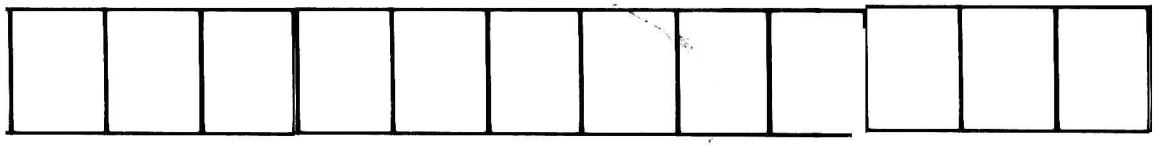
Printing Technology

3rd Edition

Adams ■ Faux ■ Rieber



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3rd Edition

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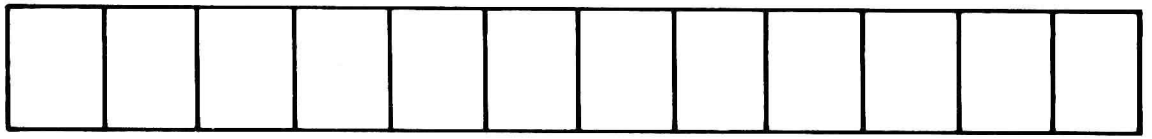

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Cover photo courtesy of Brodock Press Inc., Utica, NY.

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For information address Delmar Publishers Inc.,
2 Computer Drive, West, Box 15-015
Albany, New York 12212

Printed in the United States of America
Published simultaneously in Canada
By Nelson Canada,
A Division of International Thomson Limited

10 9 8 7 6 5 4 3

Library of Congress Cataloging-in-Publication Data
Adams, J. Michael.
Printing technology / J. Michael Adams, David D. Faux : with contributions by Lloyd J. Rieber.—3rd ed.
p. cm.
Bibliography: p.
Includes index.
ISBN 0-8273-2775-7. ISBN 0-8273-2776-5 (Instructor's guide).
ISBN 0-8273-2777-3 (Study guide)
1. Printing, Practical. I. Faux, David D. II. Rieber, Lloyd J. III. Title.
Z244.A515 1988
686.2'24—dc19 87-33032
CIP

Preface

Introduction

When *Printing Technology* was first introduced in 1977 it was one of a new generation of books that dealt with printing as a technology, rather than merely a process. The decade before had seen a revolution in the printing industry. Computer typesetting had become a commercial reality; presensitized litho plates had been introduced; offset printing had surpassed relief in percentage of sheets printed; web presses had grown in sophistication and acceptance. The first edition of *Printing Technology* covered the printing processes, but it also addressed the printing revolution and offered an introduction to the sophistication of printing.

We are still amazed by and appreciative of the reception of that first edition. Classroom teachers and their students reacted with enthusiasm. Instructors liked the combination of concepts with practice, and students liked the understandable language and contemporary illustrations. The second edition arrived in 1982, as a result of the encouragement of many individuals who offered suggestions for improvement. The second edition has been used at nearly every level of graphic arts education—in public, private and industrial training—and has found wide national and international acceptance.

Preparation of the Third Edition

As changes were planned for the third edition it became apparent the industry had experienced another revolution: The computer had entered every aspect of printing management and production, and had become the overriding element that guided all changes.

The third edition *Printing Technology* has been revised and updated to present the most current procedures and state-of-the-art materials in each phase of the printing process. The content has been reorganized to give students an understanding of the historical evolution of printing as well as knowledge about the latest equipment and processes. The third edition stresses computer applications in printing. Information about cold type composition has been totally rewritten to stress modern computer image generation and assembly, including full-page make-up and desktop publishing systems. The chapters on offset press operation have been rewritten to include web printing, computer-aided press control, and registration control devices commonly used in the industry. Flexographic printing is covered for the first time in the third edition, and an entirely new chapter on xerographic, laser, and ink-jet printing has been added. In addition to an integrated study of offset lithography—from the design through printing procedures—the text covers screen printing, gravure, and flexography. The information on color photography was strengthened and a major new section on camera calibration was created. Detailed discussions assume no previous knowledge about printing technology.

SPECIFIC CHAPTER CHANGES are as follows:

Chapter 3: Design Concerns for Printing has been rewritten to explain more about what a designer does and less about how to do de-

sign. It explains what the printer should know about design. Copyfitting and a thorough discussion on the preparation of both type and art copy have been added.

Chapter 5: The information which used to be "Cold Type Composition" has been totally rewritten into a new chapter called "Typesetting and Computer Image Generation." This chapter covers computer imaging, including basics of computer typesetting operations, computer typesetting terminology, fundamentals of computer imaging for graphic reproduction, automatic page make-up, integration of text and graphics, WYSIWYG and page display systems; output devices, microcomputer applications, and desktop systems.

Chapter 6: New information is provided on digital camera control, rapid access processing, and film processors.

Chapter 7: Expanded and simplified explanations of the main, flash, and bump tests (the three tests needed to calibrate for making a halftone negative) provided. These tests are directly applicable to areas of a continuous-tone print and the resultant halftone negative. Calculation for halftone exposures updated to include computerized calculation and on-line camera densitometers.

Chapters 8 and 9: Photography component upgraded to include the latest advances in processing.

Chapter 10: More information about color stripping and automated stripping added.

Chapter 11: Information about photopolymer presensitized surface plates added.

Chapter 12: New sections on multicolor sheetfed presses, computer press monitoring systems (including plate and press sheet scanners and press consoles), and fundamentals of web presses added.

Chapter 13: New section on quality control devices for offset printing added.

Chapter 17: New chapter on "Other Printing Processes" added; includes fundamental information on flexography, xerography, laser printing, and ink-jet printing.

Chapter 19: New section on in-line finishing added.

Chapter 20: New section on Computer-aided production control, including automated data collection (ADC) added.

Special Features

The third edition of *Printing Technology* offers the following benefits:

- An excellent, comprehensive overview of the printing industry presented in an interesting, informative, and accurate manner.
- The text is organized to allow the teacher to focus student attention on the offset process, and achieve an overview of all of the major printing processes.
- Chapters contain objectives, key terms, questions for review, and informative anecdotes which present persons or events that have contributed to the development of the printing industry.
- Computer applications in printing are stressed throughout the text.
- Pre-press imaging—photocomposition, black and white camera work, color separation, and image assembly—has been

rewritten and updated to include information on the latest computer technology.
- Hundreds of new photographs and illustrations reflect state-of-the-art equipment, operations, and processes.
- In-depth procedures for offset lithography, including new information on color stripping and platemaking.
- Information about letterpress printing has been substantially reduced and moved to the front of the text to provide an historical overview of the development of printing, and introduce students to the many printing terms that originated with the letterpress processes.
- Extensive revisions have been made in the chapters covering careers in the printing industry, image generation, press operation, and new processes in printing.
- An eight-page full-color insert highlights color process printing, special effects photography, electronic color separation, color graphics work stations, and synthetic art.

Acknowledgments

Lloyd Rieber has joined Adams and Faux as an author for this third edition. Lloyd was a major partner in the preparation of the second edition and became the driving force behind the realization of the third edition.

The authors wish to express their appreciation to John Leininger, a former student and now a professional colleague, who reviewed the manuscript. During the course of the review he saw opportunities to improve the learning effectiveness of the text and gave freely of his time and talent to prepare material which is now part of the third edition, including new material in the color insert and new Appendix A, Determining Proper Film Exposure.

Appreciation is also expressed for the contributions of the reviewers who devoted many hours to careful examination of the manuscript. Their suggestions provided valuable guidance to the authors.

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Company Acknowledgments

The following manufacturers and associations provided technical information, art, and photographs. Their generosity helped ensure that the text reflects the current level of technology of the printing industry.

Eastman Kodak Company
Multigraphics, a Division of AM International, Inc.
Kroy, Inc.
Mackenzie and Harris, Inc.
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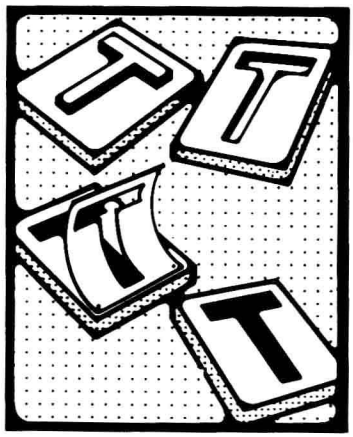

Chapter One

The Printing Industry

Anecdote to Chapter One

It is possible to trace the origins of printing to the use of seals to "sign" official documents as early as 255 B.C., during the Han dynasty in China. A ceramic stamp was pressed into a sheet of moist clay. When dry, the imprint served as a means of certifying the authenticity of the document. When paper was invented, around A.D. 105, the transition to the use of the seal with ink was a natural one.

Early documents and manuscripts were copied and recopied by hand. Frequent copying mistakes were made from one edition to the next; copies often differ significantly from the author's original. Around A.D. 175, the Chinese began the practice of cutting the writings of important scholars into stone. The stones were placed in centers of learning, and students made "rubbings," or copies on paper

An Early Chinese Press The press was a low, flat table solid enough to hold the form in place.
The Bettman Archives

from the carvings. The process was faster than hand copying, and all editions were identical to the first.

No one knows when the ideas of the seal and stone rubbings came together, but in China in A.D. 953, under the administration of Fêng Tao, a large-scale block-printing operation was begun to reproduce the Confucian classics. Block prints were generally slabs of hard fine-grained wood that were carved to leave a well-defined raised image. The raised portions were inked, paper was laid over the block, and a pad was rubbed across the surface to transfer the ink to the paper.

During the Sung dynasty, around A.D. 1401, a common man named Pi Shêng invented movable type. Building on the ideas of block printing, he cut individual characters in small pieces of clay. The clay was fired to make it hard, and individual pieces were placed in an iron frame to create the printing form. Because the pieces did not fit together perfectly, they were embedded in a mixture of hot pine resin, wax, and paper ashes. When cold, all the pieces were held together perfectly tight, and the form was inked and printed. Reheating the resin mixture loosened the pieces of type so they could be reused.

Other materials, including wood, tin, copper, and bronze, were used for the same purpose. The idea of movable type traveled to neighboring countries. In Korea, in A.D. 1403, King T'aijong ordered that everything without exception within his reach should be printed in order to pass on the tradition of what the works contained. Three hundred thousand pieces of bronze type were cast, and printing began. It is interesting to speculate on the relationship between this event and a similar one that took place not more than fifty years later in Northern Germany, which brought Johann Gutenberg the title of "father of printing."

Objectives for Chapter One

After completing this chapter you will be able to:

- Discuss the development of graphic symbols from prehistoric times to the present through the evolution of the modern alphabet.
- List the major printing processes and describe the differences between them.
- List and describe the steps in the printing cycle.
- Rank the printing industry in terms of number of individual firms, number of employees, and "value added."
- Describe the structure and purpose of each level of a small- to medium-sized printing company.
- Compare the kinds of services provided by the different types of printing businesses.
- Describe the different ways to enter, train, and advance in the printing industry.

Introduction

Graphic messages are possible because lines can be made into shapes that have meanings to humans. As early as 35,000 B.C. people were drawing messages on cave walls (figure 1.1). These were probably intended to be temporary messages, but they became permanent. They were simple drawings—merely lines—but they carried meaning to the people of that period: "This is a mammoth," "Oh, what a feast we had," or "We hunted a great hairy beast."

Development of Pictographs. Drawings that carry meaning because they look like real objects are called **pictographs** (figure 1.2a). Pictographs have a one-to-one relationship with reality. To symbolize one ox (called *aleph*), draw one symbol of an ox. To represent five oxen, draw five symbols. It is difficult to use pictographs to communicate complex ideas, such as "I have six oxen—one brown, four white, and one white and brown." It is impossible to symbolize abstract ideas, such as love or hate, with a pictographic system.

About 1200 B.C., in a small country called Phoenicia (now a part of Syria), a group of traders began to realize the limitations of the pictographic system. They attempted to simplify the picture notations in their account books by streamlining their symbols. But however they drew the lines, *aleph* still symbolized one ox and *beth* still stood for one house (figure 1.2b).

Development of Ideographs. The next step was to have drawings symbolize ideas. These drawings are called **ideographs.** With this system *aleph* became the symbol for food and

Figure 1.1. An early message Pictured is a cave drawing (message made by prehistoric people) in the Altamira caves in Spain.
Courtesy of Spanish National Tourist Office, New York

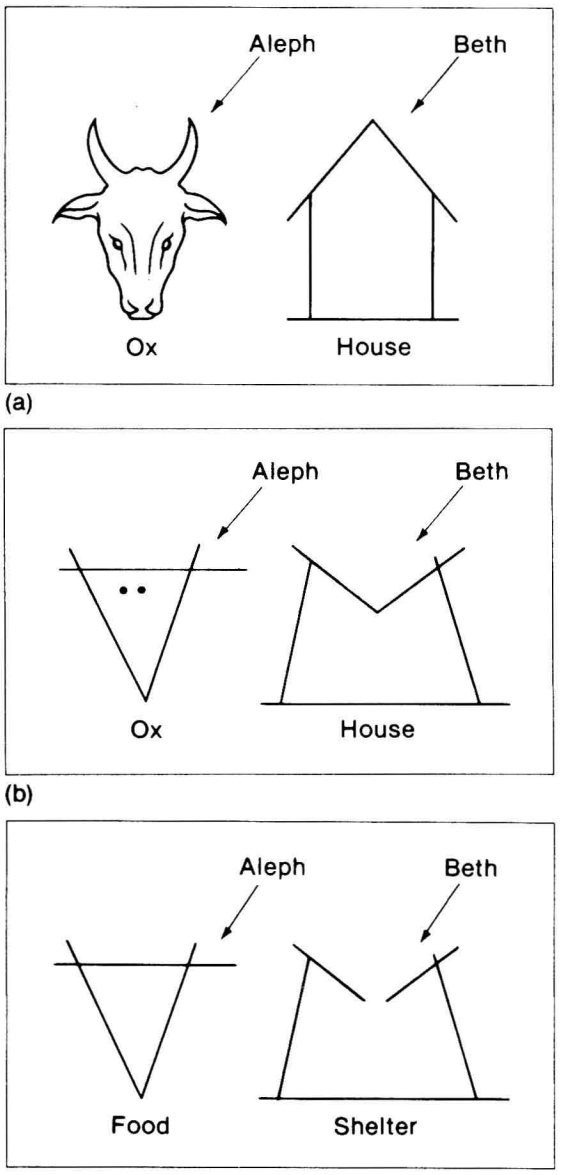

Figure 1.2. The development of ideographs Pictographs shown here in (a) and (b) were drawn to represent real objects. They were gradually simplified to represent general ideas and became known as ideographs (c).

beth represented a dwelling or shelter (figure 1.2c). **Ideographs** are simple drawings that symbolize ideas or concepts rather than concrete objects. They are a vast improvement over pictographs because complex or abstract ideas can be easily represented, but ideographs are still clumsy. The sheer number of symbols can be overwhelming. The Japanese and Chinese both still use ideographic symbol systems that contain over ten thousand different characters. It could take a lifetime to understand such a system.

Development of Phonetic Symbols. By 900 B.C. the Phoenicians had made another change. Instead of symbolizing the actual ox or food, the picture came to represent a sound. Whenever the readers saw the symbol, they could make the sound that the symbol represented. When the symbols were placed together, whole words could be repeated. This idea of representing sounds by symbols is known to us as a **phonetic symbol system** and is the basis for most modern written languages. The Phoenicians developed nineteen such symbols, but they were traders and were not concerned with recording all words used in everyday conversation. We form verbal symbols by combining consonants and vowels. The Phoenician system contained no vowels and was of little use in recording everyday speech.

By 403 B.C. the Greeks had officially adopted the Phoenician system, after adding five vowels and changing the names of the letters (figure 1.3). *Aleph* became *alpha* and *beth* became *beta*, which form our term *alphabet*.

About a hundred years later, the early Roman empire borrowed the Greek alphabet and refined it to meet its needs. It accepted thirteen letters outright, revised eight, and added *F* and *Q*, which gave it twenty-three—all that was necessary to write Latin. The Ro-

man system stood firm for nearly twelve centuries. About one thousand years ago the letter *U* was added as a rounded *V*, and two *Vs* were put together to form *W*. Five hundred years later the letter *J* was added to give us a total of twenty-six letters that form our contemporary Latin alphabet.

There were still some problems to be worked out. Early Greek and Roman writing was done by scribes—all with different "penmanship." Some wrote from left to right, some from right to left. Combine these differences with the lack of punctuation marks or spaces between words or sentences, and the whole thing could be quite a mess.

It wasn't until movable metal type was introduced by Johann Gutenberg in the mid-fifteenth century that any true standard of punctuation or sentence structure was achieved. It took printing technology to stabilize the phonetic symbol system as we know it today. Slight changes have been made, but the basic composition of our alphabet has remained the same from the time of Gutenberg.

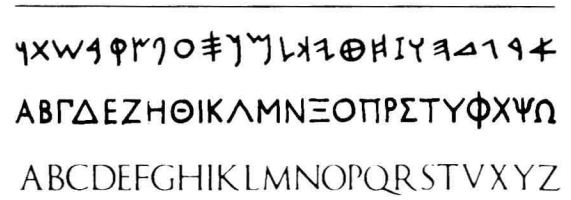

Figure 1.3. The development of our alphabet Illustrated from top to bottom are the Phoenician alphabet (900 B.C.), the Greek alphabet (403 B.C.), and the Roman alphabet (300 B.C.).

Printing Technology

Major Printing Processes

All printing processes reproduce lines and/or dots that form an image. **Printing** is the process of manufacturing multiple copies of graphic images. Although most people think of printing as ink on paper, printing is not limited to any particular materials or inks. The embossing process uses no ink at all, and all shapes and sizes of metals, wood, and plastics are common receivers of printed messages.

The following four major printing processes are used to reproduce graphic images:

- Relief printing
- Intaglio printing
- Screen printing
- Lithographic printing

Each of these processes is suited for specific applications, such as newspaper, book, package, or textile printing.

The **relief** process includes letterpress printing, flexographic printing, and all other methods of transferring an image from a raised surface (figure 1.4a). While once a major process in the printing industry, letterpress printing has been largely replaced by other printing processes. Most relief printing done today is done with flexography. Flexographic printing is used extensively in the packaging industry for printing on corrugated board, paper cartons, and plastic film. Flexography is also becoming a significant process for printing newspapers, newspaper inserts, catalogs and directories.

Intaglio printing is the reverse of the relief concept. An intaglio image is transferred from a sunken surface (figure 1.4b). Copper plate etching and engraving are two intaglio processes. One type of industrial in-

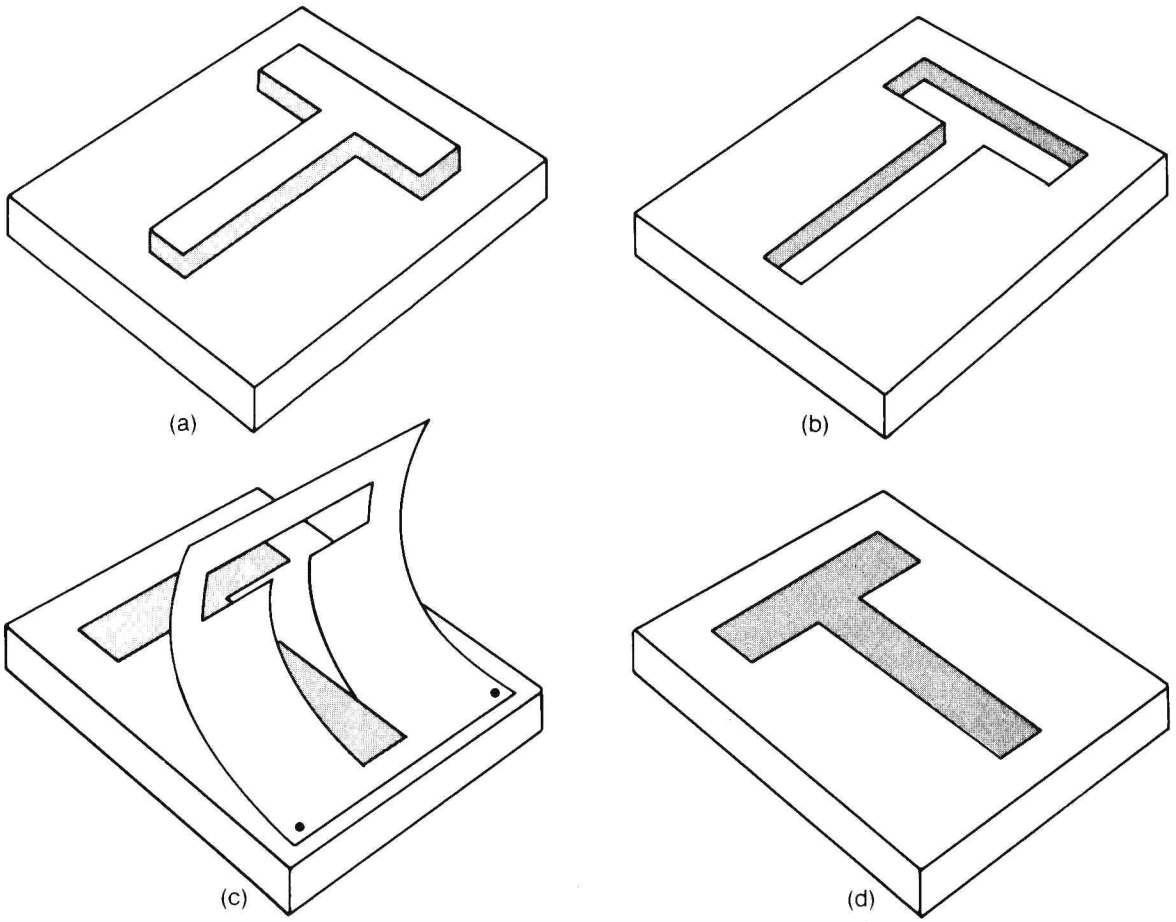

Figure 1.4. Four main printing processes Relief printing transfers an image from a raised surface (a). Intaglio printing transfers an image from a sunken surface (b). Screen printing transfers an image through a stencil (c). Lithographic printing transfers an image chemically from a flat surface (d).

taglio printing is **gravure.** Gravure is used for extremely long press runs. Cellophane and aluminum foil candy bar wrappers are two common packaging materials printed with gravure printing. *Readers Digest* and the *National Geographic* are but two of many national magazines that are printed with gravure.

Screen printing transfers an image by allowing ink to pass through openings in a stencil that has been applied to a screen mesh (figure 1.4c). The screen process is sometimes called "silk screen printing," even though silk is rarely used industrially to hold the stencil, because silk is not as durable as industrial