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An Evaluation of Microfilm As a Method of Book Storage

TO INITIATE THIS study, a literature search was conducted to find some of the most pressing problems that were confronting librarians.[1] The subject of microfilm storage was chosen from many problems which were thought to be solvable through an engineering approach. Microfilm was chosen for evaluation because it is the cheapest form of microreproduction for single copies. Although cost is not the only criterion by which it is possible to evaluate microreproductions, it is the most conclusive, as most other criteria are based on individual libraries' needs, aims, and policies.

In selecting only microfilm, the use of micro-publishing (microcards, microprints) and micro-data-processing (Filmsort, Rapid Selector, Minicard, etc.) systems are not considered. Micro-publishing costs are dependent on the number of copies made, which includes the administration involved in selling these copies. The determination of administrative costs at various levels of production and an estimate of the number of copies that could be sold were considered beyond the scope of the report.[2] The evaluation of micro-data-processing systems was not made, as they need further developmental work, and must prove themselves in use before they can gain wide acceptance.[3] Microfilm, on the other hand, is a proved technique, and the evaluation of it as a method of storage is a necessary step before an evaluation of the data-processing techniques can be made.[4]

Scope of the Report

The object of this study is to compare the cost of microfilm storage of a book collection with the cost of storing the same collection in book form. Particular attention is given to the development of a standard unit of measure that is applicable to microfilm storage and book storage, and to the development of unit costs of microfilm storage. Whether or not the cost differentials between two forms of storage justify a loss of utility to the researcher is a decision that must be made by the librarian. It is the purpose of this report to present the unit costs of the different forms of storage so that the librarian may determine which type of storage system is best suited to his library's needs and objectives.

A research library contains two classes of books, the reference portion and the research portion. This report considers only the possibility of microfilming the static, or research, portion of a book collection. The rate of use of the dynamic reference portion of the collection makes microfilm undesirable from the standpoint of convenience.

This report does not attempt to make a study of the total costs of operating a

[1] This article is a condensation of a thesis done for an M.S. degree in the Columbia University School of Engineering. Throughout the article, reference is made to the original manuscript, which is located in that school's library.

[2] Herman H. Fussler, "Photographic Reproduction of Research Materials," *Library Trends,* II (1954), 540.

[3] Haynes McMullen, "American University Libraries, 1955-2005," *CRL,* XVI (1955), 290.

[4] Rudolph Graphic Microfilm Corporation, Interview, April 30, 1956.

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library. Instead, costs for housing the research collection by various methods are compared, assuming that generally the same administration, reading room space, and the like will be required for the total library, regardless of the system used for storing the research collection.

Determination of a Standard Unit of Measure

The determination of a standard unit of measure is the first step toward evaluating microfilm as a method of storage. The costs of microfilming are proportional to the number of exposures that must be made, and, hence, to the number of pages in the collection of books being microfilmed. The unit of measure chosen should give the number of pages in the collection as a function of the number of linear feet in the collection. This will provide for a direct relationship to be established between linear feet of books on shelves and linear feet of books on microfilm.

In estimating the average number of pages per linear foot of books, a systematic sampling plan was used. A systematic sampling plan is one where the first sample of a population is chosen at random, and subsequent samples are chosen at discrete intervals determined from previous knowledge of the population. The Columbia University School of Engineering storage library was used as the population for this study. The storage library had approximately 3,000 linear feet of book shelving. Book shelving instead of books was used in estimating the size of the population because of its ease of computation. This causes the number of samples taken to differ from the number of samples that were expected. The ratio of the former to the latter gives the percentage of book shelving being used. One hundred samples were chosen as the basis of the sampling plan. The size of the sample was arbitrarily fixed at one linear foot on the assumption that a foot was large enough to cancel the errors due to the number of covers in each sample (a bias would be introduced if the size of the sample were not appreciably larger than the cover size). The distance between samples was computed to be 30 linear feet by dividing the estimated linear feet in the population by the number of samples times the sample size.

Statistically, for the Columbia University School of Engineering storage library, there are 4,600 pages per linear foot of books. This figure is not to be used as representing all libraries. It is shown statistically in the original manuscript that the composition of the collection determines the number of pages in a linear foot, and that the number of pages in a linear foot of edition-bound books and of bound journals is significantly different.

Costs of Microfilming

The costs of microfilming have been determined by dividing the costs into two categories: costs of conversion and costs of storage. Conversion costs include the cost of the film and processing, the cost of the microfilming equipment, and the cost of the labor required. The possibility of contrasting the work of conversion to film was considered, but commercial estimates were between one and two cents per page. These estimates were considered too high, and this study only considers the purchase of equipment by the library and performance of the work under library supervision. Storage costs include the costs of cabinets necessary to house the film and the floor space taken up by the cabinets and aisles. This cost was computed for building costs of $5, $10, $15, $20, and $25 per square foot.

Table I gives the description and unit cost[5] of the microfilming systems eval-

[5] Space limitations do not permit details of analysis required to arrive at these costs. They are presented in the original manuscript.

TABLE I

DESCRIPTION AND UNIT COST OF MICROFILMING SYSTEMS

System Number	*Equipment*	*Reduction Ratio*	*Rate of Feed (Images/Day) Eight-hour Day*	*Costs of Conversion Per Page*	*Costs Per Linear Foot of Books*
1	RemRand Model 12 Film-a-record Hand feed, 35 mm. film	24 – 1	8,000	$.00268	$12.33
2	RemRand Model 12 Film-a-record Automatic feed, 35 mm. film	24 – 1	35,000	.00204	9.38
3	RemRand Model 12 Film-a-record Automatic feed, 16 mm. film	37 – 1	35,000	.00111	5.11
4	Kodagraph Model C-3 Hand feed, 35 mm. film	16 – 1	3,000	.00476	21.90
5	Kodagraph Model C-3 Hand feed, 35 mm. film	24 – 1	3,000	.00402	18.49

uated. Unit costs were determined on a basis of 1,000 linear feet of books with 4,600 pages per linear foot and are for a negative copy only. Standard page size was taken as 8½ x 11 inches, providing a factor of safety in making the unit cost estimates. These five systems were chosen as being representative of the types of cameras, reduction rates, film size, and rates of feed presently in use.

The RemRand Model 12 systems require that the bindings be cut so that pages may be fed automatically into the machine. This necessitates the elimination of the books microfilmed from the collection. Since the purpose of microfilming is to reduce the space requirements, the cutting of the bindings is considered inconsequential. Any possible gain from the resale value of these books would be more than offset by the increased efficiency in filming.

The unit costs are significantly lower than the estimates of between one and two cents per page that were given by commercial firms. There are four reasons for the lower costs in the systems studied: (1) no profit is to be made on microfilming; (2) no supervision or administrative costs are allocated to the cost, as library personnel must be on hand in any event; (3) overhead costs are reduced as office and administrative space is not needed; and (4) no inspection or editing is done.

Usually, when being microfilmed, the finished roll of film is carefully edited frame by frame to detect flaws in the films, missing pages, and the like. This is a slow and expensive process, increasing labor costs immensely. For the following reasons, it is believed that such editing is unnecessary.

1. Since the material being microfilmed is little used, and in most instances is used only for a quick reference, the probability that the page desired is missing or damaged is so small that the cost of purchasing a new book when this happens will be less than the cost of inspection.

2. If pages were missing from the original text, the library would make no ef-

TABLE II

ANNUAL COSTS VERSUS BUILDING COSTS FOR COMPACT AND CONVENTIONAL BOOK STORAGE SYSTEMS

System	Origin of Annual Cost	Building Costs in Dollars per Square Foot				
		5	10	15	20	25
Bracket-type shelving, 35.5″ aisles	Shelving	1,676.27	1,676.27	1,676.27	1,676.27	1,676.27
	Building	3,351.99	6,703.98	10,055.97	13,407.96	16,759.95
	Total	5,028.26	8,380.25	11,732.24	15,084.23	18,436.22
Bracket-type shelving, 20.7″ aisles	Shelving	1,676.27	1,676.27	1,676.27	1,676.27	1,676.27
	Building	2,394.43	4,788.86	7,183.29	9,577.72	11,972.15
	Total	4,070.70	6,465.13	8,859.56	11,254.99	13,648.42
Art Metal, with 4 swing units	Shelving	6,025.80	6,025.80	6,025.80	6,025.80	6,025.80
	Building	2,192.84	4,385.68	6,578.52	8,771.36	10,964.20
	Total	8,218.64	10,411.48	12,604.32	14,797.16	16,990.00
Hamilton Units	Shelving	5,879.76	5,879.76	5,879.76	5,879.76	5,879.76
	Building	1,601.22	3,202.44	4,803.66	6,404.88	8,006.10
	Total	7,480.98	9,082.20	10,683.42	12,284.64	13,885.86

fort to replace them until someone complained. Therefore, it seems reasonable that no effort be made to replace pages in the microfilm until a complaint arises.

3. Both types of machines being considered are equipped with warning devices that indicate trouble with film, lighting, or feed. In addition, the Film-a-record automatically shuts off if more than one page enters the machine at the same time.

4. If any gross defect is present in the film, the person who prepares the box label is likely to detect it when he examines the first few frames while identifying the roll. However, this examination would not detect possible errors in the remainder of the roll.

5. If a book is so rare that a microfilmed copy could not be purchased or borrowed from another library, then the book should not have been microfilmed and discarded in the first place.

6. A careful, 100 per cent inspection will not detect all of the errors, anyway.

Space requirements are estimated by making the best fit of microfilm cabinets in a 23x23-foot module. Two makes of microfilm storage cabinets are considered: Remington Rand and Yawman and Erbe. A 23x23-foot module was selected so that the comparison of microstorage with conventional storage could be made on the basis of Muller's[6] work. Results show that one Yawman and Erbe cabinet, including necessary aisle space, requires 6.78 square feet, while a Remington Rand cabinet requires 7.06 square feet. A Yawman and Erbe cabinet holds 900—16 mm rolls or 612—35 mm rolls of film, while a Remington Rand cabinet holds 1,125—16 mm or 675—35 mm rolls. From this analysis, it is seen the the Yawman and Erbe cabinets have a slight cost advantage and, therefore, will be used in the remainder of the report.

Comparison of Systems[7]

In designing a library, considerations

[6] Robert H. Muller, "Evaluation of Compact Book Storage Systems," *Proceedings of the 1954 ACRL Building Plans Institute* (Chicago: Association of College and Reference Librarians, 1954), p. 77-93.

[7] In the original manuscript, comparison was made on both initial and annual cost bases. Due to limited space, only annual costs have been included.

TABLE III

ANNUAL COSTS VERSUS BUILDING COSTS FOR MICROFILM SYSTEMS

*System Number**	*Origin of Annual Cost*	*Building Costs in Dollars per Square Foot*				
		5	*10*	*15*	*20*	*25*
1	Initial conversion	10,313	10,313	10,313	10,313	10,313
	Yearly conversion	5,990	5,990	5,990	5,990	5,990
	Bldg. & equipment	900	1,008	1,116	1,223	1,331
	Total	17,203	17,311	17,419	17,526	17,634
2	Initial conversion	7,837	7,837	7,837	7,837	7,837
	Yearly conversion	4,870	4,870	4,870	4,870	4,870
	Bldg. & equipment	900	1,008	1,116	1,223	1,331
	Total	13,607	13,715	13,823	13,930	14,038
3	Initial conversion	4,276	4,276	4,276	4,276	4,276
	Yearly conversion	2,750	2,750	2,750	2,750	2,750
	Bldg. & equipment	423	449	492	545	593
	Total	7,449	7,475	7,518	7,571	7,619
4	Initial conversion	18,300	18,300	18,300	18,300	18,300
	Yearly conversion	10,318	10,318	10,318	10,318	10,318
	Bldg. & equipment	1,337	1,499	1,660	1,822	1,984
	Total	29,955	30,117	30,278	30,440	30,602
5	Initial conversion	15,410	15,410	15,410	15,410	15,410
	Yearly conversion	8,688	8,688	8,688	8,688	8,688
	Bldg. & equipment	900	1,008	1,116	1,233	1,331
	Total	24,998	25,106	25,214	25,321	25,429

* For definition of Systems see Table I.

must be made for housing the present collection and providing space for the expected collection at the end of some specified time period. Considered over a period of time, microfilming has two cost advantages: (1) the cost of microfilming a collection as it grows is spread over the entire period, requiring less initial investment of capital; and (2) the investment in conversion to microfilm has a much longer life expectancy than shelving. In other words, the life of microfilm can be considered infinite and the annual costs computed on this basis. The cabinets housing the film must be replaced approximately as often as shelving is replaced, but the cost of cabinets is small compared to the amount invested in shelving.

In order to compare the annual costs of conventional microfilm storage, a research collection is considered to contain 16,666⅔ linear feet of books (this figure is used by Muller), and, at the end of 25 years, a design figure proposed by Metcalf,[8] it is expected to have grown to 33,333⅓ linear feet. In conventional storage, building and stacks must be provided for the estimated figure capacity. However, microfilm conversion will be split, the current holding filmed immediately, and the rest filmed as books are

[8] Keyes D. Metcalf, "Spatial Problems in University Libraries," *Library Trends*, II (1954), 558.

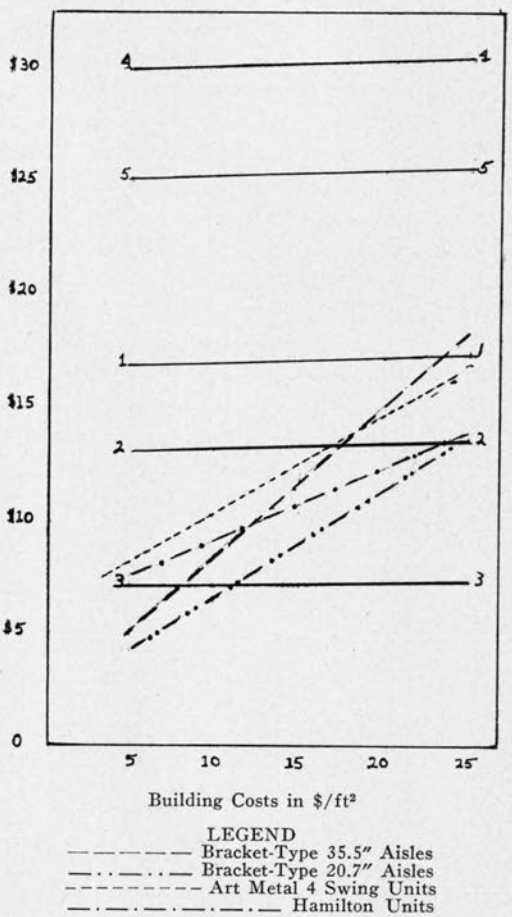
added to the research collection. This comparison is valid only when the size of the collection is over 5,000 linear feet of books, as the unit costs were derived assuming full capacity of the filming machines. If the collection is less than 5,000 books, the annual costs per linear foot of the microfilm systems increase rapidly, and comparisons at each level of operation must be made individually.

Annual cost is the division of the initial investment into equivalent uniform annual payments during the life of the investment. To compute annual costs, an interest rate of 5 per cent and a depreciation rate of 2 per cent, as assumed by Fremont Rider,[9] are used.

For building and equipment of the conventional storage systems, Muller's figures were used as a basis, and annual costs were computed from capital recovery cost based on the expected life of building and equipment. The capital recovery cost is obtained by multiplying the total investment by an appropriate capital recovery factor from compound interest tables.[10] Salvage value at the end of the life of the building and equipment is considered to be zero. These computations were made for four types of conventional storage: (1) bracket-type, 35.5″ aisles; (2) bracket-type, 20.7″ aisles; (3) Art Metal and Swing units; and (4) Hamilton units. Table II gives the annual costs of storage of 33,333⅓ linear feet in book form with estimated life of building and shelves at fifty years and interest at 5 per cent for the above four systems at various building costs per square foot.

For the annual costs of the microfilm systems, building and equipment costs are computed in the manner described for conventional systems. However, since the cost of conversion has become an intrinsic part of the value of the film, the investment in conversion is considered to have perpetual life. Therefore, only an interest charge is made. The microfilming is assumed to be done over the twenty-five years at a uniform rate.

Figure 1—Annual costs versus building costs for the systems shown, with estimated life of building and shelves at 50 years, interest at 5%, with Yawman and Erbe cabinets for 33,333 1/3 linear feet of books



The average annual charge for filming is dependent on the number of linear feet to be filmed a year. This was computed and converted to present worth[11] using compound interest tables, and interest is charged on the amount of the present worth. Table III shows the annual costs versus building costs for microfilm systems with estimated life of build-

[9] Fremont Rider, "Library Cost Accounting," *Library Quarterly*, VI (1936), 370-71.
[10] Eugene L. Grant, *Principles of Engineering Economy*. (New York: Ronald Press, 1950), chapter 7.
[11] *Ibid.*, chapter 8.

ing and shelves at fifty years, interest at 5 per cent, with Yawman and Erbe cabinets, for 33,333⅓ linear feet of books converted to microfilm, 50 per cent initially and 50 per cent over twenty-five years.

Figure 1 is a graphical representation of Tables II and III and shows that microfilm system 3 has lower annual costs than any other system when building costs rise above $12 per square foot. It is cheaper than compact storage systems at all levels of building costs. System 2 comes into favorable position cost-wise when building costs rise above $17 per square foot. Systems 1, 4, and 5 are not comparable with the other systems.

It should be noted that at the end of 25 years the library is filled to capacity. Since microfilm offers the largest saving in space,[12] the extended or increased use of microfilm will enable the library to continue operation effectively. With book storage, the efficiency of the library is going to decrease as the capacity of the building is exceeded.

Conclusions

On a cost basis, microfilm is feasible as a form of storage for a large collection only if librarians are willing to accept a high reduction ratio, little or no inspection of the finished product, an image less perfect than could be obtained using a 35 mm planetary camera, and the destruction of the text. If a positive copy of the film is required, the cost of microfilm storage is prohibitive.

[12] Percentage gain over conventional type storage (38.7″ aisles) for systems 1, 2, and 5 is 260 per cent; for system 3, 640 per cent; for system 4, 170 per cent.

The University Library

I am confident that you will agree with me that the heart of a university is its library—into which and out of which the life blood of the instructional and research programs flows in a never ceasing stream. Certainly, the University of California could not have won and held its present, proud position in the academic world with a library of lesser scope and quality than it has sought to maintain throughout its history. Nor can it hope to hold that position in the future unless its library continues to grow as knowledge expands. One of the world's distinguished centers of learning has developed here, largely because the foresight of the founders, the wisdom of the faculty, the planning of its administrators and regents, and the generosity of donors have consistently combined to build, in a new land and a young university, one of the world's greatest collections of books.—Robert Gordon Sproul, President of the University of California, in *Two Million: Several Addresses Given Upon the Acquisition of Its Two Millionth Volume by the Library of the University of California at Berkeley* (Berkeley, University of California Library, 1956), p. 15-16.