Duplicating Machines

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Duplicating machines have come to play an increasingly important role in librarianship, as they have in today's civilization generally. As the number of libraries has increased, and as individual libraries have grown into large and complex organizations with staffs so large that oral communication is ineffective, the need for some rapid and inexpensive means of communication between libraries and within libraries has stimulated the use of duplicating machines. Similarly, an expanded concept of library service has led librarians to seek ways to keep their readers informed of new acquisitions, of material available on topics of current interest, and of new services and facilities. At the beginning of the century annual reports, set in type and printed on letterpress, were almost the only publications generally issued by libraries. Today, with fast, efficient, and economical duplicating equipment available, libraries can and do issue publications of many kinds.

Some of the publications issued by libraries are periodical bulletins which, although usually intended primarily as a means of internal communication between the administration and the staff, serve also to keep other libraries abreast of developments which have not yet reached the pages of the library journals. The most notable of these is, of course, the Library of Congress Information Bulletin. Even some of the formal journals are prepared on duplicating machines rather than by letterpress, such as many of the bulletins of state library associations and some of more widespread interest, such as Serial Slants. Abstract bulletins, bibliographies, lists of current acquisitions, and reading lists are duplicated freely. The documentalists include the publishing of technical reports among their functions and usually employ duplicating machines rather than letterpress for these. Many library forms are no longer printed but are prepared on duplicating machines. One of the most important and perhaps the most

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Duplicating Machines

general use of duplicating machines in libraries has been and will continue to be for the reproduction of catalog cards. The stiff stock and small size of catalog cards presents some problems in the use of duplicating machines, and, although few duplicators have been produced specifically for catalog card production, librarians have demonstrated a great deal of ingenuity in adapting them to this function.

There are numerous duplicating machines on the market but there are only five basic types: hectograph, spirit process, stencil, relief, and offset. Each type of duplicator has its own peculiar characteristics, each has advantages over the other types for particular applications, and each has limitations. In the following paragraphs these will be presented, together with a brief description of the operations involved.

In the hectograph process, a master is prepared by typing on the master with a ribbon or carbon paper impregnated with an analine dye, or by writing on the master with a pen or pencil containing an analine dye ink or lead. When carbon paper is used, it is used exactly as ordinary carbon paper is used, between two sheets of paper; the carbon copy is the hectograph master. Once prepared, the master is pressed, face down, upon a moistened sheet of gelatin for a brief period during which the dye from the master is transferred to the gelatin. Paper is then pressed down on the gelatin and some of the dye is transferred from the gelatin to the paper and the paper is pulled from the gelatin. Other hectograph duplicators use small sheets of gelatin which are wrapped around a cylinder; with these, paper is fed into the duplicator, pressed into contact with the gelatin and stripped from it as the cylinder revolves.

The spirit process duplicator evolved from the hectograph process and is similar to it in that both make use of the transfer property of dyes. The spirit process master is prepared by typing or writing on a special master sheet placed on top of a dye impregnated carbon sheet used "wrong-side up" so that the carbon faces the verso of the master sheet. As one types, writes, or draws on the face of the master, dye from the carbon is transferred to the verso of the master, producing a mirror image of the text or drawing. The master is then placed, verso out, on the cylinder of the duplicating machine. As the cylinder is revolved paper is drawn into the duplicator, moistened with an alcohol solution and brought in contact with the master, and dye from the master is transferred to the paper.

The Azograph and Chemograph processes are similar to the spirit process in that they involve the use of a "wrong-side-up" carbon which transfers a substance to the verso of the master, and that the master
JOHN M. DAWSON

is placed verso out on the cylinder of the duplicating machine. Here the similarity stops. In the spirit process method, analine dye is transferred from the carbon, while in the Azograph and Chemograph methods the dye is formed only when the chemicals which have been used to moisten the paper come in contact with the substance on the back of the master. Copies made by Azograph are dark blue, those made by Chemograph are black. Since the dye is formed only when the solution is brought in contact with the master in the duplicating machine, these processes obviate the messiness of the spirit process.

All of these processes are relatively inexpensive, both as to the initial expenditure for equipment and for operating supplies, and they are quick and easy to operate. All are essentially short-run methods: from 50 to 100 copies can be produced from a single hectograph master, depending largely on the skill of the operator; 250 to 500 copies can be run from a single spirit process master; and both Chemograph and Azograph will give about 100 copies from one master. There is a tendency for the copies to become lighter and blurred as successive copies are run off, so that the final copies may be quite faint and indistinct. A purple dye is most commonly used with hectograph and spirit process, but other colors are available and several dyes can be used on one master to produce multi-colored copy. Since all dyes are put on one master before any copies are produced, there is no problem of insuring perfect registration of different colors with different masters. Hectograph duplicators are usually manual, but most manufacturers of spirit process duplicators make both manual and electric models, as do the manufacturers of Azograph and Chemograph. Few libraries use these processes for duplicating catalog cards, but they are often used for exchange lists, accessions lists, memoranda, and other ephemeral materials.

In the stencil or mimeograph method of duplication a wax-covered fibrous material is used as the master. The text or drawing to be reproduced is cut into the stencil by typewriter or by a steel stylus, and the typing or drawing cuts through the waxy material on the stencil so that ink can pass through. When the stencil is cut it is wrapped around a perforated drum containing a liquid ink which, as the cylinder is revolved, is forced through the cuts in the stencil onto paper. Several thousand copies can be made from a good stencil. Colored inks are available, but only one color can be printed at one time, so that if several colors are desired a separate stencil must be cut for each color to be used. This, of course, introduces the problems of aligning the
material cut into the stencils, and exact registration of the paper and stencil in the duplicating machine.

Stencil duplicators have been and still are widely used in libraries for many purposes. No other method of duplication has been so widely used in the production of catalog cards, and at one time a stencil duplicator designed especially for this purpose was marketed. This model is no longer made, but libraries have had great success in adapting other models for card reproduction. In addition to catalog cards, libraries use mimeograph to reproduce all kinds of library forms, both for internal and external use, bibliographies, reports, circular letters, news bulletins, and so forth. Both manual and electric models are available from most manufacturers, and some manufacturers make stencil duplicators of postal-card size. One very inexpensive type of stencil duplicator is of postal-card size; it is hand inked, and operates by having the stencil holder rocked over cards.

Addressing machines are not conventionally considered duplicating machines, but the type which uses very small stencils have been used in some public libraries to reproduce catalog cards and book cards for fiction and other short cards, as have those which use embossed metal plates. Both types have also been used to imprint subject and other added entries on catalog cards when it is necessary to prepare many sets of cards. It should be noted that the use of the embossed metal plate type requires the use of embossing equipment.

The most familiar of the relief processes is, of course, the printing press. It is not normally thought of as a duplicating machine in the sense the term is used here, and its operation and products are so completely familiar that it need not be discussed here.

The Multigraph Relief Process uses movable type with a raised printing surface similar to ordinary printing type. The body of the type, however, is considerably shorter than the body of printing type and is grooved to slide into channels on the drum of the Multigraph duplicator. The type comes in tubes in a variety of faces, the most common of which closely resemble that used on typewriters. In its simplest form, the operations involved in Multigraph reproduction are as follows: The text to be reproduced is composed by sliding the desired characters from a stand which holds a font of type into a composing tube until a complete line has been composed. This line of type is then slid from the composing tube into the appropriate groove in the printing cylinder or drum and, by means of special clips, locked into position. In this way all the text to be reproduced is composed and inserted in the cylinder. As the cylinder in the dupli-
cating machine is rotated, the type is brought into contact with a rubber ink roller which deposits ink on the type; as the cylinder continues its rotation, paper is fed into the duplicator and brought in contact with the type. The end product is very similar in appearance to the product of the conventional printing press. A ribbon such as is used on typewriters, but wide enough to cover the drum of the Multigraph, can be obtained and, if this is used instead of printing ink, the Multigraph will produce copies that give the appearance of having been typed. Numerous type styles are available and ink of any color can be used. Multigraph is a long-run method; the cost of type-setting is high, but when thousands of copies are required the per-copy cost is not exorbitant.

Many large libraries have used the Multigraph for the reproduction of catalog cards, but the cost of typesetting for the small number of copies wanted—even when a keyboard typesetting device has been used and the used type sold as junk metal rather than redistributed—has been so high that most of them have abandoned it.

Offset duplicating machines operate on the lithographic principle—that water and grease repel each other. The material to be duplicated is typed, written, or drawn on a master with a special ribbon, pencil, or ink which contains a greasy substance. The master is then put on a cylinder and dampened with a watery solution which is held by the surface of the master except where the greasy writing or drawing repels the water. The master then passes over an ink roller and the greasy image picks up a layer of ink while the moist surface of the remainder of the master repels the ink. The master is brought in contact with a rubber blanket on another cylinder and the ink from the master is transferred to this rubber blanket. As paper is fed into the machine it is pressed against the rubber blanket and the ink from the blanket offsets onto the paper.

Masters of paper, plastic, or metal can be used, depending upon the number of copies used and the quality of reproduction desired. Paper masters are available in different grades, ranging from very short-run for not more than 50 copies to long-run masters which will reproduce about 5,000 copies. Plastic and metal masters will permit even longer runs. Photosensitive masters, also in paper, plastic, and metal can be used to duplicate material already set up. If photosensitive masters are used, a photographic negative of the image to be copied must be made and the sensitized master exposed to this negative in a contact printer. When the sensitized master is developed it can then be used to run off copies by offset. The Library of Congress
Duplicating Machines

uses this method to reprint cards for subscribers when the initial printing is exhausted. Copies of involved line work and of halftones can be reproduced most satisfactorily in this way. Masters of high quality can also be prepared by facsimile or xerography equipment, as discussed below. All offset duplicators are electrically operated. One manufacturer distributes a model which can be used both for offset and relief printing. Models are available which can print both sides of a sheet at one running, or can print two colors on one side in one run.

Offset equipment is considerably more expensive than the hectograph, spirit process, or stencil duplicators, but because of the flexibility and high quality of reproduction possible in offset, it has been widely adopted in libraries as well as in industry. Offset is used for the reproduction of catalog cards, all kinds of bulletins and lists, technical reports, and for publications such as Serial Slants and the University of Illinois Library School Occasional Papers.

In recent years equipment has been developed for use in conjunction with duplicating equipment which has greatly extended the usefulness and scope of these machines, making it possible to copy on a master text or illustrations for further reproduction without the need for photographic negatives or photosensitized masters.

Facsimile devices reproduce materials on stencils, and offset and spirit masters. The original to be copied is wrapped around a cylindrical drum and a master or stencil is wrapped around another drum. A photoelectric scanner, mounted on a carriage which moves slowly along the length of the drum, scans the original copy as it revolves; a recording device, mounted on the same carriage, traces over the stencil or master on the receiving drum which is revolving at the same rate as the recording drum. When the scanner detects an image on the original an electrical pulse causes the recording device to reproduce the image on the stencil or master. When the scanner has covered all of the original the recording device will have reproduced a facsimile of it on the master. Some facsimile machines are so built that the reproducing device can be located miles away from the scanning device. Since the material to be copied must be mounted on a cylinder, this type of equipment is obviously unsuited for copying pages from books or journals. There is no technical reason why similar devices for scanning flat pages could not be devised; indeed, such a machine was developed for the Atomic Energy Commission.

Xerography, or Xerox, to use the trade name, relates to an electrical copying process in which an aluminum plate covered with a thin
coating of selenium serves as the transfer medium. Selenium is "photo-
conductive;" that is, it is a conductor of electricity when exposed to
light, and a non-conductor when kept in the dark. In the xerographic
process, the selenium-covered aluminum plate is given a positive
electrical charge and, in a camera unit, exposed to the original to be
copied. Where light is reflected from the white surface of the original,
the plate is exposed to light and the electric charge flows from the
selenium into the aluminum; but where the areas of writing or drawing
do not reflect the light, the selenium remains a non-conductor and
the charge remains. Thus a pattern of electric charges which is a
mirror image of the original remains on the plate. Keeping the plate
in the dark, a resinous powder is cascaded over the plate, and particles
of this powder are attracted and held by the positive charge on the
plate. The master is then placed over the plate and given a positive
electric charge, and the positively charged plate attracts and holds the
powder from the plate. At this point the powder is held only by the
electric charge and any part of the image can be removed if desired.
The master is then inserted in a fusing unit and the powder fused
permanently to the master. It should be noted that the selenium-
aluminum plates can be used hundreds of times. Copies can be made
directly on paper, on clear acetate, and on offset or spirit process
masters.

With more recent Xerox equipment it is possible to make from six
to eight copies directly from an exposed plate on paper, or several
copies on paper and the final copy on a master for duplication. The
first copies are a dark gray and the last copy black. While the cost of
Xerox is too high for use primarily as a copying machine for only a few
copies, this development might in some instances make it unnecessary
to have a copying machine in addition to Xerox equipment.

The simplest Xerox equipment is a camera unit which neither en-
larges nor reduces, a charging-developing unit, and a fuser. Three
different types of fusers are now available: a heat fuser for offset
masters and paper; a vapor unit, better for paper copies particularly
when several direct copies are to be made and essential for preparing
copies on acetate sheets; and a special "Flo-set" unit for preparing
spirit process masters. The vapor fuser is the most versatile and can
be used for paper copies, acetate copies, or offset masters. With the
present chemicals used in the vapor fuser there is a tendency to toning
in the background of offset masters, but there are indications that new
chemicals may eliminate this.
Duplicating Machines

A camera unit which permits enlarging or reducing copy is available; it will copy originals up to 17 inches by 22 inches on an 8½ by 13 inch plate. For this camera unit there is an attachment which will hold panels of visible record panels. A special "tone tray" permits reproduction of halftones and large solid areas. A recent development is a continuous process unit which can enlarge and reproduce from microfilm onto rolls of paper or offset masters.

Xerox-offset reproduction has numerous possibilities for libraries and is used by a number of large libraries for the reproduction of catalog cards, abstract bulletins, and so forth. It is sometimes used to reproduce articles from journals or parts of books for reserve use, and even to reproduce missing pages for insertion in defective copies. Forms, letterheads, and other supplies which were formerly printed on letterpress are often duplicated by Xerox-offset within the library.

Few libraries have begun using duplicating equipment for systems work, where "form" text is preprinted on masters and variable information typed on the master. The Library of Southern Illinois University now uses a preprinted master for its order forms, typing in the author, title, and other variable information. Twelve parts of this form are reproduced, including a purchase order, a report form, and LC card order, an "on order" card for the public catalog, a temporary catalog card when permanent cataloging must be deferred, and so on. The use of preprinted masters eliminates the purchase of printed multipart order forms and makes it possible to use parts of paper and card stock in the one form. There are undoubtedly many other such applications that could be developed for libraries.

Discussions of the relative costs of the various types of duplicating equipment are complex and difficult for there are many variable factors to be considered. In general, the order of cost, from least expensive to most expensive is as follows: hectograph or spirit process, mimeograph, offset, facsimile-mimeograph or facsimile-offset, Xerox-offset, and finally, Multigraph. There are many instances where this order would not obtain. An intensive discussion of cost factors in duplication may be found in the International Federation for Documentation Manual on Document Reproduction and Selection.

Recent developments in duplicating equipment have greatly enhanced its usefulness, made it easier and simpler to use, vastly more flexible and considerably less expensive. Librarians have already devised ingenious ways of exploiting duplicating machines, and there is every reason to believe that they will continue to do so.

[263]
References