

Processes of Reproduction¹

DEVELOPMENTS in the processes of graphic reproduction were as remarkable as any of the technological advances that affected printing during the nineteenth century. The traditional relief and intaglio processes were continued without fundamental change; but lithography involved an entirely new method of transferring an image from printing surface to paper; while the application of photography to printing introduced a method of reproduction that was potentially as important as printing itself, and which was eventually to penetrate if not to control every department of book production.

ENGRAVINGS

Blocks and plates continued to be cut in the nineteenth century in the same ways as before (see pp. 154–8), although the influence of Bewick led to a general improvement in the techniques of engraving, and especially in the fineness of line mastered by ordinary engravers.

Wood engravings succeeded copper plates as the chief medium for good-quality book illustration during the first decade of the century and, despite competition from steel plates in the 1830s and 1840s, they retained their position until satisfactory photographic blocks became freely available around 1890. The normal procedure was for the artist to make a reversed drawing for an illustration directly on to the face of the block, and for the engraver to cut through the drawing, interpreting the shading, etc., in his own way. The work was laborious, a detailed illustration sometimes taking ten or twelve working days to cut, but the best engravers were more than mere copyists; some indeed made blocks that were works of art in themselves, as well as being miracles of skill. From 1866–7 it became usual to photograph the original drawing on to the face of the block (which was sensitized for the purpose) as a guide to the engraver, but blocks were cut by hand until well into the 1890s.²

The life of a block could be prolonged indefinitely by making an electrotype of it with the use of a wax mould, in the same way as making an electro of a page of type (p. 206). This practice does not appear to have been common in England until the later nineteenth century, but at the Harper Establishment in New York, all blocks were electrotyped by the mid 1850s.

¹ See the bibliography, p. 408 and, for a convenient illustrated summary, Twyman, M., *Printing 1770–1970*, London 1970, ch. 2.

² Southward, J., *Progress in printing*, London 1897, p. 21; Fildes, Sir P., 'Phototransfer of drawings in wood-block engraving', *Journal of the Printing Historical Society*, v, 1969, pp. 87–97.

in the forme along with the type.³ Blocks could of course be duplicated in the same way, and by about 1850 type-founders were offering their standard cuts as electros.

Colour printing from suites of wood blocks, used hitherto chiefly for separate prints, became common for book illustration in the 1840s and soon afterwards for the printed covers of yellow-backs.⁴ The technique was to cut the design in the ordinary way for printing in black, then to transfer it from this key block to the faces of the several colour blocks by setting-off wet pulls on to them. The colour blocks were next cut to give the necessary tints to various parts of the picture; and finally the suite was printed in the way outlined (pp. 261–2) above.

The chief technical problem in printing from copperplates was, as always, that of preventing noticeable wear, and steel plates were substituted for copper around 1820.⁵ They could be softened for engraving and then retempered for printing; or they could be etched without softening. Sometimes the shaded portions of a picture were worked mechanically with a sort of 'rose engine'. Copperplates, both engraved and etched, were used again for book illustration from the mid century—in some of Dickens's novels for instance—especially after 1858 when it was found that a durable skin could be grown directly on to the surface of the plate by the electrotype process, which gave it a life comparable to that of a steel plate.^{5a}

LITHOGRAPHY⁶

The principles of lithography were established in Germany by Alois Senefelder in 1798, and the methods he developed during the succeeding twenty years were those chiefly used by his successors. Water, he saw, will not lie on a greasy surface, but a greasy printing ink will. The lithographer therefore draws a design with a grease pencil or a greasy ink on a flat surface that is sufficiently porous to retain the marks; a fine-grained limestone is especially suitable, and it can be surfaced with different grades of abrasive to produce a more or less toned effect in the design. The drawing is next fixed with an acid solution, which also slightly etches the unmarked parts of the surface. Then the whole stone is washed over with water, with the result that a film of water lies on the unmarked parts of the stone, but not on the greasy marks of the design. Next the stone is rolled with a greasy printing ink, which is repelled by the water on the unmarked part of the surface but

³ Abbott, J., *op. cit.*, p. 96.

⁴ Evans, E., *Reminiscences*, ed. McLean, R., Oxford 1967.

⁵ The steel-plate process was patented in 1810 (no. 3385, 1 Oct. 1810) but was not used commercially for ten years.

^{5a} The process of steeling copperplates was patented on 29 March 1859 (no. 667), from a communication by H. Garnier.

⁶ Twyman, M., *Lithography 1800–1850*, Oxford 1970.

is accepted by the greasy marks. Finally a sheet of printing paper is laid directly on to the surface of the stone and run through a suitable press, where it takes a reversed impression of the design.

Lithographic stones are easy to prepare, they can give a very large number of impressions, and they can be resurfaced by polishing with an abrasive. Senefelder also anticipated lithographic printing from grained zinc plates, which were cheaper though slightly coarser than the best limestone, and the use of transfer-papers on which unreversed designs could be drawn and then transferred to the stone or plate in a press. The zinc-plate and transfer methods proved to be especially valuable in photolithography, but plain lithography was generally preferred for art work.

Lithography was well established in Europe and America by 1820 for the reproduction of music, maps, and decorative prints. It was less well suited to book illustration, having to be printed separately from the letterpress, and it did not seriously challenge wood engraving except in the specialized fields of technical and scientific illustration where particularly fine detail was required.

Coloured lithographs were another matter, and they virtually created a market for high-quality colour-plate books in the 1840s, and were then widely used up to the 1890s for such things as the frontispieces to children's books and for works of popular information.⁷ Some colour had been commonly added to decorative lithographic prints from about 1818 by means of a tint stone, with which a transparent colour—usually pale buff—was printed over the whole or part of the design. But in the late 1830s Engelmann in France and Hullmandel in England developed processes of 'chromolithography' whereby pictures in full colour were printed from suites of stones. Engelmann's technique was based on the analysis of the constituent primary colours of the picture to be reproduced, and used only three colour stones (red, yellow, and blue) to make a full-colour print, with perhaps a black stone added for depth. But for the most part chromolithographers combined the three-colour method with the superimposition of flat tones (as in colour printing from wood blocks) and used a larger number of colour stones than the basic three.

Nineteenth-century lithography was a separate trade, with its own draughtsmen and printers, analogous to the copperplate trade of the hand-press period; and by the early 1820s a lithographic hand-press was in general use that was similar to the copperplate press except that the printing surface was run under a scraper rather than a roller.⁸ Towards

the end of the century, however, powered lithographic cylinder machines were developed which had a productivity comparable with that of the letterpress machinery of the period, and they were followed around 1900 by lithographic rotaries which ran at yet higher speeds. These new machines, used in conjunction with photographic transfer methods of plate preparation, pointed the way to the integration of lithographic with general letterpress printing which took place during the first half of the twentieth century.

Anastatic printing was a form of transfer metal-plate lithography which, as well as being a cheap method of duplicating specially-written documents, offered the interesting possibility of making prints direct from letterpress originals.⁹ A printed woodcut or page of type-printed matter could be soaked in nitric acid and then pressed on to the surface of a metal plate, which was attacked by the acid in the paper except where it was inhibited by the original printing ink. The plate, lightly etched in this way, could then be used to make lithographic prints which were direct mechanical copies of printed originals, not hand-drawn facsimiles; and the process was intended to be used for reproducing old printed documents as well as recent ones. (Anastatic prints have the characteristically flat appearance of lithography, and are unlikely to be confused with letterpress originals.) In fact it appears that few early originals were copied in this way; the process was used in England in a limited way for duplicating and for reproducing illustrations from about 1845 to about 1870, but then lost ground to photolithography and to cheaper methods of planographic duplication.

PHOTOGRAPHIC PROCESSES¹⁰

The early photographically-illustrated books (of which Fox Talbot's *The pencil of nature*, London 1844, was the first) contained actual photographs mounted on the pages, and the first ink-printed photographs were pictures of works of art reproduced by means of intaglio plates for sale as prints. Daguerrotypes had been etched to make plates from which a few prints could be taken as early as 1839, but it was not until the 1850s that Fox Talbot in England and Pretsch in Vienna developed methods of photo-engraving intaglio plates that had commercial possibilities.

The appearance of Pretsch's *Photographic art treasures* (London 1856-7), which consisted of large prints made by 'photogalvanography', showed the potential of the new process. A photographic exposure was made on a surface of gelatine treated so that it reproduced the picture in negative relief,

⁷ Wakeman, G., 'Anastatic printing for Sir Thomas Phillipps', *Journal of the Printing Historical Society*, v, 1969, pp. 24-40; idem., *Aspects of Victorian lithography*, Wymondham 1970.

⁸ This section is based primarily on Eder, J. F., *History of photography*, trs. Epstean, E., New York 1944; and Gernsheim, H. and A., *The history of photography . . . up to 1914*, 2nd ed., London 1970. See also [Wood, H. T.], *Modern methods of illustrating books*, London 1887.

⁷ McLean, R., *Victorian book design & colour printing*, 2nd ed., London 1972.

⁸ Twyman, M., 'The lithographic hand press 1796-1850', *Journal of the Printing Historical Society*, iii, 1967, pp. 3-50.

tone resulting from the reticulation of the drying gelatine; the surface was then moulded in rubber, the mould was electrotyped to make a copper matrix, and this matrix was itself electrotyped to make a positive intaglio plate for printing on a copperplate press. The process was very expensive—the preparation of a plate took about six weeks—and books continued to be illustrated with actual photographs, not mechanical prints.

Experiment continued vigorously until, in 1879, Karl Klič of Vienna perfected photogravure, an extremely faithful—though still expensive—method of etching the image of a photograph directly on to a copper plate which was grained with resin dust for the reproduction of tone. Of greater relevance to ordinary printing were two later developments in which Klič was again prominent: these were the toning of the plate by interposing a net of fine lines (the half-tone screen, pp. 271-2) between the projected image and the plate; and the development of a rotary press for gravure printing on which a scraper (the doctor) removed the excess ink from the surface of the intaglio plate. Rotogravure, as the fully developed process was called, was established in 1890-5, and was used for the reproduction of the highest class of book and magazine illustrations during the rest of the machine-press period.¹¹

The 1850s also saw the appearance of photolithography, whereby a chemical film spread on the surface of a litho stone or plate was rendered insoluble and water-repellent by exposure to light; so that the image of a photograph projected on to it became the equivalent of a design in grease pencil, tone being supplied by the grain of the underlying surface. The bitumen (or asphalt) photolitho process of Lemerrier and others (1852) gave only a handful of prints from each stone, but the bichromate process of Poitevin and Lemerrier (1855) could give as many as 700 prints from a single stone, and could be used with photographic transfers. The early photolitho books of 1856-7 were again collections of reproductions of art photographs, but in 1858 there was an event of greater bibliographical significance: the production of a photolitho facsimile of a printed book. The subject was the Duke of Devonshire's copy of the first quarto of *Hamlet*, of which 40 facsimiles were photolithographed on behalf of the Duke by J. Netherclift, working under the direction of the Shakespeare scholar (and forger) J. Payne Collier. This facsimile and its twin (*Q2 Hamlet*, 1859) were remarkably well done—there was little retouching, and the results are closer to the originals than were the Griggs-Furnivall photolitho facsimiles of the 1880s—and they were moreover the forerunners of a method

¹¹ The essence of photogravure is the employment of intaglio plates, not relief blocks. There are various ways of introducing tone in photogravure, the half-tone screen now being the most usual, but the term 'half-tone' by itself means a toned relief block (pp. 271-2).

of book production that was to challenge letterpress printing itself a hundred years later. Meanwhile photolithography by the zinc-plate transfer process was firmly established in the early 1860s for the printing of maps and music.

Collotype, which was also originated by Poitevin in 1855 but not immediately developed, was a version of bichromate photolithography in which tone was given by reticulation of the gelatine in the chemical film rather than by graining the underlying surface. Collotype plates could thus be made of any smooth material to which the film would adhere (finely-ground glass was an obvious choice), and commercial versions of the process appeared in 1868-70 which offered extremely faithful reproductions of photographs but which were relatively cheap; professional photographers, indeed, who needed a hundred or more copies of a photograph in the mid 1870s found it cheaper to have them printed from a collotype plate than to print them photographically from a negative. By that time 1,500 impressions from a single plate could be printed on a hand press at the rate of 200-300 a day (finished book illustrations were available at no more than 1½*d.* each), and higher speeds were to be available in the mid 1880s from powered lithographic machinery. Colour collotypes were also introduced in the 1870s; each colour plate was made from a separate colour-filtered negative, and the suite was then printed in the same way as a chromolithograph.

The last, but from the letterpress printer's point of view the most important, of the photographic processes to appear was the photo-etching of zinc blocks in relief. In fact the earliest 'zincographs', pioneered in Paris by Firmin Gillot in the early 1850s, were not made photographically but by transferring a line drawing in a greasy and acid-resistant ink on to a zinc plate and then etching it; the ink protected the lines of the design from the acid and left them standing in relief, while the whites were etched, and subsequently routed, away so that the plate could be mounted and printed like a wood-cut. The technique was similar to that of making zinc-plate lithographs by the transfer method, the difference being in the degree to which the plate was etched, and in Paris it largely replaced wood engraving for book and magazine illustration during the 1850s. Gillot continued to be prominent in the development of the process, making zincographs with photographic transfers in the mid 1860s, and proceeding in 1872 to make a line (or process) block as we know it today, by projecting a reversed photographic negative directly on to a sensitized zinc plate and then etching out the whites. Again the plate was routed mechanically and mounted for printing.

Photo-etched blocks with tone (half-tones) soon followed. Experiments with hatched screens to divide an image into small units to give tone had been made in the 1850s, and screens were now developed for use with

photographic relief blocks by Jaffé in Vienna (1877), Horgan in New York (1880), and Meisenbach in Munich (1882). A piece of glass marked with fine crossed lines was interposed between the negative and the sensitized plate on to which it was projected. The light which penetrated the interstices of this screen made dots on the emulsion (and later on the etched plate) which varied in size according to its intensity, so that when the block was printed the dots merged in the eye of the beholder to give the effect of tone. The mesh of the screen was suited to the texture of the paper on which the block was to be printed, a screen of 30 lines per linear centimetre (about 75 lines per inch) being used for rough-surfaced newsprint, and screens of up to 70 lines per cm. (about 175 lines per inch) for coated papers.

The use of half-tone blocks in newspapers and magazines spread gradually during the period 1885-95, and by the early 1890s they were being used for book illustration as well, usually in the form of inserted plates on art paper; the same decade saw the demise of commercial wood engraving. There were also experiments in the 1890s with three-colour half-tones (three plates being made with red-, yellow-, and blue-filtered negatives, usually with the addition of a black plate for depth), and with multicolour photogravure.¹²

IDENTIFICATION

The identification of the various reproduction processes in books of the machine-press period can be difficult.¹³ Letterpress blocks (wood engravings and photo-etched relief blocks) were printed in the forme along with the type and generally show some impression on the back of the leaf. Lithographs and intaglio plates, on the other hand, were printed separately from the type, often on a different paper from the ordinary sheets, and show little or no impression on the verso (although a well-etched lithographic tint stone may show a perceptible edge). Intaglio plate marks were seldom allowed to show, but there is often a slight roughness to be felt on the surface of a picture printed from copper or steel. It is not usually possible to tell a wood engraving from an electro of an engraving, or a stone lithograph from a zinc-plate lithograph.

The detail of all but the very best photographic line blocks tends to be slightly rougher at the edges than that of wood engravings or electros of engravings. The flatness of a lithograph is apparent under a magnifying glass, and there is often a slight greyness about lithographic ink when compared with letterpress ink. The texture of a half-tone block is easily

¹² See Southward, J., *Modern printing*, iii, London 1899, chs. 17-23.

¹³ A good lens (at least $\times 10$) is an essential tool. Better still is a compound magnifier such as the Seibert Emoskop which gives magnification in the range $\times 20$ - $\times 30$.

resolved with a glass into its constituent dots, which are plainly round. Photogravure dots, on the other hand, tend to be rectangular and to string together in lines; and the photogravure screen appears under magnification as a white net. The magnified images of the dots of colour half-tone and colour gravure have similar characteristics.

The reader is warned, however, that there were various other processes of reproduction (seldom, in fact, used by book printers) which can be extremely difficult to distinguish from the major processes and from each other.¹⁴

¹⁴ Harris, E. M., 'Experimental graphic processes in England 1800-1859', *Journal of the Printing Historical Society*, iv, 1968, pp. 33-86; v, 1969, pp. 41-80; vi, 1970, pp. 53-89.