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ABSTRACT

Because of the dilemma faced by librarians in the selection of suitable microform reading equipment for the 35 mm format, this paper is designed to analyze the problem of reader and micro-image incompatability, to provide a key for readily determining incongruities, to evaluate presently available readers, to provide modification and development suggestions and to consider the possibility of 35 mm microfiche for research materials. Reasons for the ascendency of 16 mm microforms to their present dominant positions are examined and librarians are urged to voice their needs for retaining the 35 mm size essential for research materials. Actions taken by the National Bureau of Standards and the National Library of Medicine supporting 35 mm are cited. (Author)

MICROFORM READERS --
THE LIBRARIANS DILEMMA

A Paper

Presented to the

Graduate Department of

Library and Information Science

Brigham Young University

Provo, Utah

BY

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August 1972

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ABSTRACT

Because of the dilemma faced by librarians in the selection of suitable microform reading equipment for the 35 mm format, this paper is designed to analyze the problem of reader and micro-image incompatability, to provide a key for readily determining incongruities, to evaluate presently available readers, to provide modification and development suggestions and to consider the possibility of 35 mm microfiche for research materials. Reasons for the acendency of 16 mm microforms to their present dominant positions are examined and librarians are urged to voice their needs for retaining the 35 mm size essential for research materials. Actions taken by the National Bureau of Standards and the National Library of Medicine supporting 35 mm are cited.

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George F. Tate

INTRODUCTION

The Library Technology Program (LTP) of the American Library Association (ALA) was established in 1959 to: (1) test and evaluate library equipment, (2) develop new and improved items and promote improvements in existing products, (3) develop performance standards to improve quality of library equipment and furnish purchasing guidelines, (4) provide individualized technical service information to the library profession.[1]

Early in the program, the problem of microform readers was considered, as the Rutgers "Summary and Evaluation of the State of the Art," had reported so adversely in this area.[2]

Beginning in 1965, a series of LTP Library Technology Reports have been issued. Forty-two of these have been on microform readers and printers. An active testing program has been conducted, first under William R. Hawken Associates, and later under R.A. Morgan Co., Inc. Guidelines for evaluating readers have been established and test results tabulated.[3]

The archival and library standard has long been 35 mm microfilm, as contrasted to 16 mm in business, industry and government.[4] Yet out of the 42 separate Library Technology Reports only three or four concern microfilm readers suitable for the full usable 1.25 inch (32 mm) width of unperforated 35 mm film in common use.[5] Reports on these machines indicate many shortcomings, and exceptionally high costs.

The manufacturing of some machines previously used extensively in libraries, has been discontinued, including that of the Recordak MPE-1, long the standard of the library world,[6] and it would currently appear that suitable, reasonably-priced machines are simply not available. As a result, librarians face a real dilemma in microform decision making, particularly in the choice of reading equipment to match the requirements of their collections.

This paper will give historical background and point out image-reader incompatability, it will analyze reduction ratios and image sizes, it will discuss "35 mm" microfiche, it will evaluate presently used equipment and recommend modifications in existing readers to make them more suitable for library use, it will provide suggestions for standardization and further development.

The scope will be primarily the 35 mm format as this is the area of immediate concern; however, consideration will be given to smaller formats and to flat film presentations (microfiche). Except for casual reference, ultrafiche, unconventional photographic methods (non-silver halide),

computer output microforms (COM), and specialized retrieval systems, will not be covered.

HISTORICAL BACKGROUND AND IMAGE-READER INCOMPATABILITY

The same year that Daguerre's photographic system was released to the world, (1839),[7] J. B. Dancer, working in England, invented microphotography by producing 160:1 reductions. The first serious application was in the Franco-German War of 1870 when microfilmed messages in great numbers were flown into Paris by carrier pigeons. However, modern microfilming began with the introduction of the Leica 35 mm hand camera in 1924.[8]

Scholars soon learned to use the Leica for photographic note taking. Initially developed for testing moving picture film, the versatile Leica used the 35 mm wide format which had already become an accepted world standard; the spacing of sprocket holes, the width of the film, and basic sizes were determined in 1889 by Thomas A. Edison as part of his early moving picture work.[9] It would indeed be difficult to find a better example of international technical cooperation, as the standards thus achieved have made it possible to use film, cameras, and projectors made in different parts of the world with the assurance of compatibility.

The basic moving picture frame size of about 3/4 x 1 inch (actually 18 x 24.5 mm) was the size adopted in early microfilming (Fig. 1).[10] This is properly known as "single-frame" although it is sometimes referred to as "half-frame," particularly by 35 mm hand camera enthusiasts, as most

35 mm cameras have a frame format double the single-frame size or about 1 1/2 x 1 inch (Fig. 2).[11] (It is common practice for individuals taking photographic notes with such cameras to copy two documents or pages side by side, thus obtaining, for all practical effects, two single frames.)

For many years microfilm reading machines were designed to use the basic 3/4 x 1 inch format by providing a micro-image area about 1 inch square so that the projected image would match that of the film, the square arrangement being made to provide for image rotation (Fig.3).

However, as interest in microfilming grew, sophisticated cameras were developed which used film no longer requiring perforations, thus enabling use of almost the full width of the film (32 mm against the full 35 mm width). In addition, the cameras included controls for varying the length of the film image from 3/8 inch to about 1 3/4 inch (Fig. 4), and also, revolving heads to provide more freedom of choice over the image orientation as well as size, thus enabling a maximum of filming efficiency and economy.[12]

Unfortunately, such versatility did not always result in making the films easier to read. The size of the images and their placement on the film was left almost entirely to the operators or to the producing laboratories.[13] It appears that the "practice has been heavily on the use of the highest possible reduction ratios and the smallest possible images in order to get the maximum number of images on the least amount of film."[14]

Some of the procedures verged on the ridiculous, and in an effort to gain better control over image placement, acceptable patterns and

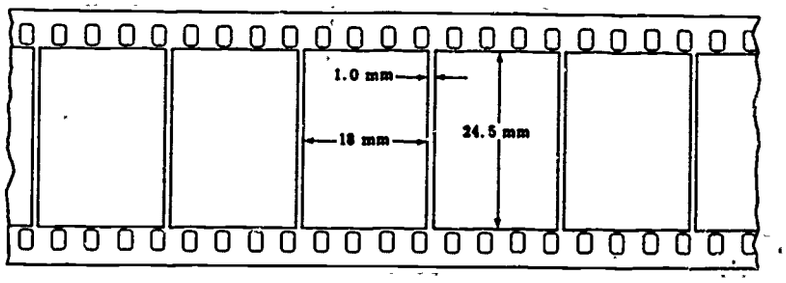


Fig. 1 - Eastman 35 mm Single-frame dimensions

Note: Olympus Fen F size is 17 x 23.5 mm with 2.0 mm between frames.

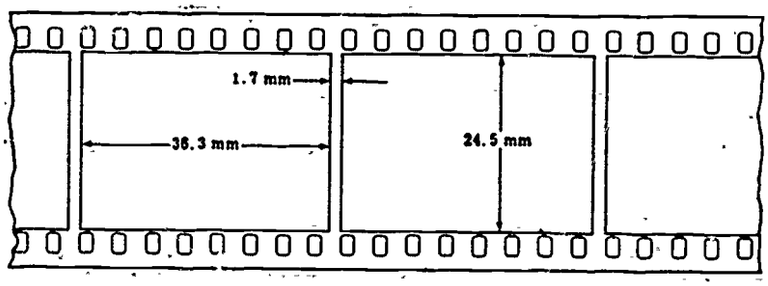
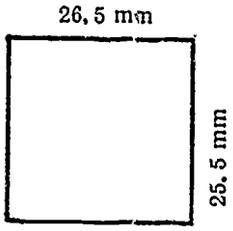


Fig. 2 - Eastman 35 mm Double-frame dimensions

Note: These figures illustrate the small print found in technical and research publications.



Area for Recordak MPE-1 shown.
Other "typicals":
Dagmar Super A = 1 x 1-1/8"
Atlantic MJR-85 = 31/32 x 31/32"

Fig. 3 - Typical Micro-image area for single-frame sizes

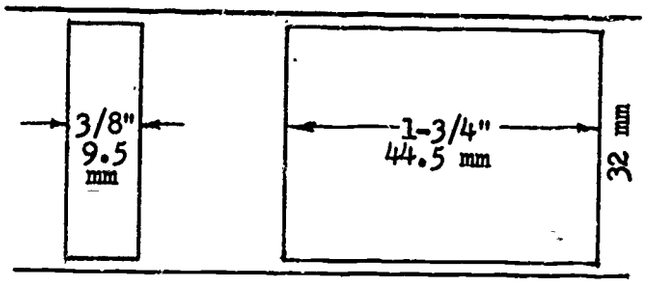


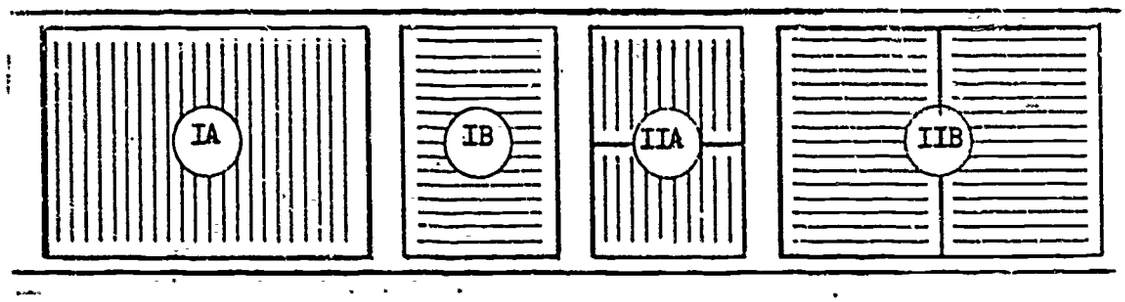
Fig. 4 - Frame length Variation Range for Recordak Camera

specifications were established as illustrated in Microfilm Norms positions IA, IB, IIA and IIB[15] (designations which appear frequently in LTP Reports and library literature). These were later established as standards under ANSI PH5.3-1967. (See Fig. 5)[16]

Even with these improvements it is apparent that the users interests were not fully considered. For example, Microfilm Norms specifies that "all documents with a width of 12 inches or less for a double page...shall always be filmed in position IIA."[17] This is an awkward and limiting arrangement requiring a zig zag reading pattern instead of the simple comic presentation where images follow each other in sequence across the length of the film.

Also, little attention was given to modifying microfilm reading machines so they could more adequately use the thirty percent increase in exposure width. Thus the popular MPE-1 Recordak Film Reader, thousands of which are used in libraries today, continued with a film aperature of 26.5 b, 25.5 mm throughout its production life (Fig. 3).[18] This was many years after Recordak cameras, made by the same firm, were producing microfilms with about 1.25 inch (32 mm) film widths. Thus it was often necessary for the reader to scan the film by moving it back and forth so that the full width could be read.

The ideal is, of course, to display the full page of the document on the reader screen. With machines designed to match the 1.25 inch (32 mm) filming width, this presents no problem for positions IB, IIB or 2A. Position



NOTE:

IA: Single page of copy arranged lengthwise on the film with the lines of print at a right angle to the edges of the film.

IB: Single page of copy with the lines of print parallel to the edges of the film.
Caution: Image width must not exceed 32 mm in this position.

IIA. Two pages side by side with the lines of print at a right angle to the edges of the film.

IIB: Two pages side by side with the lines of print parallel to the edges of the film.

Fig. 5 - Roll microfilm image positions per ANSI Standard PH5.3-1967.

IA is, however, a different matter, as image lengths up to 45 mm may be anticipated. It is not, however, considered too serious, as documents such as newspapers filmed in the IA orientation can be read by turning them through the reader to different viewing positions. This is quite different from scanning individual lines from side to side, and it avoids the necessity of a micro-image area 45 mm square.

The importance of proper microfilming orientation is illustrated by the writer's own experience during his first personal microfilming work. A 35 mm double-frame hand camera (Fig. 2 format) with reflex viewing was used and documents were copied with the lines of script running the full length of each frame, parallel to the film edges. After the film was developed as a negative roll and projected in a microfilm reader, it was discovered that only about two-thirds of each line appeared in the viewing screen. The reading of the film by scanning each line back and forth was an extremely difficult and distasteful procedure.[19]

Another factor leading to the incompatibility between film and reading machines has been the almost wholesale adoption of 16 mm size formats by business, industry, and government, making it appear to many that 35 mm was becoming a thing of the past. In line with this, Eastman discontinued production of the MPE-1 reader in favor of a more sophisticated and costly machine, which initially had even less micro-image coverage.[20] Also, several other firms produced readers heavily advertised as 35 mm models, but which were in reality, 16 mm machines, except that they had carriers

which would hold the 35 mm widths. Since the optics provided were for 16 mm film, only a portion of the 35 mm image would appear on the screen, and reading of the material could only be accomplished under difficulty. The strange thing was that evaluators seemed to accept the above mentioned grave defect as a matter of course, and considered the fact that 35 mm films would be read at all as a "plus" feature.[21]

Unfortunately, many such machines were purchased by librarians who believed they were buying readers fully suitable for the 35 mm applications. Some of these have ended up gathering dust on back room shelves, or have created serious resistance to microform applications because the machines are so unhandy to use. Twelve machines listed as "16 mm, 35 mm" in the January 1972 Library and Technology Reports up-date of "Survey of Microform Readers," fall within the above category.

The unsuitability of such machines for 35 mm use can be readily detected by merely considering the stated lens magnification provided as the approximate size of screen in inches needed to read a 35 mm microfilm. Thus a 17X lens would require a screen 17 inches square to read a 35 mm film (with a 1 inch micro-image area). To be more precise, the micro-image area times the magnification will indicate the screen size needed for full coverage. Thus in the above example, the full unperforated micro-image width of 1 1/4 inches would require a screen 21 1/4 x 21 1/4 inches square for reading without scanning from side to side. If the screen

were smaller than the 21 1/4 inches, such a machine would have questionable use as a 35 mm reader. (A simple variation of the above process wherein the size of the screen is divided by the lens magnification, will provide the size of the micro-image that can be viewed without overflowing the screen.)

In order to use specific examples of currently available readers, those supplied by University Microfilm Inc. (UMI), a Xerox Company, and covered by LTP Library Technology Reports[23] are here cited to illustrate the above conditions. These readers, known as 1013, 1212, and 1414 have screen sizes corresponding to the model numbers (10 x 13 inches, 12 x 12 inches and 14 x 14 inches respectively) and optics varying from 17X to 20X (with 22X and 40X listed as options for the 1212). Following the "rule of the thumb" guideline earlier given, it is obvious that none of the above machines can really be considered 35 mm readers despite advertising claims to the contrary.

Applying the division formula to the UMI machines, it can be readily seen that micro-image areas larger than .59 inches could not be read without scanning on the 1212 machine with the standard 17X lens (or .54 inches and .3 inches for the alternate 22X and 40X lens models). Likewise, images larger than .78 inches would be out of viewing range of the 1414 reader equipped with an 18X lens.

On the surface, it would appear a simple matter to supply optics for the above machines to make them fully suitable 35 mm readers in reason-

able price categories. For example, an 11X lens system used with the 1414 would enable full readability of the 1.25 inch maximum micro-image size without scanning (1.25 x 11 = 13.75 inches or the size of the screen needed). However, inquiries to the manufacturer indicate that they have no plans to offer the above readers in lower power versions, nor do they currently produce a machine capable of reading the full 1.25 inch film width directly.[24]

This condition reveals a distinct inconsistency. As noted, UMI supplies only 16 mm readers, yet admits that "the great bulk of materials supplied to libraries and individuals in the educational market is on 35 mm film, with a ratio of about 20-to-1 on currently supplied material and about 50-to-1 in favor of 35 mm on backfile items."[25]

Publications other than LTP Library Technology Reports present a similar story. For example, Guide to Microforms and Microform Retrieval Equipment, (Washington: Applied Library Resources, 1972), lists 38 roll microfilm readers or reader-printers, most of them being 16 mm models, many with cassette and cartridge loading and retrieval features. Of the 12 "Conventional Roll Microfilm Readers," (not motorized), 10 are shown as 16 mm 35 mm "universal readers." However, when screen sizes and magnifications are compared, not a single machine listed would show the 1.0 to 1.25 inch usable micro-image size on the screen without scanning. Further, the only machines with such capability were expensive reader-printers which offered low magnification lenses as alternates (3M, DASA, Recordak).[26]

Some explanation of the disporportionate offerings between 35 mm (library) and 16 mm (business) reading equipment may be found in the functional differences between the two types of institutions. In LTP Library and Technology Reports, "Microfilm Cartridges & Cassettes," Dr. Francis F. Spreitzer has provided an excellent analysis of these differences. Briefly, the library function is the utilization of thirty-five to forty years accumulation of vast quantities of microform copies of materials -- newspapers, manuscripts, historical documents, books, and collections of magazines and journals. Originals of these appeared in script and in a variety of types and sizes of print, in different colors, on paper or parchment, and a variety of filming techniques, image positions and reduction ratios have been used to copy them. On the other hand, business, industrial and government output includes: (1) active systems, which require rapid reference to microform catalogs, listings and directories, indexes, maintenance literature, specifications and drawings, progress records and COM generated materials, and (2) passive systems, which use microforms for storage of little used items such as cancelled checks, copies of freight bills, invoices, and other inactive office materials.[27]

Since the use of microforms in business has experienced tremendous growth in the last few years, 16 mm has dominated the field, and vendors have urged librarians to accept the smaller format.[28] While there are, undoubtedly, applications in libraries where 16 mm (including cartridge, cassettes and retrieval systems) can be used effectively (and, conversely,

many applications in business and industry where the larger 35 mm format is essential), it is anticipated that 35 mm microforms will continue to dominate the library world for many years to come. Therefore, it is difficult to understand the reluctance of industry to provide the needed 35 mm reading equipment. Perhaps the right kind of market surveying relative to libraries has not been done, or librarians have been remiss in presenting and supporting their 35 mm needs. In any event, the next section of this report will consider fundamental reasons why retention of the 35 mm system is essential in library applications.

The critical need and market potential for 35 mm reading machines in the moderately priced range of $200 to $300, can be readily visualized by examining the library operation of the Genealogical Society of The Church of Jesus Christ of Latter-day Saints, Inc., whose 35 mm collection now numbers over 800,000 rolls, with several thousand additions being made each month. Most of this vast collection, representing the equivalent of well over 3,000,000 volumes of 300 pages each, is available for distribution through a unique branch library system now totaling over 120 branches with many more in process of establishment. Since each branch normally requires several reading machines, this outlet alone represents a production need of several hundred machines. When the growth in microform use and the needs of thousands of additional libraries around the world are added, it would indeed appear that the market potential is substantial.[29]

REDUCTION RATIOS, IMAGE SIZES, MICROFICHE AND STANDARDS

Miniaturization is often cited as the raison d'etre of microforms.[30] As earlier noted, business, industry and government (as contrasted to libraries) have gone largely to 16 mm roll and comparable image size microfiche for copying their records. The resulting micro-image heights are about half that of the 35 mm format. Even greater reductions on the order of 40X to 60X are advocated.[31] "Micro-book" publication with reduction ratios of 150:1 (3200 pages on a 4 x 6 inch microfiche) is now a reality.[32] However, there are a great number of microforms in circulation which are of poor quality, and a distinct reaction is arising against making the images so small that quality is lost.

Reduction ratio is closely related to image quality. Yet it was not until 1965 that any careful, large scale study was made to relate reduction ratios with readability. The study was done by the National Bureau of Standards (NBS) for the National Library of Medicine (NLM) whose vast collection of important scientific materials was slowly deteriorating.[33] This highly significant study recommended a maximum reduction ratio of 12:1, taking into full consideration the size of the print, line widths, and variables found in their research materials.[34] The recommendation dismayed commercial and institutional microfilmers who were normally filming at reduction ratios of 16:1 or higher.[35] Also this ratio of 12:1 was

considerably below the 14:1 standard recommended by Microfilm Norms[36] and by Library of Congress specifications.[37]

To learn more about this significant matter, this writer studied the NBS Report and then addressed a letter to the National Library of Medicine to learn what steps had been taken to implement the recommendations of the report. A letter dated 13 April 1972, under the signature of Martin M. Cummings, M.D., Director, was received in reply, from which the following is quoted:

> "The National Library of Medicine is microrecording at a reduction ratio of 12:1 on 35 mm unperforated film. It is believed this reduction ratio is optimum for recording the small type-set characters common in technical journal articles, particularly when the contrast between the information and the paper on which it is printed is low. This low contrast occurs deliberately in newer material as a means of accenting and in the older material through deterioration.
>
> "With conventional equipment and materials, the higher reduction ratios required for recording on 16 mm film and in the microfiche formats (COSATI and NMA) do not provide the required quality in the camera negative when it is to be used in a multigeneration system. Other investigations verify this position. See William R. Hawken "Characteristics of Input Documents as Factors in Microform Standardization" Second International Congress on Reprography, Cologne, Germany, October 1967, and "Microform Standardization: The Problem of Research Materials and a Proposed System [sic]. NMA Journal 2 Fall 1968, p. 14.
>
> "The 'B' image orientation cited in the ANSI PH5.3 1967 is followed for most book and journal items except that if the page is 12 inches or less in height the Library includes a page centering mark. See Figure 6 in the enclosed 'Roll Film Specifications.' Images prepared in accordance with these specifications are suitable for a further 2:1 optical reduction onto 16 mm or microfiche films if economically practical. For larger books, journals, and newspapers

the Library will fill a full frame using the lowest reduction ratio possible that is above 12:1. The frame height with our current cameras is about 32 mm."[38]

The image area of the referenced Figure 6 of the "Roll Film Specification" shows a maximum micro-image area of .77 x 1 inch for the 12:1 reduction (Fig. 6 herein). This is also of particular interest as it represents additional thinking beyond the NBS report. It eliminates the awkward zig-zag reading pattern "IIA" and shows containment of normal text material (up to 12" high) within a 1" micro-image height, rather than the 1 1/4 inch (32 mm) size of normal unperforated film. While providing space for centering marks, it also enables the material to be read on older 35 mm reading machines, such as the MPE-1, without difficulty and moves in the direction of a new standard, which will be discussed later.

Microfiche

Microfiche is rapidly rising to a position of great importance in information transmission. Consequently the NBS Study Group was asked to consider it for original microfilming of NLM materials as microfiche can be easily reproduced and distributed through a low-cost system. The Study Group reported as follows:

"Unfortunately the photometric characteristics of NLM materials do not permit original page filming at the reduction ratio required for a microfiche made to COSATI specifications. Unless substantial image quality improvements can be achieved in both the original filming operation and the subsequent image transfer operations through the required three

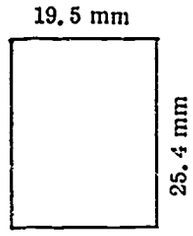


Fig. 6

National Library of Medicine (NLM) micro-image size for documents up to 9.25 x 12.00 inches maximum size with 12:1 reduction ratio (.77 x 1.0").

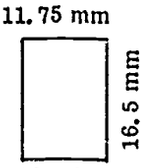


Fig. 7

COSATI
60 frame
format
(7/16 x 5/8")

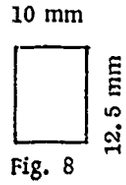


Fig. 8

NMA
98 frame
format
(25/64 x 1/2")

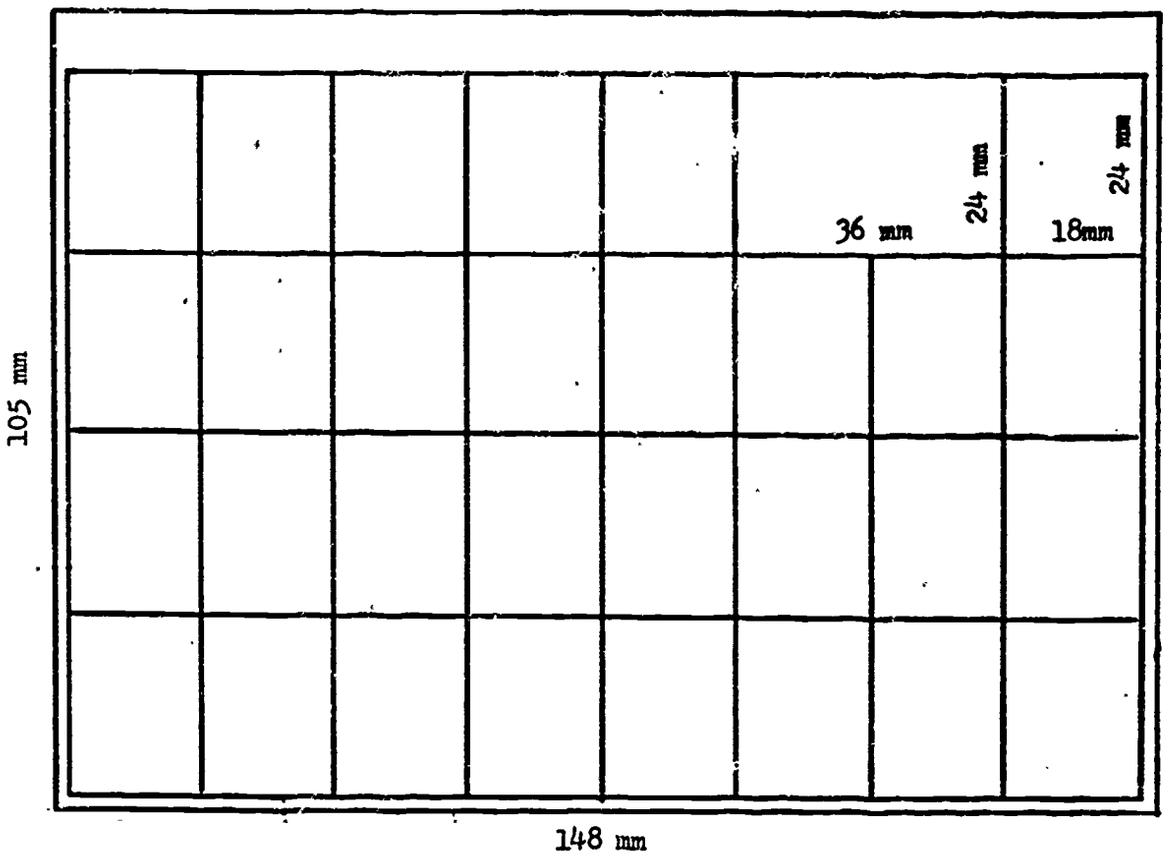


Fig. 9 - Hawken 32 frame "35 mm" format (8W4H) for documents up to 9 x 12 inches with reduction ratio of 12.7:1. (This arrangement also matches single-frame and double-frame hand camera formats which can also be jacketed (3H) with color intermixed.)

generations, information losses would occur which are unacceptable for NLM preservation requirements."[39]

As mentioned in the NLM letter, the study did, however, indicate that it was practical to make low reduction optical prints from the 12:1 masters to 16 mm roll film or microfiche for distribution and field use.

This sets forth an important observation, that after carefully filmed masters are obtained, reductions to other formats is sometimes practical; whereas, the reverse may not be true.

An example of this principle is seen in the techniques used in producing high-reduction microfiche by National Cash Register (NCR) and Library Resources, Inc. (LRI), a subsidiary of Encyclopedia Britannica. In both of the processes, the original material is first converted to microimage masters on 35 mm film using reduction ratios of 10X or lower. The output thus obtained is then photographed again with extreme resolution equipment to provide high-reduction masters from which distribution microfiche copies can be made. Magnification requirements for current end products are 90X for the LRI system and 150X for NCR. Because of production and technical complexity, both the LRI and NCR methods are primarily applicable to "micro-book" publishing efforts, rather than to "on demand" type copying.[40]

While there are many sizes and arrangements of microfiche and film jackets (transparent plastic carriers which hold flat strips of microfilm and enable rolls to be converted to flat forms), only the popular 4 x 6 inch size

(actually 105 mm x 148.75 mm) will be considered here, as the size represents a fair degree of standardization and has been adopted by many organizations. Micro-images recorded to Committee on Scientific and Technical Information (COSATI) specifications, are about half the linear dimensions of those provided by full width 1.25 inch microfilm recording, being about 7/16 x 5/8 inch (Fig. 7). This provides 60 images on one microfiche (5 rows of 12), with 72 images (6 rows of 12) on trailer sheets. Filming is usually at a reduction ratio of 18:1, with 20:1 allowed in order to bring slightly oversize sheets into the frame size limitation.[41] The equivalent National Microfilm Association (NMA) microfiche provides 98 images (7 rows of 14) with a micro-image size of about 25/64 x 1/2 inches (Fig. 8), obtained with a 24:1 reduction ratio.[42] The above standards have been largely based on the characteristics of typewritten pages rather than those of library research materials. Both in size and the ability to record detail, the COSATI and NMA standards compare with 16 mm roll film rather than to that of 35 mm. (COSATI has recently adopted the 98 image NMA format).

There is no reason, however, why images comparable to 35 mm cannot be placed on 4 x 6 inch microfiche to enable their use in library and research applications in cases where the flat form may be more advantageous. It would simply require recording near the 12:1 maximum reduction ratio, rather than at the 18:1 and 24:1 of COSATI and NMA practice.

Further, the problems of "35 mm" microfiche reader compatability should not be as serious as it might at first appear. Just as many roll

form reading machines now accomodate 4 x 6 inch microfiche, readers with 35 mm optical systems should in many cases be able to display the larger images without modification. It would also be possible to convert many of the small portable "16 mm" microfiche readers now available to read the "35 mm" image size by changing their optical systems. Also, it is apparent that "16 mm" image sizes (COSATI and NMA) could sometimes be read on "35 mm" readers where the reverse (reading 35 mm on 16 mm machines) would not be possible without troublesome scanning.

Because of the physical limitations of the 4 x 6 inch microfiche size, efficient use of the film area is best accomplished by a series of fixed frame sizes instead of the various displays characteristic of roll microfilm. In attempting to apply the NBS 12:1, 35 mm roll film recommendation to the microfiche format, William R. Hawken discovered that increasing the reduction ratio to a maximum of 12.7:1 would permit systematic recording of 32 separate 9 x 12 inch originals in an 8 wide 4 high pattern without wastage of space (Fig. 9).[43] As the page sizes of 85 percent or more of serial publications and books found in library collections are 8 1/2 x 11 inches, or smaller,[44] most reduction ratios would, likewise be smaller, than the 12.7:1 maximum, with corresponding gains in image quality. Therefore, the small difference in reduction ratios between the 12:1 NBS recommendation and the 12.7:1 needed for microfiche recording of important research materials, is not considered a deterrent.

Another interesting observation from Hawken's proposal is that the 12.7:1 maximum reduction ratio could provide a key to effective international standardization by tying the products of 35 mm hand cameras, slides and filmstrips together. This would be possible as the resulting basic image size is almost identical to the original single-frame motion picture frame size discussed at the beginning of this paper (Fig. 1). It would bring into harmony both microfiche and roll film recording.[45]

Mr. Hawken was technical consultant to the ALA Library Technology Program for several years, and his important paper "Microform Standardization: The problems of Research Materials and a Proposed Solution," should be carefully considered by librarians as a base for needed standardization. It has been reviewed here because of its importance to the microform reader problem. Microfilm is here to stay, as is also microfiche. They go hand in hand, and there is no more reason to consider microfiche as a "16 mm" format than there is to discard 35 mm presentations. As a matter of fact, 35 mm flat form presentations have been used for many years by jacketing the strips of roll film. Any reading machine program which does not fully consider a "35 mm" microfiche program, is unrealistic.

EVALUATION OF CURRENT 35 mm READERS AND RECOMMENDATIONS FOR IMPROVEMENT

Basic guidelines currently used in the American Library Association Library Technology Program for evaluating reading machines are contained in Library Technology Reports "Microform Readers for Libraries," prepared

by R. A. Morgan, Inc. in consultation with the LTP staff.[46] The first part of the report discusses general factors considered in selecting readers and a description of the testing procedures. The second part provides tabular summaries and evaluations of individual readers in accordance with the testing procedures. The Morgan paper was first issued in May 1970 with provisions for the second part to be "supplemented from time to time with reports on additional readers,"[47] the last up-date being May 1971. The tabulated summaries cover only readers evaluated from 1970 on. In addition, individual reports on the different readers tested, are prepared and filed with earlier reports by William R. Hawken Associates in "Section P: Microforms & Equipment" of the LTP Library Technology Reports Series. A cumulative index is prepared annually, the current one covering January 1965 to November 1971.[48]

The reports vary considerably in quality, from thorough going analytics by Hawken, to short summaries by Morgan and lengthy treatises by the British "National Reprographic Centre for Documentation," (NRCD); the latter being supplied under an exhange agreement with LTP.

As announced at the beginning of this report, only three or four of the readers could be identified as being suitable for reading full image width (1.25 inch - 32 mm) 35 mm microfilm. Since there are Library Technology Reports for each of the readers identified, only sufficient analysis will be provided in this section to point out important characteristics and design features which may be of value in the development, modification and

evaluation of other readers. In a like manner, observations with reference to current testing and reporting procedures will be made. After reviewing the above mentioned machines, some consideration will be given to moderately priced and portable units, and a summary made providing suggestions for direction and growth.

The LMM "Superior" Model A-B Reader

The LMM "Superior" Model A-B Reader, manufactured by Library Microfilms and Materials Company, Culver City, California, represents a departure from conventional table top readers as it is a complete floor model with reading equipment built into a comfortable carrel. It is evident that a high degree of human engineering went into the design. One interesting feature is that a quality lens designed for a photographic enlarger is used. This is identified as a Schneider Componon f 5.6 lens with a focal length of 60 mm. It was reported that the lens "exhibits no distortion of the image" and that the resolution was acceptable. The use of a standard photographic enlarger lens is noteworthy as it is difficult on most readers to identify the source of the optics supplied. Also photographic enlarger lenses are generally of high quality and reasonably priced as they are used in multiple applications. Manufacturers and designers could take a lesson from this excellent feature of the LMM machine.

Another outstanding feature of the machine is the design of the film transport mechanism, which is described as follows:

> "When the film advance knob is turned in either direction, a small electromagnet is actuated, causing a metal pin to raise the upper glass flat well off the film surface. The guide rollers, in turn, raise the film off the surface of the lower glass flat. This action occurs before any movement of the film begins and serves as an effective means to prevent scratching of the film surfaces."[49]

Film abrasion is one of the most persistent problems with roll-film readers and it is refreshing to see a design where greater effort has been expended to mitigate it. This is another feature that other suppliers could study to advantage.

That the machine is a full range 35 mm reader, is seen from the micro-image area -- 33 mm wide and 33.5 mm high, providing a projected screen size of 22-1/4 x 23-3/4 inches, with a lens magnification of 17.4X. The machine has an unusual optical path where the image is projected to a mirror in the top of the carrel and from there to the slightly tilted desk top, providing a natural and pleasant reading position, with ample note taking room on each side of the screen. Persons wearing bi-focal glasses find reading comfortable compared to most projected screens which are almost vertical. The machine is electrically driven with simple to operate variable speed and light controls. A concise well written handbook is supplied with each machine, and the 15 page LTP Library Technology Report (November, 1968), is very thorough and informative. The price is listed as $1,195.[50]

The Filmac Model 400 Series Reader-Printer

The Filmac 400 Series Reader-Printer, manufactured by 3M (Minnesota Mining and Manufacturing) Company, Microfilm Products Division, St. Paul, Minnesota, is a table top model with a small 10 x 11 1/2 inch screen. This is normally considered adequate because of its primary function as a printer. A wide selection of lenses from 6.6X through 35X are available. In the past, those usually purchased by libraries have been 12.05X, 18.25X and 23.0X. The micro-image areas for the above lenses, both for reading and for printing are given in the LTP Library Technology Report, "The 3M Filmac Model 400 Series Reader-Printer" page 5. For example, the 12.05 lens provides a 21.0 x 24.5 mm area (about .83 x .95 inches) for reading and a 17.6 x 22.9 mm area (about .69 x .89 inches) for printing. This is normally adequate for the standard single frame format (Fig. 1), although a little short on full printing height. For lower magnification, (10.60X, 8.05X and 6.59X) installation of a "Low Magnification Kit" is recommended. With the modification, and use of an 8.05X lens, a micro-image area of about 1.23 x 1.44 inches would be provided, with slightly less for printing. Thus the machine could read the 1.25 inch (32 mm) unperforated film width quite adequately. The machine has a deep throat and can read aperature cards, microfiche and jacketed film, as well as 35 mm and 16 mm microfilm on rolls, or in unmounted strips. Together with its hard copy feature it comes close to being

"universal" in its application. Filmac 400 series machines have had long and useful records in library service. Current costs are about $900 for the reader-printer combination, plus $100 for each lens, which is about the same as some machines without the printing feature. While no readers (without the printer) are shown in the literature, this avenue might be explored for machines to supplement the printing need at a moderate price.[51]

The Information Design Model 201

While the LMM "Superior" and the Filmac 400 were tested by William R. Hawken Associates (1967-1968), with well detailed informative reports, the ID Model 201 Machine, manufactured by Information Design, Inc., Menlo Park, California, was tested under the new R.A. Morgan program where minimal information, other than test results is supplied. Although "Microform Readers for Libraries," page 3, (1.) indicates that "the micro-image area (computed by dividing the screen size by the magnification of the lens) is provided," the Morgan reports seldom do so, necessitating computation before the relationship can be "discovered." It would be helpful if this information, the screen size and the films accomodated, were given in the tabulated Summary Table along with the test results. This would enable convenient evaluation and comparison with other readers. Since the micro-image area was not given for the ID machine, it was computed by dividing the 17.6X measured lens magnification into the screen size and found to be 1.33 x 1.32 which is adequate for the full

1.25 inch filming width of unperforated 35 mm film. While the report indicated that controls were well marked and "unusually easy" to operate, the tests showed that lens resolution and screen luminance was fair to poor when compared with other machines and the test specification requirements. In addition, a warning was given that film abrasion was excessive. The machine is advertised as "The Compatible 16/35 Microfilm Reader." The compatability is gained by an unusually large size screen (about 24 inches square) so that both 36 mm and 16 mm can be displayed without lens changes. Other than the large screen and accompanying "box," the machine is very similar to many "16 mm" readers using vertical screen arrangements. In the opinion of the writer, a screen about 12 or 15 inches square with dual optics to accomodate 16 mm or 35 mm separately, would be a better approach. The ID machine is listed at $780, manual, or $960 for a motorized version.[52]

Eastman Kodak Motormatic MPG

The Motormatic MPG, manufactured by Eastman Kodak Company, Rochester, New York, is covered by Library Technology Reports, May 1971, and the May 1971 Summary Table, but here again, difficulty was experienced, as needed information for satisfactory evaluation was not supplied. The stated lens magnification of 19X divided into the 15 inch screen size

indicates that only a maximum micro-image size of .76 inches could be projected (or .83 inches with the "measured magnification" of 18.1X). This is considerably short of the 1.25 inch full recording width for unperforated film and less than the approximate one inch square image provided by the older Recordak MPE-1 readers made by Eastman (Fig. 3). On this basis, the MPG reader would have to be ruled out as suitable for reading the full image width of unperforated 35 mm film. Consequently, it is difficult to justify the projected image-area statement of the report which reads as follows:

> "Except for 15-by 23-inch newspaper pages and 12-by 15-inch tabloid pages, which can be read only by scanning, images are projected within the dimensions of the screen."[53]

The report is also negative with regard to film loading, the film aperture operation and the framing control. On the other hand, the Summary Table reveals that the optics are good and the luminance exceptional compared with other machines. While the glass flats automatically open to minimize film abrasion, the only recognition of this is in a statement regarding the delay in focusing due to the platen operations. Actually the machine is a well designed product with features needed in library situations. The writer has carefully examined and operated the MPG and the MPG-TL together with the ERG Printer & Printer Base listed in the LTP Library Technology Reports, January 1972 "Survey of Microform Readers"[54] and provides the following additional information:

The MPG-TL has a slightly different screen arrangement of 16-1/2 x 14-3/4 inches as compared with the 15 x 15 inch screen of the MPG. Also it is equipped with a turret holding three lenses -- 14X, 19X and 23X. When the 14X magnification is divided into the 16-1/2 inch screen width, a micro-image width figure of 1.1 inches is obtained, almost but not quite filling the 1.25 inch full micro-image width requirement for 35 mm unperforated film. The machine includes a optical rotation feature that permits ready turning of the screen image.

The ERG Printer and Printer Base is a sophisticated device which provides acceptable hardcopy in either positive or negative modes. While printouts about 14 inches in length on the screen can be made, widths are limited to about 7-3/4 inches. Since the measured width of a 17 mm single-frame image (Fig. 1), when projected on the screen with the 14X lens, is about 8-5/8 inches, it is apparent that there would be a 7/8 inch cut-off for even this small width. Thus many documents would need to be printed in sections to obtain full coverage. Nevertheless, the printer is very useful, particularly where narrow width items such as columns in newspapers are copied. A 13X lens in place of the 14X would cover the full 1.25 inch reading width of 35 mm film, and would be highly recommended should the mechanical and optical design of the reader permit. Cost of the MPG with one lens is listed as $1,450. That of the MPG-TL (Tri-lens) is $1,920 plus $1,650 for the Printer and Printer Base.[55]

Portable Readers, Moderately Priced Units and Summary

It will be noted that all four of the above "library" readers suitable for 35 mm film are expensive units selling for about $1,000 or more. These are beyond the financial range of many library situations, particularly for those requiring many readers to meet the needs of their patrons. They are also considerably beyond the range of scholars and researchers requiring readers for their personal use.

In past years, suitable readers for the single frame 35 mm format have been available in the $100-$200 range. Many have been portables such as the Dagmar and the Atlantic reviewed in LTP Library Technology Reports (both November 1965).[56] However, most of these have disappeared from the American market, and a scholar desiring a suitable 35 mm reader may have to purchase it in Europe where such machines are still available. (Example: Dagmar Universal offered with micro-image aperatures of 34 x 43 mm, 29 x 35 mm and 17 x 17 mm in a price range of about $150.)[57]

The validity of the 35 mm library requirement and the market potential for moderately priced machines has been reviewed in this report, as has also the availablility of many 16 mm machines which could quite readily be converted. Technically, there are no major problems to be overcome. Many advances already applied to 16 mm could be readily used with 35 mm. (For example: Bell and Howell has already applied zoom lens techniques

to 16 mm readers to provide the advantage of magnification control over a continuous range.)[58]

What then is the problem? Perhaps it is one of communication. Librarians need to become more aware of conditions that exist and to voice their needs. The establishment of suitable specifications for reading machines in all categories is within the province of the LTP. The test requirements in "Microform Readers for Libraries" has already provided a base for such a step. More firmness and direction needs to be given. The LTP as the technical service organization for American libraries needs to take the lead.

Or perhaps the present is just a plateau in normal growth. Nevertheless, successful growth needs to be planned. It is hoped that this paper, in its consideration of micro-images, their various sizes and the needs for accommodating them in readers, both present and future, will be of help in such a program.

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