Photographic Reproduction of Research Materials

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IN OPENING THIS discussion of photographic processes of reproduction, brief mention should be made of some of the older and better-known techniques. The original large negative-contact print process is now seldom used for textual reproduction because of its high cost, except where illustrations are required for subsequent reproduction in a printed work. Similar to this process is the series of blue-print and diazo-print processes using very inexpensive light-sensitive papers. The rather large and expensive equipment, the non-permanent character of the prints, together with a limitation to copying only from originals with text on one side of reasonably translucent, separate sheets, have heretofore limited widespread application of these processes. The introduction of less expensive, office type diazo printing equipment and growing experience in use, particularly for the limited distribution of scientific and technical reports, suggests that the diazo processes are likely to be used more generally in the future than in the past.

The best known of all photocopies are those which have, by common acceptance, come to be called photostats. Using rather large cameras with the image passing through a mirror or prism to avoid reverse reading, documents are copied directly onto light sensitive, silver emulsion papers. Highly legible permanent copies of a great variety of originals can be made. The process is still efficient for short runs of textual reproduction, and where only one or a very few copies of an original are required. For large-scale use and multiple copies the labor costs tend to make the photostat processes rather expensive. The possible future development of small, highly mechanized photocopying cameras with integral processing equipment may greatly extend this general technique. Such machines would occupy a position between the conventional photocopying camera and the process of

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fully automatic enlarging from microfilm onto sensitive paper as in the wartime V-mail process. The costs for such enlargements are small, but the equipment for producing them is very costly and suitable only for large volume operations.

The transmission and reflex contact processes have recently become much more attractive than formerly because of fast single bath developing and fixing with solutions that can be applied so briefly that the sensitive paper emerges only slightly damp and ready for use. There now seem to be three rather distinct processes of which the simplest uses a single sensitive sheet to make transmission or reverse reading reflex negatives in the conventional manner, but with single solution fast processing. In a second process the negative sheet is exposed and is then developed in close contact with a positive "transfer" sheet. A positive image is transferred to the second sheet which emerges ready for use and the negative is discarded. A third process relies upon a physical transfer of a positive image from a negative "matrix" to unsensitized paper. From one to about five such transfers may be pulled from the same matrix. Owing to the simple equipment, the immediate production of a positive copy, the small space required, the relative ease of operation, and the moderate capital investment, these processes are likely to find an increasingly wide application in libraries and offices for the reproduction of small quantities of material when only one or two copies are required. In terms of legibility the results of most of these processes, with reasonable care, are satisfactory though probably not as high as that of well-made photostats.

We turn now from those processes which produce copies at or near the size of the original to those in which the image of the text is reduced to such an extent that optical enlargement is necessary before the text may be read. Of these processes, the most widely known and generally applied is that of microfilming. While microphotography is anything but modern, it did not come into general use for record copying purposes in commercial applications until late in the 1920's. It was not widely applied to scholarly problems until the middle and late 1930's. Conventional microfilming, as practiced in the United States, has involved the photographic reproduction of textual materials on film in 16 mm., 35 mm., and 70 mm. widths, and in lengths from a few inches or feet up to approximately 100 feet. The great majority of scholarly applications have used 35 mm. film, while commercial applications have relied heavily on 16 mm., with 70 mm. film used primarily for the copying of engineering drawings.

In commercial and industrial practice, microfilming has had no serious competitors in applications directed toward the physical preservation of document files, the security of records against war risks and other similar catastrophies, and for reductions in the space and equipment used for the storage of inactive records. In scholarly applications the distinguishing characteristic of microfilm has been its adaptability to a wide variety of originals and copying objectives. It is unique in its ability to produce a single copy of an original book, or even several hundred volumes, at rates that are on the whole reasonable, though by no means negligible. Once a master negative microfilm has been produced, almost any number of positive copies may be made from it at one time or over a period of years. This distinctive permanent in-print characteristic can become one of microfilm's most important contributions to research literature problems. The major applications of microfilm can be grouped in a variety of ways but, for our purposes, perhaps a division into three categories would be most useful: (1) those applications where the primary objective is to increase the ease of access to a text; (2) those applications where the primary objective is to preserve books or manuscripts from physical deterioration or destruction; and (3) those applications where the primary objectives are to save space, to increase internal operating efficiency, or in other ways serve as an ancillary process to some other operation. It will be noted that many applications fall into two or more of these categories simultaneously.

Because of the growth of literature, it may be anticipated that the research library in the future will be less and less autonomous in its resources and that we shall have to rely increasingly upon each other and such devices as regional storage libraries for many little-used literature requirements. If this interdependence is to be at all successful, the means by which libraries can make use of each other's resources must, in the interests of scholarship, be efficient, and, in fact, so efficient as to produce demonstrably better results than the traditional patterns of largely autonomous research collections.

Microfilm is making an important contribution in this direction at the present time, for it permits the historian in Athens, Georgia, for example, to have access, without leaving Athens, to an important collection of manuscripts in the Bancroft Library at the University of California. The cost is clearly less than that of going to California to consult the originals (unless the number of manuscripts required is very large) or that of having them reproduced by any other technique (unless the number of pages is very small). The further extension of

microfilm in such applications should be anticipated. Where the access is to unique materials located in Europe, or in remote parts of the world, the benefits to be obtained are, of course, substantially greater and no other technique now available seems to offer advantages as great as those of microfilm.

The widespread use of microfilm to meet a known and very specific need is paralleled by a large number of applications directed toward future or potential needs of research library users. Such projects have had one or both of two characteristics: either a large mass of material has been copied in one institution and deposited in another, or a large mass of material in one institution has been cooperatively reproduced and positive copies deposited in each of the cooperating institutions. The Library of Congress with its wide-ranging interests and extensive resources has undertaken a number of projects typical of such major applications. It has brought to this country for either its own use or on general cooperative projects microfilm copies of manuscripts and other important materials from Jerusalem, Mt. Sinai, Mexico City, the Japanese Foreign Office, a large number of British manuscript depositories, the National Library of Ireland, etc. On the domestic level, and with the cooperation of the University of North Carolina, the Library has sponsored the assembly, under the direction of W. S. Jenkins, of the significant statutory, constitutional, executive, administrative, judicial, and legislative records of the American colonies, territories, and states, in some 1,701 rolls of microfilm. The films acquired in such large scale undertakings add immensely to the scholarly resources of the country and at the same time reduce the risks of wartime loss.

There are a series of similar applications that more nearly approach the publication of unique originals or the republication of out-of-print items in microfilm form. The sale by the Wisconsin Historical Society of microfilm positives of parts of its Draper Manuscript Collections serves as an illustration. Even more closely related to actual scholarly publishing are the distribution by a number of universities of dissertations in microfilm form through their own facilities or through University Microfilms, Inc., and the University of Chicago project of publishing in microfilm form a series of manuscript studies on Middle American Linguistics and Cultural Anthropology.[1]

While use of microfilm is inevitably related to access, we may separately recognize it as a tool directed primarily toward the preservation of the text of the important records of man, assuming that the originals themselves might not be saved. One can say with considerable con-

fidence that the task of preserving the text of the physically deteriorating woodpulp files of domestic newspapers will be successfully carried through with microfilm although the task is by no means completed. Microfilm copies have already been made of most of the more important metropolitan files, and active planning is under way toward the preservation of many regional and local papers. The task has been and still is immense. The acquisition of large masses of manuscript and archival material from Europe, while enriching Western scholarly resources, has also clearly had as a major objective the reduction in the risks of total loss of such source materials through war, though it would appear that microfilms in Washington are probably about as vulnerable today as the originals in the Public Record Office, and perhaps even more vulnerable than originals in Cambridge, England. Nonetheless the more widely copies can be scattered, the greater are the chances for textual survival.

To date, the chief uses of microfilm in preservation have been directed toward the reproduction of woodpulp newspaper files and the duplication of unique originals which might be subject to wartime loss. We must recognize that the deterioration of woodpulp paper in monographs and serials will present a sustained problem to research libraries in the years ahead. It would now appear likely that the large research libraries, at least, will need to set apart a percentage of their budgets for the reproduction of deteriorating originals just as they now set apart a portion of their budgets for binding. To select items in time to make satisfactory reproductions before disintegration has gone so far that copying will be prohibitively expensive is a part of the problem. A number of organizations, including the Association of Research Libraries and the Midwest Inter-Library Center, have given some attention to the possibilities of cooperative efforts in the solution of this problem. Thus far, these efforts do not appear to have been particularly successful.

While archival organizations have made extensive use of microfilm to save space, research libraries have not yet gone far in this direction, though they have been duly grateful for the space saved through newspaper-salvaging operations. A recent effort directed essentially toward savings in space and binding costs has centered around the microfilming of current periodicals. The microfilms are sold on a subscription basis only to subscribers to the original paper editions, with delivery of the microfilm copy usually at the end of the volume year. It is probably too early as yet to judge how successful the use of such microfilm copies will prove in different kinds of libraries.[2]

Microfilm is not, despite all its virtues, entirely without fault or limitation. To the contrary, it has some serious ones. In the first place, very few readers indeed would willingly choose to read by means of a projector if they could get the original. The psychological objection to reading with a machine is very real and must be recognized. It suggests that libraries should do all they can to make the use of reading machines as comfortable and convenient as possible. This in turn means that libraries must have available the best possible reading equipment and enough of it to meet the demand. Such equipment is not cheap; good microfilm projectors today range in cost from around $300 to over $600.

A good, small, portable, inexpensive reader has yet to be designed and made available. Most of the small readers that have heretofore been available have been more or less unsatisfactory in image quality and film transport. This deficiency has placed a limit on the use of microfilm by the individual scholar and has tended to keep the process essentially an institutional operation. This is unfortunate, for microfilm, potentially at least, could be of very material assistance to the private individual building his own reference and working collection—if he could only use it conveniently at home or in his office.

Many persons have objected to the use of rolls, and the manual dexterity required to thread film through a microfilm projector has seemed a nearly insuperable obstacle to (a) individuals who did not want to use the microfilm in the first place, and (b) individuals who constitutionally have six thumbs. The difficulty is real, but it can easily be exaggerated. It has been observed that graduate students who have, in effect, grown up with microfilm seem to have little difficulty in threading the reading machines and do not seem to suffer eye strain where good film is being used in good projectors.

In addition to these more or less mechanical difficulties, there are some others of greater weight. Where textual comparisons are important elements of a study and all the texts are on microfilm, the investigator faces a very awkward operation. Ideally, he would surround himself with as many projectors as he had texts, but this is usually well beyond the resources of the scholar and his institution. Similarly, bibliographical analyses, where signatures, leaves, state, ink, paper, binding, and watermarks are elements of the study, are hardly possible with microfilm copies. Even so, we must recognize that for most research needs the text itself is the goal, and the text can usually be faithfully and legibly reproduced by microfilm—and sometimes the legibility can even be improved.

The cost per page, if more than a few pages are involved, will be the least of any of the processes described, ranging, for negatives, from less than one cent in long runs to two or three cents per page for ordinary materials. Since microfilming is a photographic process its costs are commonly thought of as linear, i.e., the tenth copy will cost as much as the first and the hundredth will cost as much as the tenth. This is not precisely true, for the original negative cost is always higher than a copy made from it. The negative may cost anywhere from two to as high as five or six times the cost of a positive. Positive microfilm copies can be made on high-speed continuous printers and mechanically processed so that their costs may closely approach the costs for film stock, chemicals, overhead, and a small labor cost. This relation between negative and positive cost has been a strong inducement to make many larger microfilming projects cooperative ventures in which a number of institutions would share the cost of the negative and each secure a positive. The result has been the undertaking of a good many projects that might well have been impossible otherwise, but it has also meant a wider distribution of microfilm copies than circumstances of need (since a copy could always be secured later) sometimes really required. There is some current tendency for the larger research libraries to devote their resources to filming more original material and to acquiring fewer copies, deferring such acquisitions until an actual need arises. There are also a number of moves toward the cooperative use of microfilms and the extension of interlibrary lending of films.[3] Thus the Midwest Inter-Library Center has arranged to secure microfilms of about nineteen domestic and forty-seven foreign newspapers for the joint use of member institutions.

There are two other widely known processes that require discussion with the microreproductive techniques, namely, microprint and microcards, which have certain characteristics in common. They both begin with a microfilm made more or less conventionally. In the case of microprint, however, the microfilm leads to one hundred pages of microtext printed in ink on one side of a sheet 6 x 9 inches. In the case of microcards, the microfilm is stripped out in such a way as to permit contact prints on a special, fine grain, high contrast photographic paper, measuring approximately 3 x 5 inches in size. The number of pages to the card is allowed to vary, depending in considerable measure upon the original reduction ratio used in making the microfilm, but it would appear that the number is likely to range between thirty and fifty pages of text on the majority of cards. Both processes have

an appeal over roll or strip microfilm in the ease of manipulation of a flat card or sheet as compared with the threading of a projector with film.

Microprint has been principally devoted to very large scale projects on a subscription basis. While the technique itself is not limited to large scale projects, the process clearly requires an edition, and in this sense it is to the advantage of the Microprint Corporation to organize sustained and large subscription projects insofar as they can do so to avoid the handling of separate titles. The best known of the projects of the Readex Microprint Corporation is the reproduction of the British House of Commons *Sessional Papers* for the nineteenth century, sponsored by a committee of the American Historical Association and involving about six thousand volumes of four million pages. More recently the Readex Microprint Corporation has announced a project for supplying in microprint form on an annual subscription basis non-depository United States government documents. The costs per page of text have thus far been somewhat below the probable costs of microfilm for the same material, and the 6 x 9-inch sheet is undeniably easy to store and place in the projector. There has, however, been criticism by librarians of the relatively poor quality of the projected image. Any opaque reflection process from paper has technical difficulties in the production of a bright image on a screen that can be much more easily overcome in projection from a transparency. The problem is to get sufficient light reflectance from paper to illuminate a large screen with adequate contrast and at the same time not burn up the opaque paper medium carrying the image. These problems, in the judgment of the present writer, have not yet been fully solved in the microprint process, but Albert Boni, President of the corporation, has announced a completely new reading device, greatly superior to the former models.

Thus far, at least, it is evident that microcards also have served primarily for the republication of materials in edition quantities. Microcards have been developed by Fremont Rider through the Microcard Foundation. The Foundation has established standards of format and style and has largely centralized the actual manufacture of cards, but approximately twenty different persons, firms, or organizations have sponsored microcard production and sales. There appears to be a rather wide range for the cost of cards—from a low of about 25 cents to a high of around 60 cents in some instances. The rate appears to vary with the source, being lowest for works sponsored directly by the Microcard Foundation, rather than with the number of pages or

the kind of text. While microcards have been used for a great diversity of material, including short single titles, there has been a tendency to emphasize major projects such as files of important reference works or serials of which the *Annalen der Chemie*, 1832–1943, with 5,043 cards, and Beilstein's *Handbuch der Organischen Chemie* with 965 cards, are illustrative. The use of microcards for short-run titles is illustrated by the publications of the Early English Text Society and the Hakluyt Society which are available en bloc or individually. An important application of microcards to publication involved the distribution by a special form of microcard of a series of technical reports from the Office of Naval Research beginning in 1951.[4]

A number of different projectors have been developed for microcards in which the manipulation of the card is simple and the quality of the image has been generally fair to good. Costs appear to be close to those for microfilm in similar editions and in some instances may well be higher.[5] The requirement that all microcards be 3 x 5 inches has seemed an arbitrary limitation. An examination of the publications issued under the auspices of the Microcard Foundation[6] would indicate that a card size which would accommodate text equivalent to that held on three to perhaps four conventional microcards might significantly reduce the number of cards per title that have to be filed, pulled, and inserted in the reader, then refiled, without too much loss in sensitive paper.

It is evident that at the present time neither microprint nor microcards is capable of producing economically either single copies or very small editions. When such needs arise one must turn back to the reflex contact copying processes, photostat, or microfilm.

There are a number of other processes or techniques that should be mentioned, even though they are not in general use at the present time. Among these, sheet microfilm in one form or another presents interesting possibilities. It is apparent that projection from a transparency is a less difficult optical problem than projection from an opaque medium. The opaque media that have been developed in sheet and card sizes, on the other hand, have a manipulative simplicity that is attractive to many people in comparison with long rolls of microfilm. The question, therefore, naturally arises as to whether sheet microfilm offers possibilities not now attained by the opaque or roll media. Sheet microfilm has been extensively developed and is in active use in a number of European countries. A common process relies upon a special camera in which multiple, stepped exposures are made on a negative film from which as many transparent copies

as are desired can be printed by contact on silver sensitive emulsions or diazo impregnated plastics. Such techniques, for reasons that are a little difficult to explain, have not received widespread experimental or practical applications in this country. It may be because the labor costs in copying and processing the sheet films are likely to be considerably higher than those for roll film which can be mechanically fed into a camera very efficiently, which can be processed continuously in automatic processing equipment, and from which positives can be made on continuous printing equipment at high speed.

An alternative to sheet microfilm is the mounting of short strips of 16- or 35-mm. microfilm in transparent envelopes or in slotted cards. The cards can carry indexing and other bibliographical information in full size, and manipulation is simple. Some considerable development along these lines has occurred in this country, Filmsort Inc. of Pearl River, New York, being one of the pioneers. It is possible that further experimental work along these lines might be very fruitful, for the card with inserted microfilm has the great advantage of storage and manipulative simplicity and yet retains the single copy or very small edition advantages of microfilm.

Another microtechnique now on the horizon is a development of the Eastman Kodak Company which is also referred to as microprint. The Eastman Company is developing a line of equipment which will permit any organization to produce cards on opaque photographic paper from microfilm similar to those made by the Microcard Foundation. The Eastman 3 x 5-inch card differs from the Microcard Foundation card in carrying the bibliographical description of the text on the back of the card instead of on the face, and eliminates the traditional catalog card hole at the bottom of the card, thereby permitting around sixty pages of text to be placed on each card. The Eastman Kodak Company is developing a reading machine that will accommodate microcopies ranging from 3 x 5 inches up to approximately 8 x 10 inches in size. The distribution of equipment for making opaque microcopies in a wide variety of sizes will unquestionably broaden the area of users now served only by 3 x 5-inch cards from the Microcard Foundation and the 6 x 9-inch sheets from the Readex Microprint Corporation. The equipment is scheduled for availability by the end of 1954, according to the Eastman Kodak Company.

An entirely different technique of textual reproduction has made its appearance in the past two years under the name of Xerography, developed by the Haloid Corporation of Rochester, New York. This is

a dry electrostatic process with the final images formed on paper or offset paper plates by means of a very fine powder or vapor. At present this process lends itself very well to the preparation of masters to be run on conventional offset or multilith printing presses. It is less satisfactory where multiple copies are not required. However, the future development of the process may make it highly adaptable to direct single or short-run facsimile reproduction of textual materials.

Last in our list of processes, we should not overlook the photochemical and photomechanical processes of facsimile copying. On the whole these tend to be quite new and have not generally found their way into research library applications, but they should be watched with close attention for both current and future applications, particularly as they may improve the speed and efficiency in the interchange of research materials between libraries. The present costs of facsimile equipment are high, and the available equipment is not yet really well designed for research literature. Among the manufacturers with equipment in this field are the Times Facsimile Corporation with a facsimile process called Stenafax and the Western Union Telegraph Company with a facsimile process called Intrafax. The Atomic Energy Commission has had an experimental installation of textual facsimile equipment in operation at its Oak Ridge Laboratories developed by the Radio Corporation of America. Some years ago there was a public demonstration of a process called Ultrafax for the very high-speed transmission of textual materials using microfilm and transmission techniques closely related to those used in television.

In summary, we believe the major requirements of research libraries in relation to the various techniques of textual reproduction can be grouped into six distinctive areas: (1) Techniques of reproduction can increase the inter-institutional mobility of research materials and can also increase the convenience in use and accessibility of the individual investigator to locally available materials through very high-speed, very low-cost copying, a part of which may be in lieu of circulation. (2) The direct distribution to libraries and investigators of data and research findings, in certain microtext formats, may reduce the costs of publishing, speed up the distribution of research information, extend the possibilities in the diffusion of knowledge in highly specialized areas, and may simplify certain problems of use and bibliographic organization. (3) Microtexts, if a satisfactory, small, and inexpensive projector can be developed, may make possible once more, extensive, personal, scholarly collections—today a victim of high costs for subscriptions, books, and binding, and of insufficient space.

(4) Microtexts will make important contributions to space and binding savings in research libraries, though these goals are likely to remain secondary to others of greater importance, and the position of the conventional book does not seem in serious jeopardy. (5) Reproductive techniques, and particularly microfilm, seem destined to play a vital role in the preservation of deteriorating originals and unique originals in danger of wartime destruction. (6) Photographic reproduction has important benefits in purely ancillary relationships to research literature. For example, microfilm is being used in the mechanization of bibliographical selection as in the Rapid Selector; photocopies are being used to improve the internal operating efficiency of research libraries; and infra-red and ultra-violet photography are being used as aids in the interpretation of medieval manuscripts.

It is evident from this discussion that some of the fundamental problems of research libraries, research-library use, and the diffusion of scholarly information are far from being solved. The problems themselves are growing in complexity as the bulk and diversity of the research literature increase. It is evident that while photographic reproduction will not solve all of these problems, it is now making, and is likely to continue to make, important contributions toward more satisfactory solutions. In appraising the contributions made thus far by the techniques of reproduction, we must recognize that, in relation to the time span of libraries and books, the period in which these techniques have been used is exceedingly brief. The growing diversity of the processes should be a cause for satisfaction rather than alarm, for out of a diversity of processes and techniques a far more versatile tool is likely to be forged in the next ten to fifteen years directed toward the efficient service of scholarship and investigation.

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