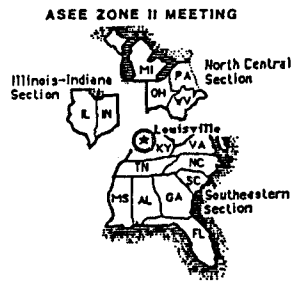

The Literature Of Semiconductors, The Bradford Distribution and Library Collection Verification

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Introduction.

The evaluation and verification of library collections is a topic that has interested librarians and faculty members for years. The literature on this subject shows that surveys about research collections were done as early as 1933[1]; these initial studies were done primarily to compare major research library collections and were used for designing purchase programs of retrospective materials.

With the continued higher costs of library materials and the increased production of the number of monographs, reports, conference proceedings and journals, libraries have come to the realization that today only a few of them can develop subject collections at a comprehensive level. To illustrate this, recent figures[2,3,4,5] show that since 1977 the Consumer Price Index for all items on August 1987 reached 184.1; during the same period the average price index for U.S. scientific and technical periodicals was 303.2; not included in this index are foreign periodicals that in recent years have experienced drastic price increases of about 30% as calculated by some experts[6,7]. U.S. science and technical books have also increased above the CPI with an average index of 228 for the same date. If the high cost of library materials are of serious concern, the production of written materials is on the rise too. According to D.J. De Solla Price[8] there were some 30,000 scientific periodicals being published in 1963; Schenk and Webster[9] estimated that by 1984 the number of these periodicals had doubled. Along the same lines, the Institute for Scientific Information[10] indexed a total of 2,104 scientific and technical proceedings published as books for 1985 alone; and when comparing the years 1977 to 1986, the annual number of monographs published in U.S. for engineering had increased about 22%. Personnel costs, storage costs, the need to equip library facilities with electronic databases and the need to link libraries with bibliographic networks have all compounded the problem.

Cooperative Collection Development.

Libraries have been sharing their resources for quite some time, the copying and lending of materials is the best know service of cooperation. A more formal and complex form of cooperation arrived when two or more libraries, usually members of a group, decided to coordinate the selection of materials of a subject matter. This type of agreement is called Cooperative or Colaborative Collection Development CCD.

The literature shows[11] that two research universities in North Carolina have been involved in a CCD program as early as 1933, but this is an exceptional case. Most CCD programs have a more recent history. Participating groups of this kind might represent a regional or state wide interest, some are national; the Research Libraries Group RLG and the cooperative collection development programs in the state of New York and California are good examples.

Around the year 1978 representatives of the RLG member libraries began to investigate some mechanisms that could provide information about the description of the collections in the RLG libraries, this was seen as a way to help structure their group into a better cooperative environment. It was thought that by finding common terms for describing the quantitative and qualitative aspects of the collections and their subject coverage, subject specialists would be able to better understand the strengths of their collections within the RLG group. An article by Gwinn and Mosher[12] published in 1983 tells us how these ideas were originated and put into effect. The product of their effort is known as the RLG Conspectus; and as a result, libraries within the RLG group have taken the responsability of building in-depth collections in some specific subject areas.

The Conspectus and the North American Collection Inventory Project.

This section is a summary of some important concepts introduced in recent years in the field of cooperative collection development.

Gwinn and Mosher[13] have defined Conspectus as:

" an overview, or summary, of existing collection strengths and future collecting intensities of RLG members. Arranged by subject, class, or a combination of these, its division contains standardized codes that describe collection/collecting levels on a scale of 0 to 5."

Figure 1 shows the elements included in a Conspectus Worksheet.

LC Class	Subject Group	ECS/ Lang C.	CCI/ Lang C.	Comments
TP	Chem. Techn.	3A/E	3B/E	TP1-498; CCI/L= 4/F TP1080-1185; CCI/L= 4/F

FIGURE 1

These elements are: A breakdown of the Library of Congress Classification System corresponding to Subject Groups or Shelflist Descriptors. A measure of the Existing Collection Strength ECS and of the Current Collecting Intensity CCI both within a scale of 0 to 5; the Conspectus also includes language codes for ECS and CCI. Scope Notes and Comment Notes are often used to clarify the coverage and to add vital information to the description of the collection.

The Conspectus approach of evaluating and comparing collections gained the acceptance of the Association of Research Libraries ARL after a successful test that was concluded in 1982. Since then RLG and ARL are working together to use the Conspectus as a basis for a North American Collection Inventory Project NCIP for evaluating research collections. In addition to the RLG group, libraries in six other states or regions have reported using a Conspectus as a method for describing their collection within a common language. Some Conspectus are computerized databases available online.

Collection Evaluation and Verification.

The information reported on the Conspectus is usually created by science and engineering librarians working in collection development; often faculty members assist them in making this evaluation. Lancaster and Joncich[14] in their book Measurement and Evaluation of Library Services presents three approaches for evaluating a library collection: Quantitative Aspects, this includes size of the collection, current growth rate and expenditures. Qualitative Aspects, this deals with direct observation and impressionistic methods, and evaluation against checking lists, catalogs and bibliographies. Use Factors, take into consideration data from circulation and in-library use and interlibrary loan requests.

The literature on collection evaluation in recent years is quite extensive; another key article is the survey by G. Bonn[15]. In this study Bonn considered several elements that may be included in the evaluation of collections: Size; Current growth; Formulae based; Subject balance; Unfilled requests; Interlibrary loan requests; Optimum size; Circulation counts; Expenditures; Checking lists, catalogs and bibliographies; Citation sources; Survey of user opinions; Direct observations and Applying standards for accreditation. Each of these methods can be put into the context prescribed by Lancaster and Joncich.

The Collection Development Committee of the American Library Association has published Guidelines[16] for evaluating collections and has identified the following essential elements in this process: Checking lists, catalogs and bibliographies; Examining the collection directly; Compiling statistics; Using citations from papers of library users; Obtaining opinions; Using standards; and Testing the library's capability of delivering documents are included. The advantages and disadvantages of each method are presented in each of the last three sources mentioned above.

In 1985 B. Hall[17] published a manual for collection assessment and defined the assessment of collections by two aspects: Collection-Centered Measures; and Client-Centered Measures, the elements included in these two areas are basically the same as presented by Lancaster, Bonn and the ALA Guidelines. Hall also gives a number of practical ideas about how to arrive at reasonable measurements. In general, the concepts of quantitative or qualitative evaluations presented with both their positive and negative reasonings have not been resolved and more often a combination of both approaches is used.

Within the content of the NCIP, the Conspectus is built based on the "universe" of a subject literature, therefore, when the assessment is done for example by using a direct observation method or by checking lists, catalogs and bibliographies, the librarian makes the assessment of the collection based on what is available as a whole. Direct observation techniques depend on the knowledge of the subject literature and perception of the evaluator; checking lists, catalogs and bibliographies depend on their availability and whether they are kept current. It is then possible to assert that certain techniques need to be incorporated into the evaluation process in order to insure meaningful communality of terms; for example, the communality of terms between two collections thousands of miles apart that support programs with similar or different concentrations. For that reason verification studies[18] to validate the information reported in the Conspectus have been part of the RLG-NCIP program and several of these verification projects have been completed. Verification techniques to check the data entered on the Conspectus can also be adapted by those librarians doing the evaluation of a collection.

The Bradford Distribution.

In this section the Bradford Distribution will be discussed. This statistical technique will be utilized in this paper as a tool for collection verification.

In a work published in 1934, S.C. Bradford[19] found that when the dispersion of articles of a given subject were obtained, and when the articles were grouped by their journal's titles, and when

the journals were ranked in order of decreasing productivity revelant to the particular subject; it was found that initially a few journals on the top of the list produce a large number of articles; subsequently, more periodicals were found producing fewer articles; further, a large number of periodicals at the end contributed only one article each. In this research Bradford also found that when this distribution of journals was divided by zones each containing an equal number of contributing articles, the number of periodicals in each zone increased geometrically. A typical Bradford Distribution is represented on a semi-log scale; on the X-axis the number of periodicals ranked in decreasing order are shown; and over the Y-axis the cumulative number of articles are indicated. The resulting graph is a plot beginning with a rising curve and at a critical point this curve becomes a straight line. More often, the end of the straight line is a soft curve to the right, this is due to the empirical nature of the data collecting process.

The Bradford Distribution also known as the Law of Scatter has been investigated by others among them Brookes[20], Leimkuhler[21], and Vickery[22]; each of them provided extensive statistical analysis of this occurence. M.G. Kendall[23] in 1960 used the Bradford Law to analyze the literature of operational research; in addition to providing a very interesting statistical approach, Kendall was the first to publish a realtion between Bradford and Zipf's Law. Bradford, Zift and Lotka are considered three fundamental laws in the field of bibliometrics.

The literature has many applications of the Bradford Distribution in the field of information retrieval, the initial preocupation of Bradford was finding the completeness of index services for scientific and technical subjects. It is possible to predict the total number of revelant citations in a given subject by using the mathematical analysis provided by the previous mentioned authors. Other applications included finding: the comprehensiveness of bibliographic databases; the core journals of a given subject; the behavior of items borrowed from a library; the measurement of obsolescence in the scientific literature; the optimum size of a collection; and the measurement of the effectiveness of retrospective searches. Brooks in the paper mentioned above suggested that this distribution can be used for publishers of books in well defined subjects since they can also be ranked in order of productivity during a time-span. The results of two papers one by Worthen[24] for monographs in some medical fields; and by Smith[25] for monographs in business and management both conform to Bradford's Law.

The time-span used in this type of bibliometric studies varies from as many as 15 years to 2 or 3 years. Brooks[26] reported of a work done by Susan Wright of the British Medical Association where the time-span of the search is related to the number of journals found and to the level of productivity for each journal; Wright suggested that a three-year search span and one relevant paper per year as a minimum of productivity level. The relationship established by Wright in most cases affects the end of the straight line of the Bradford Distribution by adding more titles of the less productives journals. In terms of collection verification this behavior has minimal impact. Finally, Oliver[27] in a paper dealing with the obsolescence of scientific periodicals did a bibliometric analysis based on a one year-span for 1963 and 1968; Oliver's paper is an example of a study based on a one year time-span. In this study the Bradford Distribution will be used for journals, monographs and conference proceedings and for items published during a one year time-span.

Definition of the Problem.

Collection development/analysis and assessment is an area of increased interest in academic libraries. The high cost of library materials for technical and scientific programs and the increased volume of these kind of publications are making research libraries enter into cooperative collection development agreements. The evaluation of their collections is an important element for structuring collections responsibilities within the members of a cooperative collection development group. Several cooperative collection development programs are already in existance; the Research Library Group, the collaborative programs in New York and California are examples of these kinds of efforts. The RLG and ARL for some time have been working on a North American Collection Inventory Project, NCIP: the idea behind this project is to established common terms for evaluating collections. The backbone of this project is the RLG Conspectus.

Methods of evaluating collections vary; most often a combination of quantitative and qualitative techniques are used in the assessment. Two methods commonly used are: Direct observation, and Checking lists, catalogs and bibliographies; the first one depends on the knowledge of a subject literature that the evaluator has and his own perception; the second one depends on the availability of these sources and if they are kept up to date.

In this study, some techniques that can be used in determining the Current Collecting Intensity level of a collection for a scientific or technical field will be presented. The CCI level is stressed because of the well known fact that in many areas of the sciences and engineering, current information is vital to study and research.

Hypothesis.

The main purpose of this study is to test the hypothesis that when the out-put of the literature of a scientific/technical field during one given year, in this case 1983, is identified and when this out-put is compared against a library's holdings, it is possible to determine the Current Collecting Intensity CCI level of the collection in that field.

Methodology.

a. The subject area chosen for this study is Semiconductors. b. The year selected is 1983. c. The literature out-put of Semiconductors was determined by searching for: 1. Periodicals, 2. Monographs, and 3. Conference proceedings in book format that were published during 1983.

The date of publication was the primary criteria for selecting books and proceedings of the chosen year, reprint editions available that year were also considered. Because the bibliographic records can be created some time later after the year of publication the search for monographs and conference proceedings was extended from 1983 to mid 1987.

d. Periodicals. A computerized search of the INSPEC database was done to determine the periodical collection for Semiconductors. The DIALOG system was selected for this search because in this system with the LIMIT ALL command a search can be limited to one specific year. Subject codes related to the engineering and the physics aspects of semiconductors were used; and a list of pre-selected 500 journals were combined with the subject codes in order to find the number of citations indexed for each journal during the year 1983.

Search Strategy:

```
? limitall/968580-1162769

   LIMITALL started

?s cc=(b25? or b4250 or b0510? or b0520?)

           9878  CC=B25?
                 .
                 .
     S1   10692  CC=(B25? OR B4250 OR B0510? OR...
?s cc=(a6150c or a6170t or a6855 or a7220? or ...

            458  CC=A6150C  Physics of crystal gro
                 .
                 .
     S2    8052  CC=(A6150C OR A6170T OR A6855 OR
?s s1 or s2

          10692  S1
           8052  S2
     S3   14905  S1 OR S2
? save temp
.
.
?s (co=apahaq) and S3

            100  CO=APAHAQ
          14905  S3
     S5      15  (CO=APAHAQ) AND S3
?s ...
```

Search stateme nt S3 shows that during 1983 INSPEC indexed 14905 items on the engineering and physics aspects of Semiconductors. Search statement S5 is an example of the kind of results obtained when the journal's codes were combined with the subject matter or statement number S3.

e. Books and Conference Proceedings. The out-put for books and for conference proceedings published in monographic form for the year 1983 was determined by searching the following sources: Books in Print, Subject Index, 1983-87; National Union Catalog, Subject Index, 1983-87; British National Bibliography, 1983-87; Directions, 1983-87, a list of books from Baker and Taylor; Ei Engineering Conference Index, 1983-84; and INSPEC database, 1983-87.

f. Libraries. Five academic libraries from the Library Computer System LCS of Illinois were chosen for this study. The campus codes used in this study are the codes used by the LCS system. UC: A comprehensive university with outstanding academic and research programs in the sciences and engineering that include programs in physics, materiarials science and electrical engineering. NO and SC: Two comprehensive state universities with similar size and programs and with graduate degrees in physics and electrical engineering. In 1983 NO had an industry and technology program only, the engineering program at NO began in 1986. IS: A large university with several graduate programs but with lesser emphasis in scientific and technical fields. IT: A private small technical institute with several doctoral programs in science and engineering.

Results.

A. Periodicals.

In order to organize tha data from the searches mentioned in the previous sections; five files were created: File A: Journals by title; File B: Journals by Rank; File C: Journals by Rank and Libraries; File D: Books; and File E: Conference Proceedings.

Table 1 corresponds to the first page of File A: Journals by Rank, and shows how the periodicals are ranked according to their productivity.

Figure 2 is a curve representing the percentages of journals productivity against the natural log J; where J is the number of journals. The result is an empirical Bradford Distribution with a nucleus centered in b= 7. The nucleus in this case covered 24.6% of the literature of Semiconductors. Therefore, Table 2 shows four typical Zones for a Bradford Distribution. This is already an important result: The literature of Semiconductors for a one year out-put is sufficient to determine the periodical literature of a well defined scientific subject.

For the practical purpose of this study, the productivity of journals will be divided in four different Zones as it is shown in Table 3. For example in Table 5 UC has a 82% of the journals titles that cover 80% of the number of citations on Semiconductors for 1983; the same library owns 66% of all titles that published all the 10984 citations.

JOURNALS BY RANK

Title of Journal	Semic. Cit.
1. J. Appl. Phys.	531
2. Appl. Phys. Lett.	443
3. Sov. Phys.- Semicond.	384
4. J. Vac. Sci. & Techno.	383
5. Thin Solid Films	349
6. Phys. Status Solidi A	326
7. J. Electrochem. Soc.	292
8. J. Cryst. Growth	282
9. Proc. SPIE Int. Soc. Opt. Eng.	251
10. IEEE Trans. Electron Devices	189
11. Electron. Lett.	179
12. Phys. Rev. B	175
13. Solid-State Electron.	167
14. Solid State Commun.	165
15. Inorg. Mater.	155
16. Nucl. Instrum. & Methods Phys. Res.	152
17. Physica B & C	145
18. J. Phys. Colloq.	142
19. Jpn. J. Appl. Phys. Part 1	141
20. IEEE Electron Device Lett.	134
21. Jpn. J. Appl. Phys. Suppl.	131
22. Jpn. J. Appl. Phys. Part 2	122
23. Solid State Technol.	120
24. Sov. Phys.-Solid State	115

TABLE 1

	Titles	No. of Cit.	Expected Value	Dev.	%
Zone 1-Nucleus	1-7	2708	2708		24.6
Zone 2	8-23	5358	5416	.01	48.8
Zone 3	24-76	8237	8124	.014	74.9
Zone 4	77-252	10452	10832	.035	95.2
Zone 5	253-475	10984			
	253-830	(13540) Next expected value			

b=7; N= 10984 citations; Number of titles= 475; n=3.3 for the relation $1:n^2:n^3\ldots$. The geometrical progression of the number of titles was obtained under reasonable deviations. Zone 5 is the next expected value of the theoretical distribution.

TABLE 2

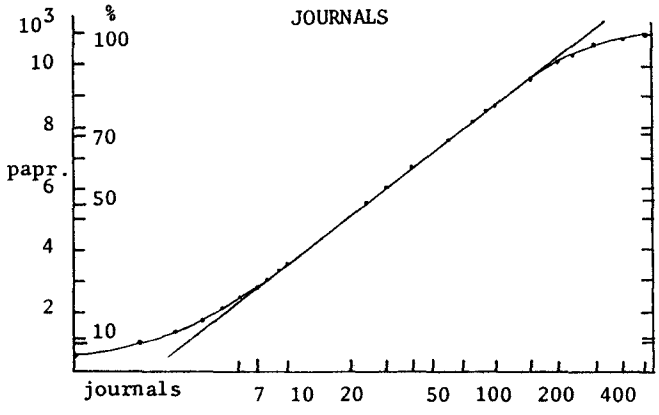

FIGURE 2

	Titles	No. of Cit.	%
Zone A	1-24	5473	50
Zone B	25-60	7695	70
Zone C	61-100	8813	80
Zone D	101-475	10984	100

TABLE 3

Library holdings - periodicals. In this section Library holdings of Semiconductors journals in the five LCS libraries are analyzed. Table 4 indicates the number of journals that each library subsbribes to in each of the four Zones.

The results of Table 5 demostrates a definitive pattern for Zone C and Zone D. In these Zones UC came out with the strongest collection, while IS shows a collection at the Basic level. SC and NO follow after UC at a distant second and third strongest collections of the group, and IT is relegated to a fourth place. This is a pattern that would be expected from these five collections. Therefore, it can be concluded that when the periodical literature of a given subject is determined from a one year out-put of the literature of that subject, the Current Collecting Intensity CCI level of that periodical collection can be established. This is part of the Hypothesis formulated previously.

	Titles		Semi. Cit.		UC	SC	IS	IT	NO
Zone A	24	5%	5473	50%	22	24	8	12	22
Zone B	60	13%	7695	70%	52	47	14	25	40
Zone C	100	21%	8813	80%	82	69	25	41	56
Zone D	475	100%	10984	100%	313	225	65	124	147

TABLE 4

Library Holdings in Percentages

	Zone C	Zone D
UC	82%	66%
SC	69%	47%
NO	56%	31%
IT	41%	26%
IS	25%	14%

TABLE 5

B. Books.

The out-put for books on Semicoductors was obtained by using appropriate subject terms and codes from the sources mentioned in Methodology e of this paper; a total of 78 books were found. In this section it will be demostrated that one year out-put of the literature of Semiconductors

published in book format agrees with the Bradford Distribution.

Table 6 and Figure 3 demostrated that the conditions of Bradford's Law were found when the production of books on Semiconductors during the year 1983 was analyzed.

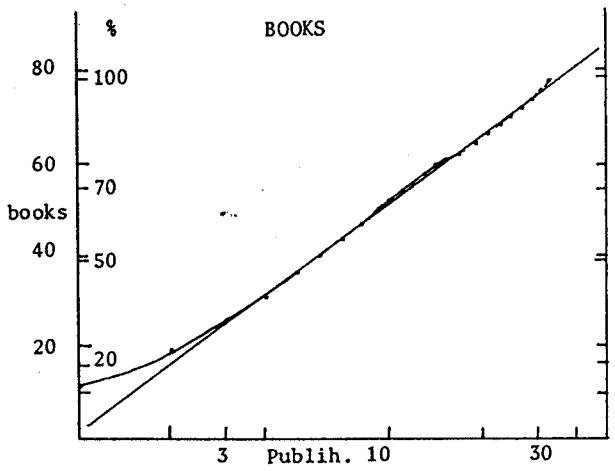

FIGURE 3

	Publishers	No. of Books	%
Zone 1-Nucleus	1-3	26	33.3
Zone 2	4-10	52	66.6
Zone 3	11-33	78	100.0

b= 3; N= 78 titles; number of publishers = 33; n= 3.3.

TABLE 6

Library holdings - Books. Table 7 indicates the number of books and their percentages that are available in each of the five libraries selected for this study. The total number of books is 78.

Here again a definite pattern can be established. UC is at the top showing the strongest collection in the group. At the bottom of the seale is IS with a Basic level collection. SC and NO continued to have the second and third strongest collections, while IT obtained a fourth place. Therefore, it is possible to conclude that a one year out-put for monographs contains sufficient data to determine the Current Collecting Intensity CCI level of a collection of scientific books.

Libraries	Titles	%
UC	49	63
SC	34	44
NO	29	37
IT	12	16
IS	4	5

TABLE 7

C. Conference Proceedings.

Ei Engineering Conference Index, Volume 1; that covers conference proceedings included in the Ei Engineering Meetings database from July 1, 1983 to June 1984 was used in order to find the behavior of the literature of conference proceedings published in one year; 198 meetings dealing with the engineering and physics aspects of Semiconductors were found. The number of papers of each meeting related to the subject matter were selected and counted. The results are in Table 8 and Figure 4.

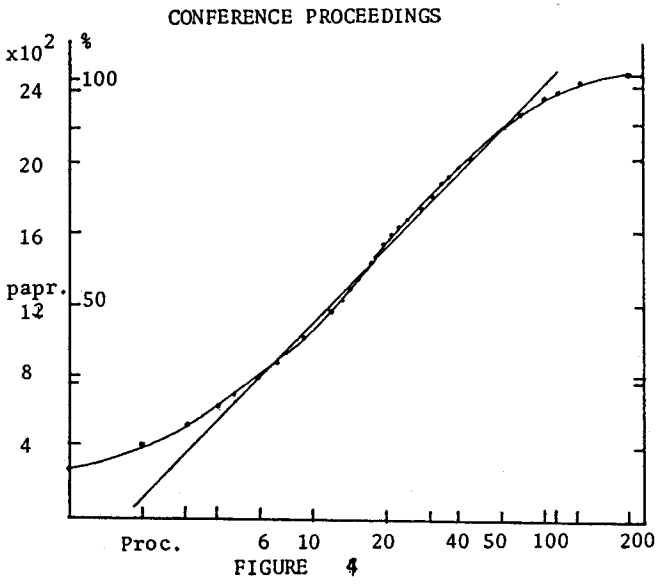

FIGURE 4

	Proceedings	No. of Papers	Expec. Value	Dev.	%
Zone 1-N	1-6	776			31
Zone 2	7-23	1608	1552	.036	65
Zone 3	24-96	2333	2328		95
Zone 4	96-198	2469			

b= 6; N= 2469 papers; number of proceedings= 198; n= 4 for the relation $1:n^2:n^3\ldots$.

TABLE 8

It can be seem from Figure 4 that 13 titles captured about 50% of the papers published in proceedings for one year. Figure 4 is also an empirical Bradford Distribution with a b value of 6. The results show that the conditions for Bradford's Law are obtained when a one year out-put of conference proceedings papers are retrieved. Thus, it is possible to conclude that a one year out-put of the conference literature for Semiconductors provided with sufficient data to determine the literature of that subject.

Library holdings - Conference proceedings. In order to determine the holdings for libraries, all conference proceedings published as issues of journals were excluded; and only monographs

retrieved from all the sources mentioned in Methology e of this paper were considered. The total number of conference proceedings published as book was 105.

The results of Table 9 are similar to the results obtained for Periodicals and for Books. UC appears to be the strongest collection followed by a distant second SC. NO and IT are in a third and fourth places, and IS reveals a very Basic level collection of proceedings on Semiconductors.

Conference Proceedings		
Libraries	No. of Titles	%
UC	71	68
SC	28	27
NO	18	17
IT	15	14
IS	2	2

TABLE 9

Conclusions.

Table 10 summarized the results for the segments of the literature of semiconductors being studied. The data in this table demostrate that the out-put of the literature of Semiconductors for one given year (1983) is sufficient to determine the Current Collecting Intensity CCI level of the collection. This was the hypothesis formulated in this paper.

PERCENTAGES OF HOLDINGS					
	UC	SC	NO	IT	IS
Periodicals	66	47	31	26	14
Books	63	44	37	16	5
Conference Proceedings	68	27	17	14	2

TABLE 10

Cost - Journals Productivity - Titles Relationship.

Table 11 includes the percentages of titles for each Zone; their number of citations; the adjusted prices for 1987, and the percentages of the cost. Adjusted prices of journals for 1987 were obtained by assuming a 30% price increased across the board, using a 1986 base.

	Titles	%	No. of Cit.	%	Adj. Cost	Cost %	Ave. Price
Zone A	1-24	5	5473	50	19688	15	631
Zone B	25-60	13	7695	70	35695	27	351
Zone C	61-100	21	8813	80	49713	38	270
Zone D	101-475	100	10984	100	131459	100	167

TABLE 11

The average Price of journals within each Zone are different. Journals in Zone A cost almost twice as much as journals in Zone B and five times more that journals in Zone D. Thus, it is possible to conclude that the most productive journals for Semiconductors are also the most expensive.

This last finding has to be considered more carefully. Table 11 also shows that for Semiconductor journals, 50% of the periodical out-put is captured by 5% of the titles, and they cost 15% of the total cost. The most productive journals are more expensive but they also represent the least number of titles that contain the largest coverage in the literature. In fact, they are the most attractive to purchase. Data taken for this study shows that three of the five libraries selected have all the titles occuring within Zone A in their collection.

Another way of looking at the cost-productivity relationship is indicated in Figure 5. Figure 5 shows the exponential nature of the productivity curve P; it also shows the behavior of curve C for periodical costs: at point 100 the C curve became a straight-line while the productivity P began to decline rapidly.

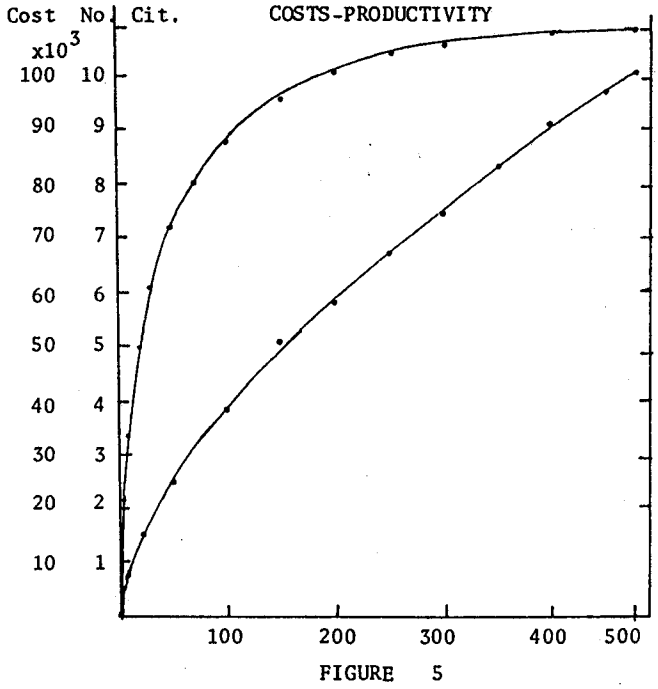

FIGURE 5

Comments.

D. Hawkins[28] did a study of the periodical literature of semiconductors in 1976, it included the period from 1970 to 1975, used 91 journal titles and found 19646 papers; when comparing the first 24 titles of Hawkins with Table 1, 14 of them are on this list.

It is important to mention that the concepts of randomness and selectivity were not included in this study. Random samples can be used when working with larger files. Selectivity, either for the academic level of materials or selectivity of subject matter within a larger subject field, could also be considered as a viable method for verification.

Finally, it is also important to state that there is agreement among selectors that libraries should maintain collection levels necessary for the support of research and academic programs. The idea of cooperation is intended to enhance the capability of libraries to get access to materials that might be considered peripheral or esoteric for local needs. To reinforce this later statement Table 1 indicates that a university with a good program in semiconductors probably needs all the journals listed but they might not be the only ones that the library should own. Optimization is then achieved for the level of research and academic programs desired without deteriorating the strengths that the collection must have.

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