panies to acquire in-house binding and finishing equipment. However, growth in demand for specialized bindery workers who assist skilled bookbinders will be slowed as binding machinery continues to become more efficient. New technology requires a considerable investment in capital expenditures and employee training; therefore, computer skills and mechanical aptitude are increasingly important.

The small number of establishments that do hand bookbinding limits opportunities for these specialists. Experienced workers will continue to have the best opportunities.

Earnings

Median hourly earnings of bookbinders were $11.42 in 2000. The middle 50 percent earned between $9.14 and $15.71 an hour. The lowest 10 percent earned less than $7.28, and the highest 10 percent earned more than $20.11.

Median hourly earnings of bindery workers were $10.05 in 2000. The middle 50 percent earned between $7.88 and $13.27 an hour. The lowest 10 percent earned less than $6.57, and the highest 10 percent earned more than $17.22. Workers covered by union contracts usually had higher earnings.

Related Occupations

Other workers who set up and operate production machinery include prepress technicians and workers; printing machine operators; machine setters, operators, and tenders—metal and plastic; and various other precision machine operators.

Sources of Additional Information

Information about apprenticeships and other training opportunities may be obtained from local printing industry associations, local bookbinding shops, local offices of the Graphic Communications International Union, or local offices of the State employment service.

For general information on bindery occupations, write to:
➤ Bindery Industries Association, International, 70 East Lake St., #300, Chicago, IL 60601.
➤ Graphic Communications International Union, 1900 L St. NW., Washington, DC 20036. Internet: **http://www.gciu.org**

For information on careers and training programs in printing and the graphic arts, contact:
➤ Graphic Communications Council, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org/edcouncil/index.html**
➤ Printing Industries of America, 100 Daingerfield Rd., Alexandria, VA 22314. Internet:
http://www.gain.org/servlet/gateway/PIA_GATF/non_index.html
➤ Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.gatf.org**

Prepress Technicians and Workers

(O*NET 51-5021.00, 51-5022.01, 51-5022.02, 51-5022.03, 51-5022.04, 51-5022.05, 51-5022.06, 51-5022.07, 51-5022.08, 51-5022.09, 51-5022.10, 51-5022.11, 51-5022.12, 51-5022.13)

Significant Points

- Most workers train on-the-job; some complete formal graphics arts programs or other postsecondary programs in printing technology.

- Most employers prefer to hire experienced prepress technicians and workers.

- Employment is projected to decline as the increased use of computers in typesetting and page layout eliminates many prepress jobs.

Nature of the Work

The printing process has three stages—prepress, press, and binding or postpress. Prepress technicians and workers prepare material for printing presses. They perform a variety of tasks involved with transforming text and pictures into finished pages and making printing plates of the pages.

Advances in computer software and printing technology continue to change prepress work. Customers, as well as prepress technicians and workers, use their computers to produce material that looks like the desired finished product. Customers, using their own computers, increasingly do much of the typesetting and page layout work formerly done by prepress technicians and workers. This process, called "desktop publishing," poses new challenges for the printing industry. (A separate statement on desktop publishers appears elsewhere in the *Handbook*.) Instead of receiving simple typed text from customers, prepress technicians and workers get the material on a computer disk. Because of this, customers are increasingly likely to have already settled on a format on their own, rather than relying on suggestions from prepress technicians and workers. Furthermore, the printing industry is rapidly moving toward complete "digital imaging," by which customers' material received on computer disks is converted directly into printing plates. Other innovations in prepress work are digital color page makeup systems, electronic page layout systems, and off-press color proofing systems.

Typesetting and page layouts also have been affected by technological changes. The old "hot type" method of text composition—which used molten lead to create individual letters, paragraphs, and full pages of text—is nearly extinct. Today, composition work is done with computers and "cold type" technology. Cold type, which is any of a variety of methods creating type without molten lead, has traditionally used "photo typesetting" to ready text and pictures for printing. Although this method has many variations, all use photography to create images on paper. The images are assembled into page format and re-photographed to create film negatives from which the actual printing plates are made. However, newer cold type methods are becoming more common. These automate the photography or make printing plates directly from electronic files.

In one common form of phototypesetting, text is entered into a computer programmed to hyphenate, space, and create columns of text. Typesetters or data entry clerks may do keyboarding of text at the printing establishment. (See the *Handbook* statement on data entry and information processing workers.) Increasingly, however, authors do this work before the job is sent out for composition. The coded text then is transferred to a typesetting machine, which uses photography, a cathode-ray tube, or a laser to create an image on typesetting paper or film. Once it has been developed the paper or film is sent to a lithographer who makes the actual printing plate.

New technologies have had a significant impact on the role of other composition workers. Sophisticated publishing software allows an entire newspaper, catalog, or book page, complete with artwork and graphics, to be made up on the computer screen exactly as it will appear in print. Although generally this is the work of desktop publishers, which are discussed separately in the *Handbook*, improvements in packaged software allow customers to do more of their own typesetting and layout work. Operators, however, still transmit the pages for production into film and then into plates or directly into plates. "Imagesetters" read text from computer memory and then "beam" it directly onto film, paper, or plates, bypassing the slower photographic process traditionally used. In small shops, *job printers* may be responsible for composition and page layout, reading proofs for errors and clarity, correcting mistakes, and printing.

With traditional photographic processes, the material is arranged and typeset, and then passed on to workers who further prepare it for the presses. *Camera operators* usually are classified as line camera operators, halftone operators, or color separation photographers. Line camera operators start the process of making a lithographic plate by photographing and developing film negatives or positives of the material to be printed. They adjust light and expose film for a specified length of time, and then develop film in a series of chemical baths. They may load exposed film in machines that automatically develop and fix the image. The use of film in printing will decline, as electronic imaging becomes more prevalent. With decreased costs and improved quality, electronic imaging has become the method of choice in the industry.

The litographic printing process requires that images be made up of tiny dots coming together to form a picture. Photographs cannot be printed without them. When normal "continuous-tone" photographs need to be reproduced, halftone camera operators separate the photograph into pictures containing the dots. Color separation photography is more complex. In this process, camera operators produce four-color separation negatives from a continuous-tone color print or transparency.

Most of this separation work is done electronically on scanners. *Scanner operators* use computerized equipment to capture photographs or art as digital data, or to create film negatives or positives of photographs or art.. The computer controls the color separation of the scanning process, and with the help of the operator, corrects for mistakes, or compensates for deficiencies in the original color print or transparency. Each scan produces a dotted image, or halftone, of the original in one of four primary printing colors—yellow, magenta, cyan, and black. The images are used to produce printing plates that print each of these colors, with transparent colored inks, one at a time. These produce "secondary" color combinations of red, green, blue, and black which can be combined to produce the colors and hues of the original photograph.

Scanners that can perform color correction during the color separation procedure are rapidly replacing *lithographic dot etchers,* who retouch film negatives or positives by sharpening or reshaping images. They work by hand, using chemicals, dyes, and special tools. Dot etchers must know the characteristics of all types of paper and must produce fine shades of color. Like camera operators, they are usually assigned to only one phase of the work, and may have job titles such as dot etcher, retoucher, or letterer.

New technology also is lessening the need for *film strippers,* who cut the film to the required size and arrange and tape the negatives onto "flats"—or layout sheets used by platemakers to make press plates. When completed, flats resemble large film negatives of the text in its final form. In large printing establishments such as newspapers, arrangement is done automatically.

Platemakers use a photographic process to make printing plates. The film assembly or flat is placed on top of a thin metal plate coated with a light-sensitive resin. Exposure to ultraviolet light activates the chemical in parts not protected by the film's dark areas. The plate then is developed in a solution that removes the unexposed non-image area, exposing bare metal. The chemical on areas of the plate exposed to the light hardens and becomes water repellent. The hardened parts of the plate form the text.

A growing number of printing plants use lasers to directly convert electronic data to plates without any use of film. Entering, storing, and retrieving information from computer-aided equipment require technical skills. In addition to operating and maintaining the equipment, lithographic platemakers must make sure that plates meet quality standards.
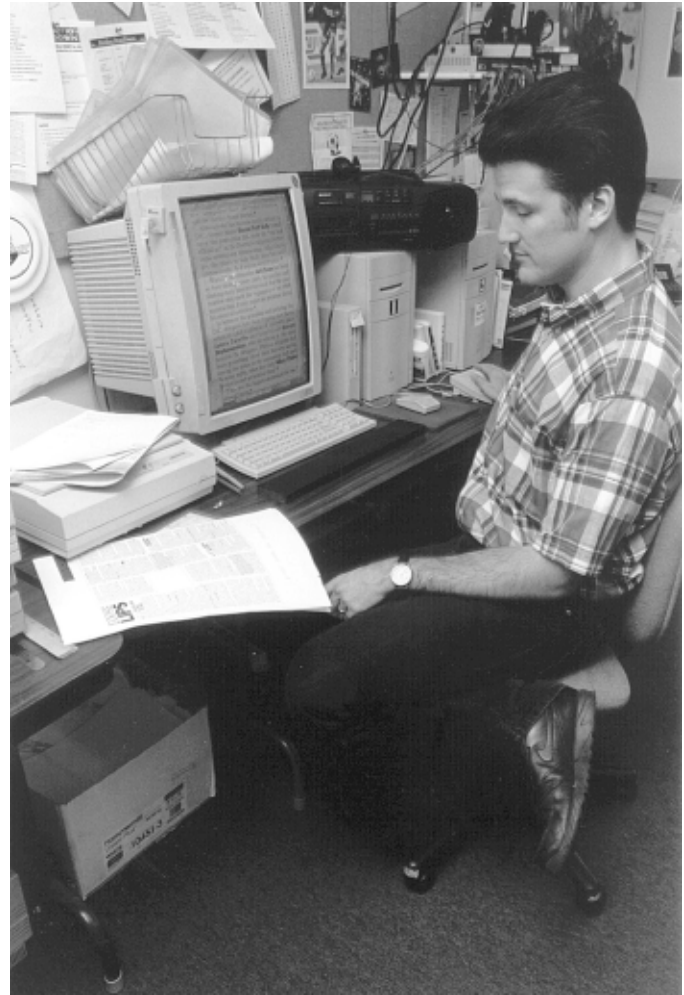
Most prepress technicians and workers train on the job; some complete postsecondary programs in printing technology.

During the printing process, the plate is first covered with a thin coat of water. The water adheres only to the bare metal non-image areas, and is repelled by the hardened areas that were exposed to light. Next, the plate comes in contact with a rubber roller covered with oil-based ink. Because oil and water do not mix, the ink is repelled by the water-coated area and sticks to the hardened areas. The ink covering the hardened text is transferred to paper.

Although computers perform a wider variety of tasks, printing still involves text composition, page layout, and plate making, so printing still will require prepress technicians and workers. As computer skills become increasingly important, these workers will need to demonstrate a desire and an ability to benefit from the frequent retraining required by rapidly changing technology.

Working Conditions
Prepress technicians and workers usually work in clean, air-conditioned areas with little noise. Some workers, such as typesetters and compositors, may develop eyestrain from working in front of a video display terminal, or musculoskeletal problems such as backaches. Lithographic artists and film strippers may find working with fine detail tiring to the eyes. Platemakers, who work with toxic chemicals, face the hazard of skin irritations. Workers often are subject to stress and the pressures of short deadlines and tight work schedules.

Prepress employees usually work an 8-hour day. Some workers—particularly those employed by newspapers—work night shifts, weekends, and holidays.

Employment

Prepress technicians and workers held about 162,000 jobs in 2000. Of these, almost 56,000 were job printers.

Most prepress jobs were found in firms that handle commercial or business printing, and in newspaper plants. Commercial printing firms print newspaper inserts, catalogs, pamphlets, and advertisements, while business form establishments print material such as sales receipts. A large number of jobs also are found in printing trade services firms and "in-plant" operations. Establishments in printing trade services typically perform custom compositing, platemaking, and related prepress services.

The printing and publishing industry is one of the most geographically dispersed in the United States, and prepress jobs are found throughout the country. However, job prospects may be best in large metropolitan cities such as New York, Chicago, Los Angeles, Philadelphia, Washington, DC, and Dallas.

Training, Other Qualifications, and Advancement

Most prepress technicians and workers train on the job; the length of training varies by occupation. Some skills, such as typesetting, can be learned in a few months, but they are the most likely to be automated in the future. Other skills, such as stripping (image assembly), require years of experience to master. However, these workers also should expect to receive intensive retraining.

Workers often start as helpers who are selected for on-the-job training programs after demonstrating their reliability and interest in the occupation. They begin with instruction from an experienced craft worker and advance based on their demonstrated mastery of skills at each level. All workers should expect to be retrained from time to time to handle new, improved equipment. As workers gain experience, they advance to positions with greater responsibility. Some move into supervisory positions.

Apprenticeship is another way to become a skilled prepress worker, although few apprenticeships have been offered in recent years. Apprenticeship programs emphasize a specific craft—such as camera operator, film stripper, lithographic etcher, scanner operator, or platemaker—but apprentices are introduced to all phases of printing.

Usually, most employers prefer to hire high school graduates who possess good communication skills, both oral and written. Prepress technicians and workers should be able to deal courteously with people, because in small shops they may take customer orders. They also may perform computations to estimate job costs. Persons interested in working for firms using advanced printing technology need to know the basics of electronics and computers. Mathematical skills also are essential for operating many of the software packages used to run modern, computerized prepress equipment.

Prepress technicians and workers need good manual dexterity, and they must be able to pay attention to detail and work independently. Good eyesight, including visual acuity, depth perception, field of view, color vision, and the ability to focus quickly, also are assets. Artistic ability is often a plus. Employers also seek persons who are even-tempered and adaptable, important qualities for workers who often must meet deadlines and learn how to operate new equipment.

Formal graphic arts programs, offered by community and junior colleges and some 4-year colleges, are a good way to learn about the industry. These programs provide job-related training, which will help when seeking full-time employment. Bachelor's degree programs in graphic arts usually are intended for students who may eventually move into management positions, and 2-year associate degree programs are designed to train skilled workers.

Courses in various aspects of printing also are available at vocational-technical institutes, industry-sponsored update and retraining programs, and private trade and technical schools.

As workers gain experience, they may advance to positions with greater responsibility. Some move into supervisory positions.

Job Outlook

Overall employment of prepress technicians and workers is expected to decline through 2010. Demand for printed material should continue to grow, spurred by rising levels of personal income, increasing school enrollments, higher levels of educational attainment, and expanding markets. However, increased use of computers in desktop publishing should eliminate many prepress jobs.

Technological advances will have a varying effect on employment among the prepress occupations. This reflects the increasing proportion of page layout and design that will be performed using computers. Most prepress technicians and workers such as paste-up, composition and typesetting, photoengraving, platemaking, film stripping, and camera operator occupations are expected to experience declines as handwork becomes automated. Computerized equipment allowing reporters and editors to specify type and style, and to format pages at a desktop computer terminal, already has eliminated many typesetting and composition jobs; more may disappear in the years ahead. In contrast, employment of job printers is expected to grow slightly because at certain times, it is more advantageous for a company to contract out this same service to a small shop. Contracting out is likely to benefit job printers because they usually are found in small shops.

Job prospects also will vary by industry. Changes in technology have shifted many employment opportunities away from the traditional printing plants into advertising agencies, public relations firms, and large corporations. Many companies are turning to in-house typesetting or desktop publishing, as personal computers with elaborate graphic capabilities have become common. Corporations are finding it more profitable to print their own newsletters and other reports than to send them out to trade shops.

Some new jobs for prepress technicians and workers are expected to emerge in commercial printing establishments. New equipment should reduce the time needed to complete a printing job, and allow commercial printers to make inroads into new markets that require fast turnaround. Because small establishments predominate, commercial printing should provide the best opportunities for inexperienced workers who want to gain a good background in all facets of printing.

Most employers prefer to hire experienced prepress technicians and workers. Among persons without experience, however, opportunities should be best for those with computer backgrounds who have completed postsecondary programs in printing technology. Many employers prefer graduates of these programs because the comprehensive training they receive helps them learn the printing process and adapt more rapidly to new processes and techniques.

Earnings

Median hourly earnings of prepress technicians and workers were $14.57 in 2000. The middle 50 percent earned between $10.70 and $19.12 an hour. The lowest 10 percent earned less than $8.20, and the highest 10 percent earned more than $23.57 an hour. Median hourly earnings in commercial printing, the industry employing the largest number of prepress technicians and workers, were $15.26 in 2000.

Median hourly earnings of job printers were $13.61 in 2000. The middle 50 percent earned between $10.00 and $17.67 an hour. The lowest 10 percent earned less than $7.81, and the highest 10 percent earned more than $21.88 an hour. Median hourly earnings in commercial printing, the industry employing the largest number of job printers, were $14.68 in 2000.

Wage rates for prepress technicians and workers vary according to occupation, level of experience, training, location, and size of the firm, and whether they are union members.

Related Occupations

Prepress technicians and workers use artistic skills in their work. These skills also are essential for artists and related workers, etchers and engravers, designers, and desktop publishers. In addition to typesetters, other workers who operate machines equipped with keyboards include data entry and information processing workers.

Sources of Additional Information

Details about apprenticeship and other training programs may be obtained from local employers such as newspapers and printing shops, or from local offices of the State employment service.

For information on careers and training in printing and the graphic arts, write to:

➤ Printing Industries of America, 100 Daingerfield Rd., Alexandria, VA 22314. Internet: **http://www.gain.org/servlet/gateway/PIA_GATF/non_index.html**

➤ Graphic Communications Council, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org/edcouncil/index.html**

➤ Graphic Communications International Union, 1900 L St. NW., Washington, DC 20036. Internet: **http://www.gciu.org**

➤ Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.gatf.org**

Printing Machine Operators

(O*NET 51-5023.01, 51-5023.02, 51-5023.03, 51-5023.04, 51-5023.05, 51-5023.06, 51-5023.07, 51-5023.08, 51-5023.09)

Significant Points

- Most are trained informally on the job.
- Employment growth will be slowed by the increasing use of new, more efficient computerized printing presses.
- Jobseekers are likely to face keen competition; opportunities should be best for persons who qualify for formal apprenticeship training or who complete postsecondary training programs.

Nature of the Work

Printing machine operators prepare, operate, and maintain the printing presses in a pressroom. Duties of printing machine operators vary according to the type of press they operate—offset lithography, gravure, flexography, screen printing, or letterpress. Offset lithography, which transfers an inked impression from a rubber-covered cylinder to paper or other material, is the dominant printing process. With gravure, the recesses on an etched plate or cylinder are inked and pressed to paper. Flexography is a form of rotary printing in which ink is applied to the surface by a flexible rubber printing plate with a raised image area. Gravure and flexography

should increase in use, but letterpress, in which an inked, raised surface is pressed against paper, will be phased out. In addition to the major printing processes, plateless or nonimpact processes are coming into general use. Plateless processes—including electronic, electrostatic, and ink-jet printing—are used for copying, duplicating, and document and specialty printing, usually by quick and in-house printing shops.

To prepare presses for printing, machine operators install and adjust the printing plate, adjust pressure, ink the presses, load paper, and adjust the press to the paper size. Press operators ensure that paper and ink meet specifications, and adjust margins and the flow of ink to the inking rollers accordingly. They then feed paper through the press cylinders and adjust feed and tension controls.

While printing presses are running, press operators monitor their operation and keep the paper feeders well stocked. They make adjustments to correct uneven ink distribution, speed, and temperatures in the drying chamber, if the press has one. If paper jams or tears and the press stops, which can happen with some offset presses, operators quickly correct the problem to minimize downtime. Similarly, operators working with other high-speed presses constantly look for problems, making quick corrections to avoid expensive losses of paper and ink. Throughout the run, operators occasionally pull sheets to check for any printing imperfections.

In most shops, press operators also perform preventive maintenance. They oil and clean the presses and make minor repairs.

Machine operators' jobs differ from one shop to another because of differences in the kinds and sizes of presses. Small commercial shops are operated by one person and tend to have relatively small presses, which print only one or two colors at a time. Operators who work with large presses have assistants and helpers. Large newspaper, magazine, and book printers use giant "in-line web" presses that require a crew of several press operators and press assistants. These presses are fed paper in big rolls, called "webs," up to 50 inches or more in width. Presses print the paper on both sides; trim, assemble, score, and fold the pages; and count the finished sections as they come off the press.

Most plants have or will soon have installed printing presses with computers and sophisticated instruments to control press operations, making it possible to set up for jobs in less time. Computers allow press operators to perform many of their tasks electronically. With this equipment, press operators monitor the printing process on a control panel or computer monitor, which allows them to adjust the press electronically.

Printing machine operators prepare, operate, and maintain the printing presses in a pressroom.