1.2 Production of Print Media

As shown in figure 1.2-1, the *production flow* involved in the production of print media comprises the stages of *prepress*, the actual *printing process* (press) itself, and *finishing* (postpress). These individual production stages are connected by the *flow of materials*, such as printing plates between prepress and press and printed sheets between press and postpress. Interconnection between the production stages has become increasingly marked by the *data flow*. Information is exchanged both for the actual production of special printed products and for the organization of the business and the production cycles. Information and data are an essential requirement for the optimal and reliable functioning of individual production processes

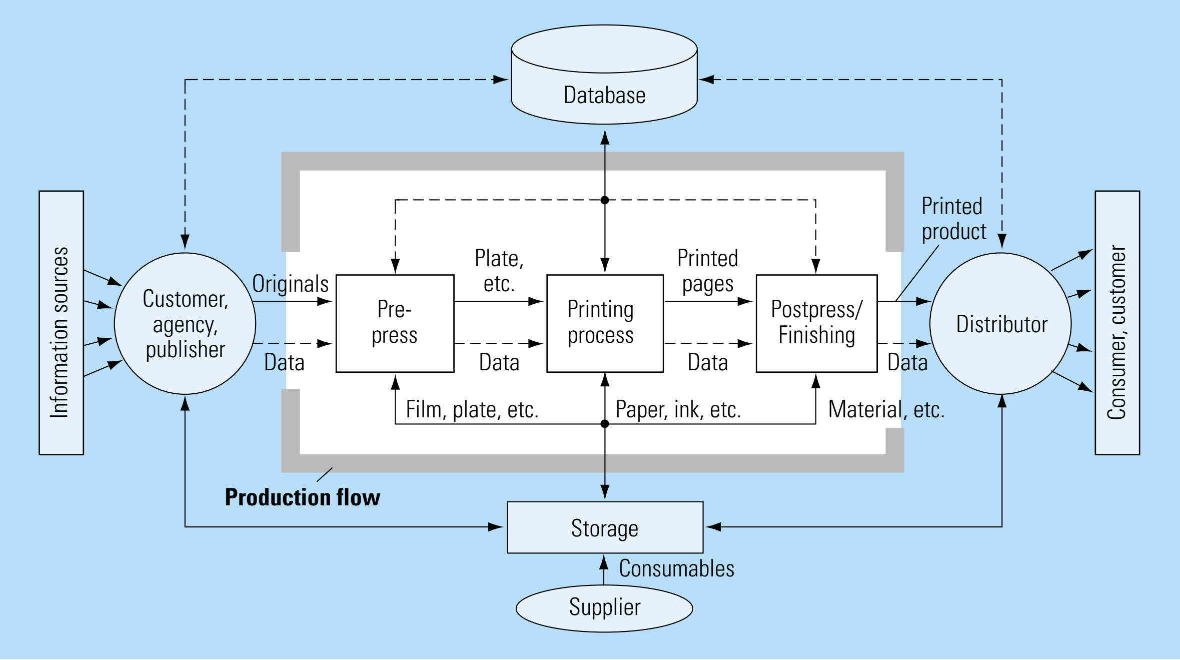


Fig. 1.2-1 Production flow, material and data flow for print media production

and equipment, and for efficient, high-quality, and economic production.

Figure 1.2-1 shows that the content, layout, and form of the printed product are based on information in the form of originals and also particularly on data. Figure 1.2-1 also depicts how the printed product is delivered via the distribution system to the end-user/consumer; here, too, organization and distribution benefit from the data technology.

The production chain of prepress, press, and postpress is logistically interlinked through storage areas for the materials needed for the production as well as by storage areas for the semi-finished and end products of the printing job. The use of efficient production management and archive systems for data to link and support all the manufacturing stages in the creation of printed products is becoming increasingly the state of the art.

The individual stages and areas involved in the production of printed matter are explained below. Full descriptions with numerous details will be found in later sections of the book.

The quality of a printed product is ultimately determined by its content, effect, and benefit to the client/consumer. The visual quality is obviously affected by high-grade processes and procedures for producing the print media. However, it is to a large extent determined by the *conception of the print medium* in text, graphics, and pictures, the representational form of the contents, that is, by *layout*, *typography*, and *graphic design*.

Before going into the actual production process – the economical and high quality duplication of information through printing tailored to the customers and the market – we will describe the rudiments of design.

1.2.1 Layout, Typography, Graphic Design

The development of type, typography, and graphic design is an important part of the history of culture as a whole. Although knowledge of other spheres of culture such as painting, music, and literature is much more widespread, it is the symbols constituting language that make communication and the dissemination of knowledge throughout the world possible. These three areas are inextricably linked: *type* is an essential element of *typography* and typography is (besides illustration and photography) an essential part of *graphic design*. Each of these means of communication and design has its own subtly different historical development, which can provide detailed insights into the whole of human development from a historical, technical, and aesthetic perspective.

1.2.1.1 Type

Origin of Type

Type first developed over the course of time as a magical feat on man's journey out of the unknown. It was a *pictographic system* of type that probably grew out of the human craving for knowledge and communication. These pictographic symbols lacked accuracy and precision, they were ciphers in need of interpretation. As human understanding grew deeper and more refined, so too did the need to design and set down clearer, more universal and accessible codes.

Pictographic system was followed by *logograms*, which were derived from the sound of the spoken word (fig. 1.2-2). Each word had its own symbol, and the more distinctive and developed a spoken language was, the greater the number of symbols it had. There were well developed writing systems in China, India, Egypt, Mesopotamia and some other countries.

Around 3000 BC the Sumerians developed *cuneiform script*, a syllabic writing system made up of about six hundred characters. The next decisive step was the de-

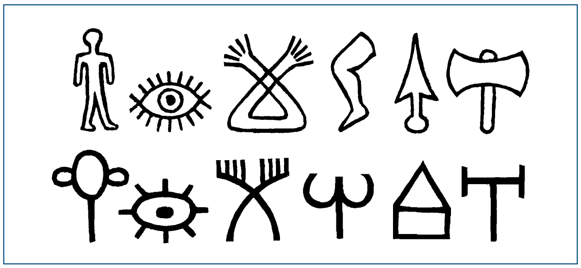


Fig. 1.2-2 Minoan hieroglyphs (above), Minoan linear type (below)

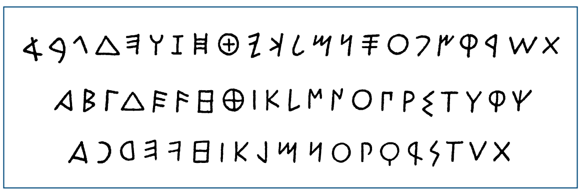


Fig. 1.2-3
Alphabets (Phoenicia, Greece, Rome; sixth to third centuries BC)

velopment of the *consonant alphabet* by the Phoenicians around 1400 BC. This alphabet consisted of twenty-two letters. It was derived as a simplified version of Egyptian hieroglyphs and Babylonian cuneiform script. The Phoenician alphabet (fig. 1.2-3) formed the basis of all European writing systems.

Around 1000 BC the Greeks adopted Phoenician script and introduced the symbols a, e, i, o, and u. The Roman alphabet was based on this development by the Greeks. The Roman capital script "Capitalis monumentalis" was developed (fig. 1.2-4), the increasing use of which led to the formation of the first *lower case type*. These early centuries AD also saw the move away from scrolls to the form of books still in use today.

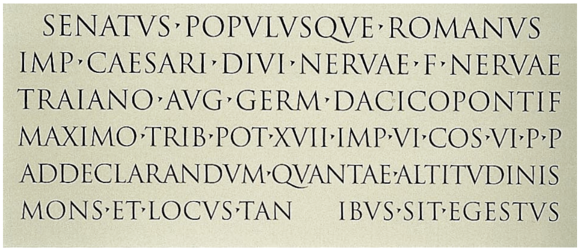
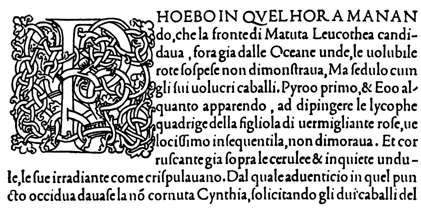


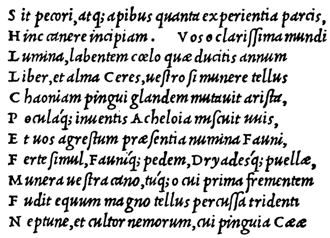
Fig. 1.2-4
Roman capitals "Capitalis monumentalis"; alphabet on the plinth of Trajan's column in Rome (AD 113)

The Middle Ages (fourth to fifteenth centuries) was a time of extensive writing and design. The carriers of written characters and text were clay, stone, wood, silk, papyrus, and then parchment. In the 7th century *paper* from China reached the Middle East, and from there Spain and the rest of Europe. The invention of duplicable printing first in China (c. 870), then in Korea with *movable metal type* (c. 1403), and finally Gutenberg's technical developments in letterpress printing (c. 1440) heralded a new era of communication, replacing the hitherto handwritten one-off texts which required rewriting in order to be passed on.

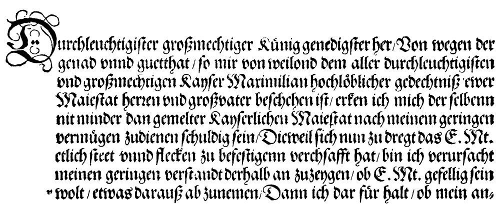
While at first old types were simply molded in lead for the new technology, new *typefaces* soon developed which have retained their formal elegance and character as model typefaces to this day: important designs originate from Claude Garamond (1480–1561), Nicolas Jenson (1420–1480), and Aldus Manutius (1459–1515). Soon after Gutenberg's invention two distinct technical concepts regarding typeface co-existed in parallel: the Roman types Antiqua and Cursive, and the broken types Fraktur, Gothic, and Schwabacher (fig. 1.2-5). From these basic forms, which were derived from the handwritten script, thousands of different typefaces were developed that had slight but important differences between them. Technical innovations as well as the quest for aesthetic improvements each led to yet more variants.

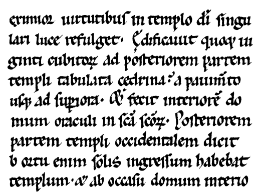
Fig. 1.2-5 Types.
a Roman types: Antiqua and Cursive;
b Broken types: Fraktur and Gothic





a) Roman typefaces:
Antiqua
Cursive





b) Broken typefaces:
Fraktur
Gothic

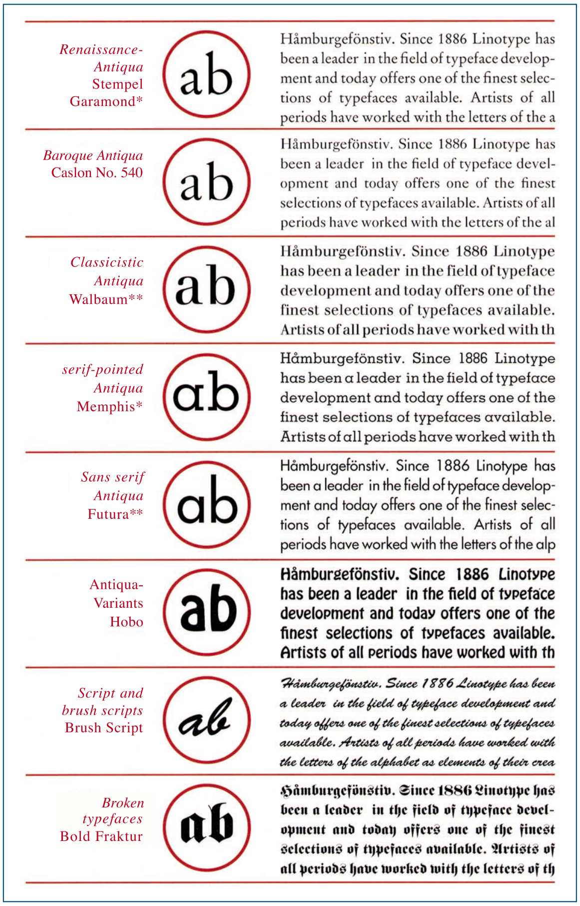


Fig. 1.2-6
Classification of typefaces (examples from DIN 16518, engl. version available)

Classification of Typefaces

The classification of typefaces formulated in 1964 (DIN 16518) allows the technical differences of all typefaces to be grouped into eleven distinct styles (see also examples of type in fig. 1.2-6):

1. Venetian Renaissance-Antiqua (Venitian)
2. French Renaissance-Antiqua (Old Face)
3. Baroque-Antiqua (Transitional)
4. Classical-Antiqua (Modern Face)
5. Serif-pointed Linear Antiqua (Slab Serif)
6. Sans Serif Linear Antiqua
7. Roman Variants (Decorative and Display)
8. Script
9. Handwritten Antiqua (Handwriting)
10. Broken types
11. Foreign types (non-Latin, non-Roman).

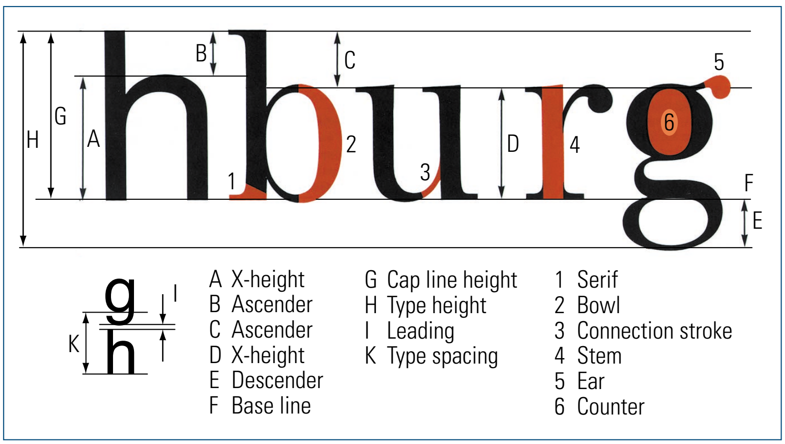
Even the latest typefaces may be technically understood and classified using these groups. At present there is a new amended DIN classification in preparation, the content of which is, however, still under discussion.

The basic construction of letters with their corresponding descriptions is shown in figure 1.2-7. The construction of letters in digital form is explained in section 3.1.1.3 and figure 3.1-2.

Design of Typefaces

Despite the numerous alphabets in existence, surprising new typefaces continue to be invented whose form best fits the spirit of their age. Some of the most important designers of the past were Anton Janson

Fig. 1.2-7
Construction of letters and naming of elements



(1620–1687), William Caslon (1692–1766), John Baskerville (1708–1775), Giambattista Bodoni (1740–1813), and Justus Erich Walbaum (1768–1837). Important typeface designers of the twentieth century were Emil Rudolf Weiss (1875–1942) with Weiss Antiqua and Weiss Gothic, Rudolf Koch (1876–1934) with Wallau and Cable, Paul Renner (1878–1956) with Futura and Plaque, Eric Gill (1882–1940) with Gill and Perpetua, Georg Trump (1896–1985) with City and Delphin, Karlgeorg Hoefer (1914–2000) with Salto and Permanent, Hermann Zapf (b. 1918) with Palatino and Optima, and Günter Gerhard Lange (b. 1921) with Arena and Concorde.

Among the typeface designers who create today's significant and widely used alphabets are Hans Eduard Meier (b. 1922) with Syntax and Syndor, Ed Benguiat (b. 1927) with Souvenir and Barcelona, Adrian Frutiger (b. 1928) with Meridien and Frutiger, Matthew Carter (b. 1937) with Galliard and Bitstream Charter, and Gerard Unger (b. 1942) with Swift and Gulliver. In the immediate present the new designs of Hermann Zapf and Adrian Frutiger are receiving particular attention. With his Zapfino typeface (1998), Zapf developed a calligraphic typeface that has achieved surprising technical versatility in this group of typefaces (fig. 1.2-8) by drawing on the possibilities of computer technology.

Frutiger's typeface Univers (fig. 1.2-9) was developed during the years 1953 to 1957 and became a classic of the modern age. In 1997 it was revised within the Linotype Library as Linotype Univers with 59 type styles (up to then, there were 21 type styles), making it all the more versatile in use.

Despite all the changes and advantages brought by technology compared to the Middle Ages, the design of typefaces is still a process which has lost nothing of the seriousness of the original way of thinking, of knowing what constitutes technical and aesthetic quality, and of the need to familiarize oneself with the essential elements of symbols for communication. Only few designers have so far succeeded in achieving the highest quality with their typefaces.

Besides Western typefaces (see DIN 16518 classification), there is an extremely large group of non-Latin, foreign types that have developed in their own way and have highly elaborate technical requirements: among others, there are Greek, Cyrillic, Hebrew, Arabic, Chinese, or Japanese types, which, with slight differences in typeface design, represent the languages of those regions and provide a diverse range of alphabets permitting typographic forms rich in detail (fig. 1.2-10).

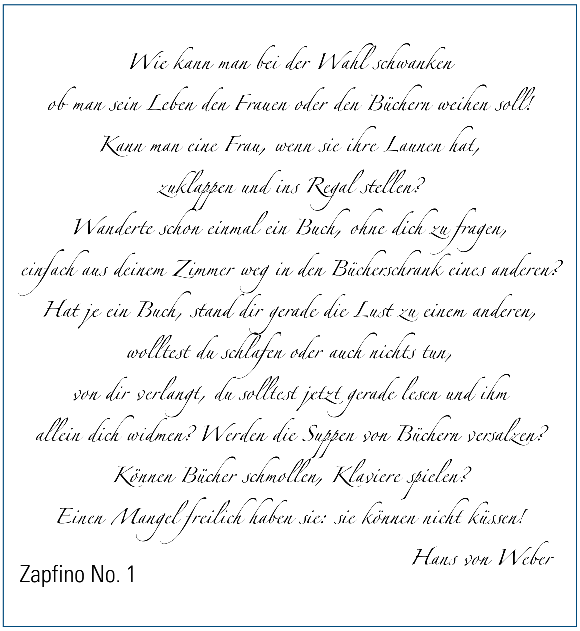


Fig. 1.2-8
Zapfino of Hermann Zapf (1998); Zapf wrote this text in his notebook in 1944; the characters were the beginnings of Zapfino

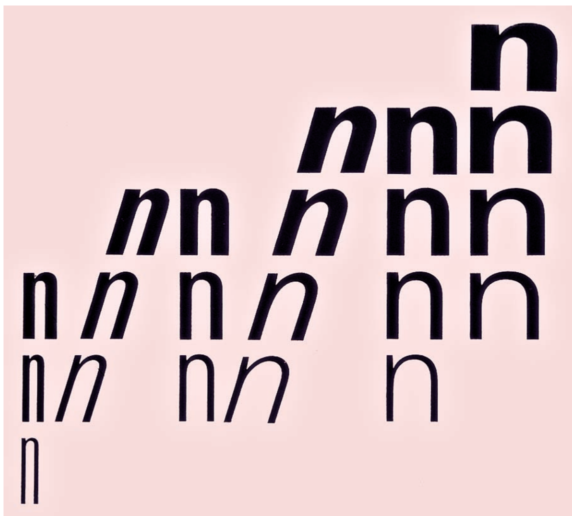


Fig. 1.2-9
Univers of Adrian Frutiger; examples of the various type designs (around 1955)

體育之宜提倡人盡皆知以其
能增進健康也德國各學校各

Chinese

מַה־נִּשְׁתַּנָּה הַלַּיְלָה הַזֶּה מִכָּל־הַלֵּילוֹת שֶׁבְּ
הלילות אָנוּ אוֹכְלִין חָמֵץ וּמַצָּה הַלַּיְלָהכל

Hebrew

وان كانت مسلوية لها فان الزاوية ايضا مساوية وان
كانت ناقصة فالزاوية لكن قرس اضعاف لقرس وقوس

Arabic

Функциональные системы управления и автоматизации листовых офсетных машин фирмы Heidelberg

Cyrillic

Fig. 1.2-10 Examples of non-Latin script

- **Point** system (**DTP**-point)
  (mainly used nowadays)
  1 pt = 1/72 Inch = 0.353 mm
  12 pt = 1 Pica = 4.23 mm
  6 Pica = 1 Inch
- **Point** system (**Pica** system)
  1 pt = 0.351 mm
  12 pt = 1 Pica = 4.21 mm
- **Didot** system in photosetting
  (Franco-German standard system), [lead type]
  1 p = 0.375 mm [0.376 mm]
  12 p = 1 c (Cicero) = 4.5 mm [4.51 mm]

Fig. 1.2-11
Comparison of typographic and metric systems of measurement

1.2.1.2 Typography

Type in its various forms is a fundamental requirement of typography. To put it simply, typography is basically the *design of printed text* using and arranging typefaces to create continuous text on a printed page. The selection of available typefaces used to portray texts and textual content and the layout of words and texts on pages or other text carriers such as boards and signs is an area of design requiring many years of apprenticeship or study, followed by consistent practice for purposes of refinement, improvement, or change.

All printing elements such as text or lines, but also the non-printing segments such as empty areas or spaces, have their own measuring system, the *point system* (fig. 1.2-11). It was developed in 1795 by Francois Ambroise Didot and his son Firmin. One point (pt) measures about 0.38 mm. One Cicero corresponds to 12 points or 4.5 mm. In Anglo-American countries the unit pica/point is used, which, at about 4.2 mm, is smaller than the Franco-German system.

Choosing the individual *design elements* for the typographical job at hand is done by selecting from a system consisting of many interrelated parts. As with all design problems, there are no hard and fast rules for making this selection, but only approximations gained from experience, which can vary over time and from different perspectives. The designer's ability to interpret form is very important in choosing the font. The Linotype FontExplorer can be very helpful in this respect. This new typeface browser enables selection of the correct fonts according to many design criteria.

It is apparent that the sensitive use of typeface determines the quality of the typography and that a fresh approach must be used for every job. After the choice of *font* comes the setting of the *font sizes* (fig. 1.2-12) for the various parts of the text, the setting of the *type styles* (e.g., light, regular, or semi-bold), and the *inclination* (e.g., normal or italic). The font color and style (e.g., upper case, lower case, mixed) must also be determined.

Once these have been decided it is necessary to establish the *text structure*: how far apart the individual lines are, what degree of line spacing (leading) there will be, what column width should be set and which *justification* will be selected. There is a distinction between justified (fig. 1.2-13a), unjustified (fig. 1.2.-13b), and centrally justified. It is important to establish whether each of the text paragraphs is to have an *indent*.

A few of the recommendations for good, *legible typography* indicate what the basic problems of design are: there should be a maximum of around 60 characters per line and around 40 lines per page. Lengthy texts should be set no smaller than 9 point and no larger than 11 point. The leading (line spacing minus size of type height) should be 2 point.

4 pt Palatino	ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890.,:;“‘[]{}£$!?&
6 pt Palatino	ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890.,:;“‘[]{}£$!?&
8 pt Palatino	ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890.,:;“‘[]{}£$!?&
10 pt Palatino	ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890.,:;“‘[]{}£$!?&
12 pt Palatino	ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890.,:;“‘[]{}£$!?&
14 pt Palatino	ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890.,:;“‘[]{}£$!?&

Fig. 1.2-12 Example of type sizes in Palatino

The Dover road lay, as to him, beyond the Dover mail, as it lumbered up Shooter’s Hill. He walked uphill in the mire by the side of the mail as the rest of the passengers did, not because they had the least relish for walking exercise, under the circumstances, but because the hill, and the harness, and the mud, and the mail, were all so heavy, that the horses had three times already come to a stop, besides once drawing the coach across the road, with the mutinous

a

The Dover road lay, as to
him, beyond the Dover mail,
as it lumbered up Shooter’s
Hill. He walked uphill in the
mire by the side of the mail
as the rest of the passen-
gers did, not because they
had the least relish for
walking exercise, under the
circumstances, but because
the hill, and the harness,
and the mud, and the mail,
were all so heavy, that the
horse had three times
already come to a stop,
besides once drawing the

b

Fig. 1.2-13 Layout.
a Justified;
b Unjustified

The technical requirements of lead type and the typesetting system created for it determined to a large extent the form typography was to take. As a rule right angle designs with horizontal lines were created. Various aesthetic ideas repeatedly gave rise not only to new typefaces but also novel typographical styles.

The twentieth century saw the appearance of historically oriented shapes (figs. 1.2-14 and 1.2-15) and expressionist and pictorial styles. There were functional and elemental styles, as well as experimental fads such as psychedelic or punk typography (figs. 1.2-16 to 18). Typography used graphic and pictorial elements as typefaces or alternatively created pictures using lettering. However, the basic typographic styles for reading matter have not changed since Gutenberg’s time, but have been continually refined.

Layout and Typography of the Present Book

The technical construction of the present book was established at the planning stage by making various mutually compatible decisions about the design. Taking this as an example the extracts show the best methods of designing a book to optimize its legibility and aesthetic impact.

Typefaces

Basic Typeface/Body Type:
Springer Minion Plus Regular, 10/11.3 pt (type size/ line spacing);
for marking (emphasis): Springer Minion Plus Italic, 10/11.3 pt.

Headings:
Linotype Univers Condensed Bold, in color (similar to Pantone 647c),

Fig. 1.2-14
Cover page of the trade journal Graphische Technik (July 1940)

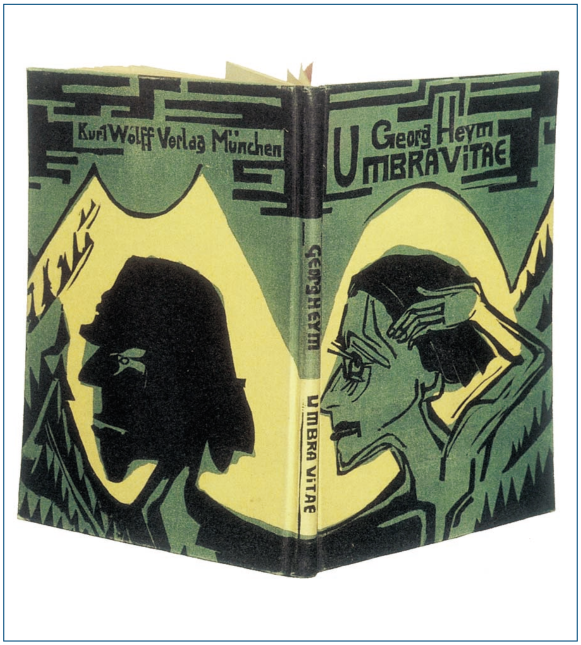


Fig. 1.2-16 Expressionist book jacket (Ernst Ludwig Kirchner 1924)

Fig. 1.2-15
Cover page of price list done in Art Noveau (approx. 1900)

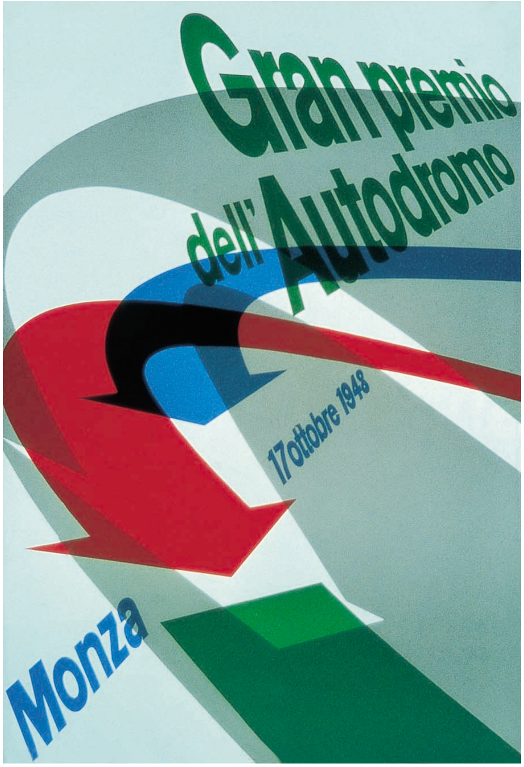


Fig. 1.2-17
Event poster with functional elements for representing the content (Max Huber 1948)

Fig. 1.2-18
Psychedelic poster for a concert from the flower-power movement (Wes Wilson 1966)

First-Level (title):	36/36 pt;
Second-Level:	18/19 pt;
Third-Level:	12/13 pt;
Fourth-Level:	10/11.3 pt.

Headers (Headings without Order Numbers):
First-Level: Linotype Univers Condensed Bold, 10/11.3 pt, black;
Second-Level: Springer Minion Plus Bold, 10/11.3 pt.

Numbering of Figures and Tables:
Linotype Univers Condensed Bold, 9/9.5 pt, in color.

Figure Inscriptions:
Linotype Univers Condensed Light, 9/9.5 pt, black.

Typeface for Captions:
Linotype Univers Condensed Light, 9/9.5 pt, black.

Column Lines/Running Head:
Linotype Univers Condensed Light, 9/9.5 pt, in color.

Special Typefaces:
Springer Symbol, Heidelberg Symbol.

Page Layout

The text is set justified on the base line grid in two columns; highlights are italicized; paragraphs start with a 3 mm indent in the first line.

A bullet is used as the first-level numbering symbol; a dash (en rule) is used as the second-level numbering symbol. There is an empty line spacing before and after a list. The following paragraph is not indented.

Besides pure typeface decisions all other aspects of the book were also determined:

Fig. 1.2-19 Illustrative poster (Jules Cheret 1893)

- the page format (193 mm × 242 mm),
- the type area with two columns (156 mm × 200 mm),
- the column width (76 mm).

The figures are preferably single column, double column, or 1.5 column width; the frames are 100% colored and 0.4 pt thick (for figures without a background), all figures with a background (e.g., photographs) remain frameless; pictures are centered within the frame.

Figure captions appear below the figure and are set justified; for 1.5 column width figures they are next to the figure and unjustified; the distance between the caption lines and the edge of the picture is 3 mm.

The figure number stands on its own if the caption text is longer than one line, otherwise it is at the beginning of the line without a following period. The part-figure designations (a, b, c, etc.) are printed black and in bold. They are always placed on their own line.

1.2.1.3 Graphic Design

For many centuries design was of a conservative nature and governed mostly by religious content. The demand for consumer goods that increasingly accompanied the expanding economic systems after the French and particularly the industrial revolutions led to an avalanche of printed matter. Up to the late nineteenth century, designs were mostly black and white, printed on paper, and relatively rare. In the twentieth century printed products such as posters, advertisements, prospectuses, magazines, and of course books, became important media and were widely distributed. This meant that information had to be continually designed to attract attention. This was achieved through long print runs, large formats, a striking amount of color, but also topical subjects. Photographs soon came to be used as well as illustrations.

Design in the Twentieth Century

The first high points of this new age were the great number of artistic-illustrative posters of surprising design produced by designers such as Henri de Toulouse-Lautrec, Jules Cheret, Eugène Grasset and A. A. Mucha (fig. 1.2-19). These designers were situated between the fine and applied arts, between the personal and general form. Informational subject matter also increased: the design of packaging, direction indicators, forms, charts, and corporate literature became tasks that no longer had to be solved with ardent artistic feeling but with clear conceptual designs.

It was the American William Addison Dwiggins who in 1922 first used the professional title "Graphic Designer" to describe more accurately the new type of designer, who was no longer to be an artist in the traditional sense. This title describes someone who has specialized in the *design of visual communication* and brings together the design tools of typography, illustration, photography, and printing with the aim of informing, teaching, or influencing. The term soon caught on.

The development of graphic design was influenced from widely divergent directions. On the one hand there were the traditionalists, who created designs using traditional artists' tools. On the other hand methods using new ideas of form and content arose, which made this new area of design an unmistakable part of twentieth century culture. The greatest contribution to this was the work of the "Bauhaus", a design school in Germany (fig. 1.2-20). The teachings of this school, which was in existence from 1919 to 1933, were further developed in Switzerland (fig. 1.2-21). After

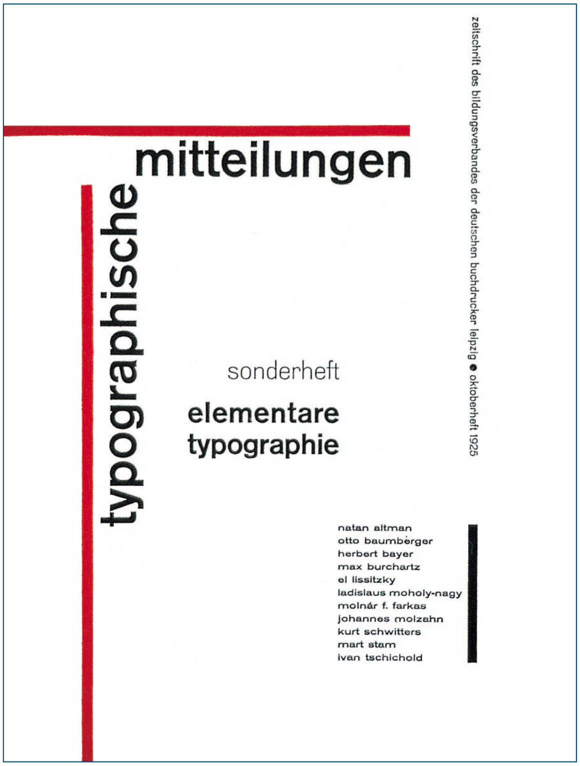


Fig. 1.2-20
Magazine cover in elemental design (Jan Tschichold 1925)

Fig. 1.2-21
Concert poster in the style of "Swiss typography" (Josef Müller-Brockmann 1960)

1945, exemplary achievements from the USA transformed this European development into the varied and differentiated field which characterizes graphic design in the world today (fig. 1.2-22).

1.2.2 Prepress

Prepress includes all the steps which are carried out before the actual printing, the transferring of information onto paper or another substrate (fig. 1.2-23). Traditional prepress is divided into three areas:

- *composition*, that is, recording text, formatting text, and pagination;
- *reproduction* of pictures and graphics, and particularly color separations for multicolor printing;
- *assembly and platemaking*, i.e., the assembly of text, picture, and graphic elements into complete pages, (page layout/make-up), from pages to print sheets,

Fig. 1.2-22
Advertisement for a magazine in contextual text-picture combination (Gene Federico 1953)

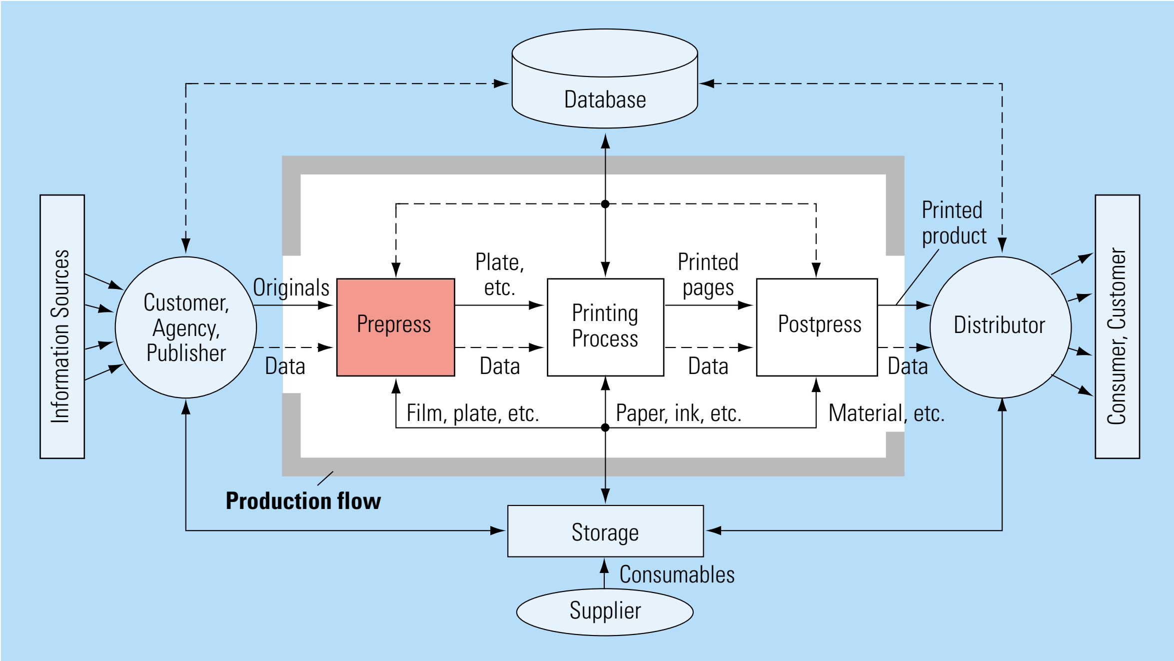


Fig. 1.2-23 Prepress in the production flow for the generation of printed products

and also the making of the printing plate as the vehicle of information in the printing press (fig.1.2-24).

Chapter 3 gives a detailed description of both so-called conventional prepress (sec. 3.1) and digital prepress (sec. 3.2).

Composition Technology

For centuries *composition technology* was dominated by the pioneering invention of Gutenberg – the letterpress with movable type. This process remained practically unchanged from the fifteenth until the end of the nineteenth century. Letters molded from lead were assembled into words, lines, and blocks of text (manual typesetting). Composition only became mechanized towards the end of the nineteenth century in the wake of industrialization. In 1885 Ottmar Mergenthaler developed a line casting machine, which became known by its trade name "Linotype." It made it possible to compose whole lines of matrices by means of a keyboard and to fill them with molten lead. This machine dominated composition until the 1960s – along with "Monotype", which operated in a similar way but produced individual letters, and the still indispensable manual typesetting.

Fig. 1.2-24
Prepress with conventional film stripping and digital master preparation (text, images, graphics) with EDP systems

As quicker and more effective printing technologies began to replace letterpress, particularly offset and gravure printing, the traditional lead composition was improved by innovations. *Photocomposition* began to be developed in the 1940s – at first, as an analog process, in which text was exposed letter by letter onto film through matrices. The breakthrough for photocomposition, and with it the decline of lead composition, first came at the beginning of the 1970s with *digital photocomposition systems*. This involved the transfer onto film of lines of text entered via a keyboard into the processor of a computer by means of cathode ray tubes and later by laser.

Pictures and Graphics

In the early days pictures and graphics were integrated in printed products in the form of woodcuts, and copper and steel engravings. *Reproduction technology* in the modern sense did not come in until the end of the nineteenth century as photographic procedures made it possible to capture pictures on film and to screen them, that is, to break them up into small dots. (*Screening* is necessary because with conventional printing technologies it is only possible to produce solid tints and not continuous tones. The continuous tone effect is simulated for the human eye by printing a number of tiny halftone dots of varying sizes next to one another.) An extra step with multicolor printing is the *separation of colors*, that is, the breaking down of color photos into the process colors used for the print (usually cyan, magenta, yellow, and black).

In *letterpress printing* the screened and separated film served first as an original for etching a relief in a metal surface (plate or printing block) from which prints were made. In *offset printing* the films can be used directly for platemaking. To check color reproduction quality before printing, a test print or proof can be made. This proof is produced photomechanically from the color separation films and simulates the result of the printing process.

In the 1970s the *scanner* emerged, which is used to optoelectronically scan, separate in colors, and screen originals and either directly record them on film by laser or first store them as digital data for further processing in a image processing system. Figure 1.2-25 shows a scanner for producing color separations, such as the ones for a four-color print shown in figure 1.2-26.

Fig. 1.2-25 Drum scanner for image capture (Tango, Heidelberg)

Platemaking

The task of platemaking is to assemble text, pictures, and graphics into pages and pages into sheets. Since the printing formats of most printing presses are essentially larger than the page format of the printed product, several pages are almost always printed on one sheet. The next step is to produce the plate for the particular printing technology.

The image carriers used for letterpress printing were traditionally made by combining blocks of text (consisting of individual letters or lines that were prepared in typesetting) and the blocks from reproduction to produce large metal forms. The platemaking for letterpress printing “flexography” is discussed in detail in section 2.3.3.

For offset printing the process films (text, graphics, and pictures) in accordance with the page arrangement are first mounted onto a film in the size of the printing format (offset assembly). The assembly then serves, at the subsequent stage for the purposes of photographic image transmission onto an offset plate in a contact method (offset platemaking). At the next stage the plate

Fig. 1.2-26
Color separations for four-color printing (Heidelberg)

serves as the image carrier for the offset press. In every printing technology a plate must be produced for each color to be printed.

Figure 1.2-24 shows how conventional methods (film assembly) as well as computer systems are used for artwork preparation (text, image, graphics) in prepress. Figure 1.2-27 shows how film assembly is set in the copying frame for platemaking in conventional copying process. Both films or plates can also be exposed using digital systems directly based on digital data, as is explained later.

For gravure printing, so-called Helioklischographs have been in use since the 1970s to make printing plates. Here, the films are mounted on the copy drum and the signals produced by an optoelectronic scanning head are transmitted to control an engraving stylus. This simultaneously engraves the image onto a copper cylinder which serves as the image carrier for gravure printing.

Fig. 1.2-27
Positioning of the film assembly in the copying frame for platemaking (Heidelberg)

Digital Prepress

Through innovations aimed at achieving digital prepress, an evolutionary change has taken place since the end of the 1980s in prepress which has almost entirely eliminated the classical division into the three areas of composition, reproduction, and platemaking.

During the 1980s, desktop publishing (DTP) became a serious alternative in prepress. This came as a result of the development of personal computers (PC) with full graphic capacity (e.g., Apple Macintosh), workstations, professional layout, graphic, and image processing software, the page description language PostScript, and high-resolution laser imagesetters with raster image processors (RIP).

Desktop publishing means that the capture and editing of text, the capture of pictures (scanning) and their editing, and designing of graphic elements, as well as the completing of pages (layout) can be carried out at one computer station. Used together with an output unit (imagesetter) the PC can also carry out color separations and screening of the finished pages, so that the whole page is exposed on a film (full-page film).

Obviously there are also programs for the digital sheet assembly which take over imposition and the positioning of printing aids (register marks, cutting marks, etc.). With the help of a large-format imagesetter, films can also be produced in the format of the printing press. *computer to film technology* is the state of the art.

At the beginning of the '90s DTP took over the prepress almost overnight and has now almost completely replaced the specialized composition and image editing systems as well as photomechanical reproduction. Since around 1995 (even earlier for gravure printing), *computer to plate technology* (CtP) has played an increasingly important role. CtP means that the printing plate is imaged directly and the intermediate step of imaging a film is abandoned. In gravure, the cylinder is directly engraved using digital information. A further step in the production flow is therefore eliminated and ultimately all the prepress steps are carried out from a single computer workstation. There are already offset printing presses that use integrated exposure units to expose the plates in the press (direct imaging). Since no film is used in CtP, a previous proof must be made digitally, usually in the form of a proof print on a special dye sublimation, ink jet, or thermal printer.

Figure 1.2-28 shows how a full-page film is made in digital prepress with a computer to film unit and laser imaging of the film. Figure 1.2-29 shows how the printing plate is produced directly from the database of the digitally described printing sheet.

These technological changes in prepress have also brought about fundamental changes in the types of job offered in prepress. The tasks of the three classical occupations of compositor, reproduction technician, and platemaker can today be carried out at one work place by a single skilled worker. This was taken into account in Germany in 1998, when a new course training candidates to become "media designers" (see sec. 13.1.2) was created. After successful training the media designer is proficient in all prepress processes. Consequently, it is considered by many to be the most demanding occupation in the graphics industry.

Thanks to DTP practically any author or graphic artist who has access to a PC and the appropriate software can perform at least some of the steps involved in prepress. Although this has opened up many opportunities to individuals, it has, unfortunately, also resulted in an increasing flow of poor-quality printed products flooding the market. The creation of printed products by computer requires not only mastery of the program used and the necessary typography and design know-how, but above all an accurate understanding of the subsequent printing and finishing processes. It is usually only trained experts who are endowed with this expertise.

Fig. 1.2-28
Full-page film output on a computer to film system (Herkules, Heidelberg)

The diagrams in figure 1.2-30 show the process of evolution in prepress from the individual steps of composition, reproduction, and assembly to an integrated process for platemaking.

1.2.3 Printing

Printing is described as the process of transferring ink onto paper (or another substrate) via a printing plate (fig. 1.2-31). In the course of the centuries many different printing technologies have been developed and these can be divided into four main technologies according to the type of image carrier used as shown in figure 1.2-32.

In section 1.3 (and in particular in chaps. 2 and 5) the different printing technologies are dealt with in detail. In section 1.6 printing presses and systems are described in detail. First, a short overview.

Letterpress (Relief) Printing. Here, the printing elements (letters, lines, dots, etc.) are raised. When the printing plate is inked, the ink adheres to the raised (printing) parts and is then transferred under pressure onto the printing substrate. The main examples of this printing technology are *letterpress* which, until a few decades ago, was the dominant printing technology and *flexography* which, by the middle of this century, had started to be used more and more in packaging printing. With traditional letterpress

Fig. 1.2-29
Computer to plate system for digital imaging printing plates (Trendsetter, Heidelberg/Creo)

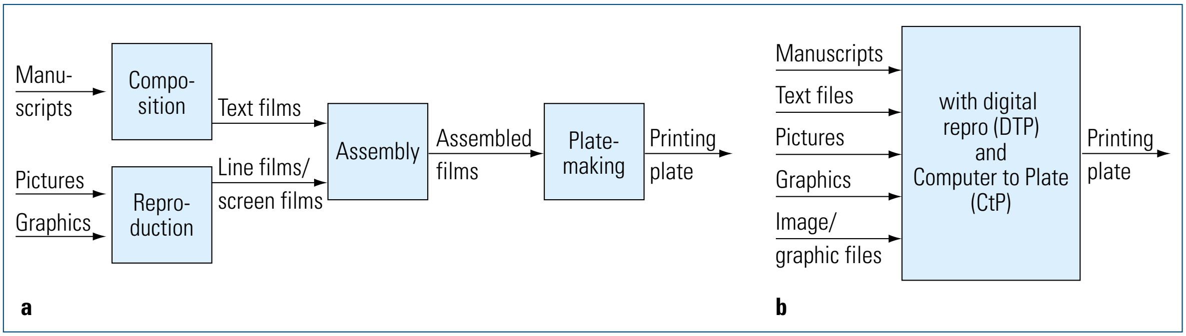


Fig. 1.2-30 Evolution in prepress through digitalization of the processing sections.
a Conventional prepress (around 1980);
b Digital prepress (around 1997)

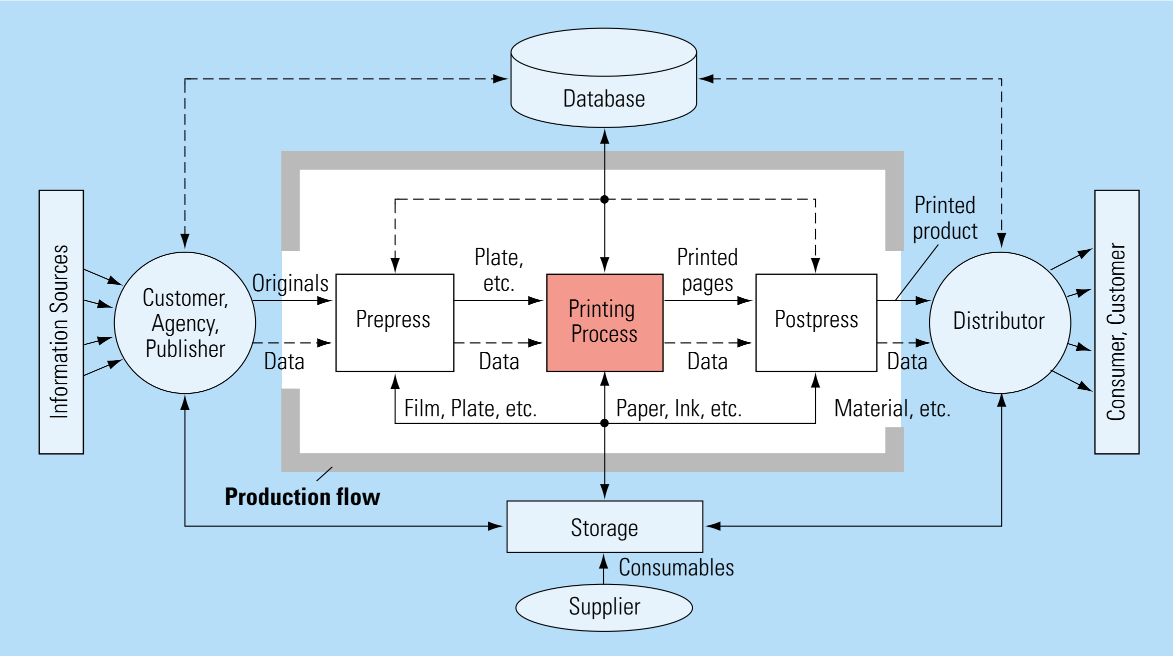


Fig. 1.2-31 The printing process in the production flow for printed products

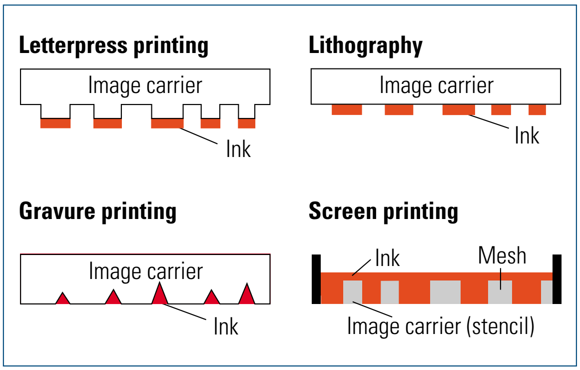


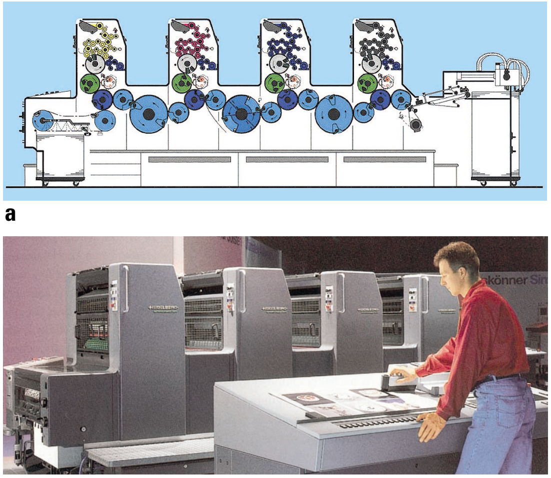
Fig. 1.2-32
The four main conventional printing technologies (in principle)

printing a hard metal printing plate (lead) is used and in flexography a flexible, soft rubber or plastic plate is employed.

Gravure Printing. Here, the printing elements are recessed. The gravure cylinder surface is covered with low viscosity ink ("flooded") and then passed under a doctor blade which removes all the excessive ink, leaving ink only in the recesses. The printing material is pressed onto the cylinder surface and takes up the ink from the recesses. The main examples of gravure printing are *rotogravure printing* and, in the area of arts and crafts, *copperplate engraving* and *die-stamping* (also security printing).

Lithography. Here, printing and non-printing elements are at the same planographic level but are usually made from different materials (e.g., aluminum and polymer coating) with different chemical and physical surface properties. During printing, the non-printing elements are usually made ink-repellent first (by wetting) and the plate is then inked so that the ink is taken up only by the printing areas. The main example of lithography is *offset printing,* which is today the dominant printing technology. Offset printing is an indirect printing technology, that is, the ink is first transferred to an intermediate carrier (rubber blanket) and from there onto the substrate (fig. 1.2-33).

Screen Printing. Here, the printing plate consists of a fine mesh (e.g., nylon). The non-printing elements of the mesh are blocked by a coating (stencil). As with



a

b

Fig. 1.2-33
Four-color sheet-fed offset press with a central control console and measuring and control technology.
a Press diagram;
b Press with remote control console (Speedmaster 74-4-P, Heidelberg)

gravure printing, the screen plate is covered with ink and a squeegee (blade) is passed over it. Through the pressure of the squeegee the ink is pushed through the screen onto the substrate lying below (see also fig. 2.4-11).

Printing Systems. In addition to the image carrier, each of these printing technologies require a back pressure element which presses the substrate onto the image carrier to transfer the ink. Gutenberg's press, an adapted wine screw-type press, worked on the principle of "plane to plane", that is, the image carrier and the back pressure element were flat. Middle- and large-sized letterpress machines of the nineteenth and twentieth centuries worked on the principle of "plane against cylinder", i.e., with a flat image carrier and a back cylinder which rolls on the image carrier. The currently dominant technologies of offset printing, as well as gravure printing and flexography, work entirely on the principle of "cylinder against cylinder" to achieve entirely rotating motion sequences in the printing unit. Only in this way is it possible to achieve the production speeds expected today of 5000 up to 100 000 impressions per hour. Multicolor printing presses, where several printing units are located one after the other, are largely constructed on the cylinder/cylinder basis.

Figure 1.2-33 shows a multicolor *sheet-fed offset press* together with the relevant control and measuring equipment in the print room. Figure 1.2-34 gives an impression of the production process in the press room of a printing company.

The four classic (conventional) printing technologies have one thing in common: the image carriers (masters) have a physically stable structure and are therefore not variable, that is to say, with the same image carrier it is possible to reproduce the same image in high quality many times.

Beginning in the middle of the twentieth century several technologies have been developed that are known today as "*non-impact printing technologies*" (NIP technology). With these technologies, the printing plate is newly imaged for each printed copy (e.g., electrophotography) or the ink is directly transferred (without a plate or image carrier) onto the substrate (e.g., ink jet). One page after another can then be printed with a different content – even if there are limitations with respect to quality and productivity.

An example for a printing system based on electrophotography is the set-up for digital multicolor printing in figure 1.2-35. A detailed description is given in section 1.3.3 and chapter 5.

Until a few years ago the non-impact technology was no alternative to conventional printing technologies as far as either quality, speed of production or cost were concerned. However, in recent years in particular, electrophotographic printing has been greatly improved and has therefore become a genuine alternative in some print media market sectors. This is particularly true of low-volume printwork and jobs involving variable data

Fig. 1.2-34 Press room of a printing company

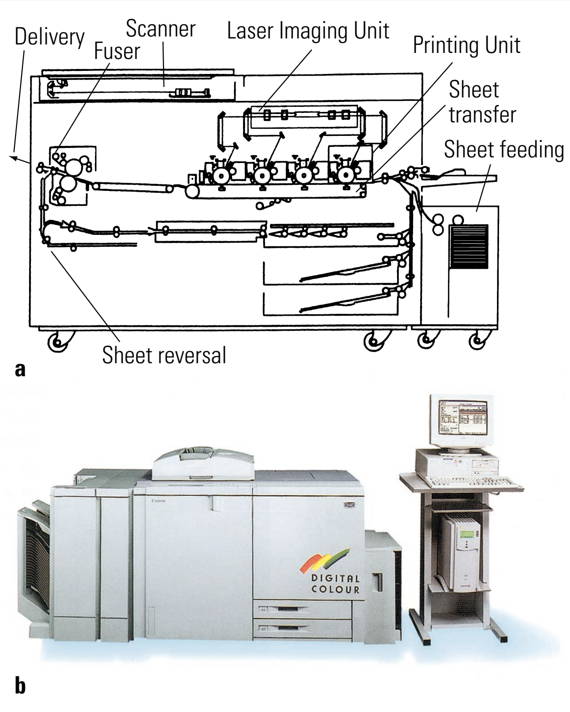


Fig. 1.2-35
Printing system for four-color printing (NIP technology: electrophotography).
a Schematic representation;
b Printing system (with sorter for collating individual sheets) (CLC 1000, Canon)

Fig. 1.2-36 Web-fed offset printing system (M-600, Heidelberg)

and/or information (such as mailings), since the image can easily be completely changed for each copy.

Sheet-fed and web-fed presses. Printing presses can be engineered as either sheet-fed or web-fed presses. *Sheet-fed presses* have a feeder, one or more printing units, and a delivery (see also fig. 1.2-33). In the feeder the sheets are taken from a pile, aligned, and forwarded to the first printing unit. The sheets are transported through all the printing units by grippers. In the delivery the printed sheets are collected in a pile.

Web-fed presses (fig. 1.2-36) have a reel stand, from which the paper web is fed to one or more printing units. This web is then fed straight to a print finishing unit or a rewinder after printing.

Web presses for high-quality print production are fitted with dryers to prevent smearing of the ink during print finishing. This is why heat-set inks are used in offset printing. Newspaper offset printing is usually carried out with cold-set inks, which do not require a special dryer, but offer a lower quality. Gravure and flexographic (letterpress) printing requires a drying section after each printing unit, i.e. after printing each individual color.

Offset printing presses and non-impact presses are designed as web-fed and sheet-fed presses, while gravure presses and flexographic presses are almost exclusively engineered as web presses. Web presses reach higher speeds than sheet-fed presses and have the advantage that in-line finishing is easier to carry out. Web presses are usually designed for one particular type of product only (e.g., newspapers). Typical market segments are newspapers, magazines, packaging, and continuous/business forms. Sheet-fed presses have the advantage of shorter set-up times, less start-up waste, and variable formats and substrates. Almost all kinds of printed matter can be produced on sheet-fed presses where high quality and flexibility is a primary concern.

Conventional printing presses have become increasingly *automated* in recent decades. Today, almost all presses come with a *remote control* station which is used to control most of the press functions. Tasks which were previously always performed manually, such as format adjustment, changing of the printing plate, correction of the register, and cleaning of the rollers and cylinders, can now be carried out at the push of a button. A digital interface for prepress makes it possible to preset the ink flow for a particular printing plate. Several manufacturers already offer offset presses with integrated imaging systems, so-called computer to press/direct imaging presses (see sec. 4.4). By their very nature, non-impact printing presses are already highly automated and can be almost completely controlled by computer.

In the last twenty years the automation of the printing press has led to a considerable increase in productivity and has raised the quality of both printed products and the work place while contributing to economically efficient production of printed matter.

Fig. 1.2-38
Cutting and folding machines for finishing in the press room (Heidelberg)

1.2.4 Postpress/Finishing

Print finishing (postpress) includes all those steps which are carried out after printing on paper or another material has taken place (fig. 1.2-37). Finishing processes are as diverse as the methods of producing printed products, whether they involve books, newspapers, folding boxes, or sets of labels. In this section only the most common processes are described. Print finishing is dealt with comprehensively in chapter 7.

Processes such as *cutting*, *folding*, *gathering*, and *binding* are important print finishing technologies for producing a finished product. Figure 1.2-38 shows finishing processes using cutting and folding machines. The system shown in figure 1.2-39 is an example of gathering and finishing folded sheets. Figure 1.2-36 shows clearly how a web offset press, which includes a folder and other print finishing equipment, can produce complete brochures.

Classical bookbinding, the production of hardcovers, today represents just a small part of the total finishing process. The following list includes the most important

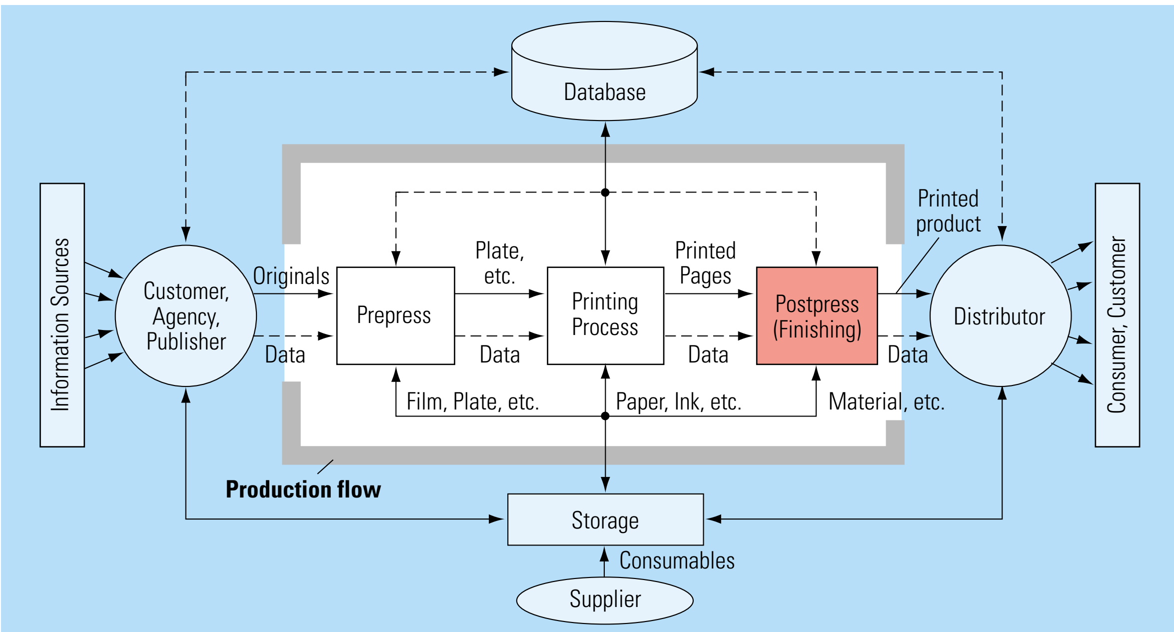
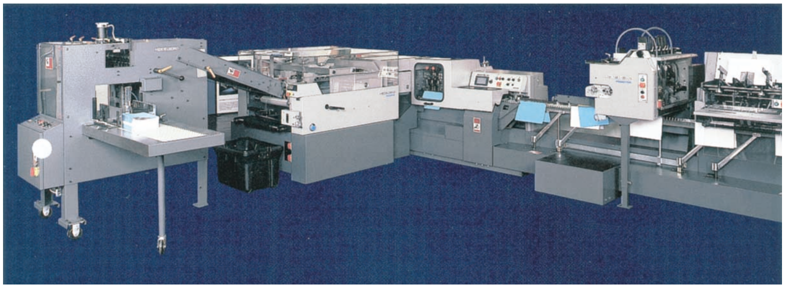


Fig. 1.2-37 Finishing processes in the production flow for printed products

Fig. 1.2-39
Gathering of folded sheets and further processing (stitching, cutting/3-side trimming, packaging) for the production of brochures (Prosetter 562, Heidelberg)



types of print finishing processes and related companies or departments of industrial print finishing:

- *Bookbinders* produce hardcovers and also perfect-bound (glued soft cover) brochures with higher print volumes.
- *Newspaper and magazine printing companies* have web printing presses (offset or gravure) with integrated print finishing units (in-line finishing).
- *Packaging printers* produce a great variety of packaging either off-line (e.g., folding boxes) or in-line (e.g., polyethylene carrier bags).
- *Label printers* are highly specialized in print finishing with automated cutting, die-cutting, and packing machines.
- Small and medium-sized printing companies are mostly connected with *finishers* where business stationery and other commercial printwork is processed, and perfect-bound and saddle-stitched brochures are produced.

Important print finishing techniques are explained below using brochure-making as an example: With *perfect-bound brochures,* glue is applied to the back and a stiff paper cover is attached (e.g., paperbacks, mail-order catalogues, and telephone books). *Saddle-stitched brochures* consist of several inserted double pages, which are fastened together at the fold with wire (e.g., magazines, periodicals). The production of brochures proceeds in five stages, which are explained below:

- *Cutting (guillotine cutting).* When several folded sheets (signatures) are printed with the same content on a large-format press, they must first be separated. The same applies to brochure covers and bound-in inserts (e.g., reply cards) which are mostly printed in multiple-ups, i.e. many copies with the same content on one sheet. Cutting machines work with vertical blades, which can cut through the paper pile to a depth of around 20 cm (see also fig. 1.2-38).
- *Folding.* The print sheets, which contain several printed pages, are folded with folders depending on format size (fig. 1.2-40). Imposition means arranging the pages on the sheet so that after folding and gathering several folded sheets, the pages are in the correct sequence. Imposition is a prepress process but always depends on the requirements or conditions of the finishing process.

In perfect binding (fig. 1.2-40b) the individual folded sheets are arranged behind one another, so sheet one contains pages 1–8 and sheet two contains pages 9–16. In saddle-stitching (fig. 1.2-40a) the folded sheets are placed inside one another, so sheet one contains the 8 outside pages (1–4 and 13–16) and sheet two, the inside eight pages (5–12).

- *Gathering/collating.* If a thirty-two-page brochure is printed with eight pages per sheet, it has four signatures. (The sections of a brochure are also called signatures). With a print volume of one thousand copies there will be four piles of one thousand folded sheets after folding. These must then be separated and arranged in accordance with the specifications of the brochure to be produced. Arranging sheets after one another (for perfect binding) is called collating and is carried out by special collating machines.
  Putting signatures inside one another (for saddle-stitching) is called gathering. This is carried out mostly on saddle-stitchers (fig. 1.2-39), which also carry out the sequential operations of stitching and three-side trimming.
- *Perfect binding/wire-stitching.* The assembled signatures for a perfect-bound brochure are first routed on

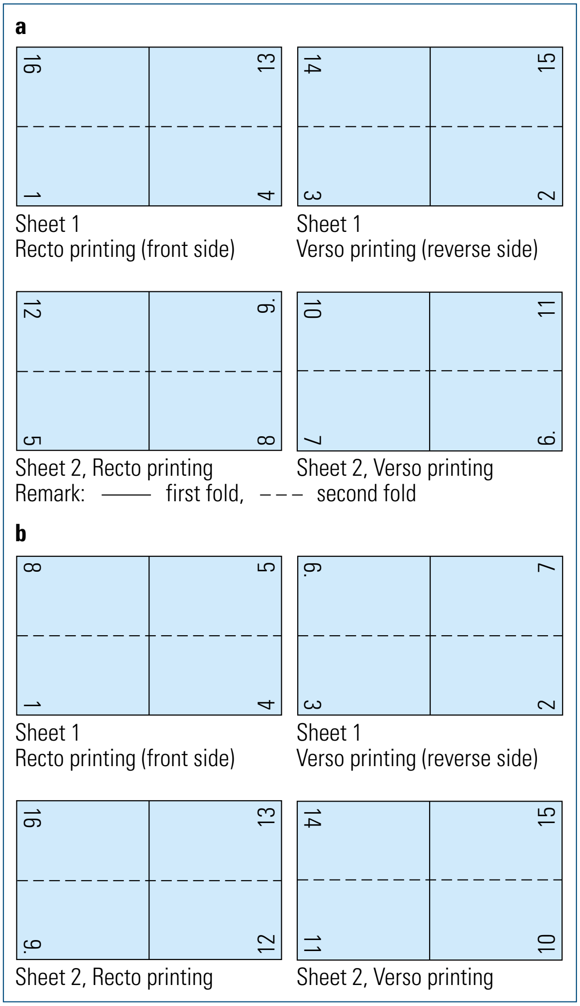


Fig. 1.2-40
Imposition layout (8-page, folded sheet) for two print sheets for a 16-page brochure.
a Layout for back-stitching (after gathering);
b Layout for perfect binding (after collating)

the spine to enable better penetration of the glue. The back (spine) is then thoroughly coated with glue (usually with hot-melt adhesive), and the cover is wrapped around it and stuck to the back. The machine for these operations is the perfect binder which can also be coupled with the upstream gathering machine and the downstream three-side trimmer.
In the gatherer-stitcher the assembled signatures of the saddle-stitched brochure are transported underneath the stitching heads, which push the staples through the back and bend them around.
- *Three-side trimming.* The sheets of the brochures bound in this way are not yet separated at the fold (e.g., on the head) as they still form a signature. Since they cannot be opened out at this stage, the folds have to be cut off. The brochures are usually cut on two, or all three sides (head, foot, and front), which at the same time means cutting the brochure to its final size. This cutting must be allowed for when preparing the job and in prepress, so that none of the contents are cut off. There are special three-knife trimmers used to trim three sides of a printed product. Modern gatherer-stitchers and perfect binders are equipped with in-line three-side trimmers.

Print finishing has been increasingly *automated* in recent years, but not nearly to the same extent as printing or, in particular, prepress. Due to the great variety of processes and the complexity of the mechanical processes, more manual intervention is required than in the other two areas (an exception to this is in-line finishing with web printing presses). That is why great efforts are being made in print finishing to introduce CIM (computer-integrated manufacturing) so that print finishing does not become the "bottleneck" in the production of printed material.

1.2.5 Digital Production Equipment in the Workflow

The production of printed products has increasingly changed from a craftsmen's trade into industrial production. As in other industrial sectors, *computer-integrated manufacturing (CIM)* is becoming important.

In recent years, computers and automated processing have had a considerable influence on prepress. The integration of prepress and press, as well as automation in printing and the integration of related processes, have also reached a certain maturity. In the other areas of production such as finishing, the integration of computers is by no means standard and is still in its infancy.

Complete digitization and integration of prepress, press, and postpress is unavoidable if computer-integrated manufacture of printed products is to be achieved. There are two main obstacles to its implementation. At the moment, partially incompatible systems and interfaces still exist and there is only a limited supply of machines and computers that can be electronically controlled, particularly in the print finishing sector.

Standardized data formats are of vital importance for the integration of prepress, press, and postpress since they facilitate an integrated interface for data which is necessary for the entire workflow.

Production planning and control are instruments for monitoring the production process. In chapter 8 the topic of material logistics and data flow will be dealt with in detail. Figure 1.2-41 relates to the theme of material logistics in the press room and in particular the transportation of paper pallets.

Planning the manufacture of a printed product is usually an upstream process, i.e., from postpress via press and back to prepress. This is best demonstrated with a simple example: A small sheet-fed offset printshop is given the job of making a catalog. The printshop has a prepress department with computer to plate equipment, a two-color press in 52 cm × 36 cm (approx. 20" × 14") format, a two-color press in 74 cm × 52 cm (approx. 29" × 20") format and a four-color machine in 74 cm × 52 cm format. The finishing department has a cutting machine, a folding machine, a gathering machine, a gatherer-stitcher with four stations and trimmers as well as a perfect-binder.

The customer's specifications for the making of the catalog require:

- binding: saddle-stitching,
- format: DIN A4,
- total pages: 32,
- paper: gloss coated art paper, 150g/m²,
- print: two color (black and cyan as decorative color), pages 1, 2, 31, 32 four-color CMYK,
- layout files with picture and graphics are already provided by the customer,
- run length: 1000 copies.

The maximum print format of the printshop is 74 cm × 52 cm, so 8 DIN A4 pages per sheet can be printed. Including the trimming allowance, a paper format of 62 cm × 45 cm is required. The number of pages comes to 32, and so requires 4 eight-page signatures. Printing and finishing require a 150 sheet waste allowance per signature for a run length of 1000 copies. Therefore 1150 × 4 = 4600 sheets are needed. Provided are: 4600 sheets of glossy art paper, 150g/m², in 62 cm × 45 cm format.

The production planning steps are as follows:

- *Finishing.* Because the customer wants a saddle-stitched catalog, the workflow is predetermined: the *folder* is set up for 2 right-angle folds, format 62 cm × 45 cm; folding of 4 signatures of 1000 sheets; makeready of the 4 *gatherer-stitcher* stations, format DIN A4; gathering, stitching, trimming of 1000 copies; *packing* of 1000 copies.
- *Printing.* In accordance with the sheet size, the 74 cm × 52 cm presses are used. The four outer pages are 4-color, all the others are 2-color. Since we are dealing with a saddle-stitched brochure, one 4/4 color signature (sheet 1) and three 2/2 colored signatures (sheets 2,3 and 4) are required. Making an allowance for waste, the print numbers per signature are: 1150 recto prints + 1150 verso prints = 2300 prints. The workflow is as follows:

Fig. 1.2-41
Transportation of material in the press room to supply sheet-fed presses with paper pallets

– four-color press: makeready – 1150 prints – change of printing plate – 1150 prints;
– two-color press: makeready – 1150 prints – 5 × change of printing plate – 5×1150 prints.

- *Prepress.* The pages are imposed according to the imposition layout for saddle-stitching and digitally assembled with 8 pages per sheet, taking into account the 3-side trimming. Folding and cutting marks are added for finishing and register marks and color control strips for printing. The individual printing characteristics of the two presses used for the job are taken into account for the plate exposure. Because of the quality demands of the customer, printing will be carried out on coated paper with a screening of 72 lines per cm. The printing plates are selected in accordance with the size requirements of the printing press.

With this *upstream planning*, a job can only be processed in prepress if the workflow for the subsequent areas is already laid out in accordance with the data provided. This means that almost all the information which is required for the printing and finishing processes flows into an image data file.

Digital workflow systems make use of these facts. They extract this information and make it available to the next work areas where it is used for the automatic set-up and presetting of the equipment. This means that existing data does not then need to be entered again at each press. Additional information can be taken from the computer-aided job preparation.

The following data which is relevant to production can be extracted from the image data file for the print job described (see also fig. 1.2-42):

- *For printing:* Sheet size, number of signatures for straight (recto) printing and perfecting (verso printing), number and type of inks, ink profile (ink distribution over the sheets in zones). Additional data from the job preparation: machine uti-

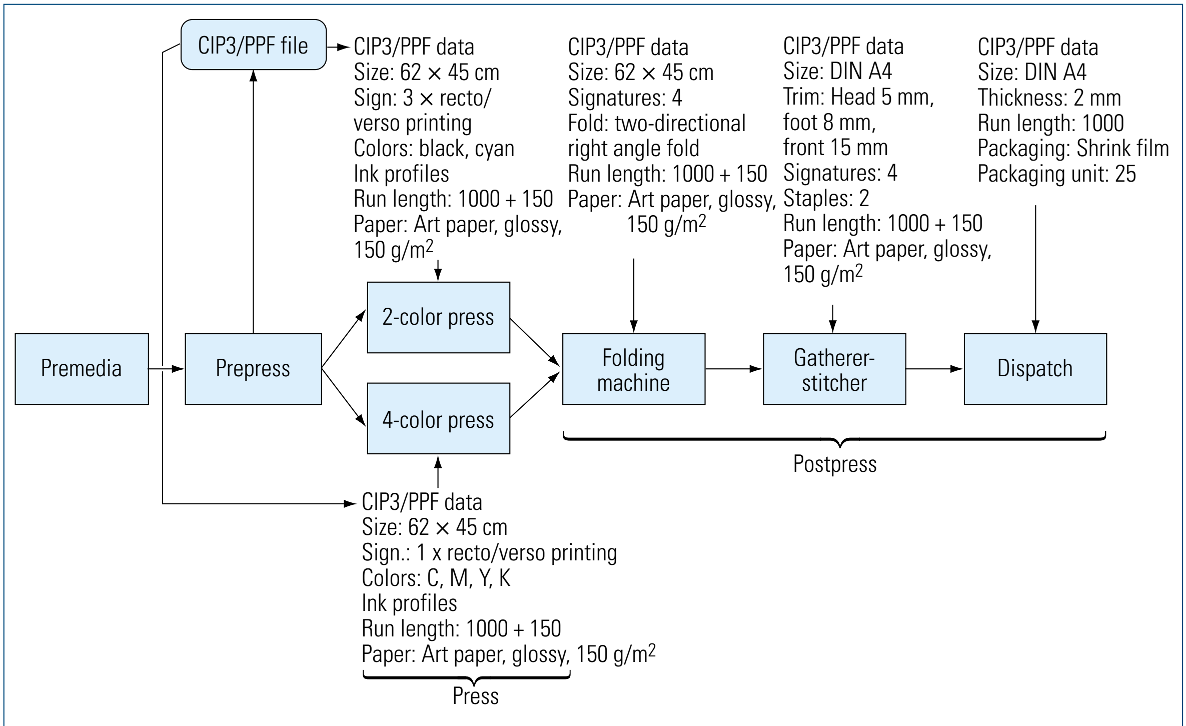


Fig. 1.2-42
Production equipment in the digital workflow for the production of print media with interfaces for processing CIP3/PPF data for the example given in the text of how a print job is processed (PPF: Print Production Format; CIP3: Cooperation in Prepress, Press and Postpress)

lization, run length, allowance for waste, type of material.

- *For finishing:* Sheet size, number of signatures, folding layout, type of binding and trimming. Additional data from the job preparation: machine utilization, run length, allowance for waste, types of material, packaging and distribution.

CIP3/PPF (Print Production Format) has been established as the standard format for the extraction and transmission of the data relevant to production. This format was worked out by a consortium of firms in the graphic arts industry (details are given in sec. 8.2.3). CIP3 stands for Cooperation in prepress, press, and postpress. Every printing and finishing machine with a CIP3 interface can be set up automatically for a particular job using a PPF data file. Printing presses with CIP3 interfaces are already available, and the technology is also beginning to penetrate the finishing sector. The aim of the development is the *networked printshop* where manual intervention in the workflow is minimized and throughput and delivery of the order can be sped up.

Figure 1.2-42 shows which CIP3 data can be used to control which machines.

1.2.6 Premedia

The preceding sections of 1.2 have shown how with today's prepress processes and equipment *the entire print job can be created in digital form* in a data file. On the basis of this data set, full-page films can be produced or the printing plate produced directly. There are printing systems which can be operated directly with the help of the job file. Print finishing also uses digital information to produce the end product. Printed matter can then be produced using modern technologies which are based on a "digital master" containing all the information on the product and its production.

The so-called "electronic media" transmit information to customers using CD-ROM or the Internet, which can be read and viewed using visual display units such as monitors and displays.

The "digital master" for the information, which is transmitted in printed or electronic form, is more or less identical. This has resulted in the creation of a premedia stage in the workflow, during which information is recorded, laid out, and made available as a digital data file, and the data is managed and organized. This "digital master" can now be copied and distributed

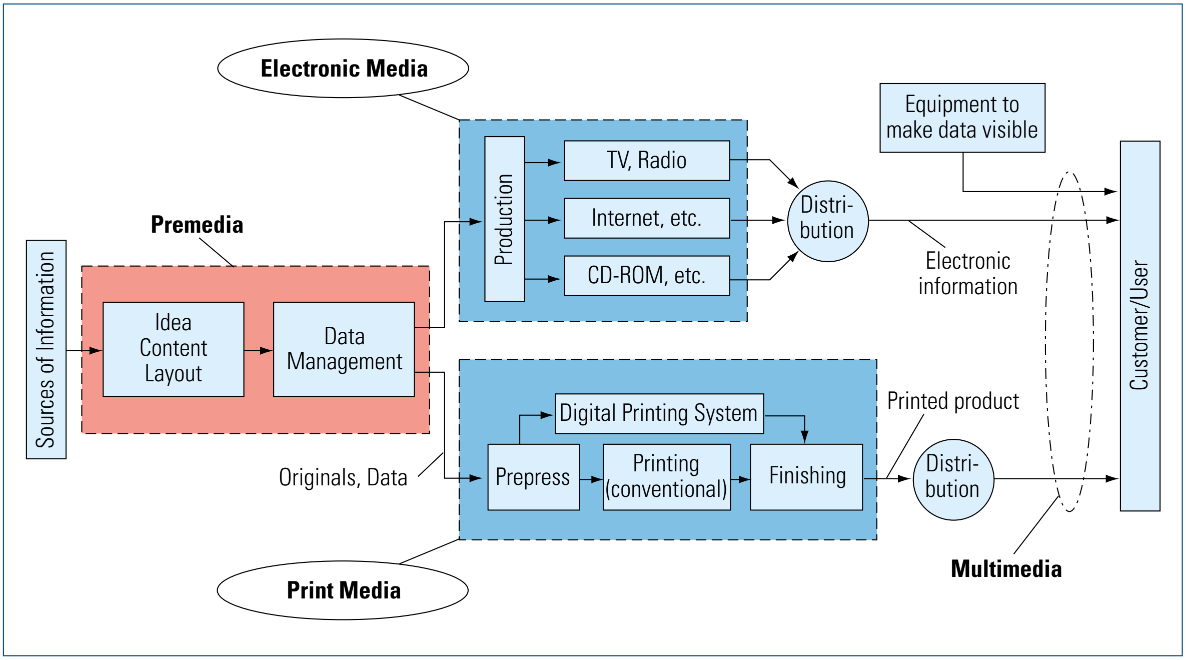


Fig. 1.2-43 Premedia in the workflow for the production of print media and electronic media

in printed or electronic form (print media or electronic media, see fig. 1.2-43).

The premedia production process, which does not depend on the output media, is also called "*Cross Media Publishing*" (CMP). A basic requirement for an effective cross-media publishing system is the assurance of consistency and integrity. All data must be available in digital form and be accessible through a data network.

Figure 1.2-43 also shows how premedia is linked with prepress, press, and postpress. It also demonstrates that a completely digital workflow depends on the level of digitization of the systems in the production chain. Figure 1.2-43 also demonstrates how the combination of an electronic medium (e.g., CD-ROM) and a print medium (e.g., a book) is a multimedia application that can be produced by one business.

This combination of different data carriers is also called "*Mixed Media Publishing*" (MMP). MMP can be used for the optimization of publications by combining the advantages of different data carriers. The value of a publication is not increased by the clever combination of individual types of information (text, tone, animation, etc.), but rather by a combination of different data carriers (e.g., CD-ROM, the Internet, and print).

Chapter 9 details potential production processes and strategies for printed media and, in particular, production strategies such as *print on demand* or *distributed printing* which can be executed on the basis of the workflow shown in figure 1.2-43 (from premedia via prepress, press, and postpress to the end product).

Further Reading for 1.2.1

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