphical formulation, because it does not conform to the typical Bradford-Zipf bibliograph, this study will accept the result obtained in the verbal formulation. The study, therefore, determined two papers as being the core, though this is a weak core when this figure is considered in relation to the total number of papers cited.

TABLE 5

ZONING OF PAPERS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (VERBAL FORMULATION)

Zone	No. of Citations	No. of Papers	Bradford Multiplier
1	57	2	...
2	76	4	2
3	68	4	1
4	53	4	1
5	58	5	1.25
6	67	7	1.4
7	40	5	0.7
8	133	19	3.8
9	78	13	0.6
10	130	26	2.0
11	192	48	1.8
12	234	78	1.6
13	348	174	2.2
14	3,097	3,097	17.8
			2.8*

*Average

A brief description of the two core books now follows:

1. Ranganathan, S. R. Prolegomena to Library Classification, 3rd ed. Bombay: Asia Publishing House, 1967.

This book, in its third edition, includes new developments in classification especially from 1957, the date of

publication of the 2nd edition, to 1966. This edition attempts to solve the problems mentioned in the second. The following are some of the topics covered: guiding principles for determining the first of a train of characteristics and the sequence of subsequent characteristics; sequence of facets, rounds and levels; assignment of characters to fundamental categories; use of connecting symbols; creation of schedules, etc. Many of the principles it covers are valid for all types of classification. Ranganathan illustrated his principles with reference to all the main general library classifications (DDC, LC, and Bliss). Vickery described it in the following way: "I believe that the Prolegomena is a tool useful in the design of all kinds of retrieval systems."[3]

2. Vickery, B. C. Classification and Indexing in Science London: Butterworths Scientific Publications, 1958.

Now in its second edition (1975), this book is primarily concerned about facet analysis in classification and indexing. It is one of the early textbooks on this subject and covers the following: the need for classification, construction of classification schedules, notation, classification and mechanical selection, indexing, classification for the classified catalog, and the future of information retrieval.

An examination of the contents of these two books revealed that they both dealt with the facet analysis in detail. Both touched on the need for faceted classification and presented brief discussions on its construction. The two

books determined as core therefore relate closely to the topic of the historical period studied.

The statistical test revealed that a core literature exists, although it is a weak core in terms of the number of papers cited. A ranked list of cited papers is presented in Appendix III. These papers are zoned and range from Zone 1, the most significant or most useful papers to Zone 14, the least significant or least useful zone. The two papers determined and identified in the core zone should be acquired by libraries if these have not been acquired. The figure obtained for core papers is small indeed especially when considered in relation to the total cited papers. The lack of a strong body of core papers would suggest that the knowledge base in bibliographical classification is spread over many titles. Libraries already having these titles would have to decide on papers to add to their collections. The usefulness of Appendix III therefore lies in the fact that it can be used in library science libraries to decide on what publications to add to their collections and those that need not be acquired.

Distribution of Citations by Authors

A total of 2,331 single and multi-authors with 5,505 citations were analyzed. This figure represents the total number of citations of cited authors, whereas the figure of 4,631 represents the population of papers cited. Bradford's verbal and graphical formulations were applied to these data.

Verbal Formulation

When the verbal formulation was applied to the data in Table 6, only one author, S. R. Ranganathan, was determined to be a core or nucleus author. The citation figure for this core zone, which is 302, was used to determine the subsequent zones in the table. A total of 12 zones were determined. The number of authors and their corresponding citations are outlined in Table 7.

TABLE 6

FREQUENCY TABLE OF AUTHORS CITED IN BIBLIOGRAPHICAL CLASSIFICATION

Citation (A)	No. of authors (B)	(AB)	Cumulation of Citation (C)	Cumulation of authors (D)
302	1	302	302	1
143	1	143	445	2
95	1	95	540	3
93	1	93	633	4
79	1	79	712	5
66	1	66	778	6
54	1	54	832	7
51	2	102	934	9
49	1	49	983	10
48	1	48	1,031	11
47	1	47	1,078	12
36	1	36	1,114	13

TABLE 6--Continued

Citation (A)	No. of authors (B)	(AB)	Cumulation of Citation (C)	Cumulation of authors (D)
34	1	34	1,148	14
33	2	66	1,214	16
32	1	32	1,246	17
30	1	30	1.276	18
29	1	29	1,305	19
28	2	56	1,361	21
27	1	27	1,388	22
26	1	26	1,414	23
25	2	50	1,464	25
24	3	72	1,536	28
23	1	23	1,559	29
22	1	22	1,581	30
21	3	63	1,644	33
20	3	60	1,704	36
19	1	19	1,723	37
18	3	54	1,777	40
17	5	85	1,862	45
16	2	32	1,894	47
14	5	70	1,964	52
13	1	13	1,977	53
12	3	36	2,013	56
11	3	33	2,046	59

TABLE 6--Continued

Citation (A)	No. of authors (B)	(AB)	Cumulation of Citation (C)	Cumulation of authors (D)
10	**3**	**30**	2,076	62
9	**11**	**99**	2,175	73
8	**13**	104	2,279	86
7	**19**	133	2,412	105
6	**18**	108	2,520	123
5	**35**	175	2,695	158
4	**46**	184	2,879	204
3	**90**	270	3,149	294
2	319	638	3,787	613
1	1,718	1,718	5,505	2,331

TABLE 7

ZONING OF AUTHORS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (VERBAL FORMULATION)

Zone	Citations	No. of Authors	Bradford Multiplier (bm)
1	302	1	...
2	331	3	3
3	301	5	1.67
4	312	8	1.6

TABLE 7--Continued

Zone	Citations	No. of Authors	Bradford Multiplier (bm)
5	313	12	1.5
6	303	16	1.33
7	313	28	1.75
8	345	50	1.78
9	359	81	1.62
10	270	90	1.11
11	638	319	3.54
12	1,718	1,718	5.3
Average			2.24

Although the Bradford multiplier was not constant, the number of authors in the zones reflect fairly the Bradford-type distribution. A better picture would, however, emerge when this formulation is compared with that of the graphical using Wilkinson's formulae.

Graphical Formulation

Fig. 6 is the Bradford-Zipf bibliograph for the author citation data. It represents the graphical formulation of the Bradford's law and was drawn from the figures in Table 6. Although the data on the cited authors seemed to conform to the Bradford's distribution, the bibliograph produced in the graphical formulation differs slightly from the typical

Bradford-Zipf bibliograph. Instead of the Groos droop to deviate to the right, it deviated to the left. This can be attributed to the data which had a large concentration of authors with one citation. Brookes attributed this phenomenon to the fact that the bibliographs of citations "conform only in part to the Bradford-Zipf distribution" because "there is no restriction on the number of citations that may be made."[4] Some may yield Zipf distributions only as in the bibliograph of citation data in plasma physics.[5]

The bibliograph revealed that 18 authors accounted for 1,276 citations, thus constituting Zone 1 of the distribution. 105 authors with 1,244 citations were determined for Zone 2, 490 authors with 1,267 citations constituted Zone 3, and 1,718 citations with a like number of authors is comprised in Zone 4. This formulation thus produced four zones, whereas, the verbal formulation produced twelve. Table 8 summarizes the zones for this graphical formulation.

The eighteen core authors determined are listed as follows: S. R. Ranganathan, U.S. Library of Congress, D. J. Foskett, B. C. Vickery, Dewey Decimal Classification, Editorial Committee, H. E. Bliss, J. Mills, International Federation for Documentation, A. Neelameghan, W. C. B. Sayers, J. E. L. Farradane, R. R. Freeman, Classification Research Group (England), P. A. Richmond, B. I. Palmer, J. M. Perreault, B. A. Custer, and C. A. Cutter. These are important personalities in bibliographical classification

FIG. 6 BRADFORD-ZIPF BIBLIOGRAPH OF AUTHORS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION

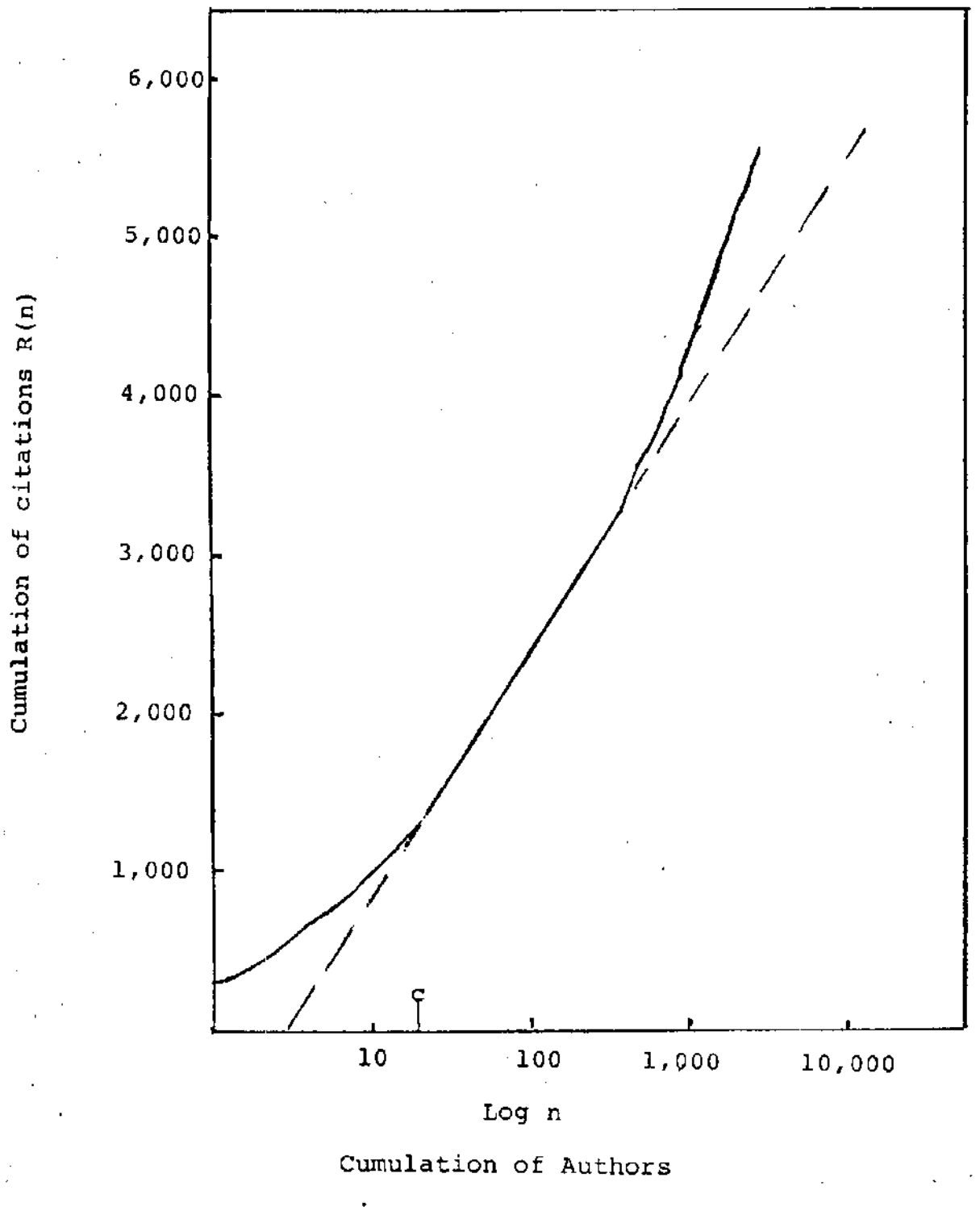


TABLE 8

ZONING OF AUTHORS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (GRAPHICAL FORMULATION)

Zone	No. of Citations	No. of Authors	Bradford Multiplier
1	1,276	18	...
2	1,244	105	5.8
3	1,267	490	4.7
4	1,718	1,718	3.5
Total			4.6*

*Average

in terms of their contributions.

When the numbers of core authors determined in the verbal and graphical formulations are compared, there is no doubt that the two results are not similar.

Wilkinson's two formulae will be applied to the authorship data to determine which formulation has the least error. As stated in Chapter 3, since there is no established percentage error for an analysis to conform to the Bradford formulation, the one with the smaller error will be accepted in this part of the study. The calculations are based on the Bradford-Zipf bibliograph in Fig. 6. The two calculations now follow:

The verbal formulation of Bradford's law will be calculated first:

S = 1,276 (Number of citations in Zone 1)

p = 18 (Number of authors in Zone 1)

q = 123 (Number of authors in Zones 1 &2)

The values of S, p, and q were determined from Fig. 6. The next step is to determine the estimated number of cited authors using the following formula:

$$N = \frac{S}{\log \alpha} \cdot \frac{p}{\alpha - 1}$$

where $\alpha = \frac{q - p}{p}$ (formula for determining α)

By substituting the values of p and q in the above formula, α can be determined

$$\alpha = \frac{123 - 18}{18}$$

$$= 5.83 \quad \text{(value of } \alpha\text{)}$$

Subsituting the values of S, α, and p to the formula for estimating N, the following is obtained:

$$N = \frac{1,276}{\log 5.83} - \frac{18}{5.83-1}$$

$$= \frac{1,276}{0.7657} - \frac{18}{4.83}$$

$$= 1,662.7$$

$$= 1,663 \quad \text{(estimated number of cited authors)}$$

Having determined the value of N, the next step is to determine the value of R(N), that is, the estimated number of citations made. This can be determined by using the following formula for finding R(N):

$$R(N) = \frac{S}{\log \alpha} \cdot \log\left[\frac{S}{\log \alpha} \cdot \frac{(\alpha - 1)}{p}\right]$$

The values of S, α, $\log \alpha$, and p are then substituted in the above formula to produce the following:

$$R(N) = \frac{1,276}{0.7657} \cdot \log\left[\frac{1,276}{0.7657} \cdot \frac{(5.83 - 1)}{18}\right]$$

$$= 1,666.4 \times \log 447.15$$

$$= 1,658.4 \times 2.6503$$

$$= 4,395 \quad \text{(estimated number of citations)}$$

The percentage error can then be calculated from the following formula:

$$\text{Percentage error} = \frac{\text{Estimated} - \text{Observed}}{\text{Observed}} \times 100 \quad \text{(at the corresponding N)}$$

The observed value of N from Fig. 6 is 5,505, that is the last observed point on the bibliograph. The estimated number of citations obtained above is 4,395. These values are then substituted in the above formula for determining the percentage error. The result now follows:

$$\text{Percentage error} = \frac{4,395 - 5,505}{5,505} \times 100$$

$$= -20.16 \text{ percent}$$

The percentage error for the verbal formulation of the Bradford's law is -20.16 percent.

Having determined the percentage error for the verbal formulation, the next step is to perform a similar exercise for the graphical formulation.

First, the values of S, p, and q are needed to begin the

calculations. These are obtained from the bibliograph in Fig. 6. The values are the same as those used in the verbal formulation above, but they will be restated here for the purpose of this analysis:

S = 1,276 (Number of citations in Zone 1)

p = 18 (Number of authors in Zone 1)

q = 123 (Number of authors in Zones 1 and 2)

The first step here is to determine the estimated number of cited authors from the following formula:

$$N = \frac{S}{\log \beta}$$

where N is the estimated number of cited authors, S is the number of citations in Zone 1, and β is a constant.

Before determining the value of N, it is necessary to find the value of the constant β. This is determined by using the following formula:

$$\beta = \frac{q}{p}$$

where q is the number of authors in Zones 1 and 2 and p is the number of authors in Zone 1.

By substituting the already determined values of p and q, the value of β can be calculated as follows:

$$\beta = \frac{123}{18}$$

$$= 6.83 \quad (\text{value of } \beta)$$

The values of S and β are substituted in the formula for estimating the value of N, to produce the following:

$$N = \frac{1,276}{\log 6.83}$$

$$= \frac{1,276}{0.8344}$$

$$= 1,529.2$$

$$= 1,529 \quad \text{(estimated number of cited authors)}$$

Having determined the estimated number of cited authors, the next step is to determine the estimated number of citations made using the following formula:

$$R(N) = \frac{S}{\log \beta} \cdot \log \left[\frac{S}{\log \beta} \cdot \frac{\beta}{p} \right]$$

The value obtained for S, β, and p are then substituted in the above formula to produce the following:

$$= \frac{1,276}{\log 6.8} \cdot \log \left[\frac{1,276}{\log 6.8} \times \frac{6.8}{18} \right]$$

$$= 1,529.2 \times \log (1,529.2 \times 0.3822)$$

$$= 1,529.2 \times \log 584.5$$

$$= 1,529.2 \times 2.7664$$

$$= 4,230.4$$

$$= 4,230 \quad \text{(the estimated number of citations)}$$

Having determined the estimated number of citations, the percentage error can be determined by subtracting the observed number of citations, 5,505, from the estimated number, 4,230, dividing the result by the observed value, and multiplying the result by 100. The formula and calculations are given as follows:

$$\text{Percentage error} = \frac{\text{Estimated - Observed}}{\text{Observed}} \times 100 \quad \text{(at corresponding N)}$$

$$= \frac{4,230 - 5,505}{5,505} \times 100$$

$$= - 23.15 \text{ percent}$$

Thus, the percentage error for the graphical formulation is calculated as -23.15 percent.

The percentage error obtained for the graphical formulation was -23.15 percent, while a percentage error of -20.16 percent was obtained for the verbal formulation. Since the percentage error for the verbal formulation was lower than that for the graphical, the result obtained in the verbal formulation is accepted by this study. The values of N and R(N) obtained in the preceding calculations are summarized in the following table.

TABLE 9

OBSERVED AND ESTIMATED VALUES OF N AND R(N) IN THE CITED LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION

	Observed	Verbal	Observed-Verbal
N	2,331	1,663	-668
R(N)	5,505	4,395	-1,110
	Observed	Graphical	Observed-Graphical
N	2,331	1,529	-802
R(N)	5,505	4,230	-1,275

From Table 9 above, the values obtained for N and R(N) in the verbal formulation of Bradford's distribution are higher than those for the graphical. Whereas 1,663 was obtained for N in the verbal formulation, 1,529 was recorded in the graphical formulation. When the two figures are compared to the observed value of 2,331 authors, the value of N for the graphical formulation is much farther from the observed value than the value of N obtained for the verbal formulation. A similar picture is to be found in the values obtained for citations. The value of R(N) obtained in the verbal formulation is 4,395, a figure that is higher than the 4,230 obtained in the graphical formulation. When the two results are compared to the observed value of 5,505, the verbal formulation was lower than 5,505 by 1,110, whereas the graphical formulation was lower by 1,275, a figure that is greater than the one obtained for the verbal formulation.

In terms of the raw figures provided in Table 9, it is clear that the verbal formulation was closer to the observed values obtained from analyses of the data than the graphical formulation. This probably accounted for the conclusion reached earlier that the verbal formulation was closer to Bradford's law than the graphical.

The fact that negative values were obtained in this analysis is attributed to the application of Wilkinson's formulae which yielded the results for N and R(N) that were found to be lower than the observed values for N and R(N).

The negative results obtained, do not, however, affect the validity of the test. They result from the application of Wilkinson's formulae which estimated lower results than those observed in the data for cited authors. It is worth mentioning that the formulae were not originally formulated to apply to citation data. The data, however, seemed to have conformed to Bradford's formulation, especially the verbal formulation. The negative results therefore stem from the use of Wilkinson's formulae.

Ranganathan, who was determined as the only core author in the verbal zone, received 302 citations. He was a famous Indian bibliographical classificationist who created the Colon Classification, a scheme that is widely used in India. He was also the one who first introduced facet analysis to classification through his Colon Classification which was first published in 1933. His ideas have strongly influenced faceted classification. The principles that guided the preparation of the Colon Classification and indeed his work on faceted classification in general are expressed in the Prolegomena to Library Classification, the third edition of which was identified as the most frequently cited title.

According to Mullins, known theory groups exhibit the following properties: a theoretical orientation which is different from that held by the parent discipline; developed and directed by an intellectual leader; verbalized in a program statement; and supported by intellectual successes.

These works usually include critiques of the parent discipline's current work. A research center or training center is also an important property of a theory group.[6]

When these properties were applied to this study, it was found that the top cited authors, namely, Ranganathan, Foskett, and Vickery were linked to the two major national classification research groups. The first belonged to the Bangalore Documentation Research Group (India), while the other two were active members of the British Classification Research Group. The questions to be addressed here, based on the cited authors, are: What is the theoretical orientation of these groups? How does it differ from that held in the parent discipline, that is, bibliographical classification? Who are the intellectual leaders of the group? What are the intellectual successes of the group? What are the research centers for these groups? What contribution did the top-cited authors determined by this study make toward the theory held by these groups? Can the journals determined as "core" be linked to these two research groups? Answers to these questions would provide an insight into the nature of these classification research groups in terms of their contributions to the advancement of the field. In the following paragraphs, an attempt will be made to examine the two research groups in terms of the properties mentioned above.

A. <u>The Bangalore Documentation Research Group (India)</u>

1. Intellectual leader: S. R. Ranganathan.

He initiated the move for the establishment of this school and was the person who planned the research agenda.[7] His principle of facet classification became the principal research focus of the librarians who teamed up with him to form the research group. He led the group from 1950 until his death in 1972 and founded the journal that published the group's research activites. He was a prolific writer, an active member of the library profession in India, and was president of the 1964 international conference on classification research at Elsinore, Denmark. Since his death, the group has been led by Professor Neelameghan, a close colleague of Ranganathan, with whom he co-authored papers. Neelameghan is himself a prolific writer, an intellectual, the head of Documentation and Research Training Center in Bangalore, and the current editor of Library Science With A Slant to Documentation.

2. Research Center:

The research center for this group is the Documentation Research Training Center, Bangalore, which was founded in 1962. The first head of this center was S. R.

Ranganathan. He was succeeded by Neelameghan. The present head is G. Bhattacharya.

3. Journal for Communicating Research Findings: Library Science With A Slant to Documentation

Founded by S. R. Ranganathan, this journal was one of the core journals determined in this study.

4. Theoretical Orientation:

Having rejected the deductive approach which characterized the traditional classification schemes, this group adopted the inductive method to classification. It was based on the principle of deriving the facets of a subject by their relation to five "fundamental" categories (Personality, Matter, Energy, Space, and Time).[8]

5. Research Trend:

Research by this study group is in three dimensions. The first dimension is the universe of subjects. This involves the developing of methods to know the overall development of the universe of subjects, new modes of development, and the emergence of new disciplines or ideas are recognized and views of specialists in different fields on the growth of knowledge are identified. The

second dimension lies in the area of theory of classification which involves the formulation of precise terminology for a discipline. The third dimension of research activity lies in the development of classification schemes. This involves the developing of a systematized method and rules for classifying the subjects of documents, providing a class number for every subject, developing a methodology and organization to gain continuous feedback on the use of classification and its problems.[9]

6. External Connections

This research group has a strong connection with external bodies such as the International Federation for Documentation (F.I.D.) and the British Classification Research Group. Ranganathan, Neelameghan, and Gopinath have had research done at the group's research center published as a report by the International Federation for Documentation. In the 1977 list of members of the British Classification Research Group, Neelameghan was listed as a member.[10]

7. Intellectual Successes

The successes of this group embrace both individual and group contributions. Some

of the successes of this group include:

1. Ranganathan, S. R. Colon Classification (first published in 1933, a scheme which has gone through six editions and is currently being maintained by the group).

2. Depth Classification (1953). Published by the research group for the Indian Library Association.

3. The publication of Library Science with a Slant to Documentation a journal that has been publishing articles and research papers done at the Documentation Research Training Center.

4. Annual Seminars held at the Documentation Research Training Center have been devoted to classification.

5. S. R. Ranganathan Prolegomena to Library Classification. (three editions of this text have been published, 1937, 1957, 1967). The author's theory of classification are expressed in these editions.

6. POPSI (Postulate-based Permuted Subject Indexing) continues to be developed at the research center.

7. S. R. Ranganathan FID Report No. 1: Classification 1957-63. "Trend Report: India."

8. M. A. Gopinath. FID/CR Report No. 6: Classification Research 1963-67. "Trend Report (India)."

9. M. A. Gopinath FID/CR Report No. 14: Classification Research 1968-73.

B. The British Classification Research Group

1. Intellectual Leader:

Brian C. Vickery: together with A. J. Wells, he assembled librarians interested in the study of classification, and this assembly resulted in the formation in 1952 of the Classification Research Group. The group's discussions on notation led to the valuable series of papers published by B. C. Vickery in the Journal of Documentation, and which were subsequently incorporated in his first book.[11] He also prepared the group's significant publication; Faceted Classification: A Guide to Construction and Use of Special Schemes, which was published by Aslib in 1960.

2. Research Center:

Unlike the Bangalore Research Group, there is no research center for the British Classification Research Group. This is because the research conducted by the Group is done in the libraries of individual members.

3. Theoretical Orientation:

   Like the previous group, this one too rejected the deductive approach which characterized traditional classification. It rejected all other principles except the facet principles of Ranganathan. It never accepted Ranganathan's "fundamental" categories as a general theory despite its usefulness in some specialist schemes.[12]

4. Nature of Research:

   Research centered on the construction of schemes for special subjects, that is, pre-defined or "given" fields of knowledge.

5. External Connections:

   The group has a close working relationship with the International Federation for Documentation (FID).

6. Journal for Communicating Research Findings:

   Journal of Documentation which was the most cited journal in this study. The group's research findings are published in this journal as bulletins of the group, with an occasional bibliography of the work of individual members of the group.

7. Intellectual Successes:

   In terms of success, not much has been done as a group except the publication of the

Library Association Record Memorandum, a classification scheme for library and information science, and a volume of essays titled Sayers Memorial Volume in honor of the great British librarian, W. C. Berwick Sayers. It organized the "Dorking Conference" of 1957 entitled "International Study Conference on Classification for Information Retrieval," sponsored by the International Federation for Documentation (FID). Many of the successes of the group, however, lie in individual contributions, some of which are as follows:

1. The need for a faceted classification as the basis of all methods of information retrieval. Library Association Record 57 (1955): 262-268.

2. Vickery, B. C. Classification and Indexing in Science. 2nd ed. London: Butterworths, 1958.

3. Classification Research Group. The Sayers Memorial Volume: Essays in Librarianship in Memory of William Berwick Sayers. Edited by D. J. Foskett and B. I. Palmer for the Classification Research Group. London: Library Association, 1961, 218p.

4. Coates, Eric James. Subject catalogues:

Headings and structure. London: Library Association, 1960, 186p.

5. Mills, A. J. A Modern Outline of Library Classification. London: Chapman & Hall, 1960, 196p.

6. Vickery, B. C. Faceted Classification: A Guide to Construction and Use of Special Schemes, prepared for the Classification Research Group. London: Aslib, 1960, 70p.

7. Vickery, B. C. Classification and Indexing in Science. 3rd ed. London: Butterworths, 1975, 228p.

8. Several special classification schemes produced by members of the group.

Research in bibliographical classification has utilized one of two methods: deductive and inductive.

The deductive method is typified by the classical method of logical division which characterizes traditional classification research. Three of the major bibliographic classification systems are based on this method: Dewey Decimal Classification, Universal Decimal Classification, and Bliss Bibliographic Classification. Although they are universal in scope, these systems are plagued by problems of uneven growth and imperfections in logical organization, limited notation, and two-plane representation.

The inductive method in bibliographical classification

builds from specifics to generals by accretion, by sorting into mutually exclusive groups according to various criteria, by combining terms into compound subjects, and by distinguishing characteristics and noting multiple relationships.[13] The method came into use as a result of the weaknesses found in the use of classification systems based on the deductive method. Two kinds of systems have been developed from inductive principles. One is the Colon Classification and its offspring, faceted classifications, which are a combination of scientific, deductive, and intuitive methods. The other is experimental classification which is a combination of scientific, probabilistic, and intuitive methods.[14]

The two classification research groups considered in this study belong to the school of inductive method, having rejected all previously existing schemes as inadequate. Research in classification by the Bangalore Research Group centered on the principle of deriving the facets of a subject out of their relation to five "fundamental" categories (Personality, Matter, Energy, Space, and Time). The British Classification Research Group realized that Ranganathan's ideas and theories had more to offer than those of most other writers, and decided to adopt at least some of the Colon terminology and method. The principle of "facet" was adopted to describe the homogeneous groups of terms that result from dividing a subject into its appropriate categories. The British group, however, never accepted Ranganathan's "fundamental" categories as a general theory despite the fact that

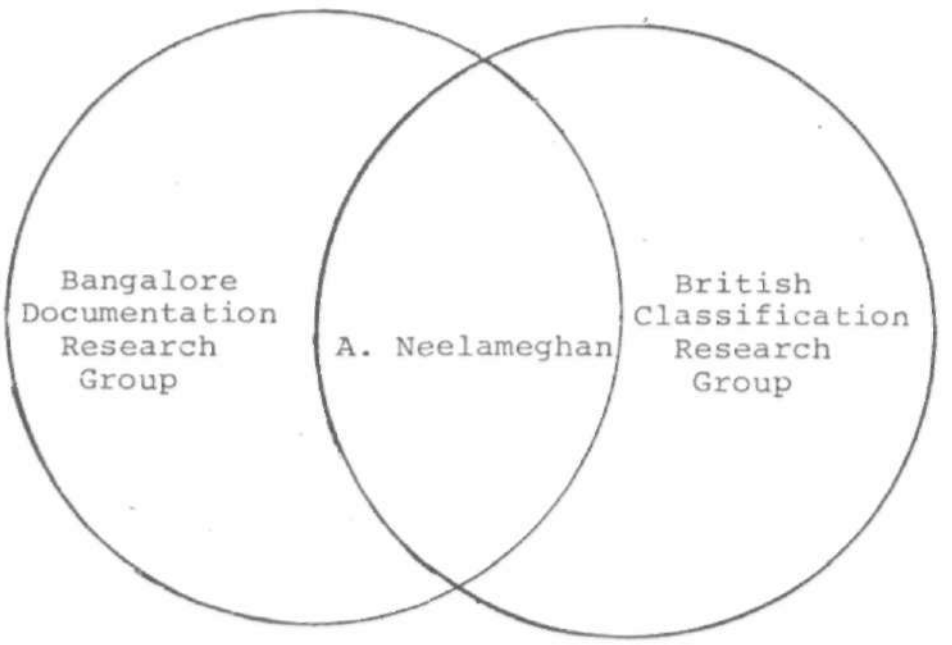
it proved useful in some specialist schemes. The British group's theory is based on the fact that one examines a subject in the first place in order to determine the categories into which its terms may be arranged, rather than trying to force them into facets based on an artificial division. In the subject Education, for example, one might consider the Educand or the School as Personality (as in Ranganathan's Colon Classification), and that Teaching and Examining equal Energy. It is not, however, easy to determine what would equate with Matter. The group, therefore, favored the use of specific terms to label the facets in any subject; thus there is the Educand facet, Schools facet, Curriculum facet, and so on, although the group continues to use the terms Personality, Matter, and Energy in discussions if found suitable.[15]

Advances made in the inductive approach to classification came largely from the research done by members of the two research groups.

Apart from Ranganathan and Vickery, other top-cited authors, namely Neelameghan of the Bangalore Documentation Research Group, Foskett, Mills, Coates, Aitchison, Austin, Atherton, Farradane, Freeman, Richmond, Palmer, and Dahlberg are all active members of the British Classification Research Group in terms of their publications in the area of bibliographical classification.[16]

Neelameghan's membership in the British Classification Research Group has served as a link between the Indian research

group and that of the British. This is an indication of the advances being made by the British group. This linkage is illustrated below in the form of a Venn diagram:



Although the Classification Research Group was influenced by the ideas of Ranganathan on faceted classification, it was the group's theoretical approach that has significantly contributed to the successful publication of many faceted classification schemes by members of the group. The group's theoretical approach as well as its attempt to solve problems related to the construction of special classification schemes made it an influential group in the Western world. Unlike many other national groups on classification research, its membership was not confined to Britain but extended beyond that country. The group's membership list published in 1978 in the Journal of Documentation, included Neelameghan, a

leading member of the Bangalore Classification Research Group: Dahlberg of Frankfurt, West Germany; Friis-Hansen of Danmarks Biblioteksskole, Copenhagen; Groeneveld of the Technical University Library, Eindhoven, Netherlands; Koerner of Munich, West Germany; Metcalfe of Sydney, Australia; Oker-Blom of Helsinki, Finland; Richmond of Cleveland, United States of America; Sorenson of Soborg, Denmark; Srivastava of the University of Rajasthan, India; Larsen of Danmarks Biblioteksskole, Copenhagen; Toman of the Czechoslovak Academy of Sciences, Prague, Czechoslovakia; Verschoor of the International Federation for Documentation; and Wahlin of Stockholm, Sweden,[17] all non-British.

It is thus clear from this list that the British Classification Research Group is very international in terms of membership. This is an indication of the significance of the group's theoretical orientation and its influence on modern approach to classification.

In his study of theory groups, Mullins stressed the importance of theory to a small theory group rather than placing emphasis on empirical considerations (that is proceeding from one research problem to another, without benefit of broad, theoretical guidance).[18] In this regard, it is worth mentioning that at the group's January 1977 meeting, it was agreed that "one meeting a year would be set aside to give members an opportunity to discuss theoretical problems, rather than on-going projects."[19] This is very important for the success of the group, and possibly for its very survival

since it is the theoretical orientation of a group that largely attracts members to it.

It has thus been shown that the active authors and the authors who contributed significantly to the theory of bibliographical classification were found to be the highly cited authors and that they belonged to the two most active research groups in the field. This finding somewhat relates to Oromaner's study of the literature of sociology in which he found that the top cited sociologists were also authors who had contributed significantly to the field.[20,21]

This chapter set out to determine if core journals, core papers, and core authors could be identified in the literature of bibliographical classification through citation analysis. The analysis revealed that there were six core journals, two core papers, and one core author. The last two figures are small indeed espcially when considered in relation to the total population of cited papers and cited authors. The application of the Bradford distribution revealed that the verbal formulation of the law conformed more to the data on cited papers and authors than the graphical, while in the data for cited journals, it was the graphical formulation that conformed more than the verbal. The highly cited authors were found to be linked to the two most active national classification research groups, namely, the British Classification Research Group and the Bangalore Documentation Research Group (India). These two research groups were found to have contributed significantly to the development of bibliographical classification theory.

Notes for Chapter Four

[1]G. S. Cline, "Application of Bradford's Law to Citation Data," College & Research Libraries 42 (1981): 59.

[2]B. C. Brookes, "Bradford's Law and the Bibliography of Science," Nature 224 (1969): 955.

[3]B. C. Vickery, Prolegomena to Library Classification, by S. R. Ranganathan (Review). Bombay, Asia Publishing House, 1967, Journal of Documentation 25 (1969): 170-171.

[4]B. C. Brookes, "Bradford's Law and the Bibliography of Science," p. 955.

[5]Ibid., p. 955

[6]Nicholas C. Mullins, Theories and Theory Groups in Contemporary American Sociology (New York: Harper & Row, 1973), p. 25.

[7]I. V. Malhan and R. L. Arora, "India's Contribution in the Field of Classification Research," Herald of Library Science 17 (1978): 271.

[8]D. J. Foskett, "The Classification Research Group, 1952-1962," Libri 12 (1962): 128.

[9]I. V. Malhan and R. L. Arora, "India's Contribution in the Field of Classification Research," p. 273.

[10]Classification Research Group, "List of Members (as at 31 July 1977)," Journal of Documentation 34 (1978): 49.

[11]B. C. Vickery, Classification and Indexing in Science (London: Butterworths, 1958), 185p.

[12]D. J. Foskett, The Classification Research Group, 1952-1962," p. 129.

[13]Phyllis A. Richmond, Aspects of Recent Research in the Arts and Science of Classification (Copenhagen: Danish Centre for Documentation, 1965), p. 13.

[14]Ibid.

[15]Foskett, "The Classification Research Group, 1952-1962," p. 127.

[16]Classification Research Group, "Bibliography of Writings by Members of the Classification Research Group," Journal of Documentation, 12 (1956): 227-330, 17 (1961):

169-172, 20 (1964): 166-169, 24 (1968): 295-298, 29 (1973): 69-71, 34 (1978): 44-48.

[17]Classification Research Group, "List of members" (as at 31 July 1977), p. 49.

[18]Nicholas C. Mullins, Theories and Theory Groups in Contemporary American Sociology, p. 21.

[19]Classification Research Group, "Bulletin No. 11," Journal of Documentation 34 (1978): 21.

[20]Mark J. Oromaner, "The Most Cited Sociologists: An Analysis of Introductory Text Citations," American Sociologist 3 (1968): 124.

[21]_____, "The Structure of Influence in Contemporary Academic Sociology," American Sociologist 7 (1972): 11.

CHAPTER FIVE

CHARACTERISTICS OF THE CITED LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION

The purpose of this chapter is to examine the citation characteristics of the literature of bibliographical classification in terms of its bibliographic format, language, subject, and the age of publications. These bibliographic characteristics are discussed statistically, and in some cases the results are compared with the findings in earlier studies for similarities and differences.

Distribution of Citations by Bibliographic Format

Table 10 presents the distribution of citations in bibliographical classification by bibliographic format. From the table, it is clear that the cited literature is predominantly monograph (57.2 percent) and journal articles (31.1 percent). The fact that monographs topped the list points out that it is the primary form of publication cited in bibliographical classification. This figure is higher than the 36.41 percent obtained by Cline and 36.9 percent by Brace in their citation study of the broader field of library and information science.[1,2] It is, however, similar to the results in some non-library science subjects, such as political science and history wherein Stewart and McAnally

found more citations to monographs than to journals.[3,4] It is not surprising that monographs were the primary publications cited in bibliographical classification because most of the classification schemes were published in monographic form. Furthermore, significant writings in the field have been published in monographic form; Appendix III shows that the top eleven titles cited were monographs of which four were classification schemes.

Journal articles played a secondary role in the overall citation pattern of bibliographical classification. They were followed by conference proceedings which accounted for 278 (6 percent) of total citations. It is not surprising that after monographs and journal articles, conference proceedings are most important because the field has witnessed a number of conferences, seminars, and workshops such as the 1964 and 1978 international conferences on classification, at Elsinore and Edinburgh respectively. Other bibliographic forms such as technical reports, theses, mimeographs, correspondences, audio-visual materials together accounted for the remaining 5.7 percent.

The evidence provided here enables one to conclude that citations in bibliographical classification are largely confined to books and journal articles, which together account for eighty-eight percent of all citations.

TABLE 10

BIBLIOGRAPHICAL FORMAT OF PUBLICATIONS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (N = 4,631)

Format	Frequency of Citation	Percent
Monographs	2,648	57.2
Journal articles	1,441	31.1
Conference proceedings	278	6
Technical reports	139	3
Theses	46	1
Mimeographs	56	1.2
Correspondences	18	0.4
Audio Visual materials	5	0.1
Total	4,631	100.0

In Table 11, the percentages of journal articles and monographs in this field are compared with those in other subject fields reported in other studies.

The pattern established in the table suggests that in those fields where there is always high demand for current information, journals (which are more quickly published than monographs) receive more citations than monographs. On the other hand, in those fields where this demand for recent publications is not so pressing, the citation pattern is either more equally divided between monographs and journals or the former receive more citations than the latter. In

TABLE 11

PERCENT OF JOURNALS AND MONOGRAPHS CITED IN DIFFERENT SUBJECT FIELDS*

Citation Analysis Studies	Bibliographic Form (in%) Journals	Monographs
Business/Mgt.--Popovich (1978)	58.6	31.9
Chemistry--Fussler (1948)	92.7	5.2
Classification--Afolabi (1983) (Bibliographical)	31.1	57.2
Library Science--Brace (1975)	33.0	38.9
Library Science--LaBorie (1976)	23.0	43.0
Physics--Fussler (1948)	91.8	7.7
Politics--Stewart (1970)	23.0	66.0
U.S. History--McAnally (1951)	9.2	45.6

*Adapted from Cline[5]

Table 11, physics, chemistry, and business management are shown to be subject fields wherein citations are largely in journal form, while history, library science, political science, and bibliographical classification are shown as monographic-oriented fields.

Distribution of Citations by Age

The distribution of citations by age is interpreted through a measure called the Price Index, which was described in Chapter Three.

The analysis of the percentage of citations made to the

last five years and their distribution by years using the Price Index is shown in Table 12 and Figure 7.

TABLE 12

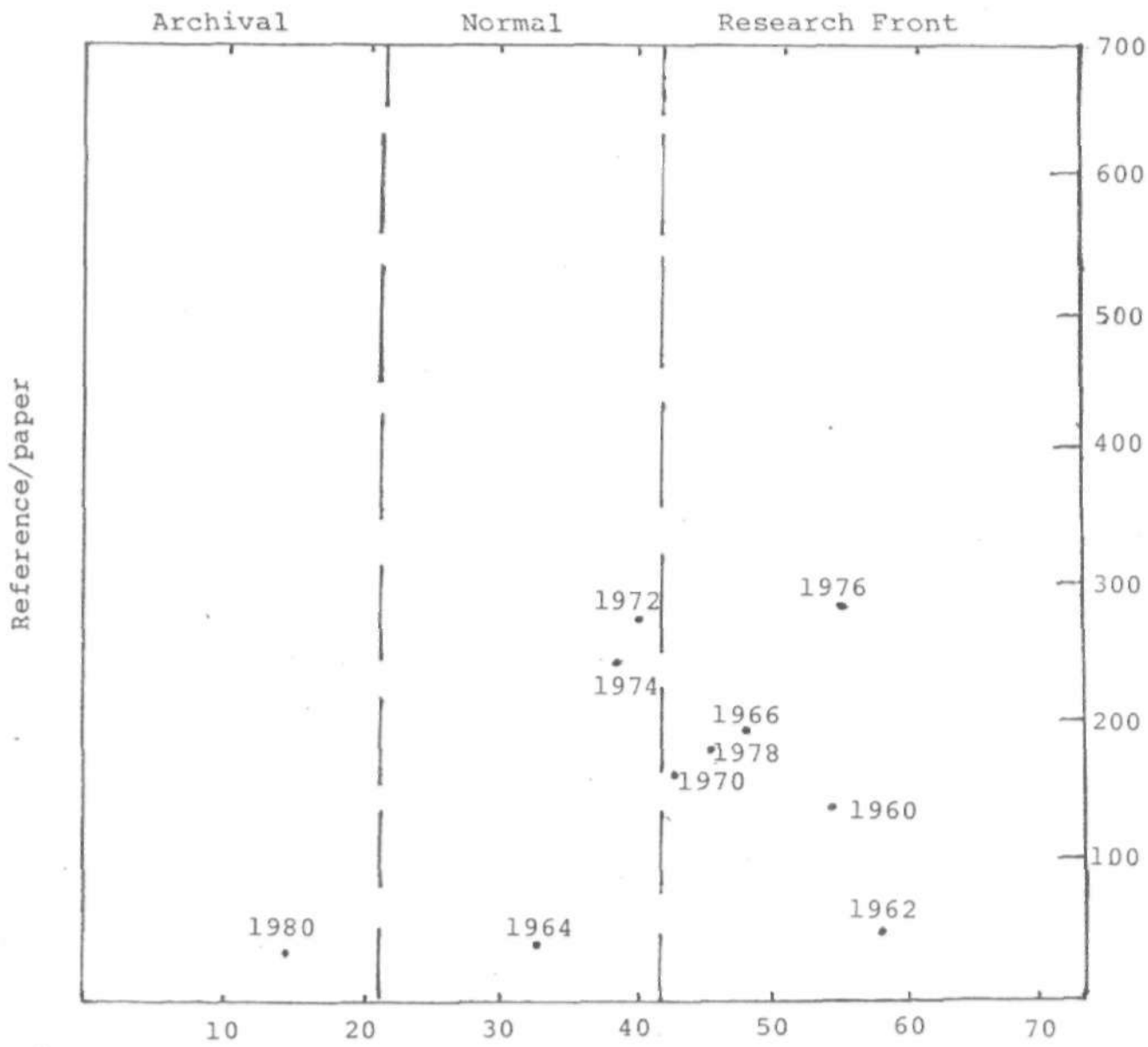
PERCENT OF WORKS CITED IN THE LAST FIVE YEARS

Year	Citations to year 0-5	Percentage
1960	140	54.4
1962	**60**	57.2
1964	**34**	32.0
1966	189	48.3
1968	614	69.3
1970	166	42.9
1972	291	40.9
1974	270	39.3
1976	299	57.4
1978	188	43.6
1980	**25**	14.0

Figure 7 is based on the information provided in Table 12. Seven of the eleven years (1960, 1962, 1966, 1968, 1970, 1976, 1978) were identified in the 'research front' column; three years (1964, 1972, and 1974) were found in the 'normal' column, while one year (1980) was identified in the archival column.

The low citations recorded from the papers published in 1980 might have accounted for the location of the 1980

FIG. 7 THE GRAPHICAL APPLICATION OF PRICE'S INDEX TO CITATIONS IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION



Price Index = Percentage of Reference dated in last five years

citations in the 'archival' column. It was the year that recorded the lowest number of published papers on bibliographical classification, and this could have accounted for the citations. This could be an aberation and it is difficult to speculate why this was so. Perhaps with time, a positive explanation for this phenomenon would emerge.

The citation patterns exhibited in 1964, 1972, and 1974 showed that the literature was 'normal' in those years. In seven out of the eleven years studied, however, the literature exhibited 'research front' characteristics. Thus it can be generalized that, based on the Price Index, the field of bibliographical classification tended to be a research front subject during the period covered by this study.

Even though the Price Index has been successfully applied to the literature cited in bibliographical classification, a critical examination should be made of its application to non-scientific subject literatures such as bibliographical classification. Although it is a social science subject, bibliographical classification mostly exhibited the index of the natural sciences, at least during the seven years in which the cited literature was determined to be 'research front'. This result deviates from Price's suggested index for social science subjects which he generally considered soft science subjects.

In general, it is doubtful if frequency of citations to recent publications can be reliably used to determine whether a social science subject is at the research front or not.

Since Price was referring to the use of literature through citations, it would be more appropriate to replace the term 'reserach front.' Thus, for the purposes of this study, the term 'research front' is being changed to 'current.' This is being done in order to conform to other parallel terms used herein, namely, 'archival for older cited literature, and 'normal' for the items cited that fell between the older and the current ones. It can be generalized that bibliographical classification experienced active intellectual discussions during the period covered by this study in the form of regional and international conferences, seminars, workshops, revisions of classification schemes, development of experimental classification, and research on faceted classification systems. The recency of citations may mean simply that concepts in the field changed as rapidly as in the natural sciences with less emphasis on the historical.

Some of the specific intellectual activities that went on during the period were: facet classification, and its application to individual subject fields, theory of integrative levels, the return to the idea of general classification system, the language of classification systems, the application of the computer to facet and hierarchical classifications, and experimental classifications devised to improve bibliographical classification such as latent class analysis, automatic classification, and factor analysis. Commenting on these experiments, Grolier, a bibliographical classificationist,

observed that he was not convinced at all that "these experiments will lead to a practical application in our field."[6] While Richmond observed that whereas the "Library of Congress was well into the classification of its 14th million books, in documentation literature, it is not unusual to find serious proposals to replace this "outmoded" functional general classification system with silly little mechanized schemes that have only been tried on 100-1,000 documents in a highly specific subject field."[7]

The Price Index appears to serve two purposes. First, it measures citations according to their degree of currency and retrospectiveness. Secondly, it attempts to measure whether a subject is at the research front stage or not. It is the view of this researcher that the Price Index is a more suitable measure for dividing the cited literature into current and retrospective than for determining whether a subject is in a 'research front' stage or not, since the frequent use of recent publications may not necessarily be evidence of research activities in a subject field. Recency of citation may rather imply changing concepts, or the nature of a subject field may simply warrant the use of current rather than retrospective publications. It is contended that the term 'research front' in the Price Index is not appropriate, and therefore the term 'current' is suggested for use instead of 'research front.' It is further contended that, whether in the natural sciences, social sciences, or humanities, the frequency of citations

to recent literature may not imply that they are at the research front. Citations in scientific literatures are made up of fairly current publications. Subjects in which citations have this characteristic can be described as having the characteristic of scientific literatures. Based on this concept, the literature of bibliographical classification could therefore be described as having this characteristic of scientific literatures.

Distribution of Citations by Subject

The distribution of the cited journals by subject is shown in Table 13.

TABLE 13

SUBJECT DISPERSION OF CITED JOURNALS
(D = 42)

Subject*	No. of Journals	%
Library & Information Science	126	50.4
Others	124	49.6
Business and Economics	1	0.4
Chemistry	2	0.8
Children and Youth	1	0.4
Communications	2	0.8
Computer Technology & Application	13	5.2
Economics	1	0.4

TABLE 13--Continued

Subject*	No. of Journals	%
Education	8	3.2
Engineering	7	2.8
Ethnic Interests	1	0.4
Food and Food Industries	1	0.4
General Interests	2	0.8
Geography	3	1.2
History	3	1.2
Linguistics	1	0.4
Literary & Political Reviews	1	0.4
Management	1	0.4
Marketing and Purchasing	1	0.4
Mathematics	3	1.2
Medical Sciences	5	2.0
Metallurgy	3	1.2
Meteorology	1	0.4
Music	1	0.4
Paper and Pulp	1	0.4
Philosophy	6	2.4
Physics	2	0.8
Political Science	2	0.8
Psychiatry	2	0.8
Psychology	12	4.8
Public Administration	2	0.8

TABLE 13--Continued

Subject*	No. of Journals	%
Religion and Theology	1	0.4
Science	10	4.0
Social Science	2	0.8
Social Services & Welfare	1	0.4
Sociology	6	2.4
Statistics	4	1.6
Technology	3	1.2
Theater	1	0.4

*Classification based on Ulrich International Directory of Periodicals, 20th ed. (New York & London: Bowker, 1981).

Table 4 shows that there were citations to journals in a wide range of subjects. There were 126 (50.4 percent) journals cited in library and information science, while 124 (49.6 percent) journals were cited in other subjects. Although the citations to other subjects may be considered quite low when compared to the figure obtained for the citing subject, the two outside fields that were most frequently cited were computer technology and applications with 13 (5.2 percent) and psychology with 12 (4.8 percent).

One reason for the prominence of the former is that in recent years, there has been a movement towards the application of computers in bibliographical classification. The application of computers to bibliographical

classification is based on the assumption that computers can be programmed to do the classifying of documents instead of humans. This body of citations can be divided into two areas. The first area is experimental classification, commonly referred to as 'automatic classification.'[8] The second area is the application of the computer to faceted and hierarchical classification schemes.[9-12]

The frequent citation to psychology journals is an indication of the possible application of findings in the field of psychology to the process of bibliographical classification. Among the writers who had attempted to use basic logic as the basis for classification is Groeneveld, who defined classification as the logical process of recognizing classes or kinds.[13] Rejecting the approach of logic, Farradane argued that

> logic offers no criterion for facts or truth, but is only a formalized system for demonstrating consistency between propositions (not between concepts), and hence not applicable to the problems of classification. The recognition of classes is, moreover, not a matter of logic, but is an innate process of perceiving common elements in mental processes, and relations may be recognized between classes, as between single concepts.[14]

Farradane further pointed out that "a sound basis for classification is to be found only in studies of the nature of knowledge and learning, that is, psychology."[15] He contended that classification represents the true structure of knowledge. Richmond noted that "since faceted procedures began much earlier, they have been carried farther and applied more broadly than experimental ones. Psychological

factors have hardly been touched."[16]

The frequency of citation to psychology journals would suggest that some psychological principles have been found useful to bibliographical classification. Some of these useful principles, based on the work of Berelson and Steiner are summarized by Richmond as follows: transfer of training, symbolized and verbalized thought process, discrimination between named things, constancy of fundamental vocabulary, concept formation, concreteness of concepts, identification of concepts, similarity of connotations among similar cultures, use of insight in new situations, methods of problem-solving.[17] Furthermore, the frequency of citation to psychology journals would suggest that there is a shifting emphasis from the principles of logic which characterized the nineteenth-century classification to those of psychology as a basis for constructing modern classification.

Distribution of Citations by Language

The distribution of the citations of the literature of bibliographical classification by language revealed that English was the leading language with 4,160 (89.8 percent) citations. It must be pointed out, however, that more publications in English than in any other language on the subject of bibliographical classification were indexed and abstracted by the sources consulted in the course of gathering data for this study. Another point that deserves mention is that English-speaking nations, especially England, India,

and the United States, have played an important role in the advancement of research in classification. The German language took the second position with 283 (6.11 percent) citations. Another important geographical area that has contributed to classification research is the Soviet Union, where the BBK classification scheme was developed. This was reflected in the study, wherein 103 (2.22 percent) of the citations were to works in the Russian language.

Other languages played far less significant roles in the citation pattern. French had 48 (1.04 percent), Swedish 12 (0.26 percent), Portuguese 8 (0.17 percent), Chinese 5 (0.11 percent), Italian 5 (0.11 percent), Spanish 5 (0.11 percent), and Czech 2 (0.04 percent). Table 14 summarizes the language distribution of the citations.

This pattern of language distribution does not differ significantly from that reported in other subject fields (Table 15). The 6.1 percent obtained in this study for the German language is almost the same as the 6.4 percent obtained by Woods for chemistry, while the 1 percent obtained for French is also similar to that of the 0.5 percent obtained by Cline in library science.

TABLE 14

LANGUAGE DISTRIBUTION OF THE CITED LITERATURE IN BIBLIOGRAPHICAL CLASSIFICATION

Language	No. of Citations	Percentage
English	4,160	89.83
German	283	6.11
Russian	103	2.22
French	48	1.04
Swedish	12	0.26
Portuguese	8	0.17
Chinese	5	0.11
Italian	5	0.11
Spanish	5	0.11
Czech	2	0.04
	4,631	100.00

TABLE 15

LANGUAGE DISTRIBUTION OF SUBJECT LITERATURES

Citation Studies Subject--Author	Percentage English	German	French	Other
Biology--Wood (1967)	75.0	3.0	3.0	19.0
Chemistry--Fussler (1948)	64.5	25.0	3.0	7.5
Chemistry--Wood (1967)	50.3	6.4	7.3	36.0
Classification--Afolabi (1983) (Bibliographical)	89.9	6.1	1.0	3.0

TABLE 15--Continued

Citation Studies Subject--Author	Percentage English	German	French	Other
Library Science--Cline (1980)	97.4	1.0	0.5	1.1
Physics--Fussler (1948)	66.6	22.1	2.9	8.4
Political Science--Stewart (1970)	82.1	—	—	—
Sociology--Baughman (1974)	95.2	0.67	2.05	2.06

*Adapted from Cline[18]

This chapter has examined the characteristics of the cited literature of bibliographical classification by bibliographic format, language, subject, and age. Monographs were the most cited bibliographic form of publication, accounting for 57.2 percent, followed by journal articles with 31.1 percent. The most cited language was English with 89.8 percent. The other two languages most frequently cited were German (6.1 percent) and Russian (2.2 percent). The most frequently cited subjects were psychology and computer technology and its application. The recency of the publications cited in each of the years studied may mean that concepts in bibliographical classification changed as rapidly as in the natural sciences, with less emphasis on the historical. The information provided in this chapter has shed light into the patterns of literature use by bibliographical classificationists.

Notes for Chapter Five

[1]G. C. Cline, "College & Research Libraries: Its First Forty Years," College & Research Libraries 43 (1982): 219.

[2]W. A. Brace, "A Citation Analysis of Doctoral Dissertations in Library and Information Science, 1961-1970 " (Ph.D. Case Western Reserve University, 1975), 157p.

[3]J. L. Stewart, "The Literature of Politics: A Citation Analysis," International Library Review 2 (1970): 331.

[4]A. M. McAnally, "Characteristics of Materials Used in Research in United States History" (Ph.D. dissertation, University of Chicago, 1951).

[5]Cline, "College & Research Libraries: Its First Forty Years," p. 222.

[6]Eric de Grolier, "Current Trends in Theory and Practice of Classification," in Classification Research (Copenhagen: Munksgaard, 1965), p. 14.

[7]Phyllis A. Richmond, Aspects of Recent Research in the Art and Science of Classification (Copenhagen: Danish Centre for Documentation, 1965), p. 53.

[8]_____, Aspects of Recent Research in the Art and Science of Classification, p. 20.

[9]Michael A. Shepherd, "Colon Classification As a Basis for Automated Full Text Retrieval" (Ph.D. dissertation, University of Western Ontario, 1978), 281p.

[10]K. B. Gupta, "Facet Analysis and Machine Coding," Library Herald 9 (1967-68): 292-6.

[11]R. R. Freeman, "Computers and Classification Systems," Journal of Documentation 20 (1964): 137-145.

[12]Malcolm Rigby, Mechanization of the U.D.C: Final Report on Pilot Project to Explore Possibilities for Mehanization of U.D.C. Schedules (Washington, D.C.: American Meteorological Society, Meteorological and Geoastrophysical Abstracts, 1964), 50p.

[13]C. P. Groeneveld, "Over de Grondslagen Van de Classificatie theorie" (On the Principles of Classification), Bibliotheekleven 39 (1954): 221.

[14]Jason E. L. Farradane, "The Psychology of Classification," Journal of Documentation 11 (1955): 188.

[15]Ibid.

[16]Richmond, Aspects of Recent Research in the Art and Science of Classification, p. 25.

[17]Ibid.

[18]Cline, "College & Research Libraries," p. 223.

CHAPTER SIX

SUMMARY AND INTERPRETATION OF FINDINGS, CONCLUSIONS, SIGNIFICANCE OF THE STUDY AND SUGGESTIONS FOR FURTHER STUDIES

The purpose of this chapter is to summarize the problem, purpose, the findings of the study, its limitations, conclusions, its significance, an interpretation of the findings and suggestions for further studies.

Summary of Problem

Several papers and journals may be useful to students of bibliographical classification, but for economic reasons, libraries can seldom acquire all materials that would be useful to these readers. The question then for librarians faced with this problem is: Are there core literature and core journals in bibliographical classification that would be more useful in library science than would the rest of the literature?

Summary of Purpose

The purpose of this study is summarized as follows:

1) To determine and identify the core journals from the population of cited journals in the literature of bibliographical classification;

2) To determine and identify the core papers from the population of cited papers in the literature of bibliographical classification;

3) To determine and identify the core authors from the population of cited authors in the literature of bibliographical classification;

4) To determine the characteristics of the cited literature of bibliographical classification by bibliographic format, language, subject, and age.

Summary of Findings

The findings obtained in this investigation are summarized as follows:

1) The citation of the literature by bibliographic format indicated that monographs were the most cited with 2,648 (57.2 percent) citations, journals 1,441 (31.1 percent), conference proceedings 278 (6 percent), technical reports 139 (3 percent), mimeographs 56 (1.2 percent), theses 46 (1 percent), correspondences 18 (0.4 percent), and audio-visual materials 5 (0.1 percent).

2) The distribution of the cited literature by language was as follows: English 4,160 (89.8 percent), German 283 (6.1 percent), Russian 103 (2.2 percent), French 48 (1 percent), Swedish 12 (0.3 percent), Portuguese 8 (0.2 percent), Chinese 5 (0.1 percent), Italian 5 (0.1 percent), Spanish 5 (0.1 percent), and Czech 2 (0.04 percent).

3) The distribution of citation by subject showed that

the two subject areas that were most frequently cited were psychology and computer technology and its applications.

4) The age of the cited literature using the Price Index revealed that bibliographical classification was a research front subject in 1960 (54.4 percent), 1962 (57.2 percent), 1966 (48.3 percent), 1968 (69.3 percent), 1970 (42.9 percent), 1976 (57.4 percent), and 1978 (43.6 percent). It was a 'normal' subject in 1964 (32.0 percent), 1972 (40.9 percent), and 1974 (39.3 percent), and an 'archival' subject in 1980 (14 percent). The recency of the publications cited in each of the years studied may mean that concepts in bibliographical classification were changing as rapidly as in the natural sciences.

5) The study revealed that there were six core journals. Their titles, and the number of times they were cited were as follows: Journal of Documentation 148 (10.6 percent), Library Resources and Technical Services 135(9.7 percent), American Society for Information Science Journal (formerly American Documentation) 93 (6.7 percent), Library Association Record 65 (4.7 percent), Aslib Proceedings 57 (4.1 percent), and Library Science with a Slant to Documentation 55 (3.9 percent).

6) The study revealed that there was one core author, S. R. Ranganathan, creator of the Colon Classification and the scholar who introduced facet analysis in bibliographical classification. The highly cited authors were linked to the Bangalore Documentation Research Group (India) and the

British Classification Research Group.

7) The test for core literature in bibliographical classification using the Bradford distribution revealed a a positive finding-- there were two core papers. These are, Prolegomena to Library Classification, 3rd ed. 1967, by S. R. Ranganathan and Classification and Indexing in Science, 2nd ed. 1958, by B. C. Vickery.

8) The application of Bradford's distribution to the data gathered for this study revealed that the data on journal titles and authors conformed to the distribution, while there was less conformity in the data on the cited papers. The verbal formulation of Bradford's law conformed more to the law with the data on authors than the graphical formulation. In the case of the data on journals, the graphical formulation was closer to the law. A comparison of the two formulae could not be made on the data for the cited papers because of the absence of the linear part of the bibliograph drawn.

Limitations

This study is limited in the following ways:

1) Data: the unavailability of publications other than journal articles in Russian, German and Spanish for citation gathering was a limitation. The ninety-three items that were not available for analysis comprised journal articles, monographs, technical reports, and conference proceedings largely published in countries outside the United States and the

seven masters theses submitted to American library schools. These items appeared from their titles and, in some cases, annotations to deal with the subject of bibliographical classification, but since they were not available for analysis, it was not possible to determine if they contained citations or to estimate the number of citations contained in them.

It may have been that the inclusion of those items containing citations might have strengthened somewhat the findings of this study. There is nonetheless a strong reliability in the findings obtained from analysis just of the items that were available for the study, since these included most of the dissertations and all of the scholarly journals which regularly cover the subject-- Journal of Documentation, Library Resources and Technical Services, Library Science with a Slant to Documentation, International Classification, Tidskrift for Documentation, Sovetskoe Bibliotekovedenie, and Zentralblatt fur Bibliothekswesen-- as well as most of the monographs published in the years studied. These available items represented 85 percent of the total items examined for the study.

If it is assumed that the ninety-three eliminated items all contained citations, it then seems likely that the rankings of the cited papers and cited journals would have been affected. With increase in the data base, the citation scores for some cited journals and papers would likely have increased, thereby altering the existing

rankings as provided in Appendix I. Some new cited journals and papers would also likely have appeared on the new list of ranked journals and papers. In the ranking of the cited authors, however, it is contended that any alteration in the rankings of the cited authors would have applied to all the Bradfordian zones except the core zone or Zone 1. The reason for this is that even if the ninety-three papers did cite the three authors determined in the second zone, the citation score for each of those three authors would still be less than that obtained by the only author determined in Zone 1.

The exclusion of the citations in the papers indexed under the eliminated "see also" subject headings would, possibly, have the following effects on the following major findings:

(a) Ranked list of cited authors: it is likely that an analysis of the citations in the papers under these headings would have affected the author rankings in two respects. First, some authors in the ranked list of cited authors could be expected to have papers in the subject areas excluded. Some of these papers might have been cited in the papers dealing with these excluded subject areas. If these papers had been included in this study and their citations analyzed, the total citation scores for some of the authors would have been higher than the scores presently given in Appendix II. Secondly, it is likely that the present Bradfordian zones determined in the study for the

cited authors would be altered in both the number of authors for each zone and the citation scores for many of the authors, because the inclusion of the citations from the papers on the excluded subject areas would have increased the citations received by some authors. Furthermore, new authors would likely have emerged on the ranked list.

It is possible that authors like Salton, Austin and Freeman who have written on some of the eliminated subject headings would have moved up on the ranked list. This is not to say that some of the highly cited authors in the present ranked list of cited authors such as Foskett, Vickery, Richmond and Neelameghan have not also written on the subject of indexing, it is rather possible that they too would be cited, which would have increased their citation scores.

b) Ranked list of cited journals: the rankings of the cited journals would be affected in ways similar to the cited authors. Journals like The Indexer, Communications of the Association for Computing Machinery and Journal of the Association for Computing Machinery might have been ranked higher since they are frequently cited in papers dealing with the subject of the eliminated entries. It is also likely that other journals might have appeared on the list, thus altering the present rankings. It is probable that the number of core journals, for instance, might have increased or decreased, with the presence of additional data.

(c) Ranked list of cited papers: Like the rankings on the cited authors and journals, the rankings of the cited papers would have been affected if the eliminated entries had been included in this study. Their inclusion would not only have raised the citation counts for some papers on the present list, but would also have caused others to be added that did not make their appearance on this list, especially frequently cited papers on the subject of the eliminated entries. An examination of the highly cited papers in Appendix III with reference to the top three zones reveals that none of the cited papers belonged to the subject areas excluded from the study.

It is, however, very unlikely that the inclusion of citation data from the eliminated entries would affect the pattern established in the distribution of citations by form, language and subject of publication. The distribution of citations by age is, however, likely to be affected by the inclusion of those additional data.

2) Statistical technique: the ambiguity created by the different results obtained for the verbal and graphical formulations limited the strength of the claims of the Bradford's distribution. Similar results by the two formulations would have given the investigator the assurance that either of the two methods could be applied without having to apply Wilkinson's formulae. This study has shown that it is necessary to employ the two methods and use Wilkinson's formulation to test for the difference since one may not

be sure which formulation is closer to Bradford's distribution.

3) Subject distribution: the subject distribution in this study is based on the subjects of journals cited instead of the actual works cited. The reason for taking this approach was given in Chapter Three. This is a limitation of the study because the distribution is limited to journals.

Conclusion

On the basis of the findings summarized above, the following conclusions are made. It has been determined in this study that there is a strong core of journals but a weak core literature in bibliographical classification. The lack of a strong core literature suggests that the knowledge base in bibliographical classification is spread over many titles. The cited papers did not show a substantial number of citations made to them as had been initially anticipated. The initial assumption that the study's data would conform to Bradford's law proved to be valid for the data on cited journals and cited authors, but less valid for those on cited papers. The two core papers, as well as many of the other top papers, were monographs. This is not surprising because the study showed that monographs were the most cited bibliographic format and both core papers substantially dealt with facet classification. Bibliographical classification can therefore be characterized as a subject with a very small core literature, monographic-oriented, predominantly English,

a more frequent use of current than retrospective publications, rapidly changing concepts, a frequent use of publications in psychology, computer technology and its applications, and a preponderance of advances in the subject being made by librarians from England, India, and the United States of America.

Significance of the Study

This study is significant in four areas, namely practical, theoretical, communication, and the technique used.

The practical significance of the study lies in the selection and discarding procedures in library science libraries. The list of cited journals and papers provided in Appendix I and III can be used to select the highly cited journals and papers that have not yet been part of their collections. The two lists could also be used to decide on the cancellation of the least cited journals being subscribed to and removing the least cited monographs from library shelves if space for shelving publications becomes a problem. This investigator recognizes the fact that a number of factors are considered when a library is acquiring publications in a subject field. It is, however, worth mentioning that these two lists should be used as aids in decision making. Language and geographical factors would, for instance, be given high priority by libraries in some countries. For instance, German libraries are likely to place their priority on Zentralblatt fur Bibliothekswesen and

Nachrichten fur Dokumentation, Soviet libraries would consider Sovetskaja Bibliografija as the more frequently used journal in this field in the Russian language, while Library Science with Slant to Documentation would be highly regarded by Indian librarians. The choice of which journals to acquire will certainly vary from one library to another.

The theoretical significance of the study is that it has shown that if the verbal and graphical formulations of the Bradford's law are applied to the same citation data, there is a difference in the results. This calls for the experimentation of both formulations to determine the one that closely conforms to the law. The study has also shown that apart from the data on the cited journals, the graphical and verbal formulations of Bradford's law were less successfully applied to the data on the cited authors and papers. This implies that some citation data may not conform to Bradford's formulation, because citation data are not bibliographically homogeneous. Another theoretical dimension of the study is that the highly cited authors were linked to the two most active theory and research groups in bibliographical classification.

Another significance of this study is the communication patterns it has revealed. It has provided an insight into the patterns of the use of information sources in the literature of bibliographical classification. We now know the most frequently cited journals, papers, authors and the bibliographic format, language, subject, and age of citations in the

literature of bibliographical classification. This quantitative approach sheds light into the patterns of literature usage in the subject field. The study has confirmed the significance of Ranganathan to bibliographical classification in terms of the significance of his publications. As the one who brought about the facet period in bibliographic classification through the publication of the Colon Classification, the study determined him as the only core author. His ideas on faceted classification have influenced modern thoughts on the subject. The importance of this influence was the subject of Matthews' doctoral dissertation.[1] Ranganathan's leading position in this study's ranked list of cited authors, therefore, quantitatively confirms the significance of his contributions to biliographical classification. His principles on classification in general and faceted classification in particular are expounded in his Prolegomena to Library Classification, the second and third editions of which appeared as the first and third highly cited papers in the ranked list of papers in this study.

This study has also quantitatively corroborated the view that bibliographical classification is indeed in a fecet period. At the onset, the study sought to find out if the papers that would be determined as core would largely deal with faceted classification. The study also confirmed the leading position of Dewey Decimal Classification over other classification schemes, for the ranked list of cited papers revealed that it was the highly cited classification scheme.

The low citations to papers is an indication of a frequent revision of publications and shifting emphasis in the subject field. This view appears to be supported by the result obtained in the analysis of citations by age, in which it was reported that the writers in the field frequently relied upon current publications.

The significance of citation analysis as a technique for determining the core journals and papers is that it enables one to produce lists of highly and lowly cited journals and papers that can be used to decide what to select and possibly acquire and what to discard. If such citation based lists were produced for other sub-fields of library and information science, an objective approach to the acquisition, discarding, and non-acquisition of publications would be available for use when the need arises. Although there will be overlap in the lists that will be produced, the top highly cited journals and papers in each sub-field would certainly differ. This point was confirmed by the result of this study. The six journals determined by this study differed from the result obtained by Brace in his ranking of the cited journals in library and information science.[2] The only journal determined as core in his list was Library Journal, a general professional journal that did not appear in the list of core journals determined for this study. This comparison indicates that the core journals in a sub-field are likely to be different from those that are devoted to the general aspects of the subject field.

Interpretation of Findings

It is pertinent to provide an overview to the study. Consequently, an interpretation of the findings obtained in the study is made in this section.

Citation Analysis

Despite the fact that citation analysis has been criticized for not necessarily being a measure of significance, it continues to attract the attention of many writers whose findings have useful practical application for libraries. Citation analysis has two important values: first, it is an unobstrusive measure of literature use; and secondly, it takes into account literature use in different countries which makes it possible for a researcher to generalize on the pattern of literature use in a subject field. If in a citation study that covered publications from many countries, some papers, authors, or journals were frequently referred to in the literature, it could be considered an indication of their significance. There is no reason why a paper that has made an important contribution to knowledge should not be cited. In bibliometrics for instance, Bradford's Documentation published in 1950 continues to be cited by most writings in this area because of the important contribution it made to the understanding of subject literatures. The journals usually identified in the core zone of most citation studies have been primary journals in the fields studied. This shows some validity in the use of the technique.

In this study, one core author, two core papers, and six core journals were determined. There is no doubt about the significance of Ranganathan in the field of bibliographical classification. His ideas on facet analysis have largely influenced the approaches to modern classification. The two publications identified as core are by no means less important in terms of the subjects they treated. Both dealt with facet analysis in classification, an approach to modern classification practice. These books were written by authors that bibliographical classificationists might regard as leaders in the field-- one being Ranganathan, the bibliographical classificationist from India and the other Vickery, the notable British bibliographical classificationist who wrote widely on faceted classification. The journals determined as core are also significant journals in the field. In the North American library scene, the two professional journals that bibliographical classificationists would readily regard as important to their field are Library Resources and Technical Services and American Society for Information Science Journal. The significance of the Journal of Documentation is not limited to Britain, its country of origin, but is world-wide. Library Science with a Slant to Documentation is a significant journal in terms of its original contributions to concepts of modern classification by the Indian classification school. It is worth mentioning that the journal was founded by S. R. Ranganathan, the author determined as the core author in this study. The

significance of the two general professional journals, Library Association Record and Aslib Proceedings to bibliographical classification cannot be underestimated. These are leading professional journals in Britain.

The journal International Classification did not appear as a core journal. Although it came into existence in 1974, one would have expected that being an international journal, its articles would quickly attract the attention of writers who would want to cite them in their publications. Its articles did not, however, attract many citations (Appendix I). Three possible reasons can be adduced for this outcome. First, the journal is one of the latest in the field; and like many new journals, it takes some time before its articles get cited. A second reason might be that many of the articles published by the journal are not specifically devoted to bibliographical classification. A cursory examination of the articles published by the journal revealed that many of the articles dealt with subject headings, indexing, thesaurus and information retrieval, although these had been included in the objectives of the journal. The third reason is that the present study included years in the sixties but the journal was not in existence then. This gave the articles in the existing journals the chance to be cited more than the articles in this journal.

In addition to the identification of core papers, core authors, and core journals, the citation approach has been used to identify the patterns of the use of literature

in a subject field. In this study, the pattern of literature usage in bibliographical classification was determined through the use of citation analysis. The findings revealed that although a variety of publication formats were cited, the most frequently cited formats were monographs and journals. This pattern conformed to use patterns in other subject literatures. This is an indication of the importance of these two formats in the field. The fact that English was the dominant language also showed its importance as the communication language in bibliographical classification. This finding concurred with findings in studies of other subject literatures. It is well known that the English-speaking world particularly England, United States and India, have contributed significantly to the progress of bibliographical classification. Bibliographical classification experienced active intellectual discussions during the period covered by this study. The recency of the publications cited in each of the years studied may mean that concepts in bibliographical classification changed as rapidly as in the natural sciences with less emphasis on the historical. The frequency of citation to psychology implies the possible application of findings in psychology to bibliographical classification while the frequency of citation to computer technology shows a movement towards the application of computers to the subject field.

The citation patterns examined in this study in terms of bibliographic formats, age, subject, language, and frequently

cited papers and journals provide a picture of the use of materials in the literature of bibliographical classification.

Application of Bradford's Distribution

Many previous studies have applied the graphical formulation of Bradford's law to their data. The verbal formulation has so far appeared to be less popular. This may be due to the difficulty in determining the core zone. This study applied both verbal and graphical formulations and found out that they yielded different results. The dilemma was resolved through the application of Wilkinson's formulae which enabled the study to determine which formulation was closer to Bradford's law. In the analysis of the data on cited journals, the graphical formulation was accepted; in the data for authors, the verbal formulation was accepted; while in the data for papers, the verbal formulation was accepted. This finding has implications for future citation studies that would apply Bradford's distribution. It calls for testing of both formulations on the same data and the possible application of Wilkinson's formulae to determine which formulation is closer to the law. It is possible that some previous citation studies that determined core journals based solely on the graphical formulation might have produced a longer or a shorter list of core journals. This study's finding also has implications for library acquisitions.

In recommending core journals for library acquisition, it is essential to apply both formulations and test for the one closer to Bradford's law. When this approach was adopted in this study, there were some surprising results. In the case of cited journals, the verbal formulation yielded two core journals whereas the graphical formulation which was found to be closer to the law in terms of less percentage errors, produced six core journals. In the case of cited authors, the graphical formulation yielded eighteen core authors whereas the verbal formulation, which was accepted, had two cited papers. This therefore points to the need to compare the results of both formulations before reaching conclusions. Bradford's law was formulated to apply to the number of articles published by journals on a particular subject. It has, however, been found to apply to citation data, especially the citation of journals. Brookes has shown that the law may not fit some citation data. The findings of this study revealed that the data on the cited journals and authors conformed to the Bradford's law, except the application of the graphical formulation to the data on papers. The large percentage errors obtained could be attributed to the fact that Wilkinson's formulae which were applied may be less appropriate as a predictive instrument for citation data since, unlike bibliographies, there is no limit to the number of citations that can be made.

The study determined that there were two core papers. This is a surprisingly low figure. Subjectively, one would

have expected more than this figure in the core zone.

Core papers could not be determined from the graphical formulation. This may be due to the low citation figures recorded for the cited papers in general. Brace's application of the law to the cited papers in library and information science revealed an absence of a core literature, and attributed this result to the low citations made to individual papers.[3] It appears that the low citations recorded for the cited papers in this study accounted for the low number of core papers and the inability of the graphical formulation to conform to the typical Bradford-Zipf bibliograph.

The application of Wilkinson's formula in the study to test for which of the two Bradford's formulation--verbal or graphical--conforms closer to the law produced positive results in its application to the cited journals and negative results in the cited authors. The explanation is that citations are not bibliographically homogeneous: Citations to other papers or journals by papers in bibliographical classification are not all to other papers in which would be classified as "bibliographical classification:" they may refer to philosophy, technology, history, education, and so on. So, this creates a difficulty in the total conformity of citations to the Bradford's distribution. Bibliographs drawn from citation data may sometimes not conform to the typical Bradford-Zipf distributon. Infact some may yield only Zipf distributions, as in the bibliograph of citation data in plasma physics.[4] It is therefore not surprising that the

bibliograph drawn for the cited papers did not produce a typical Bradford-Zipf bibliograph and that drawn for the cited authors had its Groos droop deviated to the left instead of the right. The bibliograph drawn for the cited journals, however, produced a typical Bradford-Zipf bibliograph. These graphs suggest that for this study, the data on the cited journals conform to the Bradford-Zipf bibliograph more than those on cited authors and papers.

The linkage of the highly cited authors to the central personalities of the classification research groups in Britain and India justifies the use of citations as one technique for determining the authors that are central to subject field.

Use of the Technique in Planning Library Acquisitions

The librarian of the library science library must adopt approaches that are cost-effective in the management of the library. One such approach is the use of Bradford's model to winnow a long list of cited papers and journals to a smaller but most useful one. By acquiring the core publications, the library science library on a low budget is acquiring a small number of publications that will be most frequently used. This becomes increasingly necessary when the librarian has also to acquire publications in other sub-fields of library and information science. The approach not only serves the useful purpose of being a guide to the selection of publications, but can be used by the librarian

also to justify his or her acquisition requests.

It must be borne in mind that various academic departments in a university compete for funds annually. A department that requests sufficient allocation, would have to provide adequate and convincing justification for consideration by the university administrators. The increasing number and cost of publications especially journal subscriptions make it highly necessary for a library to base its acquisition on core publications. The tight budgets that libraries have experienced in recent years create problems and difficulties, but White perceives the problem as creating "opportunities in providing an environment that requires strong management, intense critical examination, coordination, and cooperation-- all of them very much necessary and perhaps long overdue."[5] The use of the citation technique promises to be effective in measuring the use of publications, and it is through the use of such a technique that a library would be able to strengthen its acquisition requests.

Suggestions for Further Study

The following topics are suggested for further investigation:

1). Productivity of the literature of bibliographical classification: The focus of this study was on the cited literature of bibliographical classification. It would be useful to perform a productivity analysis to determine the

most productive author, journal, and country in the literature of bibliographical classification. The results of such a study could be compared to the findings of this study to determine, for example, if the core journals determined by this study are also the core journals determined in such a study.

2) Citation patterns in the works of classification research groups: A useful study could also be conducted on the specific citation patterns in the writings of the Classification Research Group (England), or that of India to determine their citation behavior.

3) Citation data and Bradford's Law: Further citation studies are needed to apply the verbal and graphical formulations of Bradford's law to the same data to test which formulation is closer to the law.

4) An analytical study of the articles published by International Classification: This small scale study is needed to determine the topic distribution of the articles published by this international journal. For instance, one question that might be asked is that: What is the percentage of articles devoted to bibliographical classification by this journal?

5) Research on the use of the Library of Congress corporate heading in citations: The United States Library of Congress occupied the second position in the ranked list of cited authors. This position is a manifestation of the important role played by this library with one of the

largest collections in the world. It is the home of a popular classification scheme, the Library of Congress Classification, which was heavily cited in this study. Several other publications cited were also published by this library. It should be noted that although some of the Library of Congress' publications have editors or compilers, in many cases authors who cited these works used the corporate name "United States, Library of Congress" as author rather than the personal names of those editors, compilers, or committees. Since citation information per se is likely to exclude the names of editors, compilers or committees, further breakdown of this bloc of entries could have been done only by locating copies of these cited publications and examining their preliminary pages. Although this was not done in the present study, such an examination might have produced meaningful results, and it is therefore suggested that a further study be conducted on the citation of such corporate authors as the Library of Congress.

6) Research on the "see also" subject headings: Since it is possible that the author, journal and paper rankings in this study might alter if the citations in the papers indexed under the "see also" subject headings such as "thesaurus," "indexing," and "subject heading," a study that would include the citations in the papers indexed under these headings is suggested. The results of such a study could be compared to those obtained in the present one to

determine differences and similarities in the rankings of cited papers, authors and journals.

Notes for Chapter Six

[1]G. O. Matthews, "The Influence of Ranganathan on Faceted Classification" (Ph.D. dissertation, Case Western Reserve University, 1980), 197p.

[2]William A. Brace, "A Citation Analysis of Dissertations in Library and Information Science" (Ph.D. dissertation, Case Western Reserve University, 1975), p. 50.

[3]Ibid., p. 85.

[4]B. C. Brookes, "Bradford's Law and the Bibliography of Science," Nature 224 (1969): 955.

[5]Herbert S. White, "Library Management in the Tight Budget Seventies: Problems, Challenges, and Opportunities," Bulletin of the Medical Library Association 65 (1977): 12.

APPENDIX I

RANKED LIST OF JOURNALS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (ZONE 1 AND 2 OF BRADFORD'S DISTRIBUTION)

Journal Title	Citations
Zone 1	
Journal of Documentation	148
Library Resources and Technical Services	135
American Society for Information Science Journal (formerly American Documentation)	93
Library Association Record	65
Aslib Proceedings	57
Library Science with Slant to Documentation	55
Zone 2	
Library Journal	39
Information Processing and Management (formerly Information Storage and Retrieval)	35
Review of Documentation	35
Zentralblatt fur Bibliothekswesen	35
Annals of Library Science	28
Libri	28
Nachrichten fur Dokumentation	24
College & Research Libraries	23
Journal of the Association for Computing Machinery	22
American Archivist	20
Library Quarterly	20

APPENDIX I--Continued

Journal Title	Citations
Zone 2	
Unesco Journal of Information Science, Librarianship and Archives Administration (formerly Unesco Bulletin for Libraries)	20
Wilson Library Bulletin	17
Indian Librarian	16
Special Libraries	16
Library Trends	15
DK-Mitteilungen	14
Journal of Librarianship	13
Zeitschrift fur Bibliothekswesen und Bibliographie	13
Library of Congress Information Bulletin	11
Communications of the ACM	10
Sovetskaja Bibliografija	10
Catalogue and Index	9
Drexel Library Quarterly	9
International Classification	9
Journal of Cataloging and Classification	9
Science	9
32 Other Journals with 3 Citations and above in Zone 3	
American Libraries	8
British Journal for the Philosophy of Science	8
Computer Journal	8
Law Library Journal	8
Journal of Library Automation	8

APPENDIX I--Continued

Journal Title	Citations
Bulletin of the Medical Library Association	8
Journal of Chemical Information & Documentation	7
Library World	7
Annals, Indian Library Association	6
Australian Library Journal	6
Education Libraries Bulletin	6
IBM Journal of Research & Development	6
Program	6
Architects Journal	4
Bulletin de Bibliothèques de France	4
Datamation	4
Indexer	4
The Information Scientist	4
International Cataloging	4
International Social Science Journal	4
Network	4
New Zealand Libraries	4
Nigerian Libraries	4
PNLA Quarterly	4
Australian Academic & Research Libraries	3
FID News Bulletin	3
IEEE Transaction Electronic Computers	3
International Library Review	3
Library Herald	3
Library Review	3

APPENDIX I--Continued

Journal Title	Citations
Notices of the American Mathematical Society	3
Tidschrift fur Documentation	3

APPENDIX II

RANKED LIST OF AUTHORS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (ZONES 1-6)

Author	Citations
Zone 1	
Ranganathan, S. R.	302
Zone 2	
United States. Library of Congress	143
Foskett, D. J.	95
Vickery, B. C.	93
Zone 3	
Dewey Decimal Classification. Editorial Committee	79
Bliss, Henry Evelyn	66
Mills, Jack	54
Federation Internationale de la Documentation FID)	51
Neelameghan, A.	51
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APPENDIX III

RANKED LIST OF PAPERS CITED IN THE LITERATURE OF BIBLIOGRAPHICAL CLASSIFICATION (ZONES 1 TO 10)

Paper	Citations
Zone 1	
Ranganathan, S. R. Prolegomena to Library Classification. 3rd ed. Bombay, Asia Publishing House, 1967.	33
Vickery, B. C. Classification and Indexing in Science. 2nd ed. London: Butterworths, 1958.	24
Zone 2	
Ranganathan, S. R. Prolegomena to Library Classification. 2nd ed. London: Library Association, 1957.	21
Bliss, H. E. A Bibliographic Classification. New York: W. H. Wilson & Co., 1953.	19
Bliss, H. E. The Organization of Knowledge in Libraries and the Subject Approach to Books. 2nd ed. New York: H. W. Wilson,1939.	18
Mills, Jack, A Modern Outline of Library Classification. London: Chapman and Hall, 1960.	18
Zone 3	
Dewey Decimal Classification. Editorial Committee. Decimal Classification. 16th ed. Lake Placid Club, Forest Press Inc., Essex County, 1958.	17
Dewey Decimal Classification. Editorial Committee. Decimal Classification. 17th ed. Lake Placid Club, New York: Forest Press, 1965.	17
Dewey Decimal Classification. Editorial Committee. Decimal Classification. 18th ed. Lake Placid Club, New York: Forest Press Inc., 1971.	17

APPENDIX III--Continued

Paper	Citations
Zone 3 (cont'd)	
Palmer, B. I. and Wells, A. J. The fundamentals of Library Classification. London: Allen and Unwin, 1951.	17
Zone 4	
LaMontagne, Leo E. American Library Classification with Special Reference to the Library of Congress. Hamden, Conn.: Shoe String Press, 1961.	14
Farradane, J. E. L. A Scientific Theory of Classification and Indexing and its Practical Applications. Journal of Documentation, 6 (1950): 84-85.	13
Grolier, Eric de. A Study of General Categories Applicable to Classification and Coding in Documentation. Paris: Unesco, 1962.	13
Sayers, W. C. Berwick. A Manual of Classification for Librarians. 3rd. ed. London: Andre Deutch, 1962.	13
Zone 5	
Foskett, D. J. Classification for a General Index Language: A Review of Recent Research by the Classification Research Group. London: Library Association, 1970.	12
Ranganathan, S. R. Design of Depth Classification Methodology. Library Science with Slant to Documentation, 1 (1964), Paper A.	12
Sayers, W. C. Berwick. A Manual of Classification for Librarians. 4th ed. revised and rewritten by Arthur Maltby. London: Andre Deutch, 1967.	12
Dewey, Melvil. A Classification and Subject Index for Cataloguing and Arranging the Books and Pamphlets of a Library. Amherst, Mass.: 1876.	11
Ranganathan, S. R. Elements of Library Classification. 3rd ed. Bombay: Asia Publishing House, 1962.	11

APPENDIX III--Continued

Paper	Citations
Zone 6	
British Standards Institution. Guide to the Universal Decimal Classification (UDC). BSI, 1963.	10
Perreault, Jean M. Reclassification: Rationale and Problems. Proceedings of a conference on classification. University of Maryland, 1968.	10
Ranganathan, S. R. Colon Classification (Rutgers' series for the intellectual organization of knowledge. Susan Artandi, editor. Rutgers State University, Graduate School of Library Science, 1965.	10
Vickery, B. C. Faceted Classification. London: Aslib, 1960.	10
American Library Association. Resources and Technical Services Division, Cataloging and Classification Committee. Statement on Types of Classification Available to New Academic Libraries. Library Resources & Technical Services, 9 (1965): 104-11.	9
Bliss, H. E. The Organization of Knowledge in Libraries and the Subject Approach to Books. New York: H. W. Wilson & Co., 1939.	9
Foskett, D. J. Classification and Indexing in the Social Sciences. London: Butterworths, 1963.	9
Zone 7	
Bliss, H. E. Organization of knowledge and the System of the sciences. New York: Holt & Co., 1929.	8
Classification Research Group. Classification and Information Control. London: Library Association, 1969.	8
Coates, E. J. Subject Catalogues: Headings and Structure. London: Library Association, 1960.	8

APPENDIX III--Continued

Paper	Citations
Zone 7 (cont'd)	
Mann, Margaret. Introduction to Cataloging and the Classification of Books. 2nd ed. Chicago: American Library Association, 1943.	8
Vickery, B. C. On Retrieval System Theory. London: Butterworths, 1961.	8
Zone 8	
Angell, R. S. On the Future of the Library of Congress Classification. In Classification Research. Proceedings of the 2nd International Study Conference. Elsinore, Denmark Sep. 14-18, edited by Pauline Atherton. Copenhagen: Munksgaard, 1965, pp. 101-112.	7
Federation Internationale de la Documentation. Guide to the Universal Decimal Classification, 3rd abridged edition, BSI, 1961.	7
Coates, E. A. The British Catalogue of Music Classification. London: Council of the British National Bibliography, 1960.	7
Custer, B. A. Dewey 17: A Preview and Report to the Profession. Library Association Record, 67 (1965): 79-83.	7
Dewey, Melvil. Dewey Decimal Classification and Relative Index. 2nd ed. Boston: Library Bureau, 1885.	7
Fairthorne, R. A. Towards Information Retrieval. London: Butterworths, 1961.	7
Foskett, A. C. The Subject Approach to Information. Hamden, Conn.: Archon Books, 1969.	7
Kelly, G. O. The Classification of Books: An Inquiry into Its Usefulness to the Reader. New York: H. W. Wilson, 1937.	7
Kyle, Barbara. Towards a Classification of Social Science Literature. American Documentation, 9 (1958): 168.	7

APPENDIX III--Continued

Paper	Citations
Zone 8 (cont'd)	
Metcalfe, John. Information Indexing and Subject Cataloging. New York: The Scarecrow Press, 1957.	7
Mills, Jack. Universal Decimal Classification. New Bruinswick, N.J.: Rutgers State University, 1964.	7
Perreault, J. M. Categories and Relators: A New Scheme. Revue Internationale de la Documentation, xxxii (1965): 136-144.	7
Ranganathan, S. R. Prolegomena to Library Classification. Madras: Madras Library Association, 1937.	7
Ranganathan, S. R. Self-perpetuating Scheme of Classification. Journal of Documentation, 4 (1949): 223-244.	7
Rider, Fremont. International Classification. Middletown, Connecticut: The Author, 1961.	7
Shera, Jesse H. & Egan, Margaret. The Classified Catalog. Chicago: American Library Association, 1956.	7
Vickery, B. C. The UDC and Technical Information Indexing. Unesco Bulletin for Libraries, 15 (1961): 126-138.	7
Zone 9	
Clapp, V. W. Progress Towards the Sixteenth Edition of Dewey. Journal of Cataloging and Classification, 12 (1956): 196-208.	6
Coates, E. J. Notation in Classification. In Proceedings of the International Study Conference on Classification for Information Retrieval. London: Aslib, 1957.	6
Foskett, D. J. Classification and Integrative Levels. In: The Sayers Memorial Volume. London: Library Association, 1961, pp. 136-150.	6

APPENDIX III--Continued

Paper	Citations
Zone 9 (cont'd)	
Freeman, Robert. Computers and Classification Systems. Journal of Documentation, 20 (1964): 137-143.	6
McGaw, H. F. Reclassification: A Bibliography. Library Resources and Technical Services, 9 (1965): 483-88.	6
Merrill, W. S. Code for Classifiers. Chicago: American Library Association, 1939.	6
Metcalfe, John. Subject Classifying and Indexing of Libraries and Literature. New York: The Scarecrow Press, Inc., 1959.	6
Maltby, A. ed. Classification in the 1970s. Hamden, Conn.: Linnet, 1976.	6
Needham, R. M. and Jones, K. S. Keywords and Clumps. Journal of Documentation, 20 (1964):	6
Palmer, B. I. Itself an Education: Six Lectures on Classification. London: Library Association, 1962.	6
Ranganathan, S. R. Library Classification Through a Century. Classification Research. Edited by Pauline Atherton. Copenhagen: Munksgaard,1965.	6
Ranganathan, S. R. Colon Classification. 6th ed. London: Aslib, 1960.	6
Rigby, Malcolm. Computers and the UDC: A Decade of Progress, 1963-1973. The Hague: F.I.D., 1974.	6
Zone 10	
Aitchison, Jean et al. Thesaurofacet: A Thesaurus and Faceted Classification for Engineering and Related Subjects. Whetstone, England, English Electric Co., 1969.	5
Baker, F. B. Information Retrieval based on Latent Class Analysis. Journal of the ACM, 9 (1962): 512-21.	5

APPENDIX III--Continued

Paper	Citations
Zone 10 (cont'd)	
Cutter, C. A. Expansive Classification. Boston: C. A. Cutter, 1891-93.	5
Cutter, C. A. Rules for Dictionary Catalog. Washington: Government Printing Office, 1904.	5
Dewey Decimal Classification. Editorial Committee. Decimal Classification. Ed. 14. Lake Placid Club, New York: Forest Press, 1942.	5
Doyle, L. B. Indexing and Abstracting by Association. American Documentation, 13 (1962): 378-390.	5
Engineering Joint Council. Thesaurus of Engineering Terms. New York: Engineering Joint Council, 1964.	5
Farradane, J. E. L. The Psychology of Classification. Journal of Documentation, 11 (1955): 187-201.	5
Foskett, A. C. The Universal Decimal Classification: the History, Present Status and Future Prospects of a Large General Classification Scheme. London: Bingley, 1973.	5
Freeman, R. R. The Management of a Classification Scheme: Modern Approaches Exemplified by the UDC Project of the American Institute of Physics. Journal of Documentation, 23 (1967): 304-320.	5
Gardin, J. C. SYNTOL. Rutgers State University, School of Library Science, 1965.	5
Gore, D. A Neglected Topic: The Cost of Classification. Library Journal, 89 (1964): 2287-91.	5
Kyle, B. The Universal Decimal Classification: A Study of the Present Position. Unesco Bulletin for Libraries, 15 (1961): 53-96.	5
Matthis, R. E. and Taylor, D. Adopting the Library of Congress Classification System. New York: Bowker, 1971.	5
Parkhi, R. S. Decimal Classification and Colon Classification in Perspective. Bombay: Asia Publishing House, 1964.	5

APPENDIX III--Continued

Paper	Citations
Zone 10 (cont'd)	
Proceedings of the International Study Conference on Classification for Information Retrieval. London: Aslib, 1957.	5
Ranganathan, S. R. Colon Classification. Madras: Madras Library Association, 1933.	5
Ranganathan, S. R. Colon Classification and Its Approach to Documentation. In Shera, J. H. and Egan, M. E. Bibliographic Organization. Chicago: University of Chicago Press, 1951.	5
Ranganathan, S. R. Colon Classification. 5th ed. Madras: Madras Library Association, 1957.	5
Richardson, E. C. Classification, Theoretical and Practical. 3rd ed. New York: H. W. Wilson, 1930.	5
Rigby, Malcolm. Mechanization of the UDC: Final Report on Pilot Project to Further Explore Possibilities for Mechanization of UDC Schedules. Washington: American Meteorological Society, 1964. PB 166 412.	5
Roberts, N. An Examination of the Personality Concept and Its Relevance to the Colon Classification. Journal of Librarianship, 1 (1969): 131-148.	5
Samore, T. Problems in Library Classification, Dewey 17 and Conversion. Papers Presented at a Two-phase Conference Held at the University of Wisconsin, Milwaukee, School of Library & Information Science, November 1966 and May 1967, New York: R. R. Bowker, 1968.	5
Taube, Mortimer. Studies in Coordinate Indexing. 5 vols. Washington, D.C.: Documentation Inc., 1953-9.	5
Webster, A. M. Webster's Third New International Dictionary. London: G. Bell & Sons Ltd., 1961.	5
Welsh, W. J. Considerations on the Adoption of the Library of Congress Classification. Library Resources and Technical Services, 11 (1967): 345-353.	5

APPENDIX IV

SOURCES OF DATA COLLECTION

Journals

American Archivist 1966, 1968

American Documentation 1964, 1966, 1968

American Libraries 1972

American Society for Information Science Journal 1974, 1976, 1978

Annals of Library Science and Documentation 1960, 1962, 1964

Art Library Journal 1978

Aslib Proceedings 1962, 1964, 1968, 1970, 1976, 1978

Assistant Librarian 1960

Australian Academic and Research Libraries 1972, 1978

Australian Library Journal 1960, 1970, 1974, 1976

Biblioteconomia 1976

Bibliotekarz 1962, 1970

Bibliothekar 1960, 1962, 1974, 1978

Biblos 1970

Buch und Bibliothek (Supersedes Bucherei und Bildung) 1968, 1976

Bulletin des bibliotheques de la France 1962, 1968, 1970, 1976

Canadian Library Journal 1976

Cape Librarian 1966

Catholic Library World 1960, 1966, 1976

College & Research Libraries 1962, 1966, 1968

Community and Mental Health Journal 1968

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Journals

Drexel Library Quarterly 1974

Fontes Artis Musicae 1976

Geographical Journal 1964

Herald of Library Science 1962, 1964, 1968, 1974, 1976, 1978, 1980

Illinois Libraries 1960, 1970

Indexer 1960, 1962

Indian Librarian 1962, 1964, 1966, 1968, 1970

Information Processing and Management (Supersedes Information Storage and Retrieval) 1968, 1974, 1976

International Association of Agricultural Librarians and Documentalists, Quarterly Bulletin 1968

International Classification 1978, 1980

Journal of Documentation 1964, 1966, 1968, 1970, 1972, 1974, 1976

Journal of Librarianship 1974, 1978

Journal of Library Automation 1972

Language Arts 1976

Law Library Journal 1974, 1976

The Library 1966

Library Association Record 1960, 1964, 1966, 1970, 1972

Library Herald 1962, 1964, 1968

Library Journal 1964, 1966, 1970

Library Resources and Technical Services 1960-1966, 1970-1980

Library Science with a Slant to Documentation 1972, 1974, 1976

Library Trends 1976

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Journals

Libri 1962, 1966, 1968, 1974

Medical Library Association Bulletin 1964, 1976

Nachrichten fur Dokumentation 1974

New Library World (Supersedes Library World) 1968, 1972

New Zealand Libraries 1974

Nigerian Libraries 1972, 1974

Nordisk Tidskrift for Bok-och Biblioteksvasen 1964

Quarterly Journal of Speech 1966

Research Quarterly 1978

The School Librarian 1974

Serials Librarian 1978

South African Libraries 1962

Sovetskoe Bibliotekovedenie 1974, 1976, 1978

Special Libraries 1962, 1972, 1976, 1978

Tennessee Librarian 1976

Texas Library Journal 1966, 1976

Tidskrift for Dokumentation 1960, 1966, 1968, 1976

Unesco Bulletin for Libraries 1960, 1976

Wilson Library Bulletin 1960, 1976

Zeitschrift fur Bibliothekswesen und Bibliographie 1960

Zentralblatt fur Bibliothekswesen 1960, 1972, 1974, 1978

Dissertations

Immroth, J. P. "An Analysis of Vocabulary Control in Library of Congress Classification, Indexes and

APPENDIX IV--Continued

Dissertations

Subject Headings and the Formulation of Rules for Chain Indexing of Library of Congress Classification." Ph.D. dissertation, University of Pittsburgh, 1970.

Matthews, G. O. "Influence of Ranganathan on Faceted Classification." Ph.D. dissertation, Case Western Reserve University, 1980.

Mohamed, Y. A. "*Knowledge and Language and their Effects* on Library Classification." Ph.D. dissertation, University of Pittsburgh, 1974.

Schaefer, B. K. "Classification of the Literature of Mathematics: A Comparative Analysis of the American Mathematical Society and the Library of Congress Schemes." Ph.D. dissertation, University of Pittsburgh, 1972.

Shepherd, M. A. "Colon Classification As a Basis for Automated Full Text Retrieval." Ph.D. dissertation, University of Western Ontario, 1978.

Stevenson, H. G. "The Classified Catalogs of German University Libraries and Its Relationship to Library *Performance Characteristics.*" Ph.D. dissertation, Indiana University, 1972.

Monographs

Aitchison, J. "Practical Application of Facet Classification: with Special Reference to the English Faceted Classification for Engineering." In Classification for Information Retrieval, pp. 43-57. Edited by K. G. B. Bakewell. London: Bingley; Hamden, Conn.: Archon Books, 1968.

Bakewell, K. G. B. Classification and Indexing Practice. London: Bingley, 1978.

Bakewell, K. G. B. "The Universal Decimal Classification." In Classification for Information Retrieval, pp. 11-21. Edited by K. G. B. Bakewell. London: Bingley, 1968.

Barnholdt, B. "ALIS- Automated Library Information System of Danmarks Tekniske Bibliotek with *UDC* Retrieval Facilities." In General Classification Systems in a Changing World, pp. 52-55. The Hague: FID, 1978.

Batty, C. D. "Some Aspects of Workflow in Reclassification."

APPENDIX IV--Continued

Monographs (cont'd)

In Reclassification, pp. 139-155. Edited by J. M. Perreault. College Park: School of Library and Information Service, University of Maryland, 1968.

Birket-Smith, K. Local Applicability of the Library of Congress Classification: A Survey with Special Reference to Non-Anglo American Libraries. Copenhagen: Danish Centre for Documentation, 1970.

Bliss, H. E. "Principles and Definitions." In Reader in Classification and Descriptive Cataloging, pp. 15-23. Edited by A. F. Painter. Washington: NCR/Microcard Editions, 1972.

Comaromi, J. P. "Knowledge Organized is Knowledge kept: The Dewey Decimal Classification, 1873-1976." In Library Literature 8: The Best of 1977, pp. 84-116. Edited by W. A. Katz. Metuchen, N. J.: Scarecrow Press, 1978.

Dahlberg, Ingetraut. "Dewey's Decimalism and the Value of Adequate Concept Notations for Science Organization and Communication." In General Classification Systems in a Changing World: UDC and Dewey Centenary, pp. 87-95. The Hague: F.I.D., 1978.

Dahlberg, Ingetraut. "New Trends in Classification." In New Trends in Documentation and Information. Proceedings of the 39th FID Congress, University of Edinburgh, 25-28 Sep. 1978, pp. 214-222. Edited by P. J. Taylor. London: Aslib, for FID, 1980.

Dewey, Harry. "The Relationships Between the Headings in the Subject Catalog and the Classification Numbers of the Books." In Reclassification, pp. 57-78. Edited by J. M. Perreault. College Park: School of Library & Information Service, University of Maryland, 1968.

Foskett, A. C. "Classification." In Five Years' Work in Librarianship, 1961-1965, pp. 391-419. Edited by P. H. Sewell. London: Library Association, 1968.

Foskett, A. C. The Subject Approach to Information. 2nd ed. Hamden, Conn.: Linnet Books, 1972, 429p.

Foskett, D. J. Classification for a General Index Language: A Review of Recent Research by the Classification Research Group. London: The Library Association, 1970, 48p.

APPENDIX IV--Continued

Monographs (cont'd)

Foskett, D. J. Classification and Indexing in the Social Sciences. 2nd ed. London: Butterworths, 1974.

Foskett, D. J. Structure in Classification & Indexing systems. Hamden, Conn.: Archon Books, 1970, pp. 67-77.

Freeman, Robert R. Modern Approaches to the Management of a Classification. Presented at the Seminar on UDC and Mechanization at the 32nd Conference of the International Federation for Documentation. The Hague, Sep. 20, 1966.

Freeman, Robert R. "Trends in Bibliographic Data Processing in the Context of Reclassification of Libraries." In Reclassification, pp. 164-77. Edited by J. M. Perreault. College Park: School of Library and Information Service, University of Maryland, 1968.

Gaines, J. E. "The Financial Aspects of Reclassification." In Reclassification pp. 116-38. Edited by J. M. Perreault. College Park: School of Library & Information Service, University of Maryland, 1968.

Herdman, M. M. Classification: An Introductory Manual, revised by J. Osborn. 3rd ed. Chicago: A.L.A., 1978, 44p.

Herrick, M. D. "Orientation of Staff and Clientele into the Library of Congress." In Use of the Library of Congress Classification, pp. 183-91. Edited by H. Shimmelpfeng. Chicago: ALA, 1968.

Hitchcock, J. E. "Cost Estimates and the Time Schedules in Reclassification." In Use of the Library of Congress Classification, pp. 192-208. Edited by H. Schimmelpfeng. Chicago: ALA, 1968.

Holmes, R. R. "Assignment of Author Numbers." In Use of Library of Congress Classification, pp. 107-20. Edited by H. Schimmelpfeng. Chicago: ALA, 1968.

Immroth, J. P. Guide to Library of Congress Classification. Rochester, N.Y.: Libraries Unlimited, 1968.

Johnson, A. F. A Programmed Course in Cataloging & Classification. London: Grafton, 1968.

Kisiedu, C. O. "One Hundred Years of the Dewey Decimal Classification." In The DDC and African Studies, pp.

APPENDIX IV--Continued

Monographs (cont'd)

19-27. Edited by A. Nitecki. Legon, Ghana: Dept. of Library Science & Archives Studies, University of Ghana, 1974.

Kofnovec, Ladislav. "Problems of Universal Classification, Based on a Comparative Study of the UDC and the Soviet Library--Bibliographic Classification." In General Classification Systems in a Changing World, pp. 65-71. The Hague: FID, 1978.

LaMontagne, Leo. "Historical Background of Classification." In Reader in Classification, pp. 24-31. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

Maltby, Arthur, ed. Classification in the 1970s. London: Clive Bingley, 1972.

_____, ed. Classification in the 1970s: A Second Look. London: Clive Bingley, 1976.

_____, "Faceted Classification." In Classification for Information Retrieval, pp. 33-41. Edited by K. G. B. Bakewell. London: Bingley; Hamden, Conn.: Archon Books, 1968.

Mekhtiev, D. M. "Use of the Universal Decimal Classification in an Automated Multi-branch Information System." In General Classification Systems in a Changing World, pp. 52-55. The Hague: FID, 1978.

Mills, Jack. A Modern Outline of Library Classification. London: Chapman & Hall, 1960.

_____. "Classification as an Indexing Device." In Reader in Classification, pp. 87-93. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

Nitecki, A. "The Role of Classification in the Library." In The Dewey Decimal Classification and African Studies, pp. 19-27. Edited by A. Nitecki. Legon, Ghana: Dept. of Library Science & Archival Studies, University of Ghana, 1974.

Oddoye, E. O. "Dewey Decimal Classification and Africana." In The Dewey Decimal Classification and African Studies, pp. 49-68. Edited by A. Nitecki. Legon, Ghana: Dept. of Library Science & Archival Studies, University of Ghana, 1974.

APPENDIX IV--Continued

Monographs (cont'd)

Ohman, E. "Alphabetic Indexes to Chinese Classification Systems." In General Classification Systems in a Changing World, pp. 36-42. The Hague: FID, 1978.

Painter, A. F. "Modern Classification Theory." Reader in Classification, pp. 100-106. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

Parthasarathy, S. "Faceted Classification as an Approach to Machine Coding." In Information Retrieval and Machine Translation, pp. 289-294. Edited by Allen Kent. New York: Interscience Publishers, 1960-61.

Perreault, J. M. "Afterword." In Reclassification, pp. 186-191. Edited by J. M. Perreault. College Park: School of Library & Information Service, University of Maryland, 1968.

Perreault, J. M. "The Universal Decimal Classification as Candidate for Reclassification either on the Shelf or in the Catalog." In Reclassification, pp. 79-88. Edited by J. M. Perreault. College Park: School of Library & Information Service, University of Maryland, 1968.

Pound, M. "Cataloging and Classification." In American Library Association: A. L. A. Yearbook, pp. 82-84. Chicago: A. L. A., 1978.

Redfern, B. L. Organizing Music in Libraries. London: Clive Bingley, 1978.

Richmond, P. A. "General Advantages and Disadvantages of Using the Library of Congress Classification." In Institute on the Use of the Library of Congress Classification, pp. 209-220. Edited by H. Schimmelpfeng. Chicago: A. L. A., 1968.

Richmond, P. A. "The Future of Generalized Systems of Classification." In Reader in Classification, pp. 94-99. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

Richmond, P. A. "Transformation and Organization of Information content: Aspects of Recent Research in the Art and Science of Classification." In International Federation for Documentation Conference, 1965,

APPENDIX IV--Continued

Monographs (cont'd)

Washington, pp. 87-106. London: Macmillan, 1966.

Rigby, M. "A Century of Mutation of the Decimal Classification." In General Classification Systems in a Changing World," pp. 45-51. The Hague: FID, 1978.

Sandison, A. "The Special Needs of a Classification for Books and Journals." In General Classification Systems in a Changing World, pp. 19-30. The Hague: FID, 1978.

Scibor, E. "UDC in Relation to thesauri (an attempt to make a state-of-the art report)." In General Classification Systems in a Changing World: UDC and Dewey Centenary, pp. 72-78. The Hague: FID, 1978.

Sealock, R. B. "International Commitments of the Dewey Decimal Classification." In General Classification Systems in a Changing World, pp. 31-35. The Hague: FID, 1978.

Sharp, J. "Classification." In Reader in Classification, pp. 57-67. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

Shell, E. E. "A Rationale for Using the Library of Congress System in Reclassification." In Reclassification, pp. 30-55. Edited by J. M. Perreault. College Park: School of Library & Information Service, University of Maryland, 1968.

Shera, J. H. "Classification: Current Functions and Applications to the Subject Analysis of Materials." In Reader in Classification, pp. 68-76. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

Simonton, W. C. "The Current Role of Dewey, Library of Congress, and other Classification Systems in Libraries." In Workshop on the Teaching of Classification, Dec. 8-10, 1966, pp. 1-2. Edited by M. F. Tauber, C. J. Frarey, and N. C. Batts. New York: Columbia University, 1968.

Stevens, J. E. "Teaching Problems Associated with the Availability and Use of Centralized Cataloging Service." In Workshop on the Teaching of Classification, Dec. 8-10, 1966, pp. 70-72. Edited by M. F. Tauber, C. J. Frarey, and N. C. Batts. New York: Columbia University, 1968.

APPENDIX IV--Continued

Monographs (cont'd)

Taulbee, O. E. "Content Analysis Specification and Control." In Annual Review of Information Science and Technology (vol. 3), pp. 105-136. Edited by Carlos Cuadara. Chicago: Encyclopaedia Britannica Inc., 1968.

Taylor, D. "Reclassification to LC: Planning and Personnel." In Reclassification, pp. 97-112. Edited by J. M. Perreault. College Park: School of Library & Information Service, University of Maryland, 1968.

Vickery, B. C. Faceted Classification: Guide to Construction and Use of Special Schemes. London: Aslib, 1960.

Vickery, B. C. Classification Schemes. Vol. V. New Bruinswick, N. J.: Graduate School of Library Service, Rutgers, The State University, 1966.

Vickery, B. C. "Faceted Classification Schemes." In Reader in Classification, pp. 107-114. Edited by A. F. Painter. Washington: Microcard Editions, 1972.

BIBLIOGRAPHY

Barnard, Walter M. "Characteristics of the Literature Used by American Authors of Journal Articles in Library Science." Masters Thesis, University of North Carolina, Chapel Hill, 1957.

Batts, M. S. "Citations in the Humanities: A Study of Citation Patterns in Literary Criticism in English, French, and German." Institute of Professional Librarians Quarterly 14 (1972): 20-40.

Baughman, J. C. "A Structural Analysis of the Literature of Sociology." Library Quarterly 44 (1974): 293-308.

Bookstein, A. "Explanations of the Bibliometric Laws." Collection Management 3 (1979): 151-162.

Brace, William A. "A Citation Analysis of Doctoral Dissertations in Library and Information Science, 1961-1970." Ph.D. dissertation, Case Western Reserve University, 1975.

Bradford, Samuel C. "Sources of Information on Specific Subjects." Engineering 137 (1934): 85-86.

_____. Documentation. Washington: Public Affairs Press, 1950.

Brookes, B. C. "Bradford's Law and the Bibliography of Science." Nature 224 (1969): 953-956.

_____. "The Derivation and Application of the Bradford-Zipf Distribution." Journal of Documentation 24 (1968): 247-265.

Buchanan, B. Theory of Library Classification. London: Bingley, 1979.

Buick, W. G. "Classification of English Literature: A Faceted Classification Compatible with D.C." Library Journal 16 (1967): 174-177.

Campbell, D. J. "Short Biography of Henry Evelyn Bliss (1870-1955)." Journal of Documentation 32 (1976): 134-145.

Classification Research Group. "Bibliography of Writings by Members of the Classification Research Group." Journal of Documentation 12 (1956): 227-330, 17 (1961): 169-172, 20 (1964): 166-169, 24 (1968): 295-298, 29 (1973): 69-71, 34 (1978): 44-48.

Classification Research Group. "Bulletin No. 11." Journal of Documentation 34 (1978): 21-50.

_____. Classification of Library Science: Preliminary Draft Edition. London: Aslib, 1965.

Cline, G. S. "Application of Bradford's Law to Citation Data." College & Research Libraries 42 (1981): 53-61.

_____. "A Bibliometric Study of Two Selected Journals in Library Science, 1940-1974." Ph.D. dissertations, University of Southern California, 1979.

_____. "College & Research Libraries: Its First Forty Years," College & Research Libraries 43 (1982): 208-232.

Comaromi, J. P. Eighteen Editions of the Dewey Decimal Classification. Albany, Forest Press, 1976.

Coyle, K. "Faceted Classification for Occupational Safety and Health." Special Libraries 66 (1975): 256-259.

Dansey, P. "A Bibliometric Survey of Primary and Secondary Information Science Literature." Aslib Proceedings 25 (1973): 252-263.

Donohue, Joseph C. Understanding Scientific Literatures: A Bibliometric Approach. Cambridge, Mass.: The MIT Press, 1973.

_____. "A Bibliometric Analysis of Certain Information Science Literature." American Society for Information Science Journal 23 (1972): 313-317.

English Electric Company. A Faceted Subject Classification for Engineering. Compiled by Jean Binns and David Bagley. English Electric Company, 1961.

Farradane, Jason E. L. "Fundamental Fallacies and New Needs in Classification." In The Sayers Memorial Volume, pp. 120-135. Edited by D. J. Foskett and B. I. Palmer. London: The Library Association, 1961.

_____. "The Psychology of Classification." Journal of Documentation 11 (1955): 187-201.

Fenichel, C. J. "Citation Patterns in Information Science." Masters Thesis, Drexel Institute of Technology, 1969.

Forster, D. L. "Magazines in the Library School." Journal of Education for Librarianship 9 (1969): 144-148.

Foskett, D. J. "The Classification Research Group, 1952-1962." Libri 12 (1962): 127-138.

Freeman, R. R. "Computers and Classification Systems." Journal of Documentation 20 (1964): 137-145.

Fussler, Herman H. "Characteristics of the Research Literature: Part II." Library Quarterly 19 (1949): 119-143.

Garfield, E. The Use of Citation Data in Writing the History of Science. Philadephia, Institute for Scientific Information, 1964.

_____. Essays of an Information Scientist. Vols. 2-4. Philadelphia: I.S.I. Press, 1974-1981.

Gilchrist, Alan. "Documentation of Documentation: A Survey of Leading Abstract Services in Documentation and an Identification of Key Journals." Aslib Proceedings 18 (1966): 62-80.

Greaves, Monica A. Librarianship: A Faceted Classification Scheme As a Teaching Aid. Ibadan: University of Ibadan, Institute of Librarianship, 1970.

Groeneveld, C. P. "Over de grondslagen van de Classificatie-theorie" (On the Principles of Classification). Bibliotheekleven 39 (1954): 221-248.

Grolier, Eric de. "Current Trends in Theory and Practice of Classification." In Classification Research, pp. 9-14. Edited by Pauline Atherton. Copenhagen: Munksgaard, 1965.

Groos, Ole V. "Bradford's Law and the Keenan-Atherton Data." American Documentation 8 (1967): 46.

Gupta, K. B. "Facet Analysis and Machine Coding." Library Herald 9 (1967-1968): 292-296.

Hart, P. W. "Periodicals for Professional Librarianship." Masters Thesis, Catholic University of America, 1950.

Harvey, J. F. "Periodicals for Professional Librarianship: A Summary and Review Article." LPRT Newsletter 2 (1955): 28-29.

Hoage, A. A. L. "The Library of Congress Classification in the United States: A Survey of Opinions and Practices, with Attention to Problems of Structure and Application." D. L. S. dissertation, Columbia University,1961.

Kent, Allen. Use of Library Materials: The University of Pittsburgh Study. New York: Marcel Dekker, 1979.

LaBorie, T. and Halperin, M. "Citation Patterns in Library Science Dissertations." Journal of Education for Librarianship 16 (1976): 271-283.

LaMontagne, L. E. American Library Classification, with Special Reference to the Library of Congress. Hamden, Conn.: Shoe String Press, 1961.

Lao Sunthara, M. E. "Some Bibliographical Characteristics of Serial Literature in the Field of Geology." Ph.D. dissertation, Indiana University, 1956.

Lawani, S. M. "Bradford's Law and the Literature of Agriculture." International Library Review 5 (1973): 341-350.

Lehnus, Donald J. "JEL, 1960-1970: An Analytical Study." Journal of Education for Librarianship 12 (1971): 71-83.

_____. "Milestones in Cataloging, 1835-1969: An Attempt at an Objective Approach to the Growth of a Subject Literature." Ph.D. dissertation, Case Western Reserve University, 1973.

Leimkuhler, F. F. "The Bradford's Distribution." Journal of Documentation 23 (1967): 197-207.

Line, M. B. "The Half-life of Periodical Literature: Apparent and Real Obsolescence." Journal of Documentation 26 (1970): 46-52.

_____. "The influence of the Type of Sources used on the Results of Citation Analyses." Journal of Documentation 35 (1979): 205-284.

_____ and Sandison, A. "Obsolescence and Changes in the Use of the Literature with Time." Journal of Documentation 30 (1974): 283-350.

Little, T. M. Use and Users of Library Literature. Preprint of a Paper Presented at the Conference on the Bibliographical Control of Library Science Literature. State University of New York at Albany, 1968.

Louttit, C. M. "The Use of Foreign Languages by Psychologists, Chemists, and Physicists." American Journal of Psychology 70 (1957): 314-316.

McAnally, A. M. "Characteristics of Materials Used in Research in United States History." Ph.D. dissertation, University of Chicago, 1951.

Kent, Allen. Use of Library Materials: The University of Pittsburgh Study. New York: Marcel Dekker, 1979.

LaBorie, T. and Halperin, M. "Citation Patterns in Library Science Dissertations." Journal of Education for Librarianship 16 (1976): 271-283.

LaMontagne, L. E. American Library Classification, with Special Reference to the Library of Congress. Hamden, Conn.: Shoe String Press, 1961.

Lao Sunthara, M. E. "Some Bibliographical Characteristics of Serial Literature in the Field of Geology." Ph.D. dissertation, Indiana University, 1956.

Lawani, S. M. "Bradford's Law and the Literature of Agriculture." International Library Review 5 (1973): 341-350.

Lehnus, Donald J. "JEL, 1960-1970: An Analytical Study." Journal of Education for Librarianship 12 (1971): 71-83.

_____. "Milestones in Cataloging, 1835-1969: An Attempt at an Objective Approach to the Growth of a Subject Literature." Ph.D. dissertation, Case Western Reserve University, 1973.

Leimkuhler, F. F. "The Bradford's Distribution." Journal of Documentation 23 (1967): 197-207.

Line, M. B. "The Half-life of Periodical Literature: Apparent and Real Obsolescence." Journal of Documentation 26 (1970): 46-52.

_____. "The influence of the Type of Sources used on the Results of Citation Analyses." Journal of Documentation 35 (1979): 205-284.

_____ and Sandison, A. "Obsolescence and Changes in the Use of the Literature with Time." Journal of Documentation 30 (1974): 283-350.

Little, T. M. Use and Users of Library Literature. Preprint of a Paper Presented at the Conference on the Bibliographical Control of Library Science Literature. State University of New York at Albany, 1968.

Louttit, C. M. "The Use of Foreign Languages by Psychologists, Chemists, and Physicists." American Journal of Psychology 70 (1957): 314-316.

McAnally, A. M. "Characteristics of Materials Used in Research in United States History." Ph.D. dissertation, University of Chicago, 1951.

McGrath, William E. "Relationships between Hard/Soft, Pure/Applied, and Life/Non-Life Disciplines and Subject Book Use in a University Library." Information Processing & Management 14 (1978): 17-28.

Malhan, I. V. and R. L. Arora. "India's Contribution in the Field of Classification Research." Herald of Library Science 17 (1978): 270-275.

Maltby, Arthur. Sayers' Manual of Classification for Librarians. 5th ed. London: Deutsch, 1975.

Matthews, G. O. "Influence of Ranganathan on Faceted Classification." Ph.D. dissertation, Case Western Reserve University, 1980.

Merton, R. K. "Priorities in Scientific Discovery: A Chapter in the Sociology of Science." American Sociological Review 22 (1957): 635-659.

Metcalfe, J. W. Information Retrieval, British and American 1876-1976. Metuchen, N. J.: Scarecrow, 1976.

Miksa, F. L. Charles Ammi Cutter, Library Systematizer. Littleton, Colo.: Libraries Unlimited, 1977.

Mills, Jack. "Classification." In Five Years Work in Librarianship, 1956-1960, pp. 237-267. Edited by P. H. Sewell. London: Library Association, 1963.

Mullins, Nicholas C. Theories and Theory Groups in Contemporary American Sociology. New York: Harper & Row, 1973.

"The Need for a Faceted Classification as the Basis of all Methods of Information Retrieval." (UNESCO I. A. C. Doc. Ter. P. A. S. memo 320/5515). Library Association Record 57 (1955): 262-268.

Oromaner, Mark J. "The Most Cited Sociologists: An Analysis of Introductory Text Citations." American Sociologist 3 (1968): 124-126.

_____. "The Structure of Influence in Contemporary Academic Sociology." American Sociologist 7 (1972): 11-13.

Palmer, B. I. "Shiyali Ramamrita Ranganathan Ayer, 1892-1972." Library Association Record 74 (1972): 228-229.

Penner, R. "Measuring a Library's Capability." Journal of Education for Librarianship 13 (1972): 17-30.

Pope, Andrew. "Bradford's Law and the Periodical Literature of Information Science." American Society for Information Science Journal 26 (1975): 207-213.

Pratt, A. D. "A Measure of Class Concentration in Bibliometrics." American Society for Information Science Journal 28 (1977): 285-292.

Praunlich, P. and Kroll, M. "Bradford's Distribution: A New Formulation." American Society for Information Science Journal 29 (1978): 51-55.

Price, Derek J. "Is Technology Historically Independent of Science? A Study in Statistical Historiography." Technology and Culture 6 (1965): 553-568.

_____. "Citation Measures of Hard Science, Soft Science, Technology, and Non-Science." In Communication Among Scientists and Engineers, pp. 3-22. Edited by Carnot E. Nelson and Donald Pollock. Lexington, Mass.: Heath, 1970.

_____. "A General Theory of Bibliometrics and Other Cumulative Advantage Processes." American Society for Information Science Journal 27 (1976): 292-306.

Ranganathan, S. R. "Library Classification Through a Century." In Classification Research, pp. 15-35. Edited by Pauline Atherton. Copenhagen: Munksgaard, 1965.

Richmond, Phyllis A. Aspects of Recent Research in the Art and Science of Classification. Copenhagen: Danish Centre for Documentation, 1965.

Rigby, Malcolm. Mechanization of the U.D.C.: Final Report on Pilot Project to Explore Possibilities for Mechanization of U.D.C. schedules. Washington D.C.: American Meteorological Society, 1964.

Salton, G. "On the Development of Information Science." American Society for Information Science Journal 24 (1973): 218-220.

Salvan, Paule. "Les Progrès de la Classification à Facettes." Bulletin des Bibliothèques de France 7 (1962): 5-17.

Saracevic, Tefko and Perk, Lawrence J. "Ascertaining Activities in a Subject Area Through Bibliometrics

Analysis." American Society for Information Science Journal 24 (1973): 120-134.

Shepherd, M. A. "Colon Classification as a Basis for Automated Full Text Retrieval." Ph.D. dissertation, University of Western Ontario, 1978.

Simonton, W. E. "Characteristics of the Research Literature of the Fine Arts during the Period 1948-1957." Ph.D dissertation, University of Illinois, 1960.

Srivastava, A. P. Theory of Knowledge Classification in Libraries . New Delhi: Lakshmi Book Store, 1964.

Stewart, June L. "The Literature of Politics: A Citation Analysis." International Library Review 2 (1970): 329-353.

Storer, Norman W. "The Hard Sciences and the Soft: Some Sociological Observations." Bulletin of the Medical Library Association 55 (1967): 75-84.

Sumner, F. B. "Some Characteristics of the Literature Used by Authors of Articles in Libri: International Library Review, 1950-1961." Masters Thesis, Kent State University, Ohio, 1967.

Ulrich International Directory of Periodicals. 20th ed. New York & London: Bowker, 1981.

Vann, S. K., ed. Melvil Dewey, His Enduring Presence in Librarianship. Littleton, Colo.: Libraries Unlimited, 1978.

Vernon, K. D. C. and Lang, V. London Classification of Business Studies. London: Graduate School of Business Studies, 1970.

Vickery, B. C. "Bradford's Law of Scattering." Journal of Documentation 4 (1948): 198-203.

_____. Classification and Indexing in Science. London: Butterworths, 1958.

_____. Prolegomena to Library Classification, by S. R. Ranganathan (Review). Bombay: Asia Publishing House, 1967. Journal of Documentation 25 (1969): 170-171.

"Vickery Leads Seminar on Faceted Classification." Special Libraries 56 (1965): 228.

Waldhart, T. J. "The Relationship Between the Citation of Scientific Literature and the Institutional Affiliation of Engineers." Ph.D. dissertation, Indiana University, 1973.

White, Herbert S. "Library Management in the Tight Budget Seventies: Problems, Challenges, and Opportunities." Bulletin of the Medical Library Association 65 (1977): 6-12.

Wilkinson, Elizabeth A. "The Ambiguity of Bradford's Law." Journal of Documentation 28 (1972): 122-130.

Zipf, G. K. Human Behavior and the Principle of Least Effort. Cambridge, Mass.: Addison-Wesley Publishing, 1949.

VITA

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He was awarded scholarship by the Federal Government of Nigeria for his undergraduate degree, masters degree and the doctorate degree. He completed work for the Masters degree in education with a specialization in student affairs administration in 1982. In the summer of 1983, he worked as reference assistant in the main library of Indiana University. His areas of specialization are library education, organization of knowledge, and educational administration. He has written some articles in professional journals and has compiled three substantial bibliographies. He was once the editorial adviser to the Library Scientist, a journal published by the Department of Library Science, Ahmadu Bello University, for the Society of Library Science Students of the department. He is a member of the Nigerian Library Association, and while a doctoral candidate, was a member of the American Society for Information Science. He is presently, a lecturer in library science at Ahmadu Bello University, Zaria, Nigeria.