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AN APPLICATION OF SYSTEMATIC ANALYSIS TO THE M. I. T. LIBRARIES

by

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Abstract

The purpose of the following systems analysis is to provide a framework for a discussion of the policy and investment decisions which the M.I.T. libraries should consider in the period extending through 1980. This paper summarizes our findings and conclusions regarding alternative systems of 1) storing books, 2) providing study spaces, 3) providing required reading material, and 4) fulfilling research needs. Considerable effort has been made in our research to include the environmental and technological factors libraries will face in the 1970's.

Acknowledgments

I would primarily like to thank Professor Fred Charles Iklé for the role he has played in the educational process which has led to this undergraduate thesis. Professor Iklé has helped me to realize that systems analysis can be a powerful aid in evaluating alternative allocations of resources. At the same time he has helped me appreciate some of the pitfalls inherent in this approach to decision-making. In addition, Professor Iklé was kind enough to assist in the arrangements for this study.

I would also like to extend my sincere appreciation to Professor Locke, Miss Natalie Nicholson, Miss Frances Lubovitz, and other library administrators for their cooperation in making this study possible.

Finally, special thanks go to Mr. Jeffrey Raffel, who has co-authored this thesis, for the numerous contributions he has made to this study.

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INTRODUCTION

We have identified at least two principal missions for the M.I.T. Libraries. The first mission is to provide material for students' course work; this usually means assigned reading as well as reference and background reading for essays, term papers, and research projects. There are several subsidiary objectives, we believe, relating to this mission:

1. To select, acquire, and organize material for course-related work;
2. To make this material available to users;
3. To provide reference and bibliographic information; and
4. To provide facilities for studying course-related material.

The second principal mission is to provide material in general support of research at M.I.T. Again there are several subsidiary objectives relating to this mission:

1. To select, acquire and organize material for research;
2. To make this material available to users;
3. To provide search and bibliographic aids; and
4. To provide facilities for research where desirable.

The present state of the Library reflects the general preponderance of science, engineering and social science at M.I.T., but in the future the Library may reflect a whole range of intellectual concern of which science and technology are but a part. The problem is then how to organize future library resources into a set of programs that best fulfills these objectives.

CHAPTER I

THE PROGRAM BUDGET

A Program Budget for the M.I.T. Libraries

The first task was to translate the current library budget into a budget relating outputs to inputs, i.e., a Program Budget. This allows the analyst to disaggregate and reaggregate relevant costs, and to expand the reporting of costs to include overhead, fringe benefits, general administration, and other quasi-fixed costs. These costs are a part of M.I.T.'s expenses in maintaining the libraries but are not charged directly to the M.I.T. library budget.

The program budget was disaggregated to display those categories (i.e. activities) for which the library was already noting output statistics. Personnel costs, in both the Central Processing and Handling Services, and the divisional libraries (Dewey, Hayden) were determined by multiplying the average salaries, fringe benefits, and general administration costs* associated with library personnel at various professional levels by the percentage of time such personnel reported spending on each of the program budget activities (Appendix 1). These time reports were taken in a July time survey which covered only the Student Center, Dewey and the Humanities Libraries, and the Cataloging, Acquisitions, and Circulation Departments. About three-quarters (73%) stated that the time allocation reported

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* Fringe benefit and general administration (payroll, hiring, etc.) were reported by the Controller's Office to add 28.5% to actual salary figures.

for the previous day's work was "very typical" or "typical" for their work during the summer.*

Floorspace costs included a charge of $1.25 for general maintenance and $2.54 as a uniform annual repayment of the capital costs and interest charges on the capital costs.

Maintenance costs were provided by the Superintendent's Office. These figures included lighting, heating, water, cleaning, guards, and supervision.

Capital costs were estimated at $40/gross square foot for an air-conditioned, on-campus library or storage facility. We used an interest rate of 6.0%, as suggested in the meeting with library directors, Professor Iklé, Professor E. D. Domar and others on December 7, 1967, and costs were allocated over a 50-year repayment period.** A more detailed discussion of the treatment of capital costs can be found in the report on alternative storage arrangements (Chapter II).

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* A further survey is necessary to indicate the reliability of the summer survey. The reliability appears to be lowest where the categories include the fewest number of workers and, fortunately, the least expense.

** The following matrix illustrates the sensitivity of the uniform annual capital cost to variations in interest rate and construction costs.

$/gross ft^2	i 4.0%	4.5%	5.0%	5.5%	6.0%
40	$1.86	$2.02	$2.19	$2.36	$2.54
45	$2.10	$2.29	$2.46	$2.66	$2.85
50	$2.33	$2.53	$2.74	$2.95	$3.17

Jobber and supply costs were reported by library administrators. Supply costs in the cataloging department were accurately known, but supply costs in the other functional categories were estimated. Fortunately, cataloging accounts for about 60% of the supply costs.

Output statistics were, in most cases, already available from the divisional libraries and central processing departmental annual reports. One important figure - the total number of inquiries in the information services - was estimated from a survey in the Hayden Library.

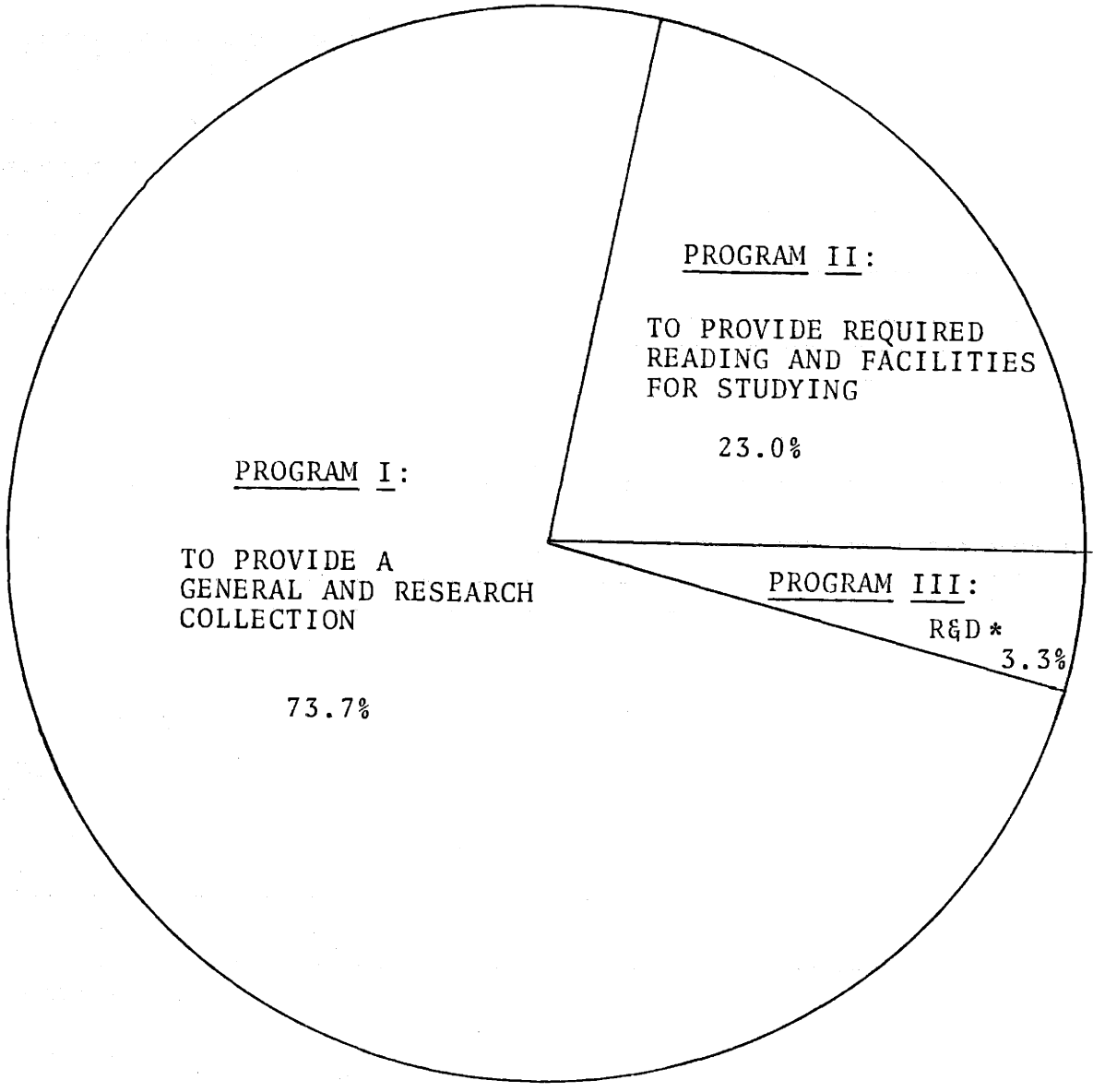
Implications of the Program Budget

Figures 1, 2 and 3 show current expenditures by program category. (Appendix 2 gives a more detailed breakdown of the Program Budget; Appendix 3 reports the cost per item in various categories.) Thus note that the M.I.T. libraries spend as much cataloging items as purchasing them, and that the libraries spend more to "store" people in study spaces (11.4%) than to store books in stacks (6.4%).

It is now possible to compare existing and new alternatives within each of the main program categories, and to identify trade-offs between program activities.

Figure 1

BREAKDOWN OF LIBRARY BUDGET BY PROGRAM



* TECHNICAL INFORMATION PROCESSING PROJECT (T.I.P.)

Figure 2

BREAKDOWN OF GENERAL AND RESEARCH COLLECTION BUDGET

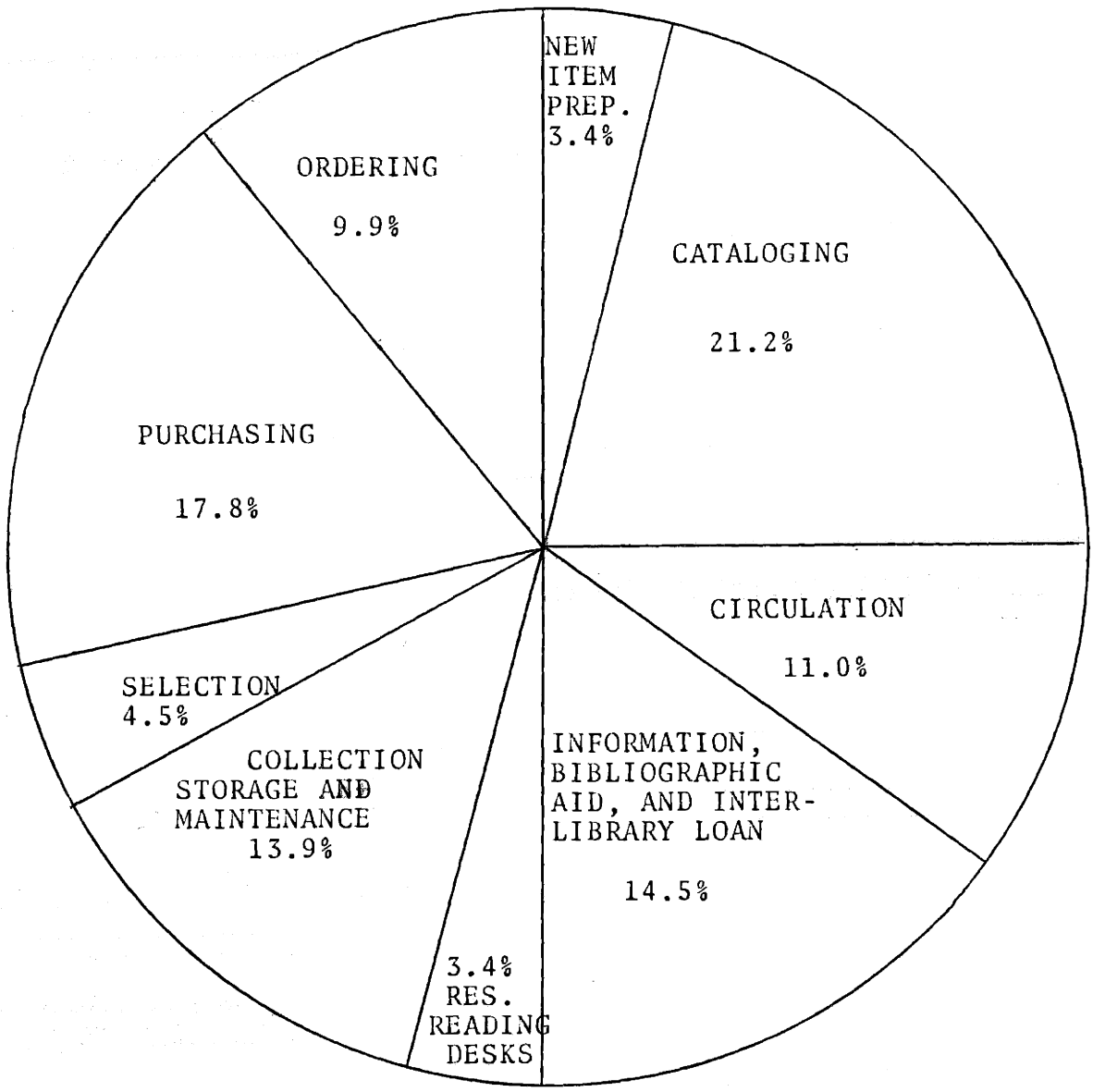
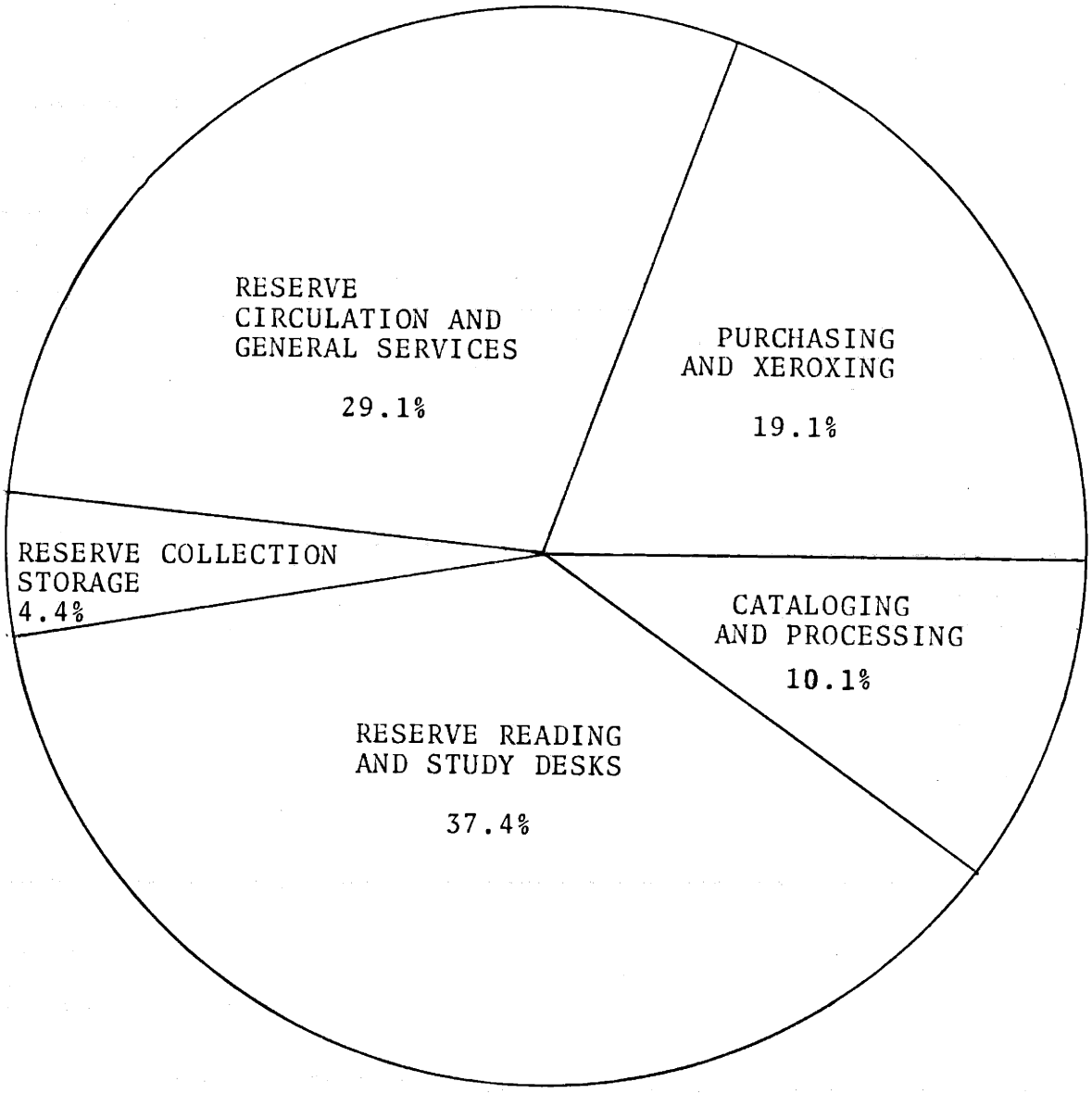


Figure 3

BREAKDOWN OF REQUIRED READING AND STUDYING BUDGET



CHAPTER II

STORING THE COLLECTION

Modeling Book Storage Costs

The variables which the library can control in determining book storage policy are:

1. Location of the storage facility - on or off campus.
2. Type of storage - conventional (with room for expansion throughout) or compact (books shelved chronologically and by size).
3. Degree of user access to the collection (closed or open stacks).

It is assumed that the degree of use associated with a given collection is a function of the type and size of the collection and the characteristics of those who use it. Although the nature of studying and research may change in future years, it was assumed that large scale inexpensive storage alternatives at M.I.T. fall into the moderate use category. The storage model used here, derived in part from the work of Metcalf,* associates the number of square feet required to store an average book given the storage policy specifications. The basic variables of the model are aisle width (greatest where user traffic is greatest), range or individual stack length (longest where use is least), and stack capacity. Thus, where use is heavy, greater area must

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* Metcalf, Keyes D., Planning Academic and Research Library Buildings, New York: McGraw-Hill, 1965.

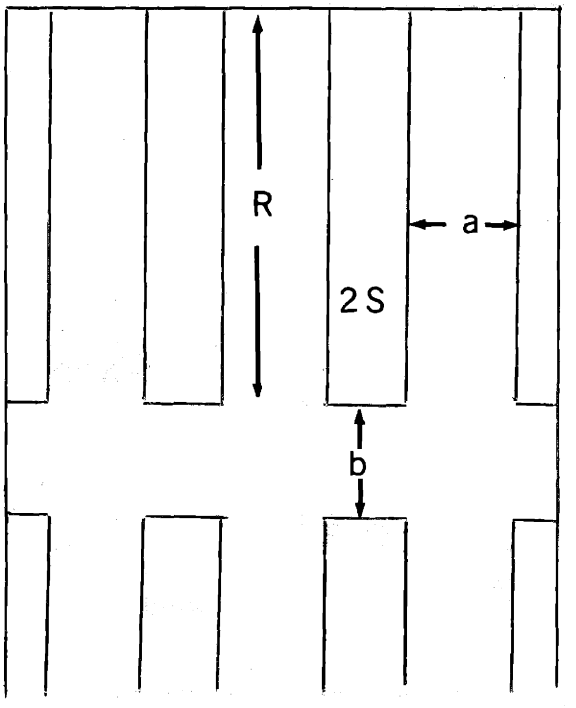
be devoted to provide access to users and thus the total square feet required to store a book is high.

Determining the area required per section of stacks:

Sections are defined as 3 linear feet of single-faced shelves, 7½ feet high. In the Metcalf model, the following variables are defined:

Let a be the aisle width in feet,
b be the cross aisle width in feet,
R be the range length in feet, and
S be the single shelf depth = 2/3 ft.

Figure 4 is included to make these definitions more meaningful.



Then the required area for each range length is

$$A = (R+b)(a+2S) \qquad \text{(Equation 1)}$$

Since each range length includes $\frac{R}{3}$ sections, and each range length consists of double-faced shelves, there are $\frac{2R}{3}$ sections in each range length. Then:

$$\frac{\text{Sections}}{\text{ft}^2 \text{ of stacks}} = \frac{2/3\ R}{(R+b)(a+4/3)} \qquad \text{(Equation 2)}$$

The following table gives the results of inserting b = 3 ft. into Equation 2 for various combinations of values for a and R.

Table 1

Ft^2 of stacks per Section

a, aisle width	R, range length 15'	25'	35'	45'	55'	65'	75'
24"	6.0	5.6	5.4	5.3	5.3	5.2	5.2
26"	6.3	5.9	5.7	5.6	5.5	5.5	5.5
28"	6.6	6.2	6.0	5.9	5.8	5.8	5.7
30"	6.9	6.4	6.3	6.1	6.1	6.0	6.0
32"	7.2	6.7	6.5	6.4	6.3	6.3	6.2
34"	7.5	7.0	6.8	6.7	6.6	6.6	6.5
36"	7.8	7.3	7.0	6.9	6.9	6.8	6.8
38"	8.1	7.6	7.3	7.2	7.1	7.1	7.0
40"	8.4	7.9	7.6	7.5	7.4	7.4	7.3
42"	8.7	8.1	7.9	7.8	7.7	7.6	7.6

The entries that have been boxed in indicate those combinations which Metcalf considers feasible. From Equation 2 it can be seen that the number of ft^2 per section is not a function

of the location of the storage facility, or of the type of storage, i.e., conventional, compact. The required area is a function only of the degree of expected use and the type of access, i.e., closed or open.

For a college research library, in particular the M.I.T. Library system, only the following alternatives were considered relevant:

Table 2

Access	Degree of Expected Use	Ft^2/section
Open	Heavy	7.8
Open	Moderate	7.0
Open	Infrequent	6.4
Closed	Moderate	6.4
Closed	Infrequent	5.9

Determining the number of volumes per section:

Conventional Storage: In his book, Metcalf* estimates the average number of volumes that could be stored on a single-faced section of stacks. The choice of a single number depends on a number of assumptions about the composition of the collection. A weighted average of the Metcalf estimates was computed, and a figure of 125 vols/sec was chosen.

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* Ibid., page 393.

Table 3

Volumes per Single-faced Section

Fiction	168
Circulating non-fiction	168
Economics	168
General Literature	147
History	147
Art	147
Technical and Scientific	126
Public Documents	105
Bound Periodicals	105

Compact Storage: Metcalf discusses various methods of compacting. The Yale Compact Storage Study, a part of Yale's Selective Book Retirement Program, shows that the added cost of mechanical and mobile shelving offsets any gain in the utilization of space. Table 4 below shows effect of three alternative compacting plans. In combination, the gain in the utilization of space is greater than the "sum of its parts."

Table 4

Method of Compacting	% Increase in Vols/Section	Vols/Section
Size (5 groups)	20%	150
Chronological	32%	165
Fore-edge	35%	169
Combination	95%	244

The number of volumes per ft^2 of stacks is then simply given by:

$$\frac{\text{Vol}}{ft^2} = \frac{\text{Vol}}{\text{Section}} \Big/ \frac{ft^2}{\text{Section}} \qquad \text{(Equation 3)}$$

Determination of Unusable Area Factor

The Unusable Area Factor is used to account for space devoted to stairways, restrooms, entrances, etc., all of which must be a part of any storage facility. The factor depends basically on the expected degree of use. Hence we have used the following scheme to obtain the UAF.

Degree of Use	Unusable Area Factor
Heavily used	1.25
Moderately used	1.20
Infrequently used	1.15

The ft^2/ vol figure is then multiplied by the UAF to obtain the gross ft^2/vol, which of course is the figure used in computing building and maintenance costs.

Maintenance Costs

The following maintenance costs were estimated by the Superintendent's Office. These figures include lighting, heating, power, water, cleaning, guards, and supervision.

Table 5

i)	On campus library maintenance for a heavily used facility	$1.50/yr-ft^2
ii)	On campus library maintenance for a moderately used facility	$1.25/yr-ft^2
iii)	On campus storage facility for infrequently used material	$ .90/yr-ft^2
iv)	On campus heavily used (open 24 hrs/day) study facility such as the Student Center Library	$2.50/yr-ft^2
v)	Off campus moderately used library (i.e., same as on campus)	$1.25/yr-ft^2
vi)	Off campus storage facility	$ .90/yr-ft^2
vii)	Off campus storage warehouse such as the NEDL	$ .60/yr-ft^2

Multiplying these per square foot annual costs by the gross area per vol, the annual maintenance cost per vol stored is obtained.

Finally, it should be noted that maintenance costs have been rising and are expected to continue rising at about 3-4% per year.

Building and Land Costs

Construction costs were estimated by the M.I.T. Operations Office. Based on recent construction at M.I.T., the following figures were used:

Table 6

Buildings	
On campus library and/or storage facility (air-conditioned)	$38/gross-ft^2
Off campus library and/or storage facility (air-conditioned)	$33/gross-ft^2
Off campus storage warehouse (air-conditioned)	$25/gross-ft^2
Land	
On campus or nearby real estate	$12/gross-ft^2
Off campus real estate	$ 3/gross-ft^2

The amount of land required for a building of course depends on the architecture, number of floors, landscaping, parking facilities, etc. For on campus buildings, we have assumed a building of four floors plus a basement similar to the Hermann Building with no new parking facilities. For off campus

buildings, we have again assumed a building of four floors plus a basement, but with parking facilities depending on the expected degree of use. The final cost figures are not sensitive to any of these assumptions.

Once the capital expenditure figures were determined, they were transformed by Equation 4 into a uniform annual cost that includes repayment of the principal, and interest on the unpaid portion of the principal over the entire life of the system. Land, naturally, was not amortized; only the interest on the cost of the land was counted.

$$R = P\left[\frac{i(1+i)^n}{(1+i)^n-1}\right] \qquad \text{(Equation 4)}$$

$$= P(\text{c.r.f.})$$

Where R is the uniform annual capital cost
P is the principal
i is the interest rate
n is the repayment period
c.r.f. is the Capital Recovery Factor

We have used an annual interest rate of 6% and a repayment period of n = 50 years. Provided n is "large," R is insensitive to changes in n.

Storage Equipment Costs

From the Yale study of book storage, the cost of conventional shelving was found to be about $\$4/ft^2$ of stacks while compact shelving was found to be about $\$6/ft^2$ of stacks.

To convert these to uniform annual costs per volume, we assumed the same capital recovery factor. Thus

$$\frac{\text{Storage Equipment Cost}}{\text{Volume-Year}} = \frac{\text{Storage Equipment Cost}}{\text{ft}^2 \text{ of stacks}} \times \frac{\text{ft}^2 \text{ of stacks}}{\text{volume}} \times$$

(c.r.f. (i=6%; n=50))

(Equation 5)

Total Cost Function

The total cost per volume per year is then the sum of the annual maintenance cost per vol, the uniform annual building and storage equipment cost per volume, and the annual interest charges on the cost of lands used for book storage per volume.

Figure 5 summarizes our findings regarding costs and benefits of alternative book storage systems, and Appendix IV breaks down the cost data for each of the alternatives.

Figure 5

Storage Alternative	Benefits	Cost/Volume/Yr
Infrequent Use		
1) Open access, conventional storage, on campus	Browsing possible	$ .2269
2) Open access, conventional storage, off campus	Browsing possible only for those willing or able to travel off campus (presumably for special projects or papers). Retrieval system necessary, hence delay incurred.	.1992
3) Closed access, compact storage, off campus	Browsing impossible. Retrieval system necessary, hence delay incurred.	.0752
Moderate Use		
1) Open access, conventional storage, on campus	Browsing possible	.2825
2) Closed access, conventional storage, on campus	Browsing possible but discouraged except for special projects.	.2581
3) Open access, conventional storage, off campus	Browsing possible for those willing to travel off campus. Retrieval system necessary - delay.	.2509
4) Closed access, conventional storage, off campus	Browsing possible only under very special circumstances. Retrieval system - delay.	.2293
5) Closed access, compact storage, on campus	Browsing impossible but retrieval delay short.	.1360
6) Closed access, compact storage, off campus	Browsing impossible, retrieval with delay necessary.	.1213
Heavy Use		
1) Open access, conventional storage, on campus	Easy browsing possible	.3474

Implications of Storage Costs

Standardization of the Collection

The first task is to standardize the M.I.T. collection consisting of books, pamphlets, journals, serials, theses, and technical reports, to a base of 125 volumes per section used in the storage model. Table 7 displays the factors used in translating these diversified types of material into volume equivalents:

Table 7

1 volume equivalent	=	1 journal
	=	$\frac{3}{2}$ hardcover monographs
	=	6 serials
	=	3 theses
	=	3 technical reports
	=	6 pamphlets

By applying these factors to M.I.T.'s collection of

about 400,000 hardcover monographs,
138,000 journals,
113,000 pamphlets,
150,000 serials,
33,000 theses, and
150,000 technical reports, a figure of 510,000 volume equivalents is obtained.

Total Cost Comparisons for Alternative Storage Systems

Given our assumptions, we estimate the annual cost of leaving the collection open to browsing is ($.2825 - $.2581) $.0244 per volume equivalent. This figure is obtained by

subtracting the annual cost of storing a volume equivalent on campus, in a closed, conventional mode ($.2581) from the annual cost of storing a volume equivalent on campus in an open, conventional mode ($.2825). In terms of a total annual figure, the cost is about (.0244 X 510,000) $12,500. Given a doubling of the collection in eight years, the saving resulting from closing the collection would then be about $25,000 per year.

Closing access to the collection may result in increased circulation costs as users called for books from storage which they would reject were browsing possible. Furthermore, benefits may be lost because difficulty in using the retrieval system may discourage some people from calling for marginally useful books.

A much larger total cost differential occurs when books are stored compactly, i.e., by size, and tightly packed. Such a compact storage system would naturally have to be a closed access system since books are stored by size rather than subject classification. The estimated annual saving is ($.2825 - $.1360) $.1465 per volume equivalent stored in this mode. If the M.I.T. libraries stored all of the present collection in compact form, the annual saving is estimated at ($.1465 X 510,000) $74,700. Again, given a doubling of the collection in eight years, the estimated annual saving resulting from compact storage would be $149,000.

If M.I.T. decided to store the entire collection in compact form, there would naturally be an initial cost of regrouping and rearranging. If M.I.T. did not store all the items this way, and this is certainly more likely, it would be necessary

to weed the collection initially and periodically, i.e., decide which books to store compactly, remove them, and change the catalog appropriately. It would also be necessary to provide a system to retrieve books from compact storage. To determine the annual savings from this method, a model making explicit the projected growth of the collection, and a particular decision rule for weeding is discussed below.

An Example of an Inexpensive Storage System

Comparison of Weeding Criteria: A Sub-optimization

There are several criteria that are available for weeding book collections. We have considered the following:

i) Weeding by past circulation, i.e., by the number of times in a recent past period that book was signed out of the library;

ii) Weeding by publication date, i.e., remove all books published more than X years ago;

iii) Weeding by acquisition date, i.e., remove all books acquired more than Y years ago;

iv) Weeding by gross characteristics, i.e., remove all items exhibiting some particular characteristic, such as all books classified in the Dewey Decimal System.

We have assumed that a preliminary measure of the benefits foregone by storing some books inexpensively is the percentage of the total annual circulations attributable to books that are inconveniently located. A constant level of benefits thus implies a constant percentage of total circulations "stored" inexpensively. Note also that since more books are added to the libraries each year, and since the use of a subcollection of

books declines systematically with age (see Figure 6), the number of books stored inexpensively can rise each year without lowering aggregate benefits. The questions are then: For a given level of benefits, which criteria maximizes savings, and what is the level of these savings?

In order to develop a picture of the popularity of the books that would be weeded by the various criteria considered in this report, a sample of N = 412 books from the Dewey Library second floor stacks was taken. From these volumes, we selected all those which were in the collection as of January, 1963 (N = 188), and examined the results of hypothetical weeding programs, had the collection been weeded in December, 1963. With our data (Appendix V), we were able to plot, for each of the weeding criteria, the percentage of books removed versus the percentage of 1964-67* circulations "lost" (Figure 7). The "foreknowledge" curve shows what an optimal criteria would have produced.

As expected, past circulation is a good indicator of future use, while the acquisition and publication date criteria, both similar, are not as useful. The question, however, is whether the added cost of weeding by the circulation criterion cancels the additional storage savings due to the ability to store more books at a given level of benefits (i.e., circulations stored inconveniently).

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* January, 1964 through July, 1967.

AVERAGE 1966 CIRCULATION OF A BOOK AS A FUNCTION OF X, THE NUMBER OF YEARS SINCE ITS PUBLICATION

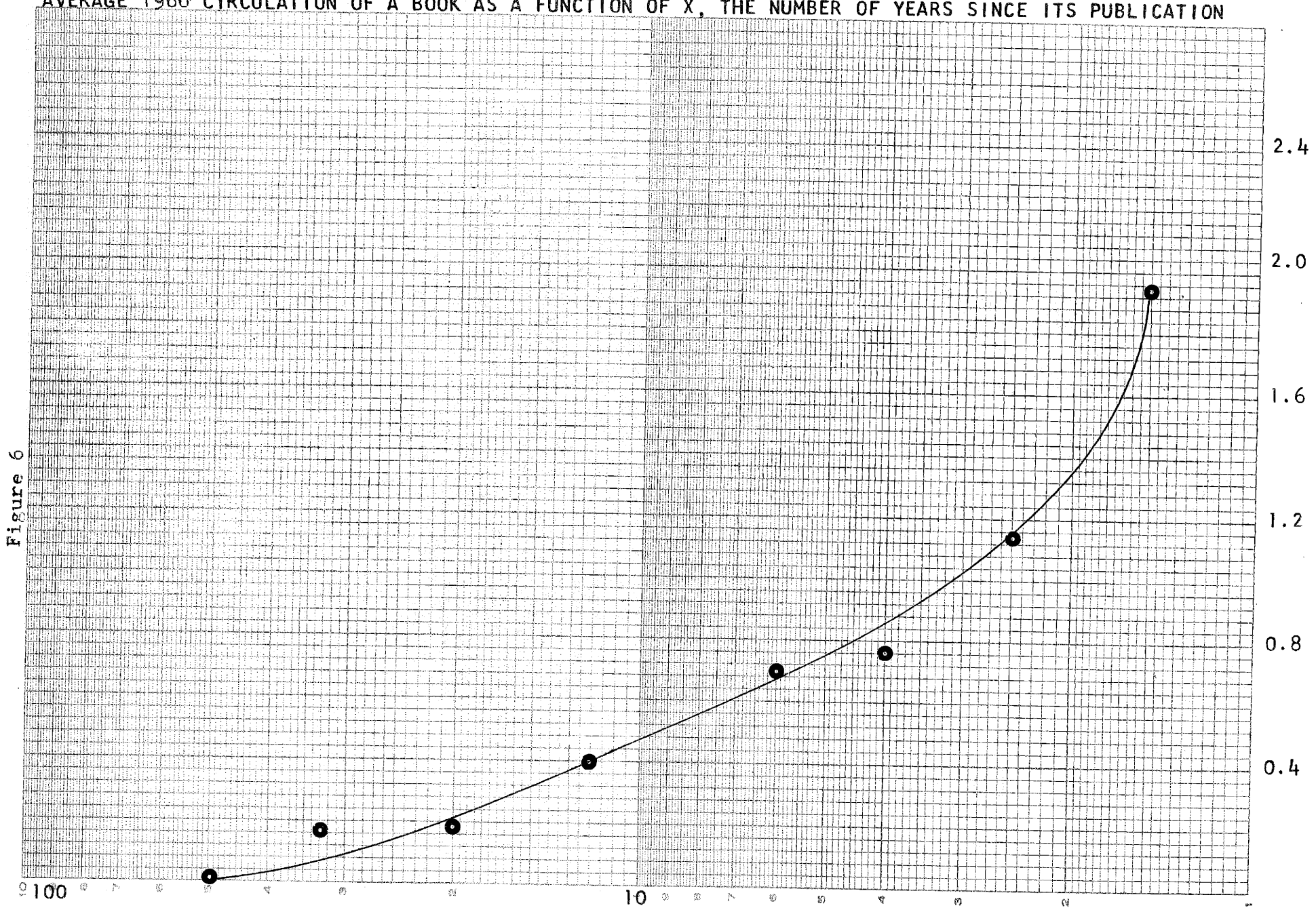


Figure 6

NO. 340-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

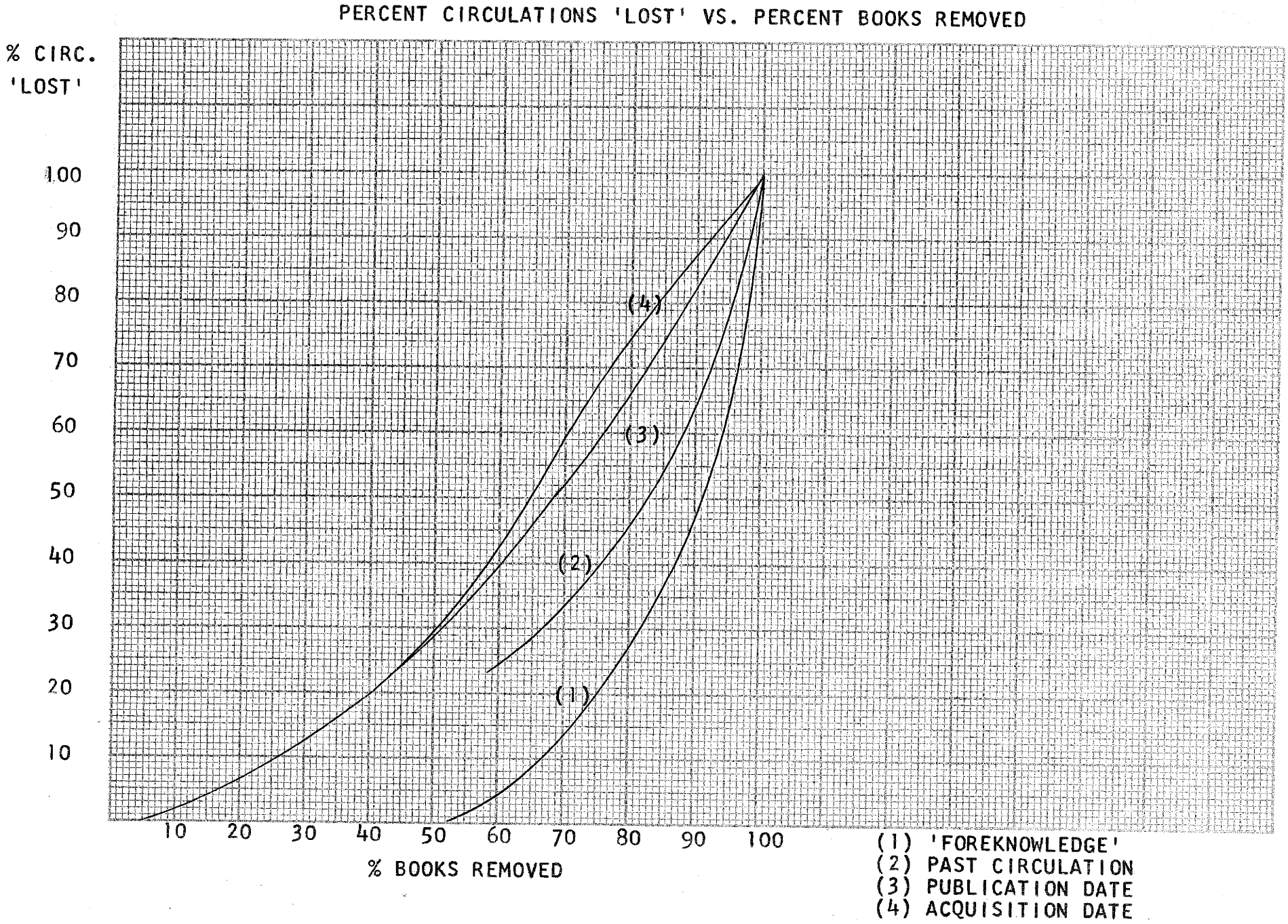


Figure 7

Costs of Weeding

By Publication Date: The publication date can be determined by reading the catalog, or examining the item. The latter method could be combined with actual weeding. The attractiveness of this method is that the catalog need not be changed to indicate which books have been removed. A sign of the type: "All books published before 1940 are now in storage," would be adequate for notifying users. We have examined two estimates of the cost of weeding by publication date, $.20 and $.40.

By Acquisition Date: This method is at best inferior to the publication date criterion. The cost of weeding is higher than with the publication date because the acquisition date is not on the catalog card and notifying users of a book's removal would necessitate a catalog card change. Furthermore, the publication date criterion allows the removal of at least as many books as with the acquisition date criterion for all levels of circulations lost. We consider this criterion dominated by the publication date criterion.

By Circulation Criterion: This method is very similar to Yale's method as reported by Ash. It required much individual attention to each book to count circulations on the withdrawal card. Furthermore, it is necessary to indicate on all the catalog cards associated with the book that it has been stored. The Yale experiment found a cost per volume of $.61, but they did some weeding en masse and did not add on fringe benefit and general

administration costs. We feel that $.80 to $1.00 a volume would be a more reasonable range of the cost of weeding by this criterion.

By Gross Characteristics of a Collection Subset: With this criterion we are assuming we can characterize a given subset of books by its total circulation. We cannot graph a continuous plot for this criterion, for we either remove the entire set or not. The advantage here accrues when only a sign is needed to indicate that a particular subcollection has been removed to storage. Furthermore, as in the case with the Dewey Decimal System books in the Hermann Building Library, these books are already housed as a separate collection. We estimate that $.03 per book would be sufficient to remove such a collection.

One way to compare these costs is to treat weeding costs as capital expenditures, and convert them into annual payments. The annual net saving at a particular level of benefits B for weeding criterion j is then given by the formula:

$$Nf_j(B) \left[.1465 - W_j \text{ (c.r.f.}(i=6\%, n=50) \text{)} \right] \qquad \text{(Equation 6)}$$

Where N is the size of the collection in volume equivalents

$f_j(B)$ is the fraction of volumes removed by criterion j for the level of benefits B

W_j is the weeding cost per volume removed by criterion j

and c.r.f. is the 50 year, 6% capital recovery factor.

Table 8 gives the results of Equation 6 for several levels of circulations "stored," i.e., benefits.

We have concluded that for the collection characterized by our sample, the publication date criterion is probably more cost-effective, particularly at higher levels of circulations "stored." Given the greater decline in use of science books with age, the publication date criterion would probably prove superior for weeding science collections. The most useful criterion for humanities books was not determined, although it may still be more efficient to accept a loss in discriminating ability by using the publication date criterion rather than pay the added expense of determining past circulation patterns of books and changing the catalog for each book individually.

Table 8

% Circulation "Lost"	% Books Removed		Annual Net Savings for 510,000 Volume Equivalents			
	Circulation Criterion	Publication Date Criterion	Circulation Criterion		Publication Date Criterion	
B	$f_j(B)$		W_j= $.80	$1.00	W_j= $.20	$.40
15%	47%	35%	$23,200	$19,900	$24,000	$21,700
20	54	42	26,500	22,800	28,700	26,000
25	62	47	30,500	26,200	32,100	29,200
50	83	69	40,800	35,100	47,200	42,800
75	94	86	46,300	39,800	59,000	53,500

Dynamic Model Completed

Figure 8 combines projected growth data and specific weeding costs in order to compare All Conventional Storage with 25% of Circulations Compactly Stored over the next 15 to 20 years. In our accounting, the cost of weeding is paid before savings are accrued. The length of this transition period depends on the cost of weeding and, of course, the interest rate (6%).

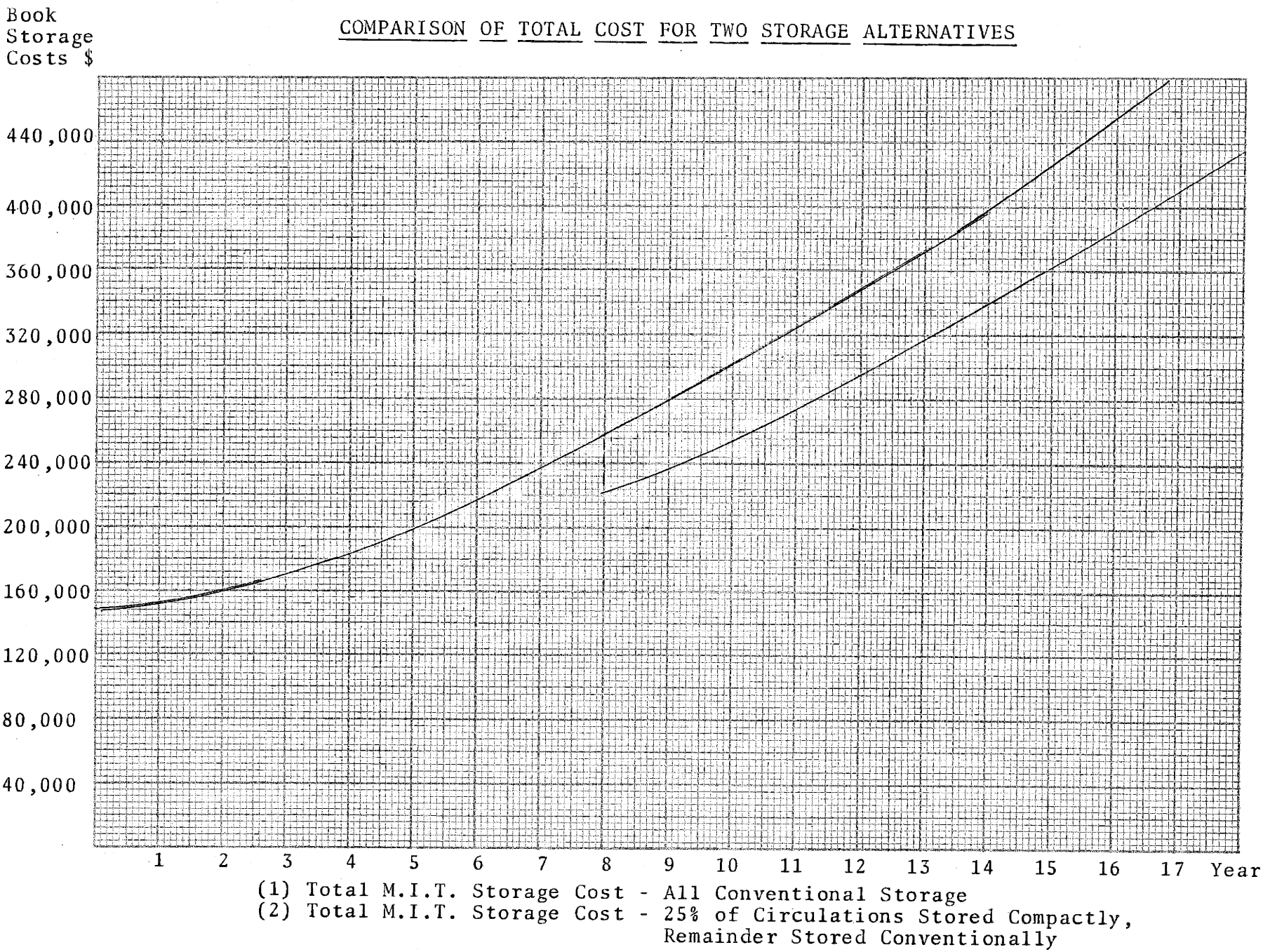
After such a transition period, the library would be storing those books which became X years old in the given year and the savings would thus be a time-lagged function of the acquisitions rate. Although only a small percentage (10-20%) of the total amount that the libraries spend on storage can be saved each year by this storage policy, the accumulated savings reaches $368,000 in 15 years.

Criticism of Lister's Model

Lister defines his total cost function as: Total Cost over H years = Building Costs + Maintenance and Operating Costs + Circulation Costs + Relocation Costs. Each of these costs is assumed to be either a constant per volume, or a linear function of the number of volumes. Lister writes the total cost expression as a function of the "critical age," the parameter defining which books should be removed to storage, and differentiates the total cost expression with respect to the "critical age" parameter to obtain the minimum cost conditions. In the formulation of the model, no attention is given to benefits or loss in benefits. In a belated attempt to remedy this, Lister

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

COMPARISON OF TOTAL COST FOR TWO STORAGE ALTERNATIVES



(1) Total M.I.T. Storage Cost - All Conventional Storage
(2) Total M.I.T. Storage Cost - 25% of Circulations Stored Compactly, Remainder Stored Conventionally

Figure 8

introduces the concept of a shadow cost of the delay associated with books circulated from remote storage.

The sensitivity of his "critical age" parameter to this shadow cost renders the derived minimum cost conditions just about useless.*

Bringing Inexpensively Stored Books to the User: Retrieval Systems

If some books are placed in inexpensive storage outside the main collection, a system is needed to bring the user to those books or the books to the user. It is assumed that users would prefer the latter. A motorized system is necessary where library personnel cannot easily walk to retrieve books. The qualitative difference in the two systems - motorized vs. library personnel - is reflected in the two cost figures. We estimate that the motorized system would cost $17,000 per year, $15,000 of which would be for the additional personnel. In this case, great savings would result from sharing the cost of the system with another function, e.g., transporting students to Wellesley classes.

The ability to share the cost of a retrieval system may affect the remote storage decision. For example, the saving in compactly storing a book off-campus as opposed to on-campus is about 1½¢ per volume equivalent per year. For 250,000 volume

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* See Least Cost Decision Rules for the Selection of Library Material for Compact Storage, Lister, Winston C., Ph.D. Thesis, Purdue University, 1967, pg. 59.

equivalents, about 50% of the present M.I.T. collection, the saving would be $3750 annually. This would not pay for a retrieval system, but given some sharing of costs, off-campus compact storage might be a defensible alternative.

Microform Storage

The microform alternative is currently dominated by each of the other alternatives as a storage method because of the large cost of converting hardcover, print material to microfilm or microfiche. Current technology allows us to convert a page of print to microform for about $.02. A four hundred page book would thus cost $8.00 to convert. Since we pay about $.28 a year to store the hardbound book, it would take almost 30 years just to pay for the original conversion without even considering interest charges, microform readers, or storage cabinets for the microforms. Without having to pay the cost of converting print to microform, a microform system is an inexpensive type of storage system. Its cost is very sensitive, however, to the number of microform readers the library installs. If we assume that the library provided one inexpensive reader, i.e. $250, for every ten users, then the total annual storage cost for 200,000 volumes and 2000 users would be approximately $10,000 or $.05 per volume. If the library installed alternatively 25% reader printers, the cost would rise to $32,000 annually or $.16 per volume. The first alternative is less than one-fifth of current per volume storage costs while the second is about one-half of current costs. The attractiveness of microfiche storage

thus depends on the amount and kind of reader equipment and the availability of the material in microform.

Storage of Books: Conclusion

We must conclude that altering the current storage system is not a very satisfactory way to save money.

The best alternative system, compact storage, saves only about 15% of current library expenditures on the storage of books, while storage expenditures themselves are only 6.4% of the annual budget. The saving, about 1% of annual library resources (less, if expensive retrieval systems are necessary), involves a major loss of benefits due to limitations on browsing and retrieval delay times of perhaps several hours.

CHAPTER III

PROVIDING STUDY SPACES AND REQUIRED READING MATERIAL

Introduction

As the program budget indicates, the M.I.T. libraries spend almost twice as much on "storing" people in study spaces as they spend on storing books in stacks. A shortage in book storage space may be more observable, but the study space issue is more significant in terms of annual costs.

The objective of the study-reserve system is to provide students with course-related materials and pleasant facilities to use these materials. The present system includes 1) the reserve section of the library, 2) library seats for studying and using reserve items, 3) a source of textbooks, i.e., the Coop, 4) departmental reading and study rooms, and 5) dormitory room desks. This report examines only the activities directly related to the library, the first two subsystems, which account for only about one-third of the total amount spent by M.I.T. and its students on required reading and studying.*

There are three basic methods of fulfilling the study reserve function. First, the M.I.T. libraries can distribute (with or without charge) course related materials to students

* For example, if the average M.I.T. student spends $100 annually on course related books, the total outlay would be $720,000.

to be used primarily in the dormitory rooms, libraries, and scattered study places. The Coop presently sells books; in the future the library could distribute or sell duplicated copies or microfiche cards of articles, or entire books.

A second approach is to make the library the center of all required reading and to provide students with needed materials for limited amounts of time. This method is best where the cost of an item is high and use of it is low. A third approach is to maintain the library as the central lending office but also to encourage students to duplicate and then remove those materials they want the most.

The Present Study - Reserve System

We estimate that the present library system costs about $517,000 annually, 38% for personnel, 38% for floorspace (primarily study space), and 19% for books and duplicated articles.* There are several alternatives which would reduce the seating requirements of the library so that either current seating could be converted to stacks or the construction of new library facilities could be postponed despite an increase** in the

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* The floorspace expense assumes that 75% of the current seating is used for study-reserve activities during peak hours. The Program Budget underestimates the cost per seat because the cost of furniture is added as an average cost across all activities to basic construction costs. However, study space furniture has a relatively short life and is relatively more expensive. Furthermore, although the library reports a total of 1788 seats, the number of "effective" or usable seats probably approaches 1200. Given these factors, the current uncertainty in the use of seats in the library, it should be noted that seating costs are rough estimates only.

** See Appendix VI.

number of students. The study-bedroom alternative has not been included as a separate alternative because improving study conditions in dormitory rooms without increasing user access to required reading, i.e., without changing the nature of the reserve system, will have little effect on library seating demands.

Alternative Study - Reserve Systems

Utilization of Adjacent Areas

The first alternative requires no funds but rather long-range planning. Future libraries could be built to be adjacent to or to encircle classrooms so that table-desk study places could be administered as part of the library during evening hours. To give present classrooms a "library" atmosphere, it might cost $5 a square foot or about 30¢ a square foot per year when allocated over 50 years for more study space. Since such a plan requires classrooms to be near libraries, it would not greatly alter current seating requirements.

All Articles Xeroxed

A second alternative is to distribute articles or parts of books, as is now done with books through the Coop. The library would thus duplicate, for instance, all required articles and parts of books 60 pages or less and distribute them to all enrolled students in a course.*

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* According to the Chief Legal Counsel to the Library of Congress, the new copyright law is designed to update and generally tighten the old one. Reproduction of copyrighted material by any means including computers, video electronics (i.e., CRT), Xerox, microfilm, etc., except for "fair use," without permission by or compensation to the author will be in violation of the law.

It is our estimate that many of the users would use the printed articles outside of the library. We calculated that the high volume of such a duplicating system would lower the cost per copy to $.0167 per page (with current technology). This amounts to an additional $87,000 annually. Since M.I.T. is now spending $196,300 on reserve seating, in order to hold spending down to the present level, the demand for seating in the library would have to be reduced by about 45%. This is approximately the current percentage of items on reserve which would be distributed by this system, i.e., less than 60 pages. It is improbable, however, that all of these articles would be read outside of the library. If seating is reduced by 25%, the system would cost about $38,000 more than the present system. Given the sensitivity of the system to seating demand and personnel requirements, a user behavior study and a further time survey of the reserve libraries are required to estimate costs more precisely.

(footnote continued from previous page)

For libraries this will mean that any large-scale systematic reproduction of parts of books, magazines, etc., such as the "Xerox All Articles" or "Microfiche" reserve systems, will involve copyright considerations. One estimate of the cost that libraries may in the future have to remunerate publishers by as much as 10% of the cost of reproduction. This, it has been suggested, would be handled by an organization similar to BMI (Broadcast Music, Inc.).

Change Xerox Pricing

Another alternative would lower the costs of Xeroxing to local commercial rates, 5¢ for the first copy, 3¢ for the second through tenth, and 2¢ for additional copies. The added cost of this system depends on the relationship between the price of Xeroxing and the quantity demanded (i.e., the demand curve). Thus we examined a range of responses which would cost the library from $4000 to $10,000 a year. To match current costs, this system would have to reduce current seating requirements by, at most, 5%. Given the number of pages likely to be reproduced, the range of seat demand savings was determined to vary from 0 to 10%.

Lowering the Xerox price should also have two other cost-cutting effects. First, circulation of certain types of material such as journals should decline, as more people reproduce journal articles; and second, the demand for seating to use journals and serials should also decline. This latter effect, our Dewey Survey indicates, may be more important than the reduction in seating demand associated with reserve material.

Microfiche Systems - Portable Readers

A fourth alternative which would reduce seating costs is a microfiche system, where all articles and parts of books 60 pages or less are put on microfiche and distributed to students. Each student is given a portable microfiche reader, primarily to be used in his dormitory room. Such a system would cost about

$219,000 more than the present system and thus involves an additional cost that could not be recovered, regardless of any change in the demand for seats. It is quite possible, however, that technological advances will reduce the cost of microfiche readers. Yet, even if the reader prices fall by 50% and if the demand for seating in the library were halved, this alternative would still be dominated by the present system.

Another possibility would be for students to buy their own readers, but we believe that users would find the all-Xerox alternative more attractive.

Microfiche - Readers in Dormitories and Libraries

Another proposed system, the dormitory-library microfiche system, would make it unnecessary for a student to travel to the library each time he wanted to do required reading. It would also allow him to maintain a permanent file of articles, but would make students dependent on library-dormitory facilities for microfiche reading devices. Students could, if they wished, buy a portable microfiche reader much as they now invest in a typewriter for college. The added cost of this system is due to conversion costs and equipment purchase costs; we assumed the readers take up the same space as current seats in the library. Some of this cost is offset by decreased personnel costs due to decreased circulation and handling. The annual cost of this system is estimated to be $39,000 over that of the present system. If M.I.T. encouraged students to purchase their own portable readers, the demand for seating in the libraries would

presumably shift downward, but under present conditions such a meaningful change in user behavior seems unlikely.

Providing Additional Copies of Required Reading and Extending Circulation Periods

Another method of reducing seating requirements is to provide more copies per article and to buy more copies of books in order to allow longer circulation periods (perhaps two days). It is estimated that providing three times the present ratio of ten students per copy would cost at least $56,400. This cost is based on the assumptions that books are not cataloged or processed, virtually all will be paperbacks, and that they are thrown away after they are taken off reserve. Even with such optimistic assumptions, seating demands would have to be reduced by 29% to maintain current expenditures.

Given the frequent time lag between a book being placed on reserve and its being originally ordered for the collection, ordering costs would probably raise the net cost of this system an additional 40%.

Centralization

It has been suggested that the centralization of the reserve-study facilities would result in increased benefits and decreased costs. Benefits would increase because students would be able to do their work for any or all of their courses in one library, the chances of finding a specific item in one library would increase due to the concentration of copies of required

readings, and the concentration of students would lead to greater social benefits. The decreased costs would result from economies of scale in the areas of personnel and seating costs.

As already indicated, personnel costs represent about 38% of current study-reserve expenditures. Yet almost all of these personnel costs, at least in the smaller reserve libraries, are for locating books, putting them on reserve, etc. rather than for circulation control or other costs which could be reduced by centralization.

A preliminary study of the cost of different types of seats indicated a wide inter-library difference in seating costs. For example, it was found that providing a lounge seat in the Lindgren Library ($370) is almost twice as costly as the average Student Center lounge seat ($197). Part of this difference appears to be attributable to the availability of larger areas for seating in the Student Center and the resulting flexibility in planning seating arrangements. Another part of this difference is attributable to closer spacing and different combinations of facilities in the Student Center.

Figure 9 shows comparative costs associated with seating accommodations for three recently built M.I.T. libraries.

Figure 9

COMPARATIVE SEATING COSTS

Type	# Units in Group	# Seats in Unit	# Seats in Group	Area of Unit in ft^2	50 year 6% per unit unit construction costs per year @ $58/$ft^2$*	Annual Maintenance Cost per Unit
Lounge Setting						
Student Center	15	1	15	28	$103.00	$ 70.00
Dewey	6	1	6	56	135.00	140.00
Lindgren	4	1	4	56	206.00	140.00
Study Tables						
Student Center	12	4	48	84	309.00	210.00
Carrels						
Student Center	5	2	10	76	280.00	190.00
Lindgren	6	2	12	63	232.00	158.00

* $58/$ft^2$ was the reported construction costs for the Student Center and the Green Building (Lindgren Library). However, a figure of $38/$ft^2$ was used for the Dewey Library.

Capital Cost of Furniture per unit	15 year 6% Furniture Cost per unit per year	Total Annual Cost per unit	Total Annual Cost per seat
$236.00	$24.00	$197.00	$197.00
236.00	24.00	299.00	299.00
236.00	24.00	370.00	370.00
312.00	32.00	551.00	138.00
270.00	28.00	498.00	249.00
160.00	16.00	406.00	203.00

Decentralization

The cost of decentralized, departmental reading-study libraries, depends primarily on personnel requirements. Several examples of departmental reading-study libraries are suggested in Appendix VII.

A system of (20) departmental libraries to supplement the current study-reserve system would cost about $223,000 minus seating savings more than the present 'unsupplemented' system. Since these supplementary libraries would provide about 400 new seats, about 33% of the current (effective) seating, the expected seating savings (33%) would lower the additional annual cost to $158,000.

The cost of a system of (20) departmental libraries that would replace the divisional reserve collections would be about $114,000 more than the current system, $88,000 of which would be for additional personnel.

Divisional personnel would still be required to locate materials for departmental libraries when needed, and departmental libraries would be responsible for circulation control.

Study-Reserve Alternatives: Conclusion

In the preceding sections, we have analyzed alternative ways of providing course-related material and facilities to use this material. Because the costs of these alternatives are sensitive to the requirement for study space in the library, we have in Figure 10 displayed the costs of these systems for a

range of seating requirements. This range reflects a set of pessimistic, best guess, and optimistic predictions for the reduction in the demand for seating in the library.

Appendix VIII breaks down the cost figures by personnel costs, study space costs, special equipment costs, etc.

Figure 10

	Annual Cost with Current Seating Demand	Annual Cost with Probable Seating Demand	Annual Cost with Optimistically Low Seating Demand
Microfiche Systems			
Each article and book sections (60 pp or less) is placed on a microfiche card, duplicated, and distributed to students at the beginning of the semester or soon thereafter. Students maintain permanent files of assigned articles in the space of a shoebox. Readers are necessary to read the cards; dependence on reading devices is the price of guaranteed access to material. This system would supplement, not replace, books which are assigned.			
Portable Microfiche Readers			
Portable readers would be distributed to students for use primarily in their dorm rooms or home thus guaranteeing access for all to a reader. A limited number of readers and reader-printers in the library would supplement portable readers.	$736,000	$696,800	$657,600
Library or Dormitory Microfiche Readers			
Readers would be distributed throughout campus, but students would not have guaranteed access to readers (and/or reader printers). Students will always have the material but, depending on the level of the system (number of readers and reader-printers provided), would not always find a reader available.	556,000	546,200 (10 Students/Reader)	497,200

	Annual Cost with Current Seating Demand	Annual Cost with Probable Seating Demand	Annual Cost with Optimistically Low Seating Demand
Xerox Systems			
These systems allow students to use the material at the time and place of their own choosing.			
All Article Xerox			
This system takes advantage of the lower per copy cost as volume is increased. Instead of providing an article per 10 students, the libraries would make enough copies for each student in the relevant course and would distribute these articles early in the semester.	$604,000	$545,200	$506,000
Low-Cost Xerox			
The library would lower the charge for Xeroxing to commercial rates, provide an operator, and encourage users to reproduce Library materials. Users could thus duplicate important materials at a low cost and would, to some degree, use the material outside of the library.	521,000 (Elastic Demand)	519,000	501,400
	527,000 (Inelastic Demand)	525,000	507,400
Conventional Systems			
These systems are based on the current technology of most libraries: books, limited Xeroxing, and Microfiche.			
Present System			
We now have a reserve desk, collection, personnel, and reading area (or at least some seats used for required reading) in each of the divisional libraries. Supplementing these are independent libraries or reading rooms throughout campus directed by departments, research groups, or laboratories. The independent libraries, dormitory room desks and the library independent student study desks or halls, provide study spaces.	517,000		

	Annual Cost with Current Seating Demand	Annual Cost with Probable Seating Demand	Annual Cost with Optimistically Low Seating Demand
Departmental Libraries			
Located near classrooms, these libraries would house ten years of the 200 most used journals and a collection of 3000 books. These libraries would also have about 20 table seats but provide no services beyond minimal cataloging. (In the future, they might be combined with graduate lounges and study areas.) Such libraries would either replace the current reserves system or would supplement it, thereby increasing the convenience and availability of required readings of recent vintage and, perhaps, lessening the seating requirements of the main libraries.	$740,000	$681,200 (Supplemental)	$642,000
	631,000	(Replacement)	
Centralized Reserve			
Replacing the decentralized reserve systems with two main reserve-study centers (similar to the Student Center) would lessen the current convenience of the more localized reserve sections but would allow students to do all their work at one location.	433,500	433,500	368,800
Additional Copies			
Increasing the ratio of required readings to students from 1:10 to 1:3.3 for all books would increase the availability of materials, allow longer circulation periods, and reduce seating requirement on the library now due to restricted circulations.	573,400	534,200 (Low Cost Assumptions)	495,000
	741,700	702,500 (High Cost Assumptions)	663,300

	Annual Cost with Current Seating Demand	Annual Cost with Probable Seating Demand	Annual Cost with Optimistically Low Seating Demand

Adjacent Areas for Dual Purposes

This system takes advantage of different peak load times in different facilities. Both classrooms and cafeterias are not used as much at night when the strains on the library are greatest. By designing libraries to be adjacent to or to surround such areas the tables could be used at night as part of the library at no extra cost.

Study Bedroom

This alternative is based on the notion that by making dormitory rooms more attractive for studying, it will encourage more people to use them for studying.

Subsidizing the Coop

This alternative would provide money to allow the Coop to lower prices on required readings. It is expected that students would be encouraged to purchase their own books and thus use the library less.

Optimal Seating Accommodations in the Library

By "optimal seating accommodations," we mean a particular mix of seating accommodations within the study library that meets certain standards established by library administrators, at minimum cost.

We believe that at least two types of standards, i.e., constraints, should be considered by library administrators: capacity constraints (i.e., how many seats should be provided), and preference constraints (i.e., what is the relative 'worth' of each type of seating accommodation). The reason for this is clear: there is an underlying conflict between providing, at a given budget level, the largest number of seats and providing the most attractive seats from the point of view of the user.

Capacity Constraints

Library administrators must decide for what percentage of students should seating accommodations be provided. Table 9 shows the current seating ratio for several large university libraries.

Table 9

Seating Statistics for Larger University Libraries*

	Current Library Seats	Current Seating Ratio	Ratio Expected 1970
Harvard	6,381	43.0	40.0-45.0
Yale	1,152	13.5	27.5
Princeton	2,946	62.0	73.0
M.I.T.	1,781	25.0	-
Columbia	4,208	25.0	37.0
California - B	4,591	17.0	24.0
Cornell	4,466	32.0	30.0
Stanford	4,000	36.0	36.0
Chicago	2,474	33.0	47.0
Michigan	5,783	20.5	-
Illinois	3,892	13.4	18.5
Pennsylvania	3,242	27.0	36.0

* From College and Research Libraries, Nov. 1967, p. 412.

Preference Constraints

It has been tacitly assumed that students are not indifferent to the three types of seating accommodations and they will, in fact, prefer one type, if given a choice. Preference coefficients, let us assume, have been determined by asking students what type of accommodation either lounge, table or carrel, they use, or like to use most. Since, we believe, preferences change as the term moves into its closing weeks, at least two determinations of the preference coefficients seem advisable.

The Optimal Mix by Linear Programming

Suppose, for this example, the libraries want to provide some seating for 25% of M.I.T. students (about 1800 seats), and suppose also there is a desire to provide the "preferred" type of seating to the first 1000 students. Then: let k_{ij} be the preference coefficient for the ith type of seating in the jth period. In this example, we are considering three types of accommodations, lounges, tables, and carrels, and two periods.

Let L be the number of lounge units,
T be the number of table units,
C be the number of carrel units

then substituting seating costs from Figure 11 into the total cost function, we obtain the linear programming problem

$$\min \$ = 197L + 551T + 498C$$

subject to $L + 4T + 2C \geq 1800$ (capacity constraint)

$$k_{11}L + k_{12}T + k_{13}C \geq 1000$$
$$k_{21}L + k_{22}T + k_{23}G \geq 1000$$ (preference constraints)

If the k_{ij}'s are known, the problem can be solved for the optimal mix L, T and C, and the total cost.

CHAPTER IV

FULFILLING RESEARCH NEEDS

Introduction

The Program Budget of the M.I.T. Libraries has indicated not only the large cost of providing study spaces but also the large (and growing) costs of building the collection.

The discussion that follows describes some of the real alternatives that relate to the problems of building the collection and fulfilling research needs. Figure 12 lists systems relating to:

1) alternative cataloging schemes
2) alternative ordering schemes
3) enlarged extra-M.I.T. retrieval systems
4) improved access to other collections
5) improved selection.

Figure 12

A. Alternative Cataloging Schemes

1. Current system
2. Limited cataloging
3. Temporary cataloging
4. Augmented catalog
5. Additional catalogs
6. MARC cataloging

B. Alternative Ordering Schemes

1. Delayed ordering
2. Fast ordering
3. Xeroxing from Interlibrary loan

C. "Extra-M.I.T." retrieval System

1. Direct messenger service
2. Internal speedup of interlibrary service
3. Library of Congress messenger service

D. "Access to Other Collections"

1. User transportation to nearby collections
2. User transportation to distant collections
3. Catalogs of other collections on M.I.T. campus

E. Improved Selection and Acquisition

1. "Better selection" - fewer books
2. Common acquisitions policy with sister school

Alternative Cataloging Schemes

The largest processing cost is for cataloging. We have examined the expenses involved in cataloging items to determine where savings are possible. Figure 13 breaks down cataloging expenses by activity professional and non-professionals. The major item is classifying of items, by professional librarians, which costs the library (.50 X 196,500=) $98,250 annually. It would probably be worthwhile to determine the effects of lowering this cost by "limited" cataloging. This might take the form of limiting the time spent by professional catalogers to a shorter period, limiting the number of subject references for a given book, or perhaps not subject cataloging "difficult" cases at all. Another area of possible savings attributed to limited cataloging is the proofreading and checking of catalog cards which currently costs the library about $46,000 annually. It would be necessary, however, to know the effect of errors and other shortcomings in the catalog on the level of benefits.

Alternatively, what benefits would accrue to a more elaborate cataloging scheme such as Project Intrex's "Augmented Catalog"? A complete assessment can probably only be made when the Augmented Catalog is operational.

Cost figures seem to indicate that the money saved in waiting for the LC cards is substantial.* However, delaying cataloging will inescapably lead to a decrease in benefits.

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* The library currently reports that about 30% of the books cataloged are "non-LC," i.e., books for which LC cards are not on hand. Up to $55,000/year could be saved if original cataloging were eliminated, and these books were LC cataloged whenever the cards arrived.

Figure 13

Cataloging Costs

	Professional	Non-Professional
Classifying	50%	4%
Proofreading, checking	17	10
Typing	17	28
Searching for LC Card	8	7
Placing Cards in Catalog	6	25
LC Cataloging	1	16
Total Moneys (with fringe benefits, library administration, general administration costs included)	$196,500	$134,000

Notifying the requester or potential user of a book's arrival may help to overcome some of the loss. Perhaps temporary "in-house" cataloging of "non-LC" books may prove valuable.

In order to evaluate this last possibility, information on the number of "non-LC" books cataloged last year, the distribution of delays and the average number of potential uses should be obtained.

It is true, however, that the Library of Congress is cataloging a higher percentage of all monographs (see Figure 14) each year under Title IIC, and the average cataloging cost per book should continue to decline. In 1965, 68% of American imprints were cataloged before publication. By 1970 the Library of Congress expects this to climb to 75%. Thus not only is the Library of Congress cataloging a higher percentage of books each year under Title IIC, but they are also improving the speed of service.

An Analysis of Temporary Cataloging

Each year M.I.T. does original cataloging for about 10,000 monographs at a cost of about $150,000. Suppose that temporary cataloging could be done at one-third the cost of original cataloging.* Suppose also that it is M.I.T. policy to do the original cataloging on imprints for which the expected delay in receiving the LC cards is greater than six months. Since these are usually foreign language publications, library

* This is close to the cost of 'recataloging' and is, no doubt, too low as an estimate. This was deliberately done to weight the argument in favor of 'temporary cataloging.'

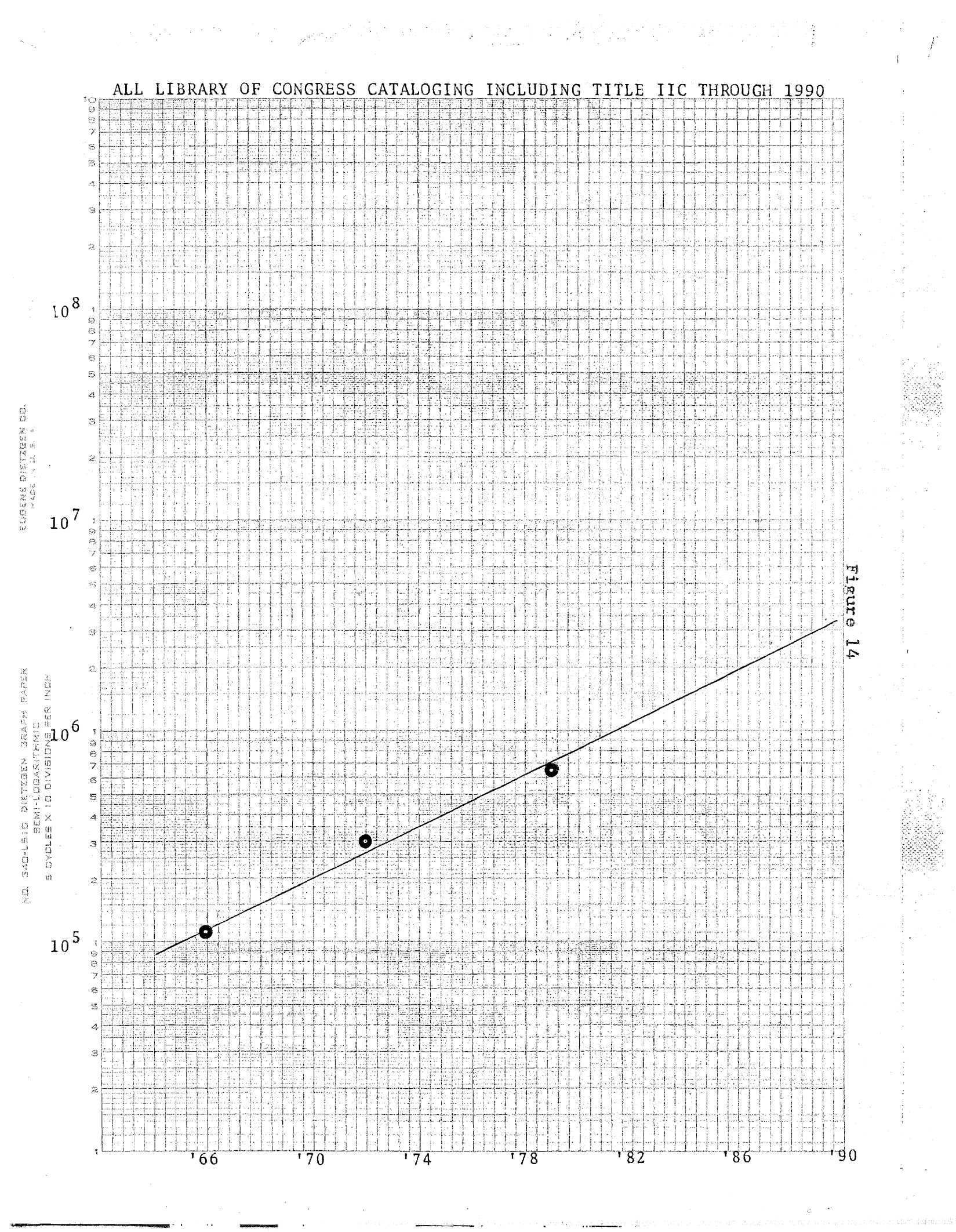
ALL LIBRARY OF CONGRESS CATALOGING INCLUDING TITLE IIC THROUGH 1990
10^8
10^7
10^6
10^5
'66
'70
'74
'78
'82
'86
'90
EUGENE DIETZGEN CO.
NO. 340-LS10 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
5 CYCLES X 10 DIVISIONS PER INCH

Figure 14

personnel have little difficulty in identifying this subset.

If it is assumed that 10% of the 10,000 "non-LC" books fall into this subset, then the cost of cataloging them is (1000 X $15) $15,000. The remaining 90% of "non-LC" books are "temporarily" cataloged at first at a cost of (9000 X $5) $45,000, and then LC cataloged, when the LC cards arrive, at a cost of (9000 X $9.45) $85,000. If these "temporarily" cataloged books have been put into the stacks there would be an additional cost of at least $.50 per book to track down and retrieve them to be LC cataloged. This would entail an additional cost of (9000 X $.50) $4,500.

At this point the a fortiori argument is made that the savings from the temporary cataloging scheme described above are so small that the decrease in benefits cannot be justified.

Current Original Cataloging Cost	$150,000/yr
Cost of Temporary Cataloging Scheme:	
a) Temporarily "cataloging of 90%" non-LC books	45,000/yr
b) Retrieving these books to be LC cataloged	4,500/yr
c) LC cataloging of these books	85,000/yr
d) Original cataloging for remaining 10% of "non-LC" books	15,000/yr
	$149,500/yr

Net savings - $500/yr

Project MARC

Another interesting alternative will soon be possible when the Library of Congress's Project MARC begins selling machine readable catalog information on magnetic tape for all English language books plus some German and French monographs. Presently, these tapes can only be used to duplicate the LC cards, but eventually could become the input data to a computerized on-line catalog.

Cost figures on these tapes are still unavailable.

Alternative Ordering Schemes

Because the processing costs of journals and serials consist mainly of handling rather than cataloging, a saving of about $20 per journal could be realized if these journals were purchased on commercially produced microfilm.

This saving would be accompanied by a loss in benefits because microfilm can only be purchased at the end of the year. Alternatively, more journals than the M.I.T. library currently receives could be purchased at the current budget level if the microfilm version were specified.

This is particularly significant since the number of journals (and average price) has been increasing (see Appendix IX). Thus, with current policies, in order to maintain the same percentage of coverage, the library will have to allocate twice as much money as now for serials and journals by 1976. This will not be a burden, however, so long as materials appropriations

grow at this rate too. Figure 15 shows the materials appropriations projected through 1976.

Another interesting alternative would be "fast ordering." For about $20,000/year, all items* necessary for reserve or specifically requested by students or faculty could be ordered by long-distance telephone calls, telegrams, etc., and received by special delivery mail.

Extra-M.I.T. Retrieval Systems

There are several proposals which would decrease the time between asking for an item not in the M.I.T. libraries until its delivery.

The first alternative, a direct messenger service run by M.I.T. for M.I.T. users would retrieve requested books as soon as the lending library in the Boston area indicated that it had located the book. It would also bring request slips directly and immediately to local schools. Such a fast service would cost from $5000 to $12,000 annually depending on the volume of such loans, the number of hours the system would be in operation, and the number and location of participating libraries. This system would thus limit waiting time to the reaction time of the lending library.

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* Dewey records indicated that 17% of monographs ordered were for reserve or were requested by students or faculty.

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MATERIALS APPROPRIATIONS* PROJECTED THROUGH 1976

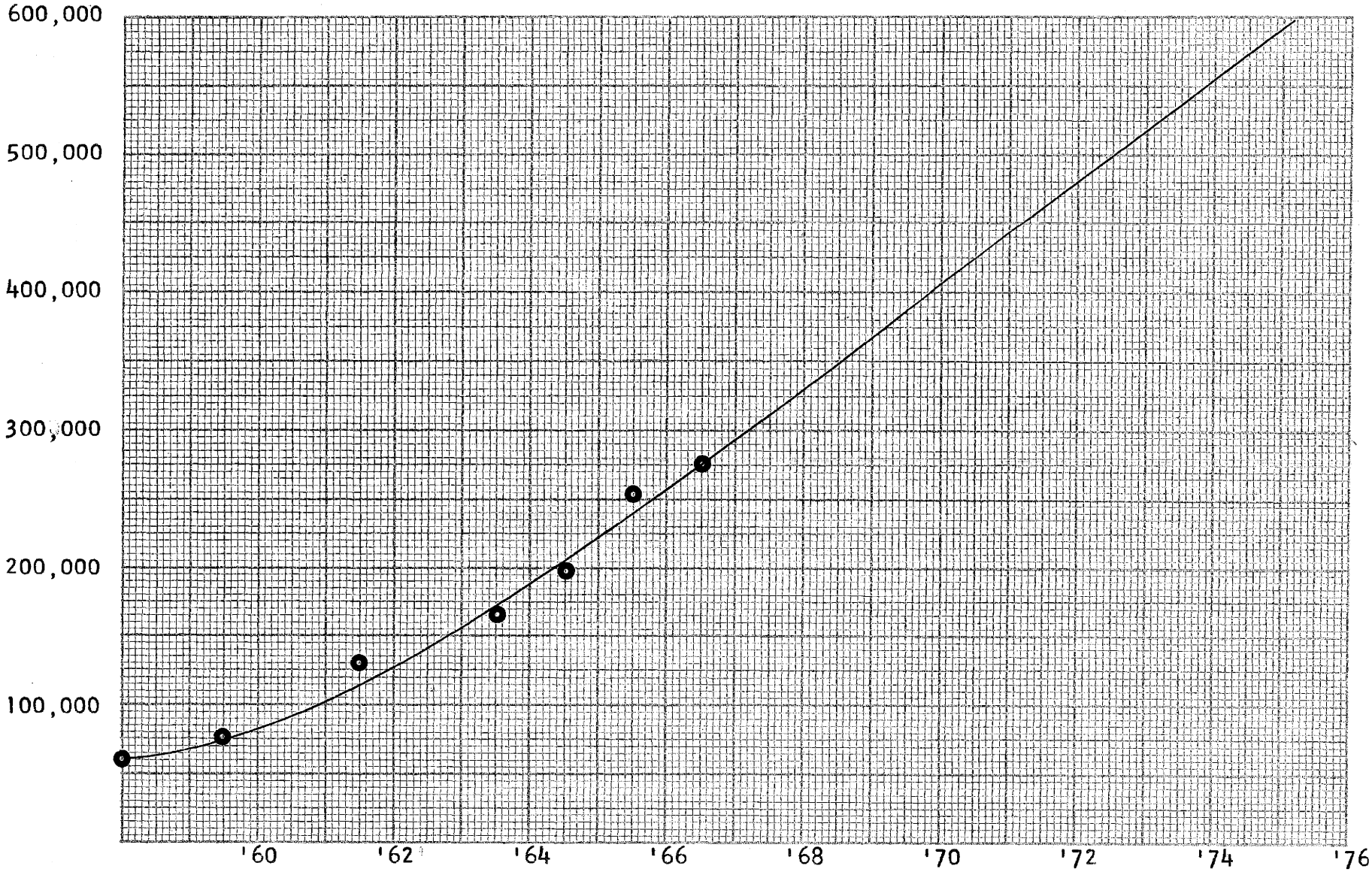

Figure 15

* These figures include the Dewey, Engineering, Humanities, Rotch, and Science libraries.

The delay in inter-library loan may be due to intra-library rather than inter-library deficiencies. The cost of reducing such delays would vary with the given library and would have to be based on cooperative agreements.

In determining the level of expenditures for inter-library loan, it is necessary to determine not only the cost of purchasing and processing a book, but also the use of the book as a function of time. With an elaborate loan system, a book ordered through inter-library loan might incur a cost of $20.00 a request. In terms of present value the cost of fulfilling that request 5 years in the future is about $15.00, and for 10 years in the future about $11.00. Thus, the comparison must be in terms of the present cost of purchasing and processing and the present value of the future requests and associated costs of borrowing the book.

For those books which are difficult to locate in the Boston Metropolitan Area, a more expensive but longer range retrieval system is possible. A messenger could be sent to the Library of Congress in Washington, D. C. for under $100 per trip. Making the trip twice a week, 40 weeks per year, the cost of such a system would be $8,000 a year. Borrowing two books a week this way, would bring the cost to $100 a book; twenty books weekly would average out to $10 a book - the cost of Interlibrary Loan! It would be necessary to determine the percentage of requested books which the local and LC systems could handle.

Access to Other Collections

The first alternative for increasing access to other libraries would provide a transportation system (where a public system is limited or non-existent) for users to travel to other collections. This alternative appears attractive where external economies exist, where the cost of transportation is shared by more than one system. Given the pressures on libraries to provide seats when such a system would be most desirable, its use appears to be limited.

Occasionally a user requires specialized items in areas not covered in local libraries. The size of the budget for distant (to the West Coast, Paris, South America) travel to other collections of course is a function of the frequency of such needs.

A microstrip catalog of M.I.T.'s entire union catalog could fit, with a microstrip reader, on a desk top. The initial cost of converting the catalog (say one million volumes) would be about $50,000. The cost of duplicating copies of such a catalog would be about $2,500 for each. Appendix X lists the costs of four arrangements with other libraries where the costs per library (assuming an equal sharing of costs) range from $38,785 to $257,250 initially. Added to the initial cost of duplication is the cost of reduplicating or maintaining an additional catalog for items acquired after the initial duplication. Such an annual cost would be at least $25,000 annually. Catalog duplication is thus a very expensive alternative.

On line computerized catalogs will be ideal for this purpose once operationalized for such a searching procedure. Closed circuit television connecting users to other libraries has not worked in the past but, given proper investments, might be a solution. A telephone hot line, not run by librarians at the user's library might encourage people to find out what is available in other libraries. A librarian or less skilled person at each school could handle about 5000 requests annually at a cost of under $10,000. Given the high costs of other systems, this may be the most interesting alternative.

Improved Selection and Acquisition

It is an observable fact that the number of books, pamphlets and periodicals has been increasing for many years (see Appendix XI). Furthermore, book prices and serial prices have also been rising, and at a rate greater than the overall price index (see Figure 16). Figure 17 combines publisher's output data with price data to show that with current selection policies resources programmed for acquisitions will have to double every 6 to 8 years. Even then it is possible that the M.I.T. libraries may be unable to acquire a significant portion of "desirable" material. It should also be noted that it will be relatively more costly to maintain an up-to-date science and technology collection than a social science collection.

To demonstrate the magnitude of possible savings from better selection, the percentage of books which have been in the collection for some long period, say 15 years, but have only zero, one or possibly two "significant uses" in that period,

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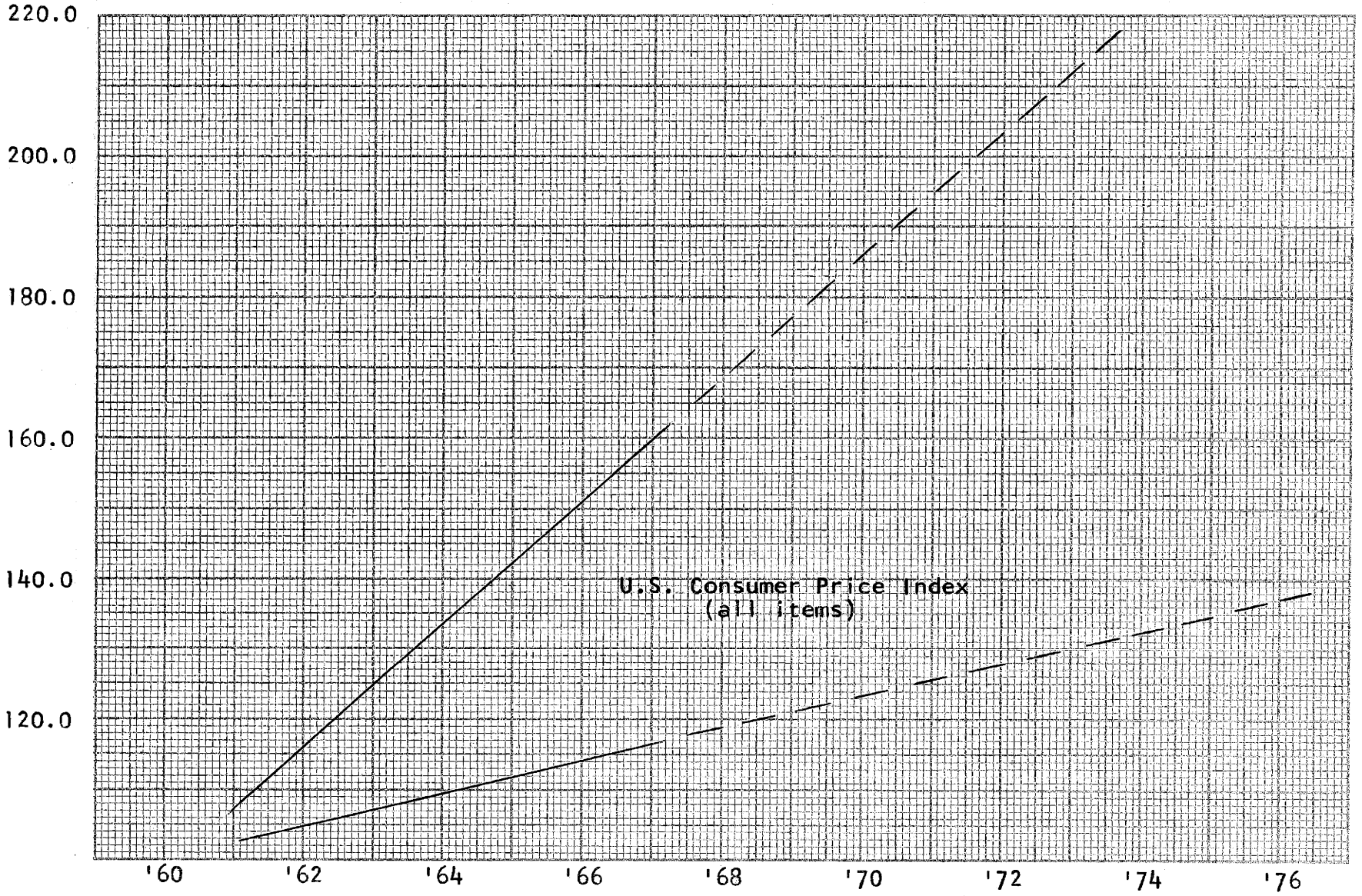
LIST PRICE INDEX OF BOOKS* (HARDCOVER, TRADE-TECHNICAL) PROJECTED THROUGH 1976

(1957 - 59 = 100.0)



* This index is computed from the individual price indexes of books for nineteen subject catagories weighted by the proportion of new books published in that catagory.

Figure 16

Figure 17

New Editions and Titles

	1962	1966	1972	1976
A. All Non-Fiction hard & paper	21,000	33,400	50,000	62,400
B. Non-Fiction hardbound only	16,600 @$ 6.00 =$99,600	25,300 @$ 8.00 =$202,400	38,600 @$ 10.25 =$395,650	47,300 @$ 12.60 =$595,980
C. Non-Fiction paperbound	3,400 @$ 2.10 =$ 7,140	8,100 @$ 2.80 =$ 22,680	11,400 @$ 4.20 =$ 47,880	15,100 @$ 5.00 =$ 75,500
D. Total Cost (B + C)	$106,740	$225,080	$443,530	$671,480

New Editions and Titles by Category

A. Science and Technology	3,200 @$ 9.80 =$31,360	5,600 @$ 12.50 =$70,000	9,200 @$ 16.70 =$153,640	12,000 @$ 19.60 =$235,200
B. Sociology, Economics, Business & History	4,050 @$ 7.70 =$31,185	7,000 @$ 9.00 =$63,000	11,800 @$ 10.90 =$128,620	14,800 @$ 12.10 =$179,080

would have to be known. Since each of these books represents an investment of about $25.00 (selection, purchase price, cataloging, storage, etc.), this amount minus both the cost of better selection and a charge for providing the book, if requested, by some alternative fast means, such as an improved inter-library loan, could be saved, were the book not acquired. If it is assumed that the level of benefits is measured by the number of "significant uses," then the loss in benefits would be extremely small.

In order to evaluate different selection policies, information on yearly expected circulations (or better, yearly circulation probability density functions), for books in different subject areas, when chosen by selection plans characterized by alternative budget levels, would have to be known.

Comparing Alternative Selection Plans

A First Attempt at Modeling Selection Principles

The optimization principle here is that for a given level of benefits, the library seeks to minimize the total cost of selecting, ordering, purchasing, cataloging and storing for, say,15 years, its new acquisitions. All of these costs, except selection, can be aggregated into a single average cost (a membership fee) per new acquisition.

Mathematically:

Let m be the membership fee, say $25

N, the number of new acquisitions

S, the aggregate selection costs

C(N,S), the number of significant uses of new acquisitions,i.e., benefits. C(N,S) is a continuous and twice-differentiable function of its arguments.

Then the library seeks to minimize mN+S subject to $C_o = C(N,S)$; and the optimization condition is:

$$m = \frac{\partial C}{\partial N} \Big/ \frac{\partial C}{\partial S}$$

This model requires strict knowledge of the marginal contribution to benefits of a new acquisition, and the marginal contribution to benefits of a dollar spent on selection. Operationally, the library should be able to increase its S-budget (selection) by X dollars, and decrease its mN-budget (purchasing/processing) by $Y \geq X$ dollars, in order to secure the same number, C_o, of 'significant uses.'

The key assumption in this model is that ceteris paribus* the number of significant uses of new acquisitions is a function only of the selection budget and the number of new acquisitions. So long as alternative means, such as Inter-library Loan, of creating 'significant uses' account for only a small percentage of the total number of significant uses,** the above assumption is defensible.

Another Model

Figure 18 below shows how alternative combinations of inputs : money for books and money for selection, might relate to hypothetical levels of outputs : number of new acquisitions and number of 'significant uses' in 15 years. This model represents an improvement over the one above since there is now a primary benefit: number of significant uses, and a secondary benefit: number of books.

Figure 18

Alternative	Inputs			Outputs	
	Money for books = \$25 N_o	Money for Selection	Total	Number of New Acquisitions = N_o	Number of Significant Uses in 15 yrs from N_o Books
A	\$250,000	\$10,000	\$260,000	10,000	90,000
B	\$150,000	\$25,000	\$175,000	6,000	72,000
C	\$200,000	\$20,000	\$220,000	8,000	84,000
D	\$250,000	\$ 5,000	\$255,000	10,000	86,000
E	\$300,000	\$ 5,000	\$305,000	12,000	92,000
F	\$275,000	\$30,000	\$305,000	11,000	92,000

* i.e., for a given number of users, for a particular mode of storage, etc.

** Presently, I.L.L. accounts for about .5% of total circulation.

Any estimates of the net benefits would also have to include the number of unsuccessful attempts to locate a book in the library and the disutility of not having those books for each one of the alternatives.

Common Acquisition with Wellesley

Another important alternative is for M.I.T. to seek some arrangement with another nearby research library amounting to a common acquisition policy. Because of the new degree of cooperation, one school suggests itself immediately - Wellesley. Figure 19 projects the research acquisition rate for both M.I.T. and Wellesley, the latter being measured from the M.I.T. curve. If the acquisition rates were fully additive, which of course they are not, the total rate would about cover the projected publisher's output of non-fiction through 1976. (Appendix XI) Naturally, a common acquisitions policy must be accompanied by commonality of user services and privileges. In addition, some user transportation and improved inter-library loan would become desirable.

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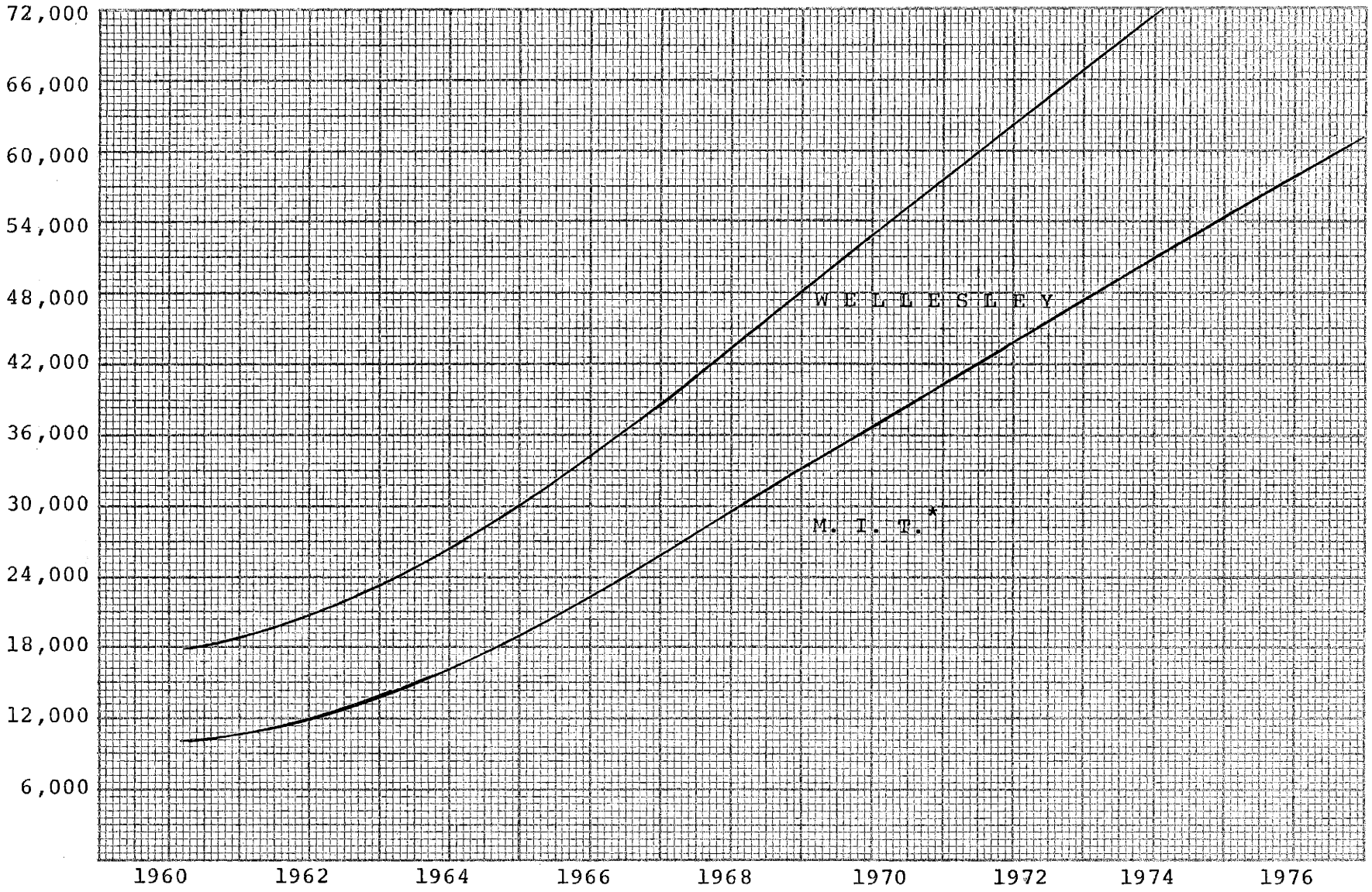
M.I.T. & WELLESLEY ANNUAL ACQUISITIONS PROJECTED THROUGH 1976



* Excluding Student Center

Figure 19

CHAPTER V

BENEFITS AND OTHER RESEARCH QUESTIONS

Some Theoretical Considerations

In the past, quantitative measures of library performance have generally been based on library ineffectiveness rather than library effectiveness. The reason for this is clear: it is a matter of relative ease to measure the number of times the system fails in N trials, but it is quite difficult to measure the number of successes in an unspecified sample size, particularly since it is not exactly clear what constitutes a success. Any sample taken of people entering the library systematically excludes those who have 'given up altogether.' How can the library's role in fostering inadvertent discovery (browsing, etc.) be gauged? How can the value (utility) of a "success" be measured, and if it can, what part of that value is attributable to the library? These questions are especially relevant in comparing alternative selection policies.

We believe that one of the problems in measuring the benefits of the library, or of its subsystems, is the lack of definite quantifiable, tangible objectives to be attained. In the first attempt to model selection principles (Chapter IV), this quality was present: to attain C_o significant uses. This production function model was quickly discarded in favor of less explicit model.

Another consideration in evaluating alternative allocations of library resources is the social welfare implications. The allocation of a fixed budget represents a set of decisions about which functions should be fulfilled (and, therefore, which users should be satisfied) at the relative expense of other activities (and users). At present, for example, we estimate that of the $1,350,000 spent on providing required reading to students, the library absorbs 40%, students 50%,* and other M.I.T. budgets (the dormitories) about 10% of the total cost. The amount that professors and researchers spend on research is not now known. The library spends about 75% of its $2,280,000 Program Budget on this function. It may be that while students carry the burden of the expense of providing required reading, the faculty bears a small portion of the research cost directly.

A third consideration is how to compare related streams of costs and benefits. The question first arises in connection with the compact storage of 50% of the M.I.T. collection representing about 25% of the total annual circulations (benefits).

---

* An analysis of 96 responses from people using the Dewey Library shows that $100 is a reasonable estimate of what people think they spend on course required and recommended reading per year:

	Graduate	Undergraduate
All	$103 N=53	$103 N=43
Courses 14, 15, 17	$107 N=47	$105 N=15
All other courses and Undesignates	$70 N=6	$101 N=28

In that example, while absolute dollar savings rise each year, the percentage of circulations from storage or relative benefits remains constant over time.

User Evaluation of Alternatives

To allow decision makers to weigh the desires of different user subgroups, a user benefit evaluation study is planned. As a first step, a preliminary study to determine who uses the library and how they use library facilities was undertaken. In a sample of 120 people entering the Hermann Building (Dewey) Library, taken over a period of three days (December 18th - 20th, 1967), 36% were undergraduates, 22% were masters degree candidates, 20% were Ph.D. degree candidates not currently working on a thesis, 7% were Ph.D. degree candidates working on their theses, 2% were DSR personnel, 3% were faculty, and 10% were classified as Other.

Out of 120 responses, 54% (65) reported that the primary purpose of their visit to the library was to study course-related material. (53% (64) actually reported using either their own material, a reserve book, or a reserve article.) A similar study at the Ohio State University Library revealed that "almost 55% of those completing questionnaires were in the library for general study purposes, rather than in search of specific information, materials, or services."*

As a refinement, our study was designed to produce data on the percentages of aggregate man-hours spent in the library

---

* See Behling, Orlando, and Kermit Cudd, "A Library Looks at itself," College and Research Libraries, Nov. 1967, pg. 420.

by everyone in the sample on various types of library and non-library material. Table 10 below shows how the sample divided on primary purpose.

Table 10

Primary Purpose	n	% of Total
1. Take out books	17	14%
2. Return books	3	3
3. Relax	8	6
4. Study course related material	65	54
5. Browsing	5	4
6. Research	14	12
7. Writing	2	2
8. Make Xerox copies	0	0
9. Other	6	5
	N=120	100%

Table 11 shows how the aggregate number of man-hours spent in the library by everyone in the sample was allocated over various types of library and non-library material.

Table 11

Type of Material	Number Reporting Using Material*	Total Man-hours Using Material by Everyone	Average Number of Man-hours per User	% of Total Number of Man-hours
1. Own material	42	69.75	1.66	32%
2. Reserve book	30	45.50	1.52	21
3. Reserve article	13	16.50	1.27	7
4. Journal	24	35.75	1.49	16
5. General book	16	27.08	1.69	12
6. Specific reference	15	9.25	.62	4
7. Newspaper, magazine, etc.	23	11.75	.51	5
8. Other	11	5.00	.45	3

One of the immediate consequences of this preliminary study was a downward revision in the Probable Reduction in Seating Demand and Optimistic Reduction in Seating Demand for several of the study-reserve alternatives (Appendix VIII).

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* The number of people using any combination of material can be determined by drawing the proper Venn diagram.

The User Evaluation Questionnaire

A short self-administered questionnaire will be distributed by mail to several hundred members of the M.I.T. community, generally students and faculty. Whether the sample should be stratified according to library usage is still undecided. The respondents will be requested to fill in the necessary information and return the completed questionnaires within a week following receipt. After a week and a half has elapsed, the delinquent respondents will be contacted by phone. An offer will be made to assist the respondent in interpreting the questionnaire and where required the questionnaire will be administered by personal interview.

Several types of questions are planned at this time. Respondents will be asked, in pairwise comparisons, which systems or subsystems they prefer at different budget levels. If we want to compare n alternatives at the same budget level, then

$\frac{n!}{(n-2)!2!}$ comparisons must be made in order to

obtain an overall ranking of alternatives. Scherer suggests that the choices of individual respondents can be aggregated by means of scaling factors into a group consensus ranking.* For any alternative A the scaling factor is defined as

$$\frac{\text{Number of times A was chosen over other programs}}{\text{Total number of choices involving A}}$$

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* Dorfman, Robert (ed.), Measuring Benefits of Government Investments, pg. 30.

If there is "significant evidence of intransitivity in the individual respondent's paired comparisons"; or if there is "little agreement among the various respondents on their ranking of the different alternatives," then this procedure would suffer from a lack of validity.*

Other questions in our user benefit evaluation study will deal with how much money respondents would be willing to pay for each of a set of related systems or subsystems. For example, how much respondents would be willing to pay for a telephone hot-line to Widner vs. a closed circuit telephone/television to Widner.

Another set of questions will help to evaluate major trade-offs. Examples are:

a) placing that half of the book collection which accounts for 25% of the circulation into <u>compact</u> storage (no browsing)
vs.
eliminating 25% of the seats in the libraries by turning the area into open stock book-storage space.

b) Xerox all required <u>reserve</u> readings below 60 pages and distribute to students for free;
vs.
adding 100 carrel units to libraries (i.e., about 12% increase in seating).

<u>Other Research Questions</u>

Figure 20 below outlines some additional research questions that would be helpful in evaluating future library systems.

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* Ibid., pg. 32.

Figure 20

Future Research Questions

Selection -

a. Relation between selection expenses and benefits
b. Extent to which circulations measure the value of a book
c. Cost and benefits of faculty selection systems
d. Possibility of cooperation in acquisitions with local universities

Cataloging -

a. Loss in benefits and decrease in costs associated with "limited" cataloging
b. Augmented catalogs

User Behavior -

a. Seating preferences and seating behavior
b. Frequency of serendipitous activities
c. Use of Xerox and Xeroxed materials throughout M.I.T. - study of Xerox system
d. Frequency and types of browsing

Collection Description

a. Variation across libraries and fields by use, age

Miscellaneous -

a. Reliability of Personnel Costs - fall or spring time survey
b. User preferences
c. Possibility of combining graduate lounges, study rooms
d. Coop subsidization or incorporation with the library
e. Economies of scale in seating arrangements
f. Student expenditures on course required or recommended material - the "community budget"

MAJOR CONCLUSIONS

1. The best alternative storage arrangement is decentralized compact storage of 50% of the M.I.T. collection accounting for 25% of the total annual circulations. Even though the accumulated savings over say 15 years are substantial (about $370,000), the annual cost is only about 1% of total M.I.T. Library Program Budget. Since eventually books will be stored magnetically, these savings will terminate altogether.

2. Microform storage will probably not be a major alternative since conversion costs are still too high.

3. The current reserve could be vastly improved by a 10 - 20% increase in that component of the Program Budget.

4. Study space will continue to be a major expense, but there are many things to hold the cost down, e.g., centralization, dual purpose areas, etc.

5. Lower Xerox charges to local commercial rates.

6. Computerized catalogs (particularly regional hook-ups of catalogs of several university libraries) will probably revolutionize libraries.

7. A common acquisitions policy with Wellesley, as well as commonality of user services and privileges appears to be a relatively inexpensive way of truly complementing our current library holdings.

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APPENDIX I

APPENDIX I

Library Function — Hours

A. Selection of Books, etc. for Acquisition

1. Processing recommendations, selecting tentative list to be ordered.
2. Checking catalogs to see if book is already ordered or in the collection.
3. Other (please specify).

B. Ordering of Books, Pamphlets, etc.

1. Combining order lists, writing orders to publisher or jobbers, receive and record incoming books, claim missing titles.
2. Changing order lists (or catalog) and collection catalog.
3. Other.

C. Cataloging

1. Searching for Library of Congress catalog card.
2. Classifying (i.e., cataloging) non-Library of Congress book, pamphlet, etc.
3. Typing catalog card or card additions.
4. Proofreading catalog cards, checking catalog.
5. Placing cards in catalog.
6. LC cataloging.
7. Other.

D. Preparation and Binding

1. Books, reports, pamphlets - bookmarking of ownership, date received, pocketing, jacketing, call number placement.
2. Periodicals
   a. Binding.
   b. Rebinding and repairing.
3. Books, reports, other non-periodicals - rebinding and repairing.
4. Other

E. Circulation

1. Shelving
   a. New books
   b. Returns - taken out of library
   c. Returns - in library circulation
   d. Misplaced, errant
2. Recording books to be taken out (date, etc.)
3. Finding and notifying delinquents.
4. Theft and circulation checking.
5. Interlibrary loan
   a. Lending
   b. Borrowing
6. Removal - weeding, storage, disposal.
7. Other.

F. Reference and Information

1. Forming bibliographies, abstracting, indices, selected lists.
2. Intermediate inquiries (answer wanted on the spot).
   a. Catalog aid or search
   b. Equipment instruction
   c. Search for specific book
   d. Search for specific information
   e. Library instruction
3. Delayed inquiries (not urgent rather than those questions delayed by necessity - say when lacking material for reply).
4. Other

G. Reserve

1. Collect, collate lists of required reading from professors.
2. Search out books, reports, etc. needed, check if already on reserve.
3. Reproduction of reserve materials (done by your library or department).
4. Set up reserve catalog or listing.
5. Information - answer inquiries.
6. Maintain shelves.
7. Return books to general collection.
8. Circulation - checking out books, theft control.
9. Other.

H. Supervision

1. Available for emergencies, information, but not engaged actively in work (as an example, sitting at desk in reserve room waiting to be asked any questions that arise).

I. Reproduction

1. Giving instructions on using machines.
2. Reproducing materials for students, faculty, guests.
3. Reproducing material for library (OTHER THAN FOR RESERVE).
   a. Catalog cards
   b. Other
4. Other.

J. Other - Please try to match your time with the above descriptions. However, if you perform an activity that has not been listed, please describe here and indicate

1. Straightening up desks.
2. Reading shelves.
3. Working on mail.
4. Working on invoices.
5. Messenger.

How would you describe your activities yesterday?

__ Very typical for the summer months	5%
__ Typical for the summer months	46
__ Not typical for the summer months	10
__ Extraordinary for the summer months	0
__ Don't know	7

If you have answered not typical, extraordinary, or don't know, please indicate why and how your time estimates would differ.

No answer = 15

Total = 83

Very typical and typical	61%
Not typical	12
Don't know	8
No answer	18

N = 83

APPENDIX I

FLOOR SPACE - sq. ft.

	20000+7980+ 2950 sq' Dewey-Rotch-Aero	20000 ft² Stu	5000 sq' Lind	20000 Eng	67740 Hayden	1740 RR
Sel.	615	200	50	50	1500	--
Ord.	1500	200	50	50	1500	--
Purch.	--	--	--	--	--	--
Cat. (divide evenly) a.	250	--	25	50	500	--
b.	250	--	25	50	500	--
c.	250	--	25	50	500	--
Prep.	250	200	--	--	200	--
Dist.	--	--	--	--	--	--
Stacks	7100	--	980	15200	17220	--
Repair	250	--	--	50	200	--
Bind	250	--	--	--	200	--
Circ.						
a. Res	1225	600	--	--	3720	1040
b. Non	460	--	100	100	200	--
c. Interlibrary	--	--	--	--	--	--
Study (includes lounges, tables)	15600	19000	3240	4100	21600	700
Copying	250	--	--	50	3400	--
Info (divide evenly) a.	--	--	--	--	--	--
b.	--	--	--	--	--	--
c.	--	--	--	--	--	--
Gen. Admin.	2600	--	225	350	1620	--
T.I.P.	--	--	--	--	1800	--

APPENDIX II

PROGRAM BUDGET 1966-67

		Personnel Costs				Purchase	Floor	Total	% of	
	RESEARCH AND GENERAL COLLECTION	Central Processing	Library Divs.	Gen. Library Admin.	Jobber Costs	Supply Costs	Space Costs	Annual Costs	Total Budget	
A.	Collection Building									
	Selection of Items to be Ordered for Collection	$ 7,125	$49,250	$ 5,800	$ 0	$6,000	$8,060	$76,235	3.3	
	Ordering of Items from Publishers, Jobber	49,600	84,000	14,900	0	6,000	11,900	166,400	7.3	
	Purchase Costs of - a) Books, Monographs	0	0	0	0	168,000	0	168,000	7.4	
	b) Serials	0	0	0	0	39,265	0	39,265	1.7	
	c) Journals	0	0	0	0	91,116	0	91,116	4.0	
	Cataloging Items a) Using Library of Congress card	88,800	26,250	11,500	0	6,900	3,120	136,570	6.0	
	b) Original Cataloging	130,200	18,560	14,900	0	5,200	3,120	171,980	7.5	
	c) Recataloging	19,400	14,900	6,900	0	3,950	1,560	46,710	2.1	
	New Item Preparation (Bookmarking, etc.) and Distribution to Divisional Libraries	32,800	5,980	3,100	5,950	6,820	2,340	56,990	2.5	
										Subtotal 41.8%
B.	Collection Maintenance									
	Stacks	0	0	0	0	0	144,800	144,800	6.4	
	Item Repair, Rebinding	11,900	7,460	1,770	5,513	6,225	1,900	34,768	1.5	
	Binding of Serials, Journals	7,300	8,710	1,440	28,028	6,225	1,700	53,403	2.3	
										Subtotal 10.2%
C.	User Services									
	Research Reading Desks (25% of total)	0	0	0	0	0	64,800	64,800	2.8	
	Circulation	32,400	130,000	16,100	0	2,275	3,280	184,055	8.1	
	Interlibrary Loan and Borrowing	0	18,000	1,690	0	1,650	0	21,340	1.0	
	Information and Bibliographic Aid	4,400	196,000	20,000	0	0	0	220,400	9.8	
										Subtotal 21.7%
	REQUIRED READING AND STUDYING									
A.	Collection Building									
	Purchasing (Books)	0	0	0	0	81,200	0	81,200	3.6	
	Processing (Selection, Ordering, Preparation)	4,775	7,450	0	300	1,005	1,110	14,640	.6	
	Xeroxing	0	0	0	0	18,000	0	18,000	.8	
	Cataloging (added copies)	19,400	14,900	0	0	3,950	1,560	39,810	1.7	
										Subtotal 6.7%
B.	Collection Maintenance									
	Stacks, Desk, General	0	0	0	0	0	25,000	25,000	1.0	
										Subtotal 1.0%
C.	User Services									
	General Services, Information, Aid, Circulation	25,175	112,000	13,700	0	2,275	0	153,150	6.7	
	Study Spaces (75% of total)	0	0	0	0	0	196,300	196,300	8.6	
										Subtotal 15.3%
	RESEARCH AND DEVELOPMENT - Technical Information Processing Project	56,340	0	0	0	11,500	6,800	74,640	3.3	Subtotal 3.3%
								$2,279,572	100.0%	

Form 20 Technology Store

APPENDIX III

Cost/Item - from M.I.T. Program Budget

Processing	Total Annual Cost	Total Number Books, Serials, etc.	Cost/Item
Selection	$ 76,235	49,656	$ 1.54
Ordering	166,400	49,656	3.35
Preparation (Book-marking, etc.)	56,990	95,661	.60
Cataloging with LC card	136,570	14,421	9.47
Cataloging without LC card	160,000 *	10,885	14.70
Cataloging Additional copies	46,710	8,231	5.67
Purchasing			
Monographs (Books, Pamphlets, Slides)	168,000	39,660	4.24
Serials	39,265	4,601	8.53
Journals	91,116	5,234	17.40

Storing the Collection

Total number of volumes (including books, slides, serials, etc.)	= 1,155,480
Total cost/year	= $144,800
Cost/volume/year	= $.12

User Services

Non-reserve Circulations	= 167,575
Total Cost/year	= $184,055
Cost/non-reserve Circulation	= $1.10
Information and Bibliographic Aid - Approximate number of inquiries	= 100,000
Total Cost/year	= $220,400
Cost/inquiry	= $2.20

---

* Part of the total original cataloging costs pertains only to cataloging of pamphlets in the Dewey Industrial Relations collection. The $11,620 deducted represents an estimate of those costs as reported in the time survey.

Interlibrary Loan -	
Number of Fulfilled Requests	= 2899
Total Cost of Lending and Borrowing System	= $21,340
Cost/Fulfilled Request	= $7.35
Number of Seats	= 1631
Total Cost/Year	= $261,100
Cost/Seat/Year	= $160.00
Number of Items Repaired or Rebound	= 2302
Total Cost	= $34,768
Cost/Item	= $15.10
Number of Journal Volumes Bound	= 6,610
Total Cost	= $53,403.00
Cost/Journal	= $8.08

APPENDIX IV

AVERAGE STORAGE COSTS (CAPITAL INVESTMENT REPAID OVER 50 YEARS)

										At 4% Annual Interest on the Unpaid Principal						At 6% Annual Interest on the Unpaid Principal			
Degree of Use	Access	Storage Type	Location	ft^2/ sec.	Vol/Sec	Vol/ft^2	ft^2/vol	Unusable Area Factor	Gross Area ft^2/vol	per ft^2 annual Maintenance Cost	per vol Annual Maintenance Cost	per vol Uniform Annual Storage Equip. Costs	per vol Uniform Annual Construction Cost	per vol Annual Land Costs	per vol Annual Average Total Cost	Per vol Uniform Annual Storage Equip. Costs	Per vol Univorm Annual Construction Costs	Per vol Annual Land Cost	Per vol. Annual Average Total Cost
Infrequent	Open	Conventional	On Campus	6.4	125	19.5	.0512	1.15	.0589	.90	.0530	.0110	.1042	.0113	.1795	.0149	.1420	.0170	.2269
Moderate	Open	Conventional	On Campus	7.0	125	17.9	.0560	1.20	.0672	1.25	.0840	.0125	.1189	.0129	.2283	.0171	.1620	.0194	.2825
Heavy	Open	Conventional	On Campus	7.8	125	16.0	.0624	1.25	.0780	1.50	.1170	.0145	.1380	.0150	.2845	.0198	.1881	.0225	.3474
Moderate	Closed	Conventional	On Campus	6.4	125	19.5	.0512	1.20	.0614	1.25	.0768	.0114	.1086	.0118	.2086	.0156	.1480	.0177	.2581
Moderate	Closed	Compact	On Campus	6.4	244	38.1	.0262	1.20	.0314	1.25	.0393	.0088	.0555	.0060	.1096	.0120	.0757	.0090	.1360
Infrequent	Open	Conventional	Off Campus	6.4	125	19.5	.0512	1.15	.0589	.90	.0530	.0110	.0905	.0053	.1598	.0149	.1233	.0080	.1992
Moderate	Open	Conventional	Off Campus	7.0	125	17.9	.0560	1.20	.0672	1.25	.0840	.0125	.1032	.0060	.2057	.0171	.1407	.0091	.2509
Moderate	Closed	Conventional	Off Campus	6.4	125	19.5	.0512	1.20	.0614	1.25	.0768	.0114	.0943	.0055	.1880	.0156	.1286	.0083	.2293
Infrequent	Closed	Compact	Off Campus	5.9	244	41.4	.0242	1.15	.0278	.60	.0167	.0078	.0324	.0025	.0594	.0106	.0441	.0038	.0752
Moderate	Closed	Compact	Off Campus	6.4	244	38.1	.0262	1.20	.0314	1.25	.0393	.0088	.0482	.0028	.0991	.0120	.0658	.0042	.1213

APPENDIX V

DATA FOR CRITERIA COMPARISON

A. Acquisition Date

Years Old	Acquired Up To	Total Circulations 1964-67*	Total Book Removed	% Circulations Lost	% Books
25-34	1929	0	10	0 %	5.3%
15-24	1939	9	27	3.2	14.4
10-14	1949	42	66	14.8	35.0
5-9	1954	75	91	26.5	48.5
2-4	1959	162	130	57.2	69.1
1	1962	283	188	100.0	100.0

B. Publication Date

25-34	1929	1	14	0 %	0 %
15-24	1939	16	35	5.7	18.8
10-14	1949)	59	77	21.0	41.2
5-9	1954)				
2-4	1959	172	145	61.0	77.5
1	1962	282	187	100.0	100.0

* January, 1964 through July, 1967

C. Circulation Date

1963 Circulation	Cumulative Number of Books	Cumulative Total Circulations 1964-67	% Books Removed	% Circulations Lost
0	126	84	67.0%	30.0%
1	163	156	87.0	55.4
2	172	190	91.5	67.5
3	177	212	94.5	75.0
4	183	258	97.5	91.6
5	186	272	99.9	96.5
6	187	279	99.9	99.0
9	188	282	100.0	100.0

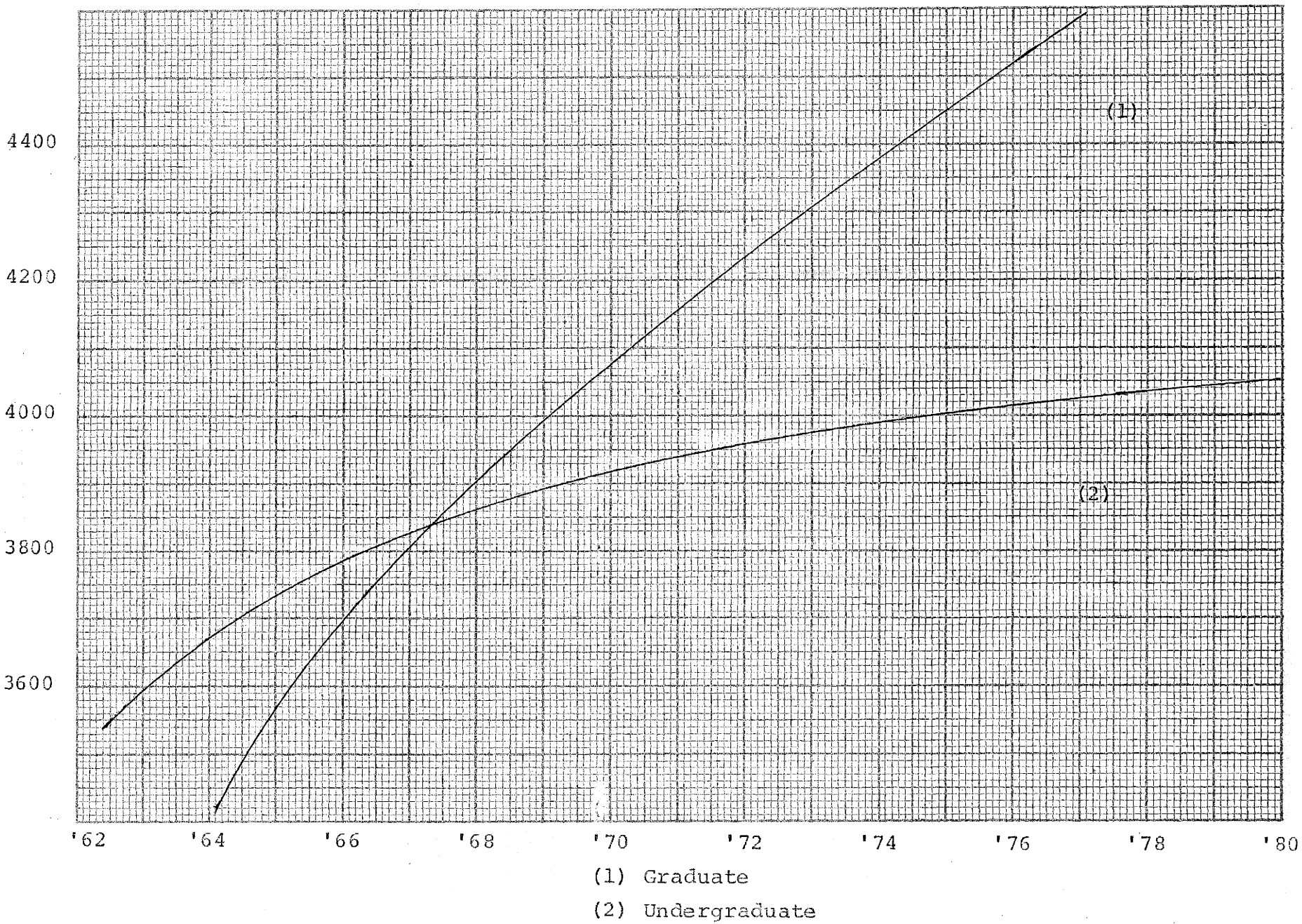
D. Foreknowledge

Number of Circulations	Number of Books	Cumulative Number of Books	Cumulative Total Circulations 1964-67	% Books Removed	% Circulations Lost
0	99	99	0	52.5%	0 %
1	31	130	31	69.1	11.5
2	24	154	79	82.0	28.9
3	12	166	115	88.3	42.0
4	8	174	147	92.6	53.6
5	2	176	157	93.6	57.4
6	0	176	157	93.6	57.4
7	2	178	171	94.7	62.4
8	5	183	211	97.5	77.1
9	2	185	229	98.5	83.8
10	0	185	229	98.5	83.8
11	1	186	240	99.0	87.8
12	0	186	240	99.0	87.8
13	0	186	240	99.0	87.8
14	0	186	240	99.0	87.8
15	0	186	240	99.0	87.8
16	2	188	272	100.0	100.0

APPENDIX VI

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

PROJECTED STUDENT ENROLLMENT

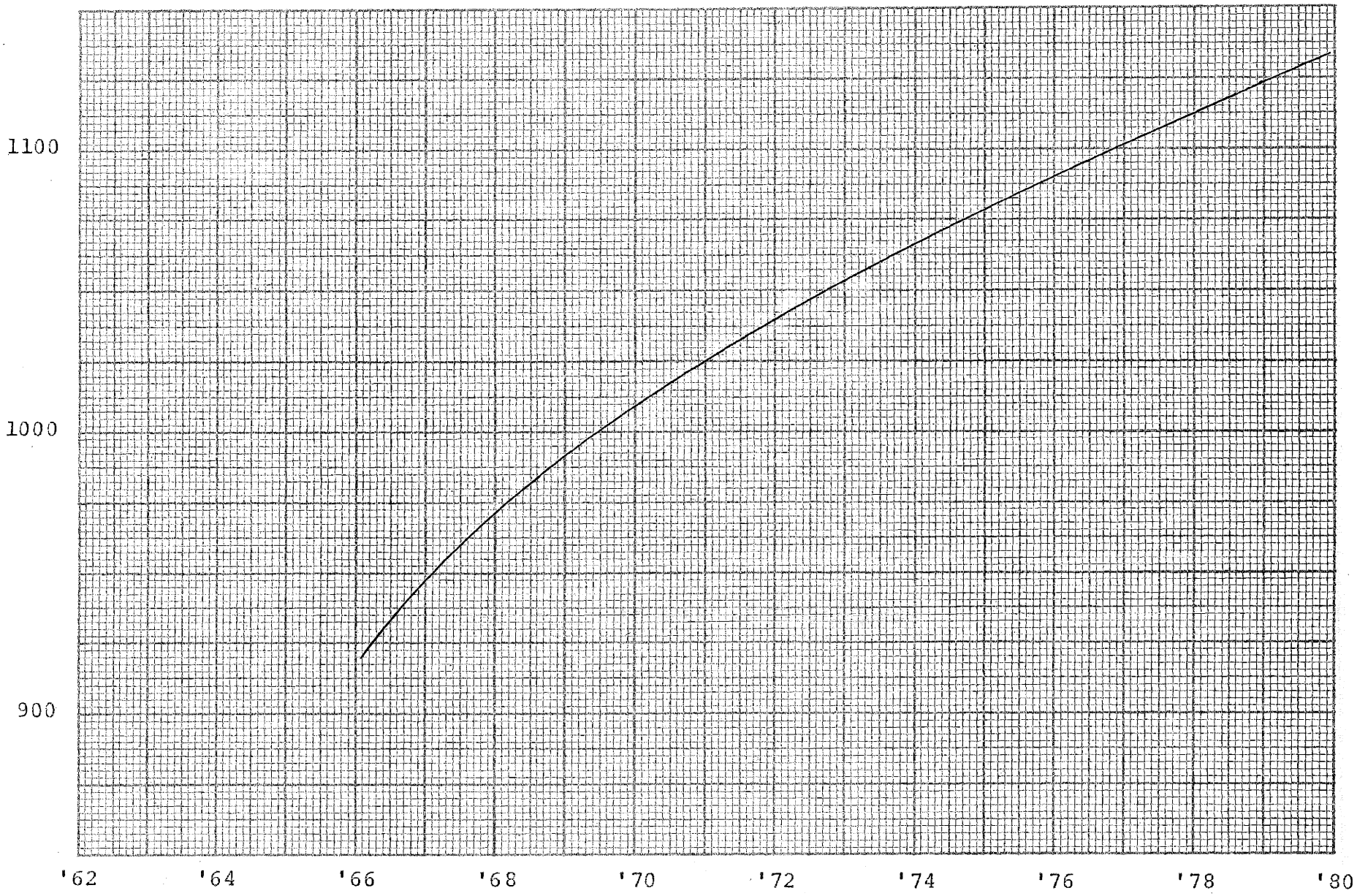


(1) Graduate

(2) Undergraduate

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

PROJECTED FACULTY



APPENDIX VII

DEPARTMENTAL LIBRARY ALTERNATIVES

Collection Description	A	B	C	D	E
Total Collection					
a) Journals	2000	2000	2000	4000	2000
b) Books	3000	3000	3000	6000	3000
Purchases/Year					
a) Journals	225	225	225	450	225
b) Books	300	300	600	600	300
Circulation	Limited	Limited	Limited	Limited	Allowed
Seats	7-table	20-table	20-table	30-table	20-table
Example	Center for International Studies	Minimal Departmental	Very Current Collection	Extensive Collection	Extensive Service
Cost Categories					
a) Selection					
b) Ordering					
c) Preparation	$4400	$4400	$8800	$8800	$4400
d) Cataloging					
e) Purchase					
1) Journals	2000	2000	2000	4000	2000
2) Books	2750	2750	5500	5500	2750
f) Storage	520	520	520	1040	520
g) Reference, information	2650	100	100	100	4000
h) Circulation	250	100	100	100	3000
i) Study Spaces	800	3000	3000	4500	3000
TOTAL	$13,570	$12,870	$20,020	$24,040	$17,670

APPENDIX VIII

STUDY-RESERVE ALTERNATIVES

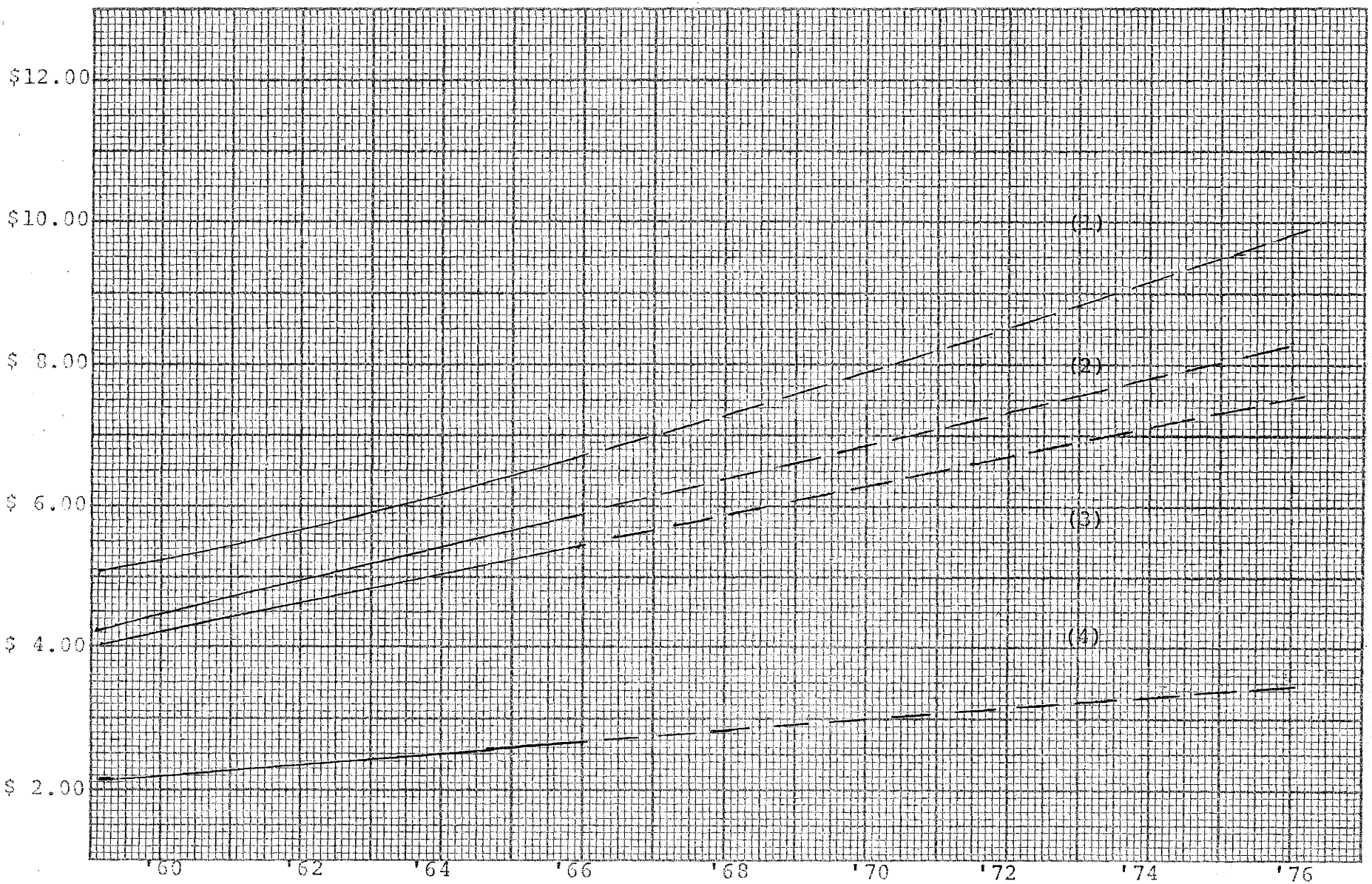
	Book Purchase	Xerox	Fiche Duplication	Equipment	Personnel	Floor Space	Seating	Total with Current Seating	Total Cost With Probable Seating Effect	Optimistic[A] Seating Effect	Optimistic[B] Probable Seating + 25% Technological Price Changes
Microfiche											
Portable Readers	$75,000	$ 0	$54,000	$216,000	$170,000	$25,000	$196,000	$736,000	$696,800 (20%)	$657,600 (40%)	$629,300
Library-dorm Readers											
(1:10 students)	75,000	0	54,000	36,000	170,000	25,000	196,000	556,000	546,200 (5%)	497,200 (30%)	523,700
(1:5 students)	75,000	0	54,000	72,000	170,000	25,000	196,000	592,000	582,200 (5%)	533,200 (30%)	550,700
(1:20 students)	75,000	0	54,000	18,000	170,000	25,000	196,000	584,800	528,200 (5%)	479,200 (30%)	510,200
(1:10 + 1:100 Reader Printers)	75,000	0	54,000	64,800	170,000	25,000	196,000	584,800	575,000 (5%)	526,000 (30%)	544,450
Xerox											
All Article	75,000	138,000	0	0	170,000	25,000	196,000	604,000	545,200 (30%)	506,000 (50%)	510,700
Commercial Rates											
Elastic Demand	81,000	22,000	0	0	197,000	25,000	196,000	521,000	519,000 (1%)	501,400 (10%)	--
Inelastic Demand	81,000	28,000	0	0	197,000	25,000	196,000	527,000	525,000 (1%)	507,400 (10%)	--
Conventional											
Present System Departmental Libraries	81,000	18,000*	0	0	197,000	25,000	196,000	517,000	--	--	--
Supplement (20)	141,000	18,000	0	0	290,000	95,000	196,000	740,000	681,200 (30%)	642,000 (50%)	--
Replacement (20)	100,000	25,000	0	0	285,000	25,000	196,000	631,000	--	--	--
Additional Copies (Low cost assumption)	113,400	36,000	0	0	200,000	28,000	196,000	573,400	534,200 (20%)	495,000 (40%)	--
(High cost)	263,700	54,000	0	0	200,000	28,000	196,000	741,700	702,500 (20%)	663,300 (40%)	--
Centralized Reserve (say 25% overlap)	65,000	13,500	0	0	170,000	22,000	163,000	433,500	433,500 (1/6 Economy of Scale)	368,800 (1/3 Economy of Scale)	--

* Dewey and Student Center Xeroxing is estimated to be about 2/3 of the total Xeroxing budget for the library.

** Numbers in parentheses are the estimated percentages of seats "saved."

APPENDIX IX

AVERAGE PRICE OF PERIODICALS BY CATEGORY PROJECTED THROUGH 1976

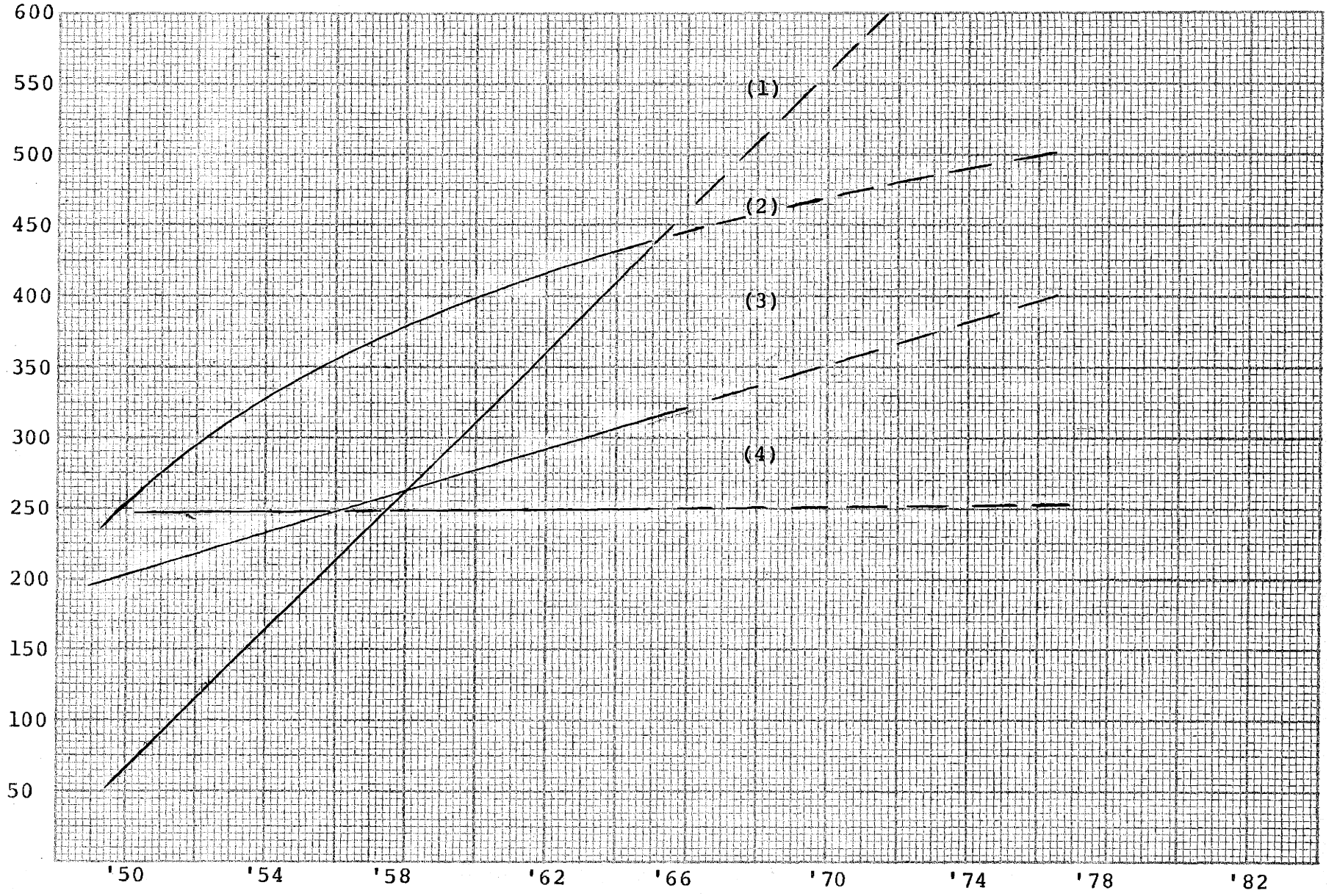


(1) Business & Economics (3) Sociology and Anthropology

(2) Political Science (4) Labor & Industrial Relations

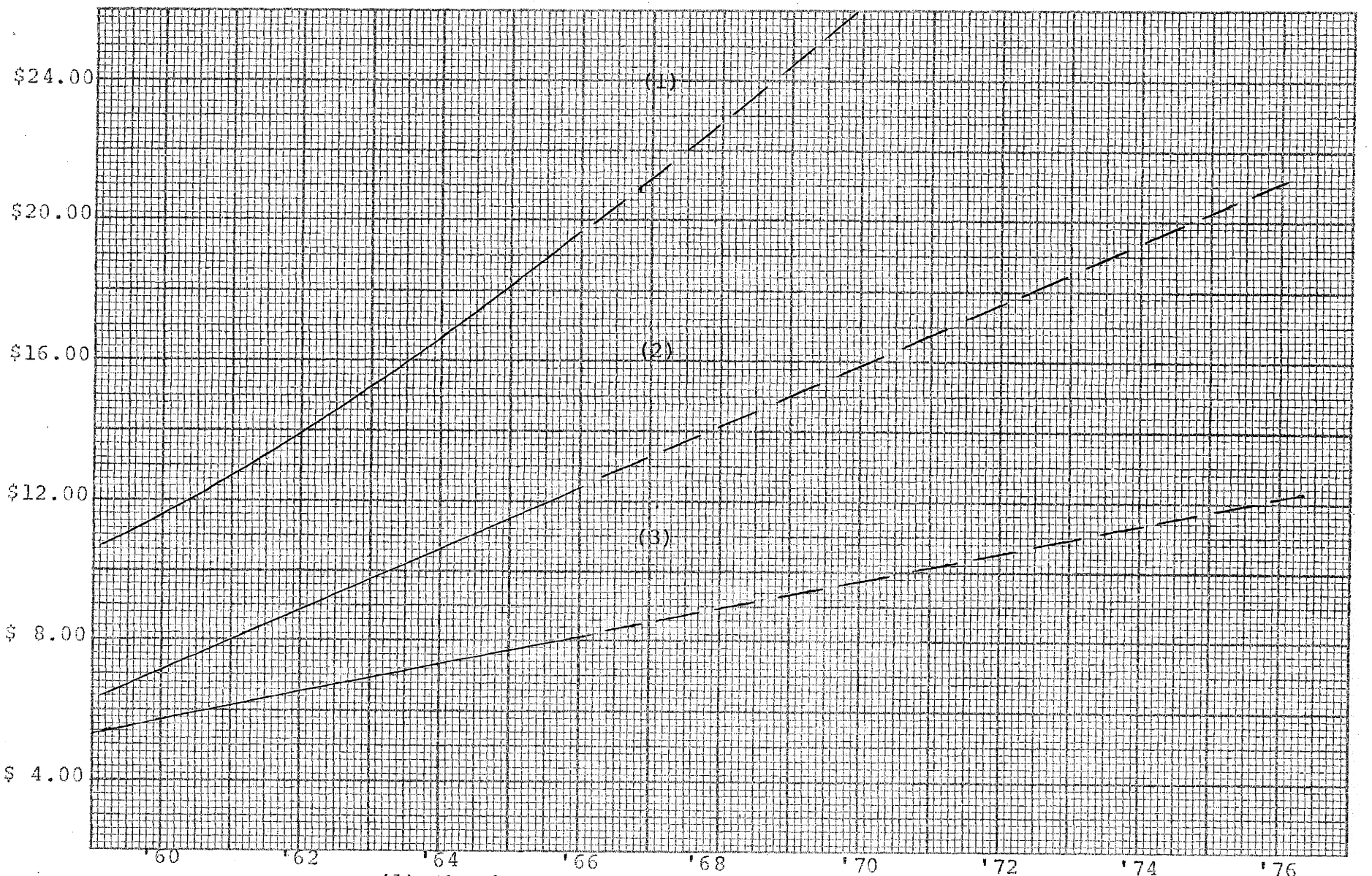
FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

GROWTH OF PERIODICALS & SERIALS IN THE SOCIAL SCIENCES PROJECTED THROUGH 1976



(1) Management and Economics
(2) Political Science & I.R.
(3) Sociology and Anthropology
(4) Labor & Industrial Relations

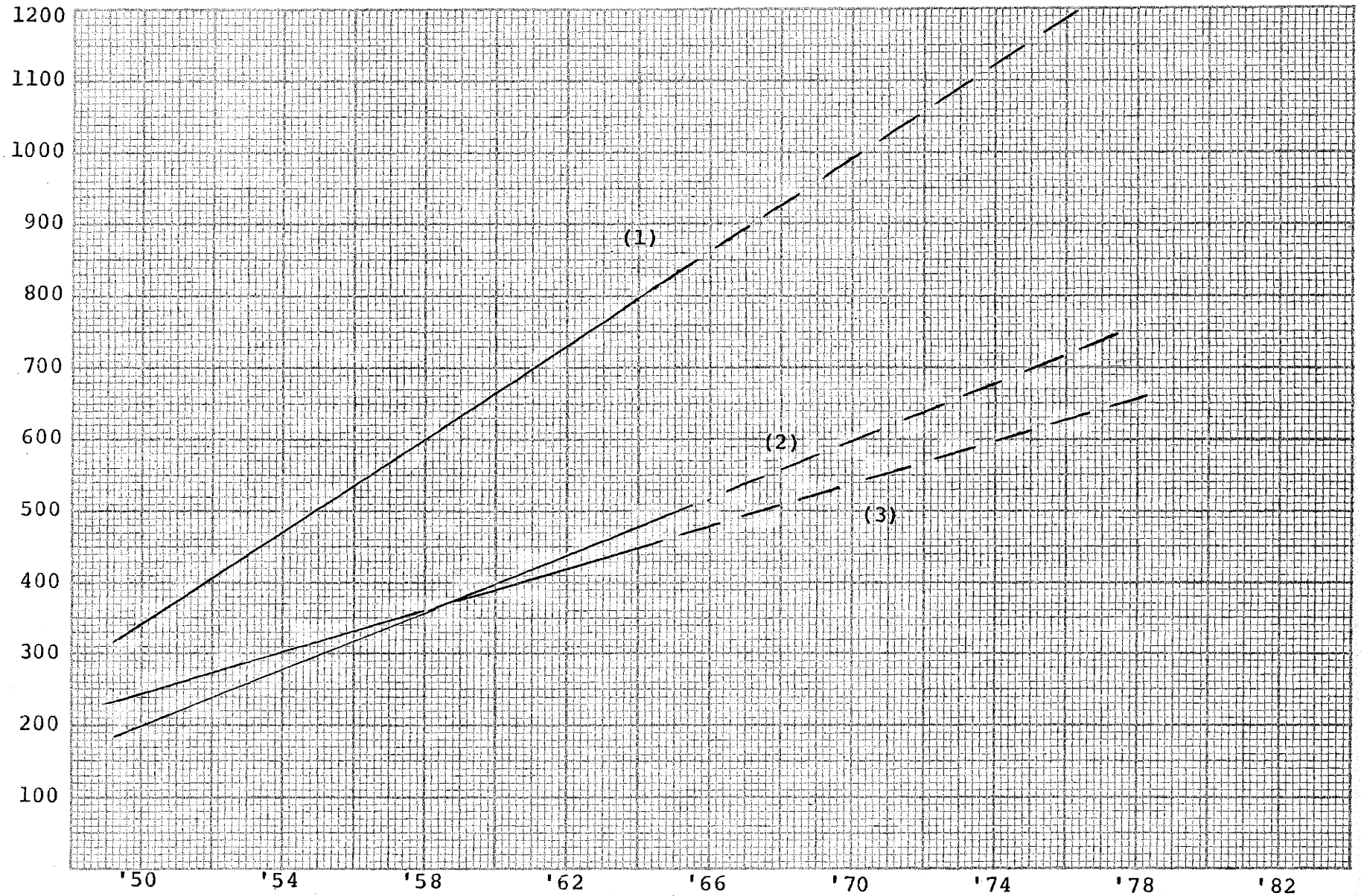
AVERAGE PRICE OF PERIODICALS BY CATEGORY PROJECTED THROUGH 1976



(1) Chemistry and Physics
(2) Mathematics, Botany, Geology, & General Science
(3) Engineering

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

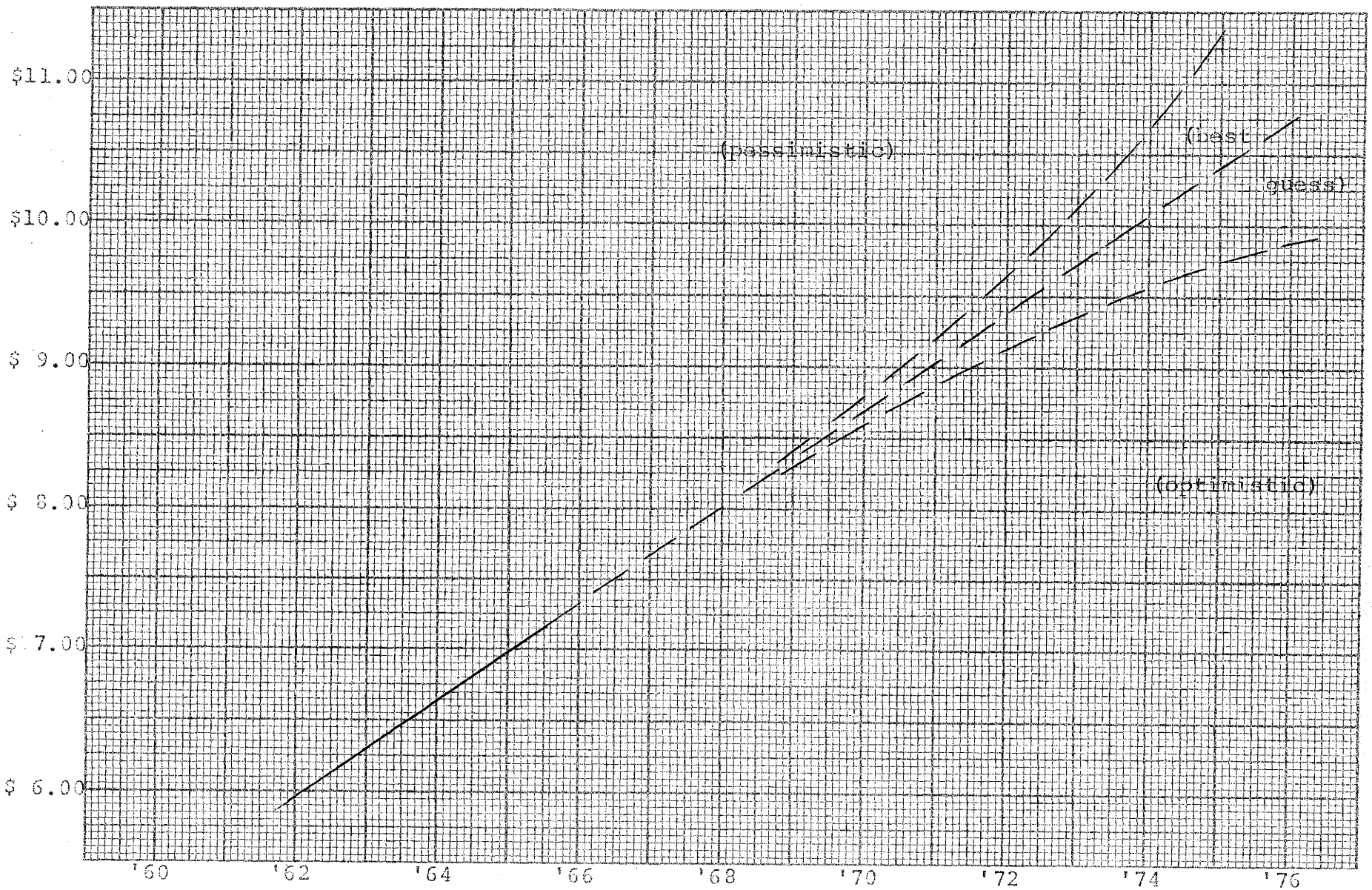
GROWTH OF PERIODICALS & SERIALS IN ENGINEERING & THE NATURAL SCIENCES PROJECTED THROUGH 1976



(1) Mathematics & Natural Sciences except Chemistry & Physics
(2) Chemistry and Physics
(3) All Engineering

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

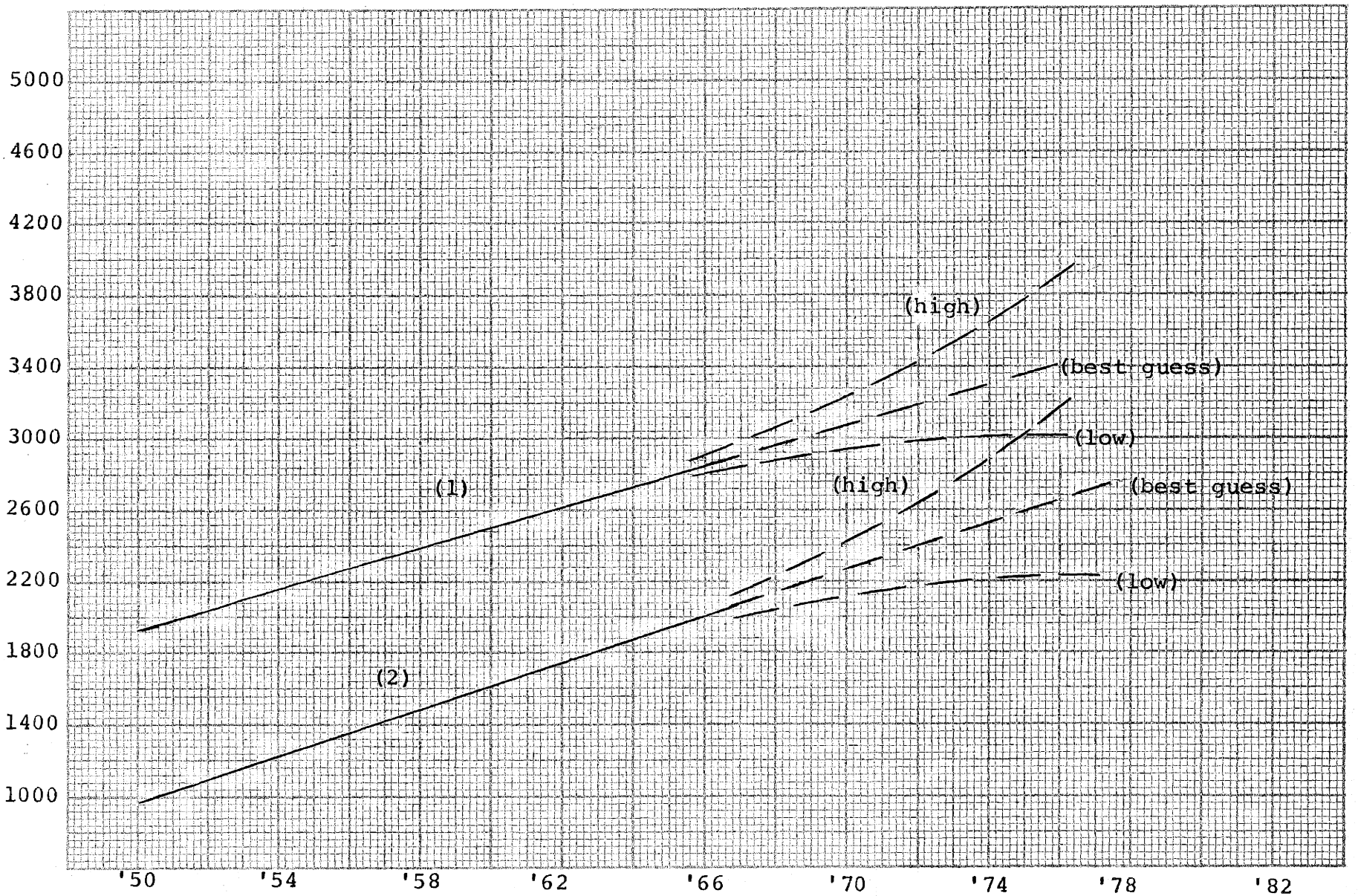
AVERAGE PRICE OF PERIODICALS* PROJECTED THROUGH 1976



*This average is computed from the individual average price of periodicals for twenty-four subject categories weighted by the proportion of periodicals published in that category.

FORM 4 T TECHNOLOGY STORE, M. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

GROWTH IN SERIALS & PERIODICALS BY CATEGORY PROJECTED THROUGH 1976



(1) All Physical & Natural Sciences & All Engineering
(2) All Social Sciences, Business, & History

APPENDIX X

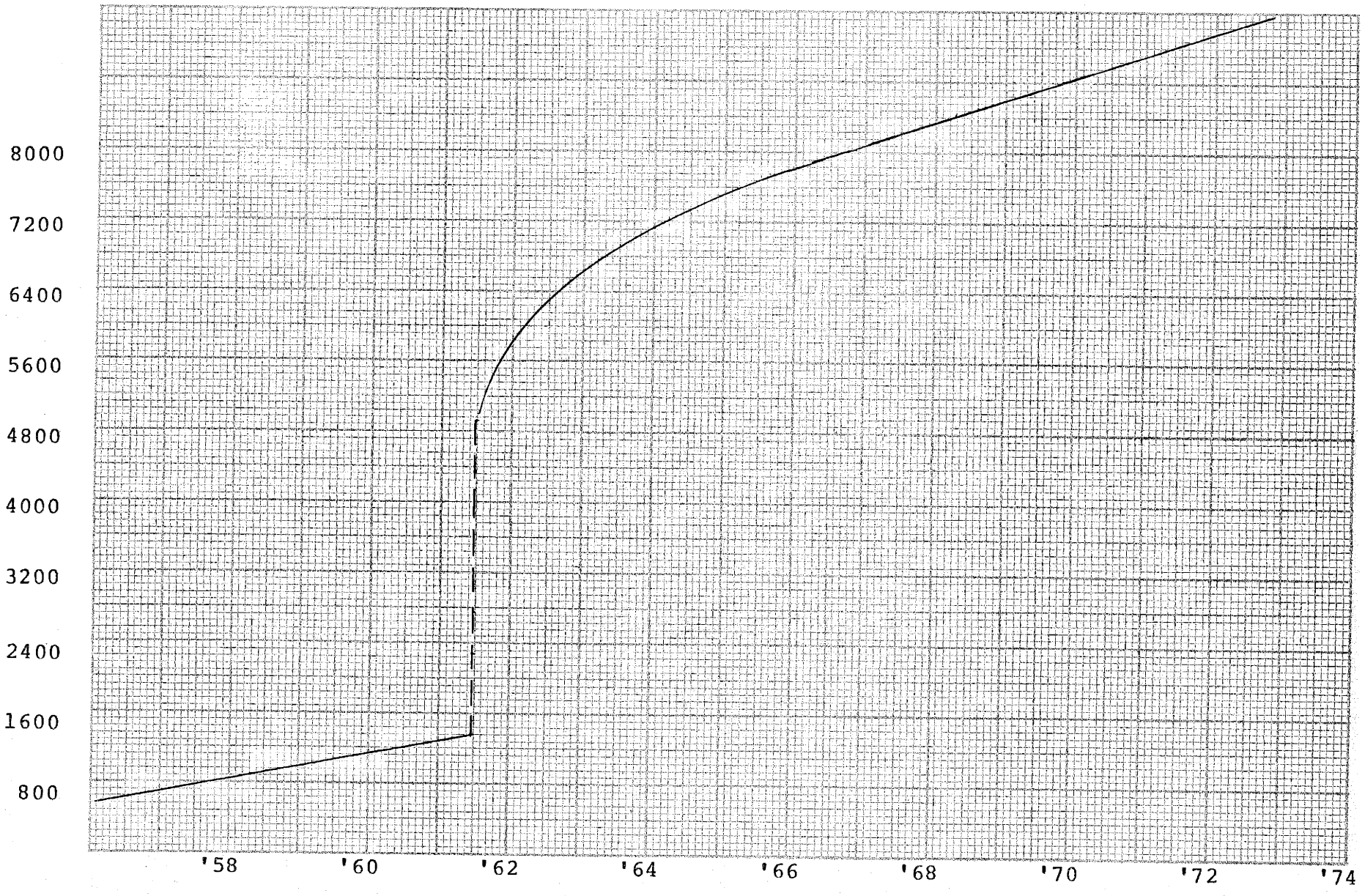
DUPLICATING CATALOGS ON MICROFORM

		Original	Duplicating Costs	Cost to Each School if Divided Equally
A.	Harvard + M.I.T.	$490,000	$24,500/copy	$257,250
B.	M.I.T. + Wellesley	85,000	4,250	44,625
C.	M.I.T. + Wellesley + 5 (½ million Volume) Libraries	210,000	10,250	38,785
D.	M.I.T. + Wellesley + Harvard	645,000	32,250	109,000

APPENDIX XI

FORM 4 T TECHNOLOGY STORE, M. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

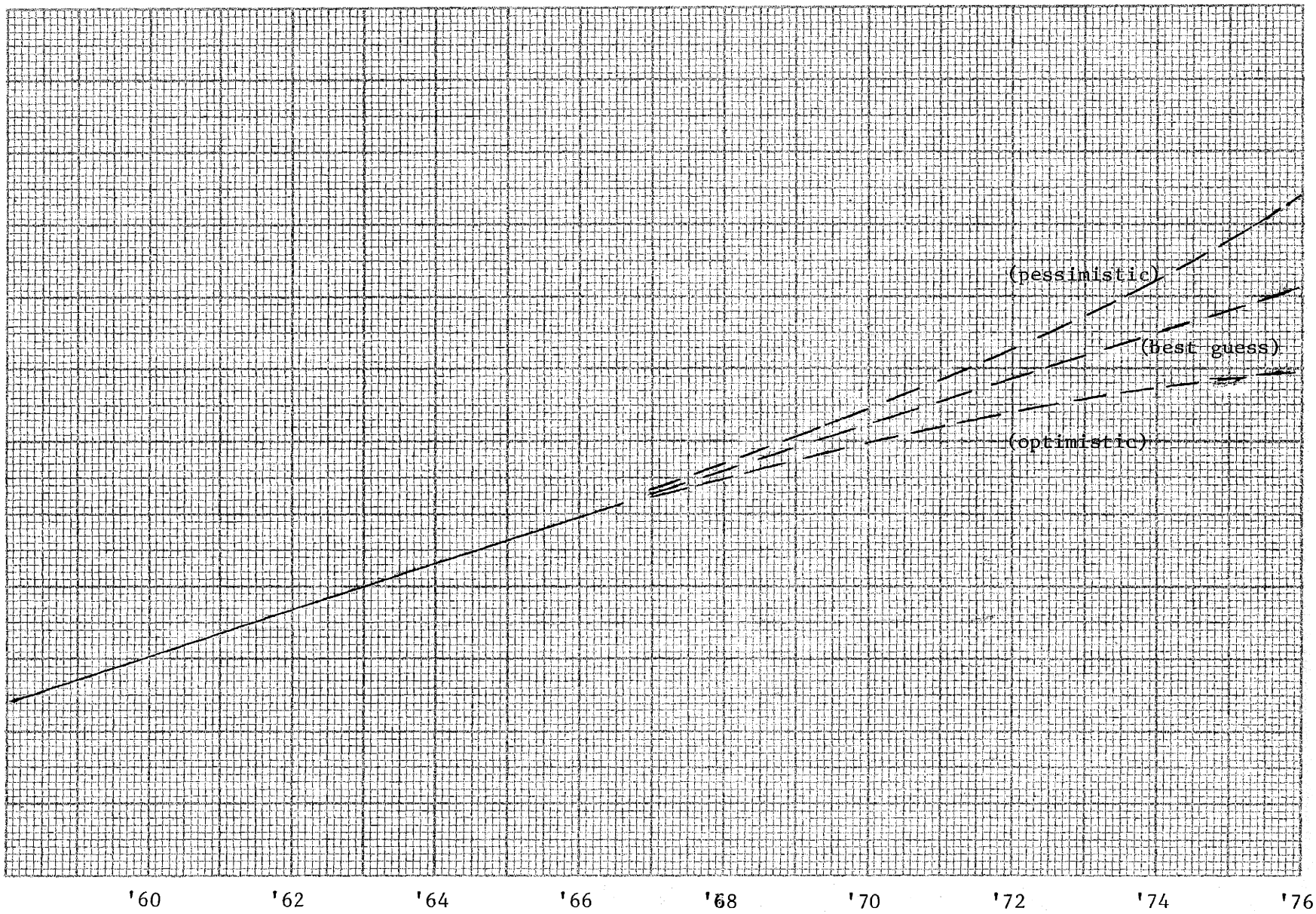
NUMBER OF NEW NON-FICTION TITLES AND EDITIONS*(PAPERBACKS ONLY) PROJECTED THROUGH 1974



* As listed in Publishers' Weekly

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

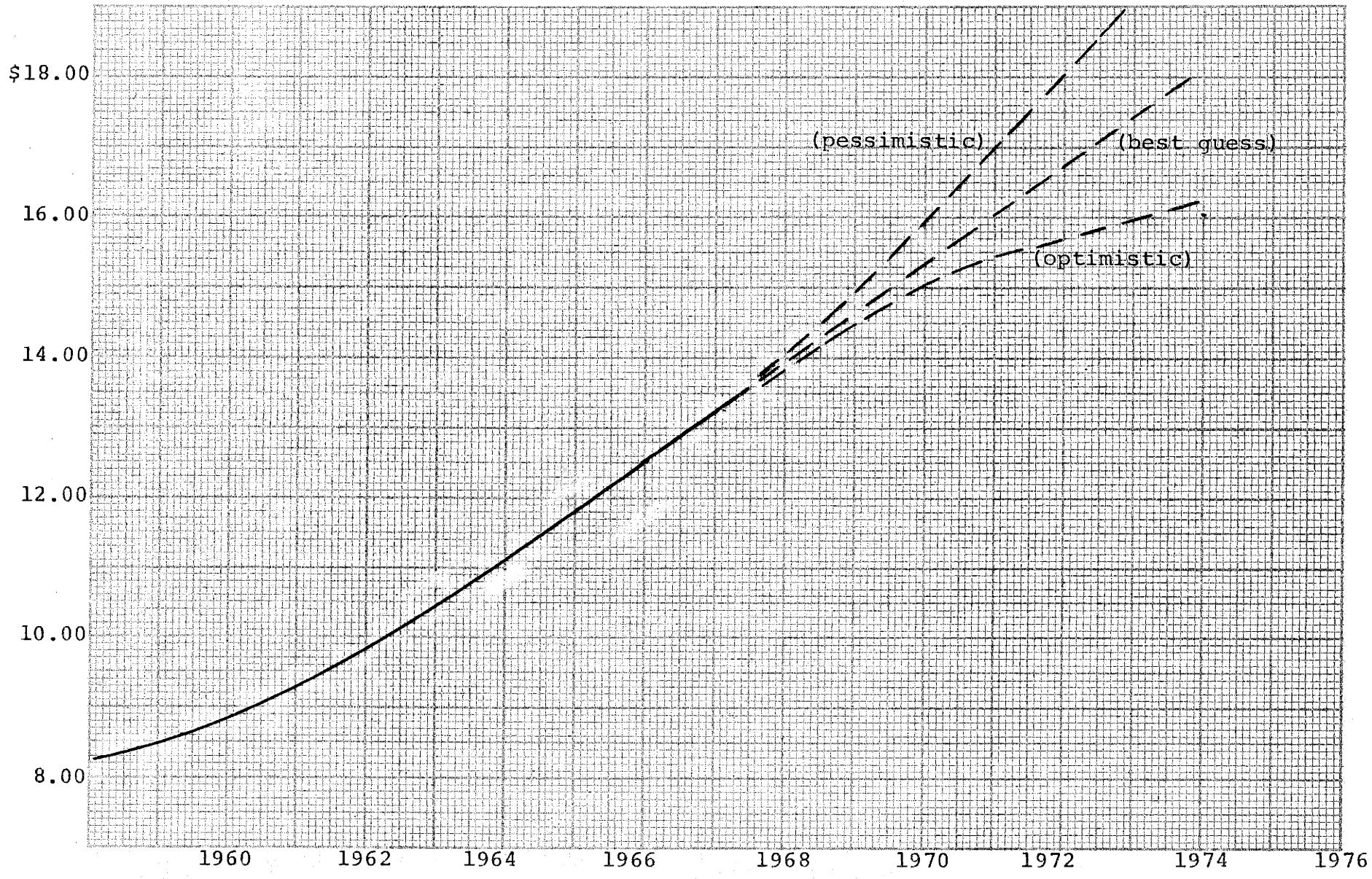
AVERAGE LIST PRICE OF BOOKS IN THE SOCIAL SCIENCES* PROJECTED THROUGH 1976



* This average is derived from projected prices of books in economics, business, political science, sociology, and history, weighted by the relative number of new titles and editions in that field.

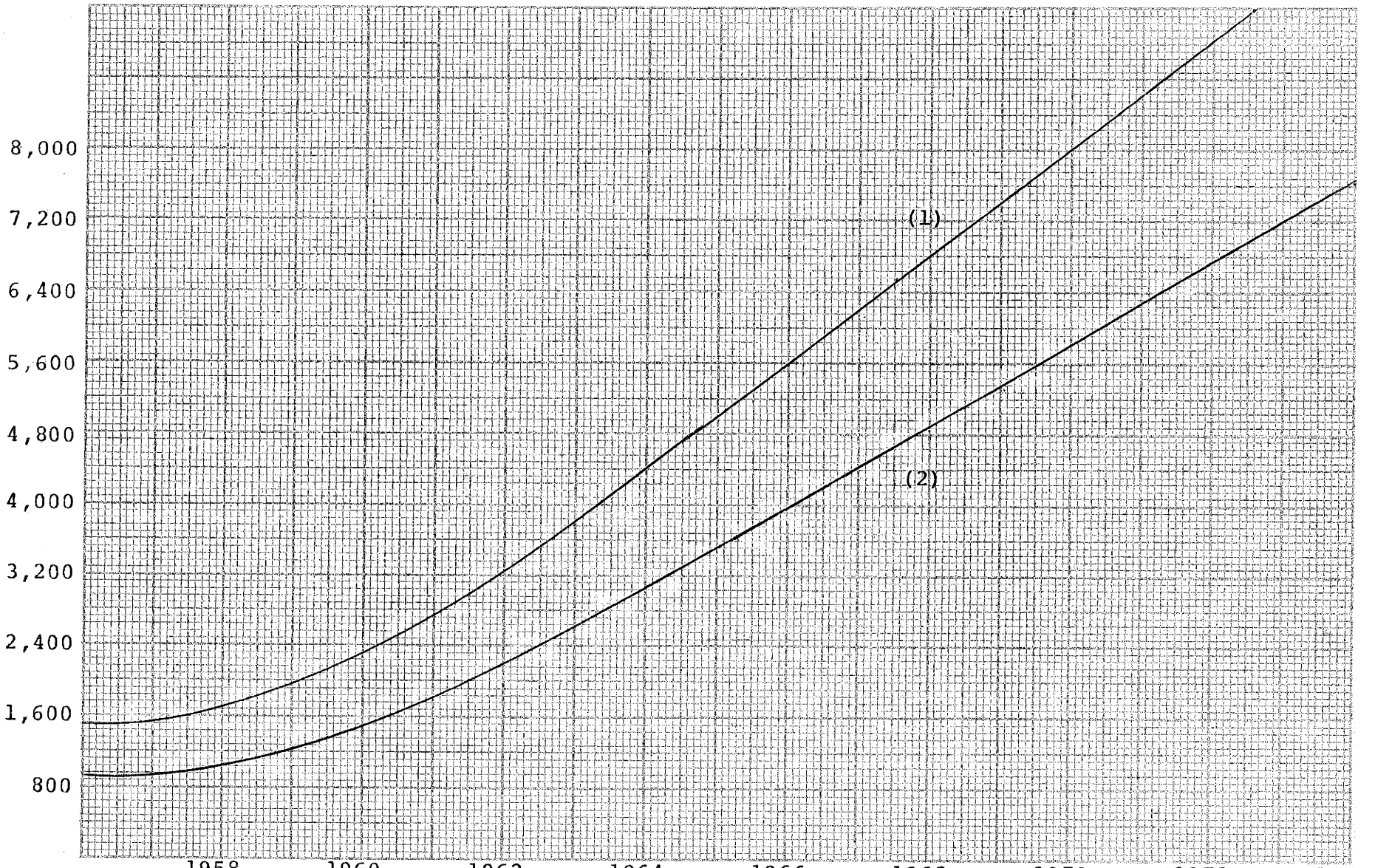
FORM 4 T TECHNOLOGY STORE, M. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

AVERAGE LIST PRICE OF BOOKS IN SCIENCE & ENGINEERING PROJECTED THROUGH 1976



FORM 4 T TECHNOLOGY STORE, M. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

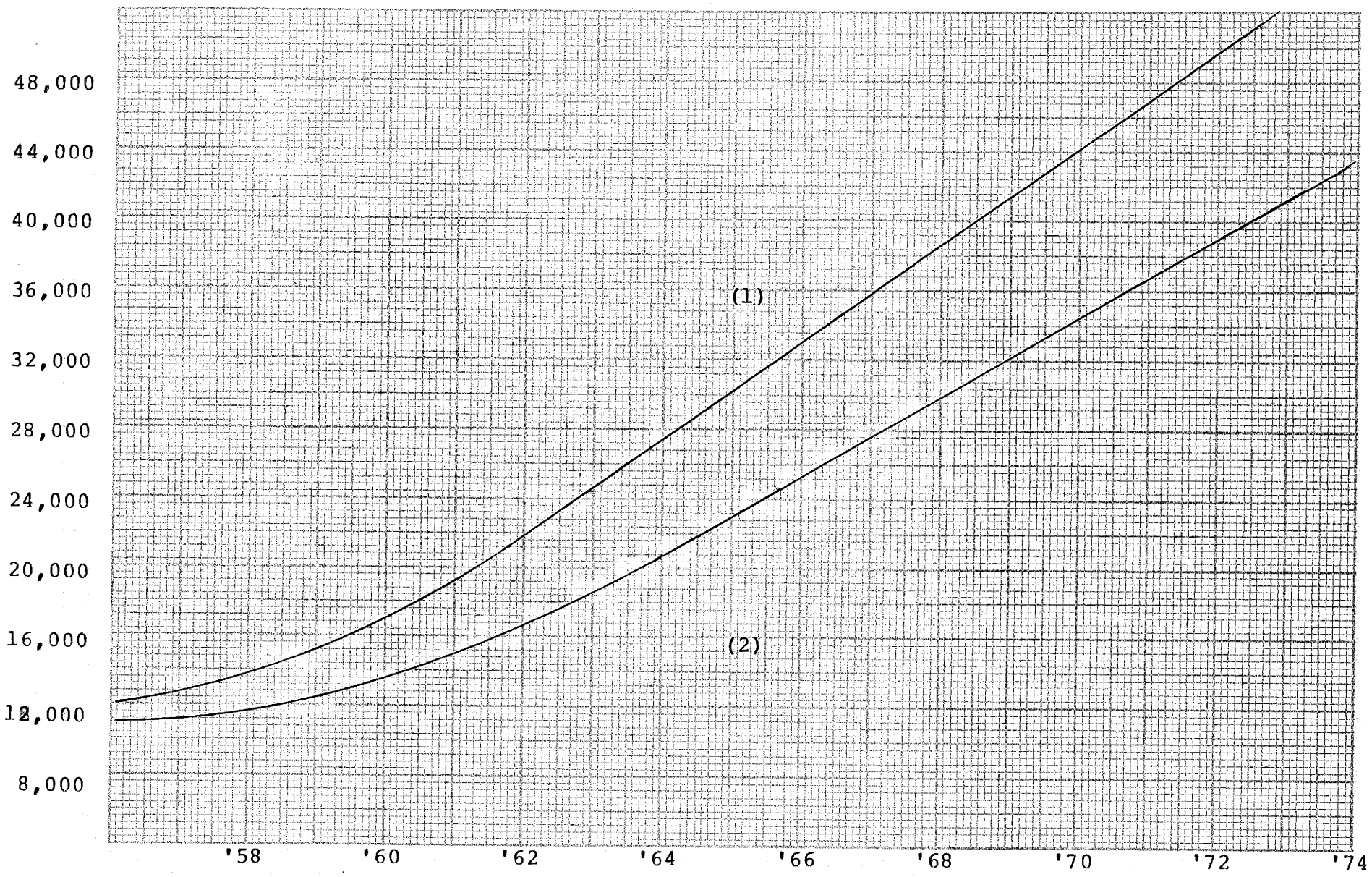
NUMBER OF NEW TITLES & EDITIONS* (HARDBOUND & PAPERBOUND) BY CATEGORY PROJECTED THROUGH 1974



(1) Science and Technology
(2) Science
*As listed in Publisher's Weekly

FORM 4 T TECHNOLOGY STORE, M. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

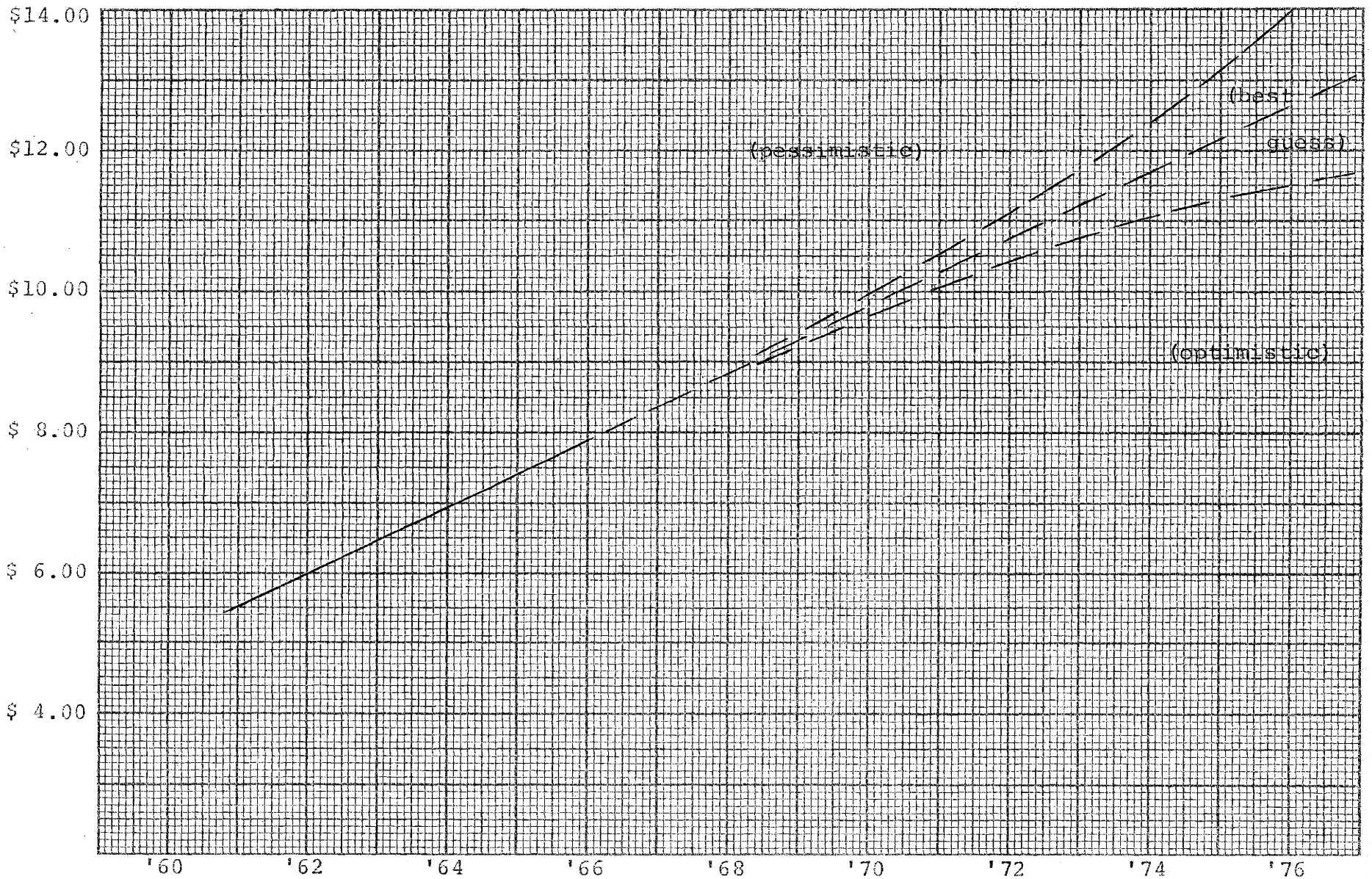
NUMBER OF NEW NON-FICTION TITLES AND EDITIONS* PROJECTED THROUGH 1974



(1) Hardbound & Paperbound
(2) Hardbound only

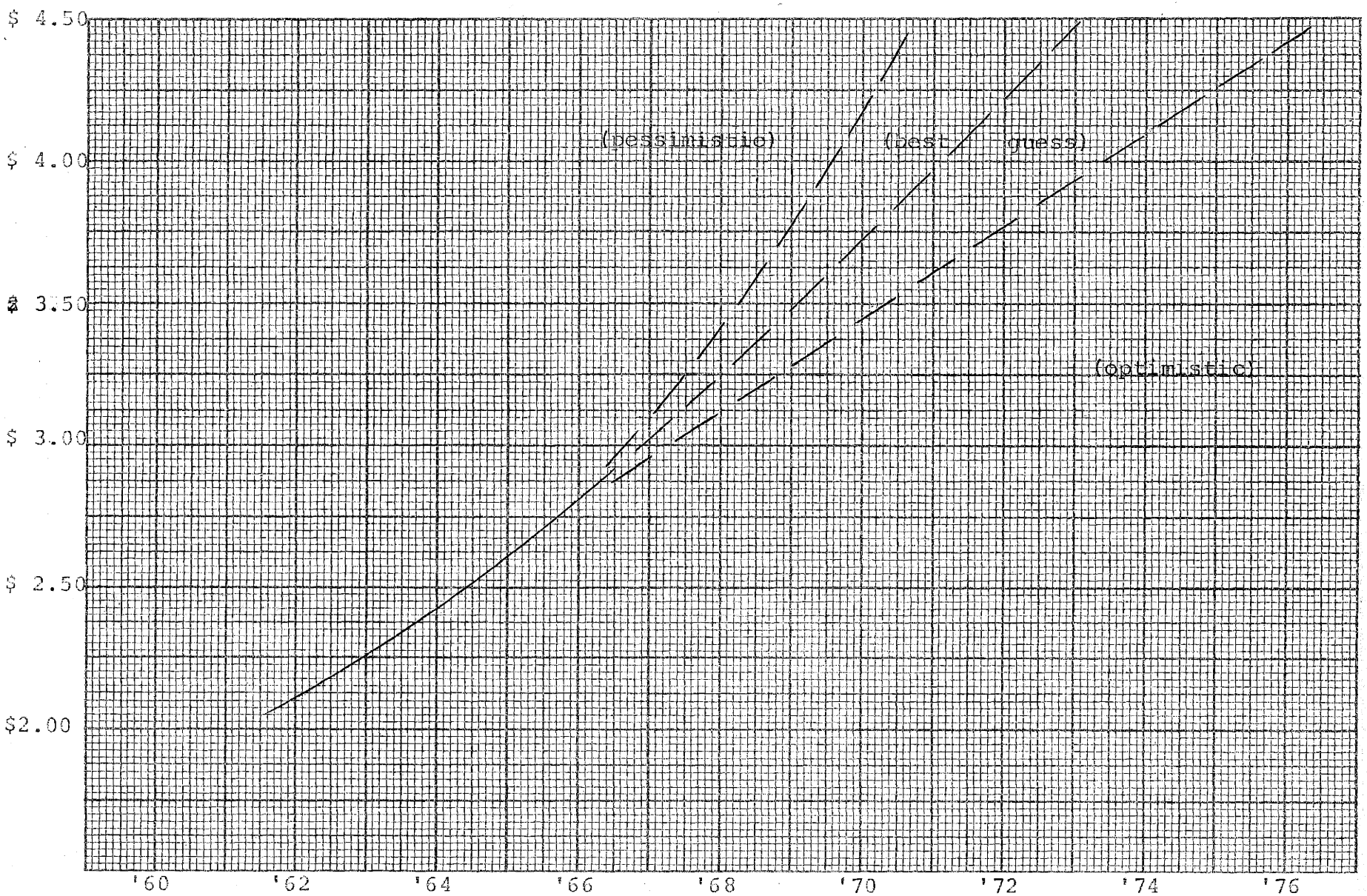
* This includes new titles, new editions, and imports published, as listed in Publishers' Weekly

AVERAGE LIST PRICE OF BOOKS* (HARDCOVER, TRADE-TECHNICAL) PROJECTED THROUGH 1976



*This average is computed from the individual average list price of books for nineteen subject categories weighted by the proportion of books published in that category.

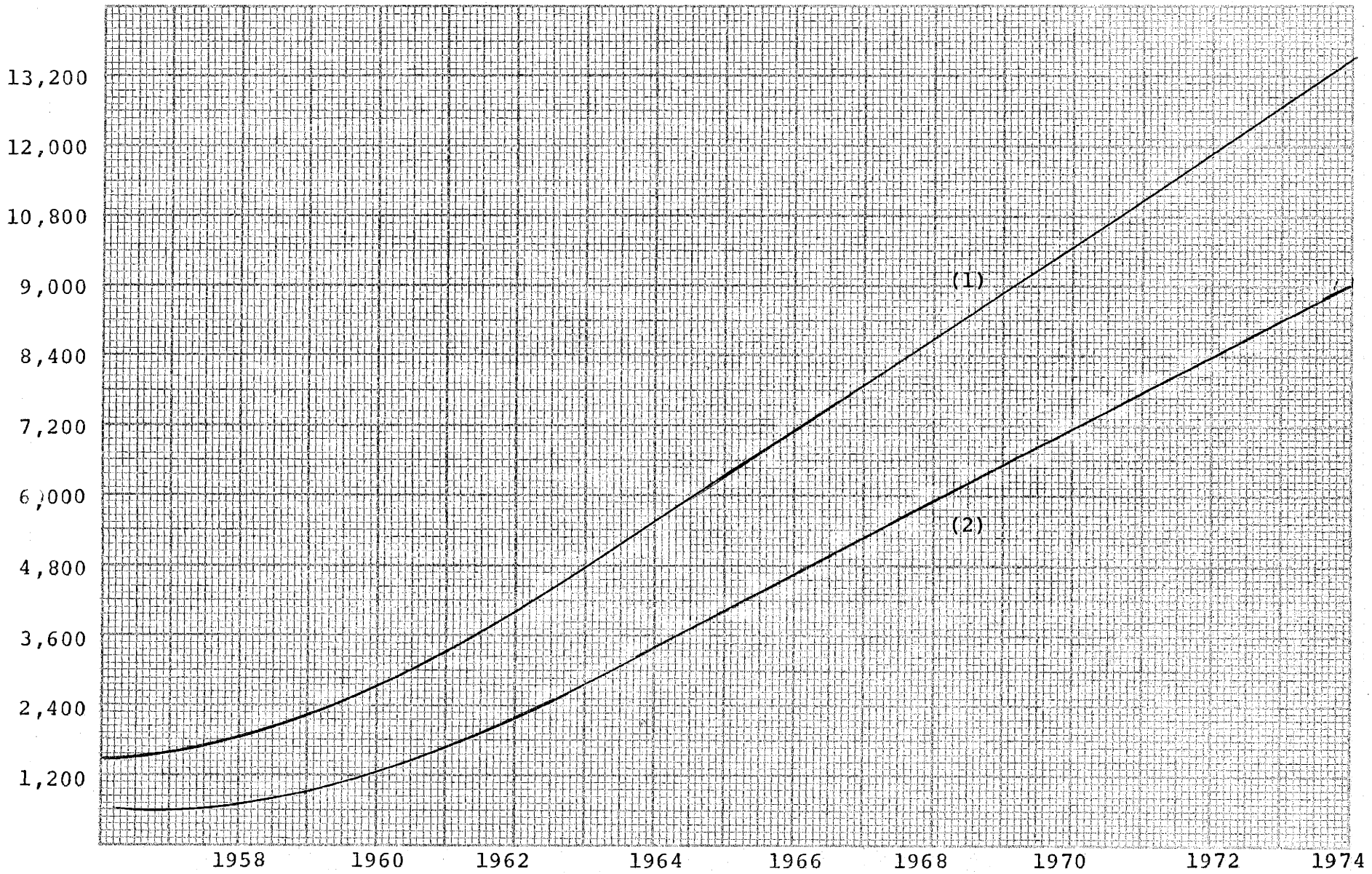
AVERAGE LIST PRICE OF PAPERBACK BOOKS* (TRADE PAPERBACKS) PROJECTED THROUGH 1976



*This average is computed from the individual average list price of paperback books for eighteen subject categories weighted by the proportion of new paperback books published in that category.

FORM 4 T TECHNOLOGY STORE, H. C. S. 40 MASS. AVE., CAMBRIDGE, MASS.

NUMBER OF NEW TITLES & EDITIONS* (HARDBOUND & SOFTBOUND) BY CATEGORY PROJECTED THROUGH 1974



(1) Sociology, Economics, Business, & History
(2) Sociology and Economics
* As listed in Publisher's Weekly