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PHOTOCOPIERS

In marked contrast with the attention paid to writing, printing, and telecommunications, the impact of copying has remained largely undocumented and unexamined by historians. The ability to make facsimile copies mechanically has had an enormous impact on commerce, education, bureaucracy, and scholarship as a convenience, for preservation, and by enabling further products.

Tracing paper and tracing parchment were known already in the Middle Ages and were used to aid the making of engraved facsimiles; images were also transferred by pouncing, which involved poking holes to outline an image and spreading colored dust through them onto a sheet below.

From the early seventeenth century the *pantograph*, a pen mechanically linked to a pointer tracing an existing diagram, would create a copy or, if linked to a writer's pen, a copy of what was being written. The first widespread copying technique developed in the eighteenth century was the *copying letter press* (entirely different from letterpress printing) in which a thin moist paper was pressed on top of a freshly written letter such that enough of the ink on the original would seep through to the front of the moistened paper to create a copy. Thomas Jefferson was a well-known user.

Copying options were transformed once techniques for enduring photographic images were developed in the 1830s. Joseph Nicéphore Niepce made lithographic plates from photographic images, and John Benjamin Dancer promptly made daguerreotype microphotographs of texts. But before 1900 photocopying was little more than a novelty, occasionally used for the urgent copying of military battle plans, responding to interlibrary loan requests, and, famously, by René Dagron for sending microphotographed news over enemy lines by homing pigeons during the siege of Paris in 1870.

Widespread use of photocopying began with the *photostat* process developed by French orientalist René Graffin to aid his editing of Syriac manuscripts. Photostat, which was both a generic name and a trade name, used a large camera to photograph documents directly onto sensitized paper without using a negative as an intermediate step. One simply fixed the exposed paper to obtain a negative print of any desired size showing white text on a black ground. Left-to-right reversal was corrected by using a forty-five-degree prism attached to the lens. If desired, a photostat of a photostat would reverse the reversal to produce a black text on a white ground. Graffin's camera won a prize at the International Exposition on Paris in 1900, and the process was prominently endorsed by a US federal efficiency commission in 1912. At that time the US government was sending staff to transcribe foreign archives by hand or by typewriter. Photostat's overwhelming superiority in speed, simplicity, efficiency, accuracy, and versatility, especially for copying images, was obvious. Photostat cameras became commercially available in 1910, were widely adopted, and remained the copying technique of choice until at least the 1930s. Copying speeds of up to six hundred pages an hour were claimed for advanced equipment. Photostatic prints had additional advantages over the use of photographic film: For a while photostats were accepted as legal evidence, whereas prints made using a negative, being indirect copies, were not. More importantly, the storage of images on photographic film, then nitrate

based and inflammable, was effectively prohibited by insurance companies.

Widespread use of *microfilm* had to await improvements in photographic technology and the commercial availability of acetate safety film. Major applications during the late 1920s and 1930s included banks’ filming of presented checks to reduce fraud, the reduction of space needed for storing business records, and libraries’ use of microfilm to copy newspapers and other documents. Microfilm was more compact, more easily transported, and easier to reproduce than photostats.

High-profile microfilming initiatives by individual historians include Fernand Braudel, who aroused attention in 1927 by using an old movie camera to microfilm up to three thousand pages a day in the General Archive of the Simancas, which he later reviewed at leisure using a projector. Vernon D. Tate’s extensive filming of Mexican port archives for his doctoral research led to a lifetime leadership role in micrographic developments. The Library of Congress undertook a number of high-profile microfilming projects starting in the 1930s.

Other microforms, notably *microfiche* (small sheets of film, typically 105 × 148 mm or 75 × 125 mm, reproducing some one hundred pages) and *microprint* (like microfiche but printed on opaque white cards) were used after 1945, primarily as publication media. In practice the benefits of microfilming are conveniently achieved at reductions of 1:10 or 1:20, but smaller is technically possible. In 1925 Emanuel Goldberg demonstrated extreme reduction *microdots* with a resolution equal to fifty Bibles per square inch, an achievement that J. Edgar Hoover prominently and inexplicably attributed to a mythical “Prof. Zapp.” Such tiny images are hard to find, which led Goldberg to develop an electronic search engine for use on photocopied documents on rolls 35 mm film, a technology popularized by Vannevar Bush’s imaginary desktop Memex information system.

Much simpler than photostat or microforms, life-sized *contact prints* were made without a camera by placing sensitive paper on or under the original. In the simplest case, light shone on to the original would pass through the paper except where ink marks absorbed the light creating a silhouette recorded on the light-sensitive sheet placed behind the original. Cyanotype engineering “blue prints” used this method. When paper had ink marks on both sides or was opaque, a reflex method was used. The sensitive sheet would be placed in front of the original and record light reflected by the paper except where absorbed by ink. A similar method (thermofax) used heat-sensitive paper to record where ink had been heated by absorbed light.

In 1937 Chester F. Carlson developed an *electrostatic copying* process. Light temporarily increases the conductivity of selenium, so projecting patterns of light creates patterns of increased conductivity on a selenium surface. Negatively charged particles of ink (toner) cling to the surface in proportion to the increased conductivity. The toner pattern is then transferred to and fused into a sheet of paper, replicating the pattern of light originally projected. When offered this technology, Kodak declined, preferring to concentrate on its technical leadership in photochemical processes. The Haloid company, a maker of photostat paper seeking to escape Kodak’s overwhelming market presence, made a strategic decision to invest in a product different from Kodak’s and adopted Carlson’s “electrophotographic” technique. Because this process avoided the use of wet chemicals, it was renamed xerography (“dry writing”), and after many difficulties Haloid, renamed Xerox, brought it to market. It became the technology of choice for copiers and computer printers.

Duplication refers to a variety of late nineteenth- and twentieth-century techniques for making multiple nonfacsimile copies of texts or line drawings, typically in runs of twenty to one

hundred copies. Best known are the spirit duplicators (“ditto”), in which typing transfers waxy ink onto a sheet used for printing; stencil duplicators (“mimeo”), in which typed incisions in an ink-proof paper allow ink to flow through on a rotary press; and hectographs, in which waxy ink is laid on a flat gelatin printing surface. These and similar processes create a new master and are more properly considered small-run printing.

Photocopying techniques can achieve much more than the making of copies because the image made can also serve as input for other *derivative procedures*, especially the production of photolithographic plates for printing and the special case of “halftone” plates familiar in newspaper illustrations, in which tiny black dots (pixels) of increasing density produce the effect of a continuous graduation from white through increasingly dark grays to solid black—and similarly in color printings.

Strictly speaking, copying is not simply making a copy but a rendering or a version of the original, and any such process might introduce errors or distortions. The significance of this is that versions or renderings can be used for specialized purposes of image enhancement such as changing the size or increasing contrast. ng contrast. Use of wavelengths outside the visual spectrum can be used to make erased text visible, to read through censor’s redactions or inkblots, to detect forgeries, to read charred records, and in many other forms of forensic analysis. The classic example is the development by Raphael Kögel (aka Gustav Kögel) of improved techniques for reading medieval texts that had been erased on recycled parchment (palimpsests). Kögel found that ultraviolet light generated fluorescent light except where the writing had been and so was able to convert the resulting effect into a legible text. Lodewyk Bendikson used infrared light to reveal the text written underneath a huge blot where Benjamin Franklin had spilled his ink pot on a page of his manuscript autobiography. Similarly, when the ink used by a censor when redacting a printed work was chemically different from printer’s ink used in the printed original, Bendikson made a copy using a wavelength that penetrated the former but not the latter and so was able to read the redacted original.

The history and impact of photocopying techniques have been unduly neglected. Photographic techniques, notably photostat, microfilm, photolithography, and, now, electrostatic processes, have pervaded our daily lives and have transformed what can be done with both graphic and textual records.

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Further Reading

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David McKitterick, *Old Books, New Technologies: The Representation, Conservation and Transformation of Books since 1700*, 2013.