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The Columbia Guide to Digital Publishing

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Contents

Markup enables the various parts and features of a given set of content to be distinguished and named. It provides a way to label, describe, and delimit these in a publication so that processing systems can tell them apart and know how they relate to each other. Markup languages are used to define specific markup schemes. In the past, markup languages were typically proprietary and used only by specialists. The Web gave rise to one of the simplest and most widely used markup languages ever devised, HTML, and also to one of the most flexible and powerful: XML, the Extensible Markup

Language. After a brief overview of earlier markup languages, this chapter focuses on the technologies in the XML family— XML itself, and related standards for defining, styling, linking, transforming, and annotating—that provide the foundation for digital publishing today.

The production and distribution of content are two of the most important functions carried out by publishers. Historically, these publishing functions had only to concern themselves with how to produce and distribute physical items: books, magazines, and journals printed on paper. However, since the mid-1990s publishers have recognized that in order to meet the demands of digital publishing, their publishing processes require radical rethinking. The traditional print requirements must continue to be fulfilled, but the additional demands of digital publishing must also be met. The content must be available electronically—usually on-line. It must be consistently produced to a high standard, available at the same time or ahead of print, and it must provide maximum functionality—which often means linking both internally and externally, and sometimes means including nonprint content. Of course, all of this must be achieved at minimum added cost to the publisher.

Chapter 5. Data Capture & Conversion *179*

Mark Gross, President, Data Conversion Laboratory

This chapter discusses the ins and outs of converting and upgrading textual data and related information from all kinds of formats into markup languages for publishing purposes. While the issues and approaches apply to all markup languages, particular emphasis is given to the issues of converting documents into XML, SGML, and HTML. The chapter looks at the issues surrounding the capture of data from sources such as paper and microfilm, word processors, publishing systems, PDF, and ASCII — the main issue being the need to untangle content from structure.

Publishing in the digital era, to an overwhelming degree, still means publishing in print. More often than not what is published electronically today first started as print. While much of the energy in digital publishing has shifted to the electronic conveyance and display of information, the bulk of the economic activity still centers on print-based publishing. Electronic publishing is the future of the industry, but print publishing pays today's bills. Today's digital tools, technologies, and techniques are as often used in print as in electronic publishing. Mastering print publishing demands knowledge of a broad range of processes and technologies surrounding composition, design, and graphics. Print publishing has reached the intersection of 500 years of analog craft and a new era in digital computer graphics. Publishing practitioners require an appreciation of both. This chapter is a broad overview of the processes and technologies that comprise the practice of print publishing in the era of digital publishing. We focus on the digital technologies that are moving the process forward into the future, *and the traditional craft-based skills still important in the digital era that optimize quality in everyday work.*

Digital publishing technologies offer publishers and other content providers a new dimension in shaping their publications. Well-constructed digital content can be configured to be used with a wide range of accessibility tools, including specialized software such as text-to-speech programs, designed to help people with disabilities gain access to published materials that would otherwise be unavailable to them. This has not been lost on disability *advocates, who have driven recent federal and state legislation that puts increasing pressure on publishers to provide their products in formats accessible to people with a variety of disabilities. This chapter will inform the reader of key issues, problems, and opportunities in content accessibility and what publishers must do, operationally, to meet accessibility needs. It also contains strategic suggestions about factoring accessibility requirements into product and business plans.*

Since the format of the book evolved from the continuous scroll to the page-oriented folio, no change in the practice of publishing texts has had such an impact on the way we perceive and use a book as electronic publishing. This paradigm shift changes the way text is perceived in time and space and the integration of text, video, and audio into a multimedia product is a logical step in an electronic medium. Yet it is not the technology that undergoes the biggest change, but the role of the publisher, who has to re-emerge as the *agent of a new medium, still in statu nascendi. In the first phase of multimedia, everybody seemed to be empowered by the new tools and technologies to become a multimedia producer. Most multimedia publications do not live up to the promise of an interactive and integrated experience, but remain an exploration into technologies without a clear goal. It is the publisher who needs to act as the integrator of multiple media types, multiple experts, and multiple industries in order to do his job—to turn an idea into a product and make it public. This chapter gives an overview of the different technologies, standards, and business issues to be considered when extending electronic publishing into multimedia.*

This chapter tackles two subjects—the process of publishing on the Web, and the technology called content management that has emerged to address Web publishing. Publishers who have moved to the Web have found it brings all the challenges of print publishing—and some new challenges that are unique to the Web. Content management technology has grown to meet these challenges, but has also brought with it technical complexity that is new for some publishers. This chapter outlines the technical issues regarding content management, and gives the readers a framework for understanding how content management technology can help their publishing processes.

Allen Renear, University of Illinois, Urbana-Champaign
Dorothea Salo, University of Wisconsin, Madison

Electronic books, or e-books, will soon be a major part of electronic publishing. This chapter introduces the notion of electronic books, reviewing their history, the advantages they promise, and the difficulties in predicting the pace and nature of e-book development and adoption. It then analyzes some of the critical problems facing both individual publishers and the industry as a whole, drawing on our current understanding of fundamental principles and best practice in information processing and publishing. In the context of this analysis the Open eBook Forum Publication Structure, a widely used XML-based content format, is presented as a foundation for high-performance electronic publishing.

Maintaining ownership of commercially viable digital assets is increasingly important. As digital files have become the de facto standard for use and reuse of products published both in print and electronic formats, libraries and publishers are working to create a viable way to store and preserve digital assets. Publishers have additional reasons for creating the process and infrastructure for storing their digital materials: the potential for reduced operating costs and increased profit margins associated with reusable content and the increased revenue derived from licensing, selling, or otherwise making available content that is centrally available. This chapter will focus on the issues facing publishers, but will also provide an overview of the wider issues involving archiving.

The purpose of this chapter is to give a succinct overview of the various legal doctrines that apply to digital publishing and to make the concepts and basic rules as accessible as possible. This chapter does not substitute for legal advice on any specific matter that the reader may encounter; rather, it is intended to help the reader be more alert to legal issues that may arise, and be a more informed consumer of legal services. It does not, of course, purport to address all the legal issues that a publisher will encounter. Publishers are businesses, and must deal with all the laws that affect businesses of every kind. Nor does this chapter address some issues that are common to everyone who does business on the Internet, such as the laws of consumer privacy, e-commerce, and the like. The main focus is on copyright, as that creates the property that is the currency of publishing. This chapter will also deal with other intellectual property principles and with some other concerns, such as libel, that are uniquely central to publishing.

Chapter 14. International Issues *587*

Robert E. Baensch, Director, Center for Publishing, New York University

This chapter highlights the twelve key elements that are most important for international communications, online publishing, and e-commerce on the Internet. The size of organization or location of country is irrelevant, because the World Wide Web is a stateless network and framework that goes beyond the physical location of electronic resources and information by connecting millions of computers into a seamless global network. Statistics on Internet users worldwide, with a focus on Europe, Asia, and South America, establish a meaningful framework for what it really means to publish globally. A review of the international publishing activities of professional, legal, scientific, technical, and medical journal publishers offers realistic working examples for publishers who are considering the development of their international on-line business. A concise analysis of geographic, cultural, language, economic, technological, and legal factors provides perspective on the global environment for digital publishing.

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8 Digital Printing

GEORGE ALEXANDER
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The technology that is used to print books digitally has been evolving rapidly. Initially, sheetfed monochrome laser printers were the only technology available. But today, high-speed roll-fed devices are often used, full color is becoming more economical, and other printing technologies (such as inkjet) are coming into use. This chapter describes the available printing and binding options and some of the new publishing options they create.

8.1 OVERVIEW

The digital printing of books is a tantalizing concept. One can imagine walking into a neighborhood bookstore (or perhaps a neighborhood copy shop) and ordering virtually any book ever published. Within five minutes, the book could printed, bound, and in your hands. For publishers, there is the possibility of never having overstocks to dispose of. For educators, the technology can provide custom books for each class, or even for each student.

The technology to support these possibilities is not completely available yet (or if it is, the costs are still prohibitive for many applications). But the technology is getting very close, and costs are coming down rapidly. In this chapter, we will look at the digital printing technologies that are available today and some that are on the way. The associated input techniques and binding technologies are also discussed.

Increasingly, digital printing is taking work away from the traditional offset process. We will discuss the advantages and disadvantages of both approaches and list some of the applications for which digital printing is clearly superior. The shift from offset to digital printing also means changes in the where books are produced and how they are distributed. These, too, will be touched on.

8.2 DIGITAL PRINTING TECHNOLOGIES

The technology of digital printing has been evolving rapidly. It is not just the printing techniques themselves that are in flux, but also the associated technologies (such as those involved in scanning and binding). This section describes the technologies behind digital printing and some of the important related issues.

(I) INPUT: SCANNING, POSTSCRIPT, PDF, AND OTHER OPTIONS

Various methods and technologies are available to prepare material for digital printing. The most fundamental fact, however, is that digital printing is done directly from digital files. Content is either created in a digital format or it must somehow be converted from print to a digital format.

For the publishing industry, most files created in a digital format end up either in the ***PostScript*** language, or in its close cousin, the Portable Document Format (***PDF***). Both languages are the invention of Adobe Systems. Adobe, although it makes the specifications of these languages public, keeps tight control over the direction and details of both. Content that does not originate in digital form—that is, printed originals—must be digitized. Most often, this is done simply by scanning, which results in a bitmapped file, usually a TIFF.

The chapters on **data conversion** [5.3.1.1] and on **composition and graphics** [6.11.1] discuss the details of the processes of scanning and conversion by rekeying; for conversions, this section focuses on digital conversion rather than manual rekeying.

1. Scanning

Scanning—that is, making an image of a printed page rather than using ***OCR*** software to create a digital text file—is generally easy to accomplish, but it has a significant drawback. No matter how good the scanner, and how good the page being scanned, the image created via scanning is never quite as good as the same image created directly from the source data. Some degradation is inevitable in the image-then-scan sequence. For example, the pages are usually not precisely straight, since scanning is a mechanical process; the resulting images usually need ***deskewing***. Likewise, it is virtually impossible not to pick up specks of dust and other flaws in the image; this requires ***despeckling***. Finally, the pages usually need to be aligned into the position required by the new product, with uniform margins and with right- and left-hand pages being differentiated. In spite of great improvements in image-processing technology, these issues are still true. For that reason, scanning is now rarely used as an input method for digital printing. The big exception to this rule is reprinting books (and other documents) where no digital original is available—and this is the case for most reprinted books today.

The scanning process usually produces a bitmapped file known as a ***TIFF*** file. One-bit TIFFs are often used for text; they capture the image simply in terms of black or white pixels. Eight-bit TIFFs are more sophisticated: they are able to capture ***grayscale*** information (shades of gray) and thus are more appropriate when photographs appear in the originals. However, when text is scanned as 8-bit, it is often a bit blurry. The best results are accomplished by scanning at 8-bit and then downsampling the text areas to 1-bit (ideally, smoothing out the jagged edges of the type and despeckling the surrounding white areas) and leaving the image areas as 8-bit data.

2. PostScript and PDF

PostScript is a very general-purpose page-description language, and its incorporation into the first Apple LaserWriter was an important factor in the development of "desktop publishing" in the 1980s. The versatility of PostScript was important in its early success—it was much more flexible than the other languages used to drive printers in those days—but its very flexibility made it somewhat unpredictable. ***PDF***, which can be thought of as an efficient and predictable subset of PostScript, is gradually taking over PostScript's role as the normal file format for output to a digital printer.

Although other languages are used to drive office printers (notably Hewlett-Packard's ***PCL***) and to drive high-speed printers in data centers, PostScript and PDF are the norm for publishing applications. That doesn't mean, however, that all publishers provide their printers with PostScript or PDF files. Most are still providing native files from their layout package (e.g. QuarkXpress, Adobe InDesign, or Microsoft Publisher) and letting the printer produce the final PostScript or PDF file. This gives the printer more flexibility in fixing errors and avoiding production problems. New dialects of PDF (such as PDF/X-1a and PDF/3), along with the appropriate software support, promise to make it easier for publishers to supply files that will be suitable for printing. The chapter on **composition and graphics** [6.12.11.5] discusses these technologies in more detail.

It should also be noted that it is possible for PostScript or PDF files to consist mainly or only of bitmapped data (usually TIFFs), since the ability to incorporate TIFF images is an important feature of both of these technologies. This can be the cause of great confusion. Generally, when PostScript or PDF files are being referred to, it is assumed that they are text-based files that were generated from a digital page-makeup process; such files are editable and searchable, and use fonts and vector data to conform to the resolution of whatever output device is being used. If, on the other hand, they are simply scanned data captured as TIFFs and then enclosed in PostScript or PDF "wrappers," the data they contain is not editable or searchable and will not adapt; their resolution is dependent on how much data was captured in those original scans. Especially when PDF files are being provided to or received from a new source, it is important for all parties to be aware whether the underlying data is true text-and-vector data or bitmapped image data, or both.

(ii) IMAGING TECHNOLOGIES FOR DIGITAL PRINTING

The majority of digital printing is done with toner-based devices, but a growing amount is being accomplished in other ways. Each approach, and there are many, has a specific set of advantages and disadvantages.

1. Laser printers and other toner-based printers

The most common kind of toner-based printing device is the laser printer. A laser beam bounces off a spinning mirror and sweeps across a charged photoconductive drum or belt, which is discharged wherever the laser light touches it. Charged toner particles adhere to the drum or belt where it was exposed. The toner is then transferred to the paper (sometimes via an intermediate drum or belt). Once on the paper, the toner is fused (melted in place), usually by a hot roller. The most common production-speed monochrome laser printers are made by Xerox, Canon, and Ricoh. (Specific printers are discussed in the section on **available printing systems** [8.4] below.)

A color machine works on the same principles as a monochrome one, except that there are four different toners (cyan, yellow, magenta, and black). There are often four different lasers and four different drums (or belts) as well, but sometimes these components are used in common for the four toners.

The same sort of device can be built with an array of light-emitting diodes (***LED***s) instead of a laser and a spinning mirror. Heidelberg and Oce use this technology in their monochrome devices. And it is not even necessary to have a light source or a photosensitive drum. One supplier (Oce) has a color printer that uses a drum whose surface is encircled by fine electrical channels. The channels are rapidly and precisely charged and discharged as the drum turns, to attract charged toner to the appropriate spots. Another supplier (Delphax) uses a special charge-plate with tiny holes to deliver packets of electrons to charge a rotating drum in its electron-beam approach. Yet another (Nipson) uses magnetic toner and a steel drum with a special surface that can be magnetized via a special writing head. This technology is not suitable for color printing, since the toner has to be magnetic and magnetic materials of the appropriate colors are not available.

The quality possible with toner-based printing is limited by the resolution of the printer, which is usually stated in dots per inch (dpi). To reproduce photographs adequately, a toner-based printer must generally have a resolution of at least 600 dpi. This level of resolution is required because toner is a "binary" material—it is either present or not, and if it is present, it is at full strength (solid black). To give the appearance of various levels of gray (in a monochrome device) or shades of color (in a color device), the toner must be applied in "halftone dots" of varying size. If a printer's resolution is much below 600 dpi, the halftone dots are objectionably large. Simliarly, artifacts called "jaggies" are visible in the diagonal edges of text and line art when it is printed on machines with a resolution below 600 dpi. The appearance of both halftones and line art improves detectably as the resolution increases to about 1,000 dpi, but higher resolution than that has little visual effect.

To be useful for book printing, a printer must be resonably fast. A ten-page-per-minute printer could be used to print a 300-page book, but it would take half an hour. In most applications, that would be much too slow. Most book printing is done on machines that print upwards of 100 pages per minute (ppm). Sheetfed printers are available that run up to 180 ppm and roll-fed ones can go well over 1,000 ppm. (Details on the available machines are given **below** [8.4].) The fastest machines are not toner-based, but rather inkjet printers.

Even the fastest of all the digital machines can only match the speed of a moderately slow offset book press. But what digital printing gives up in speed, it compensates for in other advantages, such as flexibility, cost-effectiveness in short runs, and simplified binding processes.

2. Inkjet

Inkjet printing is an entirely different approach to digital printing. Tiny droplets of ink are squirted directly onto the paper from a printhead containing hundreds or thousands of nozzles, each under electronic control.

Most inkjet printing is done using ***drop-on-demand*** technology. Droplets are forced out of each nozzle as they are needed, either by heat (thermal drop-on-demand) or pressure (piezo-electric drop-on-demand). So far, though, the machines using drop-on-demand technology are just not fast enough for most publishing applications, though they are quickly becoming the standard way to produce color proofs. For really fast printing, ***continuous-inkjet*** technology is required. In this technology, all the nozzles in the printhead emit a continuous stream of droplets, but most are electrostaticly deflected back into a gutter and recirculated. Only the undeflected droplets continue on to the paper.

The pioneer in the use of continuous-inkjet systems for publishing is Scitex Digital Printing. Initially, the company supplied partial-page systems for applications like addressing and the printing of variable-text letters, but in recent years they have expanded into full-page systems. Their roll-fed monochrome (Versamark) and color (Business Color Press) systems are not only the first inkjet systems to be used for publishing, they are also the fastest available digital devices of any kind, capable of printing 500 to 1,000 feet per minute—

the equivalent of several thousand pages per minute. Drop-on-demand systems have yet to come near these speeds, though there is much promising development work in this area.

The resolution of the Scitex inkjet machines is just 300 dpi—low, relative to almost any toner-based machine used for book printing. The image quality of the printed result is limited by the resolution. The same will probably be true of other high-speed inkjet machines being readied for the market. But most inkjet technologies have an advantage that toner-based printing does not. Inkjet devices can have variable droplet size (or droplets that consist of variable numbers of sub-droplets) and this allows a certain amount of variation in shades of color or gray without resorting to hafltone dots. By exploiting this "grayscale" capability, inkjet vendors can produce output whose quality (especially where images are concerned) matches that produced by higher-resolution devices. So far, however, no devices that exploit this technique and that would be suitable for book printing are commercially available.

3. Elcography

Finally, there is another unique technology which is not related to either toner-based or inkjet printing. It is called "elcography," and the first elcographic press is being delivered to the first customer as this is written. A distinguishing feature of elcography is that it can print 8-bit greyscale data, reflecting the photographic background of its creators. The technique was invented by the Canadian company Elcorsy, and it is described in more detail in the section on **roll-fed printing** [8.4.2].

(iii) OTHER FACTORS AFFECTING CHOICES IN DIGITAL PRINTING

Although imaging technologies are a key factor in digital printing, other technology issues can play an important role when deciding what system to buy or use. These include costs, speed, flexibility, appearance issues, and binding issues.

1. Cost

Though capital costs are important in digital printing (color devices can range from the hundreds of thousands of dollars into the millions), it is running costs that tend to dominate discussions of the use of digital printing. It is not hard to see why: in many markets, digital printing is competing with offset, and offset's cost per full-color page (once the job is on the press and running) is only a penny or two per letter-size image. Throughout the 1990s, the cost of running a digital press generally exceeded $0.25 per page (and of course the ultimate customer had to be charged substantially more than that if the transaction was to be profitable for the printer). This meant that digital printing was confined to two small niches: very short runs (usually less than 500)—where offset's higher setup costs come into play—and variable-data printing. Now, with the latest generation of digital devices, page costs have come down substantially. The vendors say they will be in the under-ten-cents range for a letter-sized full-color page. If so, digital printing will be competitive at 2,000 copies—not yet the heart of the offset market, but a substantial inroad all the same.

Monochrome digital printing is already competitive with offset in most markets and, in fact, has almost completely eliminated offset in some. Sheetfed monochrome devices—notably the Xerox DocuTech family—displaced much of the low page-count work previously done on offset duplicators; and the high-speed monochrome machines from IBM, Oce, and others are starting to have a similar effect on short-run book printing.

2. Speed

For some applications, speed is important. A speed of 120 ppm sounds impressive, but if you are printing 600-page books on a printer that speed, it can only produce twelve copies per hour. At that rate, a run of 2,500 books would take well over a week, running three shifts and seven days. Only roll-fed printers have the speed necessary for book production in substantial volume. On the other hand, inexpensive sheetfed machines open up interesting new opportunities for very short runs and for printing individual books on demand.

3. Flexibility

Substrate flexibility—what materials can be printed on, and in what form—is an issue with some kinds of digital printing. Not every kind of paper will work in every machine. Some papers do badly with certain toners or certain fusing processes. Some tend to jam in specific machines. Many companies involved in digital printing rely on a qualification process, carried out by their printer and paper suppliers, to make sure that the papers they select will work in their machines. In general, newer machines are more flexible in terms of dealing with surface textures and paper weights than previous models. One supplier, Nipson, has found a niche in monochrome printing on hard-to-image substrates. The combination of its unique magnetographic technology and its low-heat "flash-fusing" approach mean that it can handle a wide variety of plastics and other materials.

Substrate flexibility also means the ability to run a mix of substrates, either in a single job or in successive jobs. Vendors have been adding extra feed trays to their machines, either as standard equipment or as options, in an effort to provide more of this kind of flexibility. This is one area where sheetfed machines have the upper hand. Roll-fed devices cannot mix paper stocks in a job, and it takes several minutes to switch them from one type of paper to another, whereas the same switch is instantaneous for a sheetfed machine with multiple input hoppers.

4. Appearance

The appearance of the printed page can be a very important issue in some applications, and of little significance in others. For a decade, digital-press vendors have been striving to match the appearance of offset-printed pages, since the failure to do so has been a stumbling block in their sales efforts. The current top-of-the-line machines from HP/Indigo, Xerox, and Nexpress do a good job in this respect. Among the problems that have been overcome are: toner sheen (the overly shiny appearance of heavy concentrations of toner), streaking, surface oil (remaining on the paper from the fuser rollers), ***halftone*** quality problems, and ***color gamut*** limitations. Some or all of these appearance problems are still to be found in lower-priced devices. In addition, software issues can contribute to appearance issues such as color problems, image resolution problems, and problems with fonts. These, however, can all be fixed with the right software and expertise (the chapter on composition and graphics discusses using **color** [6.9], **image resolution** [6.11], and **fonts** [6.7] in more detail).

5. Binding

Finally, digital printing requires different binding equipment than does offset. There is no market where this is more obvious than the book market. Offset book printing is done on large presses that produce signatures of eight, sixteen, or thirty-two pages. These have to be folded, gathered (collated), and then bound. Digital book printing is done one, two, or three pages at a time, and they are delivered in sequence from the machine, so no collation is required. Traditional binding equipment handles many hundreds of books per hour. It is unlikely that the binding process for a digital printer, even a very fast roll-fed one, would ever need to exceed one hundred books per hour. And for a sheetfed machine, the number would be a fraction of that. The traditional bookbinding equipment is simply inappropriate.

Suppliers of binding equipment are belatedly responding to this need, especially in the key perfect-bound (softcover) area. There are expensive machines (several hundred thousand dollars) designed to handle the output of the roll-fed printers and the fastest sheetfed ones, and inexpensive ($15,000 and less) manual machines designed to handle book-on-demand binding from slower sheetfed devices. For the moment, though, there are no machines in the great gap between.

8.3 USES OF DIGITAL PRINTING

(I) DIGITAL PRINTING VS. OFFSET PRINTING

Most books and journals are printed via the offset process. (Although other traditional printing processes, including letterpress, gravure, and flexography can also be used, this happens only rarely. See the chapter on **composition and graphics** [6.13] for a discussion of these processes.) For some book printing, digital printing (which includes toner-based processes, ink-jet printing, and other processes that do not involve making a plate or other master) is starting to be an important competitor to offset. Important suppliers of toner-based machines for book printing include Xerox, Heidelberg, HP/Indigo, Oce, Xeikon, and IBM. At present there is only one significant supplier of ink-jet printing equipment suitable for books, Scitex Digital Printing, but others are preparing to enter this field.

To understand the developing competition between offset and digital printing, it is useful to consider the main characteristics that distinguish them today: quality, speed, flexibility, cost, and operational factors.

1. Quality

Though both toner and inkjet printing have historically been unable to match offset quality, that has recently changed. Now, the best of the toner-based "digital presses" can match the quality of most commercial offset work. Some low-speed inkjet devices are also capable of offset-quality printing, but for now they are far too slow to be used for book and journal printing and are used mostly for proofing.

2. Speed

Toner-based machines cannot, in general, match the speed of an offset press running continuously. But an offset press doing short runs spends more time during job-to-job changeover than it does actually printing, and in that situation a toner-based device can be as fast or faster. The high-speed inkjet printers from Scitex Digital Printing are much faster than the toner-based machines, and they can compete directly on speed (although not yet on quality) with offset presses.

3. Flexibility

Each approach offers specific kinds of flexibility. Offset printing currently offers more flexibility in terms of papers, inks (including spot colors and varnish), and binding options. Digital printing, of course, offers the flexibility of completely changing each page from one impression to the next.

4. Cost

Offset has a higher cost for starting up a job, because plates must be prepared and some paper is wasted during the initial run-up to the first good sheet. The binding process that goes with offset (print in signatures, fold, gather, bind, and trim) can also be more expensive than the binding process for digital printing, where large signatures and gathering are not required. But, at present, the cost per page of the actual printing is lower for offset, and this is the dominant cost in long runs. So short runs are more economical with digital printing, and longer ones are more economical with offset. The crossover point between the two methods is somewhere between 200 copies and 5,000 copies, depending on the exact equipment being compared.

5. Operational factors

Generally speaking, offset printing requires a highly-trained operator and a production (factory-like) working environment. The quality obtained from an offset press often depends on the skill of the operator. Digital printing tends to place less demands on the operator and to produce more uniform results. It can usually be done in an office-like environment. One implication of these differences is that highly-efficient, "lean" manufacturing of print is more likely to be accomplished with digital devices, given devices of comparable speed.

(ii) PRINTING ON DEMAND

The phrase "printing on demand" (***POD***) is used in various ways, but we will choose the most restrictive meaning: the printing of a document in response to the requirement of a specific end user. This definition makes clear the difference between POD and "short runs" (see separate discussion in the section on **short runs** [8.3.3]). Examples of POD would include the production of a manual for a bulldozer at the time when the bulldozer itself is produced, and the in-store printing of a book for a waiting customer. Printing on demand is one of two types of printing (the other is variable-data printing) that digital printing can address but conventional printing, which is restricted to producing multiple copies of the same document, cannot.

Most printing that is done in the office and the home could be classified as printing on demand. Items are printed as the need arises, and only the quantity that can be immediately used is produced—often just one copy.

But successful examples of printing on demand as a business are hard to find. The reason for this is not technical. The technology for printing on demand is exactly the same as it is for short runs: if you can print a run of fifity copies, you can print a run of one. Rather, the non-printing costs surrounding printing on demand (selling, processing the order, delivering the document, and billing) tend to make the whole process uneconomic. A particular printer may be able to produce a single copy of a paperback book at a cost of five dollars, for example, but if it costs the printer an additional five dollars to process the order and do the billing, the prospects of a profitable POD business are slim. And it is hard to fit a sales force paid on commission, which is often the case in the printing industry, into a print-on-demand model.

1. Books on demand: making it work

Because of the business issues discussed above, successful ***POD*** operations generally need to be highly automated and paid for in an efficient transaction.

On-demand production of individual books in the bookstore, if it ever becomes a commercial reality, would be an example. Here, the transaction would be handled by a clerk who is already handling many other sales, so the transaction costs would be low. As of late 2002, there is only one actual case of a book production device being installed in a bookstore—the machine is made by the Instabook Corporation, and the bookstore is Book Express in Cambridge, Ontario, Canada). Several companies are developing similar devices, and they should appear on the market over the next few years.

The engineering challenge of creating a self-contained book-production machine is formidable, but a greater obstacle may turn out to be setting up the infrastructure that allows such a machine to have access to all the books it might be called upon to print, while still guaranteeing the publisher a suitable commission and no loss of control over the intellectual property. This problem, like the analogous problem for e-books, is far from being solved. The case of Book Express is instructive: the Instabook machine seems to be working fine, but there very few books are produced on it because of the limited number of titles available.

In a few cases, print-on-demand book production has reached relatively large scale. The best example is Lightning Source, a subsidiary of the book distributor Ingram. Lightning Source has developed a very efficient system for producing books digitally. The work produced is a combination of true on-demand printing (one or two copies) and short runs. By mid-2002, the company had produced over three million books and had over 100,000 titles in its system.

(iii) SHORT-RUN PRINTING

Once the print run is underway, digital printing costs more per page than offset printing. The cost difference is very high (but declining every year) for color pages. It is small but still significant for black-and-white pages. This economic fact means that digital printing can be justified only in selected niches where other factors make up for the high cost per page.

Some costs are incurred in offset printing before the first good sheet comes off the press. Two such cost areas, the cost associated with platemaking and the cost associated with the wasted sheets used in getting the press "up to color," are avoided entirely in digital printing. A digital device needs no plate and switches instantly from one job to the next. Normally, neither paper nor time is wasted during the switch. This means that if the print run is short, the overall cost for printing a job digitally can be less than offset even though the cost per page is higher with digital printing.

For jobs involving fewer than 200 copies of a document, digital printing is almost always less expensive than offset. Depending on exactly what kinds of presses are being compared, digital printing can sometimes be competitive up to 1,000 copies or more. And sometimes factors apart from the printing itself (for example, the avoidance of signature gathering when printing documents with high page counts) can help justify digital printing, making it economical at still higher quantities.

1. Applications for short-run printing

Short-run digital printing has found application in a number of book-publishing niches, including:

1. COURSE PACKS AND CUSTOM TEXTBOOKS

These are materials selected by a professor for a specific course, and produced in the quantity required for the enrollment in that course.

2. ADVANCE COPIES AND REVIEW COPIES

These are copies of a book produced ahead of the primary (offset) print run and used for promotion. Publishers want their books to be reviewed to coincide with their availability in bookstores, and they want the sales force to have advance copies to obtain bookstore orders. In the past, these needs for early copies have been satisfied, if at all, with "bound galleys" produced on high-speed copiers. Digital printing provides a better solution.

3. BACKLIST BOOKS

If a book has slow but steady sales of a few dozen to a few hundred copies per year, the publisher will be reluctant to tie up capital in an offset print run that will take years to sell out. But short runs of twenty to fifty books make sense in this situation, even though the cost per book is comparatively high.

4. SMALL PUBLISHERS AND SELF-PUBLISHERS

For many small book publishers, and most self-publishers, a very short initial print run, using digital printing, is a wise choice. If the book sells in sufficient quantity, a switch to longer offset print runs can be made.

2. The success of short-run digital printing

In the twenty-year history of digital printing, by far the majority of the work produced has been in the short run category. The reasons for this are organizational rather than technical: short-run printing doesn't require new approaches to purchasing, sales, and job management (as POD does), and it doesn't require new skill sets and new ways of relating to the customer (as variable-data printing does). For printers (and their customers) who move from offset printing into short-run digital printing, the relationship and procedures can remain essentially unchanged.

With each passing year, new digital printing equipment is introduced that features higher speed and lower cost per page. This causes digital printing to become ever more competitive with offset. The longest economical short run will get longer and longer. Eventually (probably within a decade or two) there will be no difference in per-page costs, and digital printing will take over most of the work that is currently produced using offset presses. At that point, there will no longer be a reason to distinguish short runs from other press runs.

(iv) PERSONALIZED AND CUSTOM DOCUMENTS

Custom and personalized documents are an area of special strength for digital printing. Custom documents are those created for a small group of readers; personalized documents are each unique. It is practical to produce custom documents via offset printing for an audience of at least a few hundred, but smaller print runs call for digital printing. And of course, personalized documents (with a run length of one) require digital printing.

The actual printing of custom documents tends to be less important than the creation of the document content, which is where most of the costs tend to lie. There have been relatively few examples of successful business opportunities based on the production of custom books. The most notable one is custom college textbooks. Several publishers, beginning with McGraw-Hill's pioneering Primis project, established repositories of content in various fields of study. Professors get to select the content they want for their classes and have it produced as a custom book. The technology to do this has been around for almost two decades, and there are several successful examples, but this type of custom publishing is still not wide-spread. It turns out that establishing the repository (and especially, obtaining permissions and setting up royalty arrangements for all the content items) is the most difficult aspect. Another fairly common application of custom publishing is in creating spin-off products from a database. For example, the technique has been used to create industry-specific subsets of a catalog for a company to hand out at a specialized trade show.

Personalized printing is occasionally used for books. Sometimes, each copy of a custom-published textbook is imprinted with the student's name, which is a trivial example of personalization. Personalized children's books, with the use of the child's name and other information (e.g. the name of a pet, or the child's street), are common. Sometimes even the child's photo is scanned and used in illustrations throughout the book.

(v) THE ROLE OF THE WEB

Much has been made of the Web as a potential competitor to print publishing. But the Web is a key enabler for certain kinds of printing. As is noted in the discussion of **printing on demand** [8.3.2], the transaction costs for books printed on demand are a key factor in making the process profitable. Books ordered over the Web can have a very low transaction cost, since the customer does all the work of specifying the book, the delivery address, the payment option, and so on. Similarly, custom and personalized book production operations are much more likely to be profitable if the books are ordered via the Web.

The Web can also be helpful in streamlining the process leading up to the publication of a book. A notable example of this is the large number of book production services that have sprung up to serve the small publisher and self-publisher. These companies tend to use the Web for almost all of their interactions with customers, including bidding and contracts as well as the receipt of the finished manuscript and illustrations.

8.4 AVAILABLE PRINTING SYSTEMS

(I) SHEETFED PRINTERS

The most common digital printing devices print on individual sheets of paper. They aren't as fast as roll-fed devices (which are covered **below** [8.4.2]), but they are more flexible (since it is easy to switch paper stocks and sizes) and usually less expensive. The first digital printing devices to be commercialized were monochrome laser printers, in the late 1970s. Not until the 1990s did digital printing in color really become practical.

1. Monochrome sheetfed printing

In 1976, the first of two high-speed digital printing machines was introduced. The two were notably similar in their basic laser-printing functionality, but very different in their implementation. What's more, the segments of the digital printing market that were pioneered by each machine would remain separate for decades. Only now, two-and-a-half decades later, are they finally merging to form a truly mass market.

1. IBM 3800

First to arrive was the IBM 3800. Its speed was astonishing for the time: 215 ppm. However, the 3800 made little impact on the publishing industry, for a variety of reasons—two of the major ones being insufficient resolution at 240 dpi and woefully inadequate fonts. The 3800, though, was not intended for publishing in the first place. It was intended to replace line printers attached to mainframe computers, a niche it filled quite well. At the time it appeared, all printed output in the mainframe environment was generated on mechanical impact printers—chain printers, train printers, flying-drum printers, and others of that ilk. They were noisy, inflexible, and often unreliable. During the machine's thirteen-year lifetime, IBM sold over 8,000 3800s. These trailblazing machines revolutionized the data center, and their offspring (right down to the HP LaserJet) revolutionized the office.

2. XEROX 9700

The other pioneering laser printer to appear in the 70s was the Xerox 9700, introduced in 1977. Unlike the IBM printer, the 9700 was not originally intended as a replacement for any particular machine. It printed 120 ppm at 300 dpi, and it could use any fonts that could be loaded into its memory (from 8KB to 32KB of bitmap memory, enough for 4 to 12 fonts at 10 point). One drawback was that a separate font was needed for each different size, and larger sizes took up more memory. Fonts could be downloaded along with the job to be printed.

The 9700 and its successors (down to the Apple LaserWriter) revolutionized document printing and publishing. Just as the IBM 3800 gave rise to an entire industry of laser printing for mainframe (and eventually office) output, the Xerox 9700 initiated an industry of laser printing for documents and publishing. (To this day, in the high-speed printing market, the convergence of the two segments is still not quite complete.)

Like all machines of its time (and most others for a decade to come), the 9700 was basically a text-only machine. The only graphics it could handle were small logos and crude line art assembled from special "fonts." These were limitations imposed by the technology of the day, in particular, the high cost of random-access memory (RAM). The 9700 was ideal for textual documents of high value and variable content, and it turned out that the insurance industry was its natural home. It could print out single copies of custom policies, replacing a pick-and-assemble manual process.

But the 9700 and the machines that followed it were too limited and required too much computer infrastructure to be used for ordinary publishing applications.

3. POSTSCRIPT AND DOCUTECH

Until the arrival of ***PostScript*** laser printers on the market in 1985, each brand of laser printer had its own interface language or "page description language," and software to drive laser printers was complex and expensive. PostScript would eventually put an end to the proliferation of proprietary languages, but it took years before computer performance increased to the point that driving a high-speed printer with PostScript was practical.

In 1990, Xerox announced the ***DocuTech***, the machine that dominated publishing applications of monochrome digital printing throughout the 1990s. This 120 ppm digital printer was initially marketed as a very sophisticated copier, but Xerox soon introduced a PostScript capability for it and it was increasingly used as a high-speed digital printer rather than a copier. With the DocuTech, Xerox began to displace large amounts of monochrome offset printing. It introduced new models in various speed ranges, culminating with the DocuTech 6180 at 180 ppm. It is still the fastest sheetfed digital printer capable of duplex (two-sided) printing.

The Xerox DocuTech didn't have much competition, though Kodak (first on its own and later in partnership with Heidelberg) did offer a 110 ppm device. The higher-speed DocuTech models were without competition until the 150 ppm Heidelberg Digimaster 9150 and the 155 ppm Oce VarioPrint 5160 were finally introduced in the fall of 2002.

4. THE MARKET TODAY

Xerox continues to dominate the high-speed monochrome sheetfed market. Apart from Heidelberg (whose machines are also sold by Canon, IBM, Ikon, and Danka), there are a number of vendors (led by Canon and Ricoh) with laser printers at 100 ppm and below, all looking for an opportunity to take some of the remaining monochrome business from offset printing (or from Xerox and Heidelberg). Some of these machines are very aggressively priced, and it is clear that both the initial investment and the cost per page of high-speed digital printing will decline sharply.

The DocuTech and the machines that compete with it owe a lot to copier technology. They all use photosensitive drums or belts, and they use either a laser or LEDs to create the image to be printed. Most of the manufacturers (Heidelberg being the major exception) are very active in the copier market as well.

There is one monochrome sheetfed machine worthy of mention that is outside the mainstream markets: the Delphax Imaggia. This is a specialized machine for check printing. It is actually faster than any other sheetfed printer, but it prints only on one side. It is capable of printing with magnetic ink (a requirement for checks) and it can handle an extremely wide range of paper weights. It uses Delphax' unique imaging technology, called electron-beam imaging.

2. Color sheetfed printing

The earliest color digital printers were basically color copiers with a computer interface. Their low speeds and modest quality, combined with a relatively high cost per page, meant that they could not be used for any "publishing" applications except early-stage proofing. In 1993, two companies—Indigo and Xeikon—began to change this. Xeikon's machine was roll-fed and is discussed **below** [8.4.2]. Indigo's E-Print 1000 was a 17 ppm printer using liquid toner (the company called it "Electro-ink"). From the start, it produced quality that could compete for many offset jobs.

During the course of the 1990s, copier companies gradually expanded the market for office color printing. Canon in particular found a corporate market for its CLC series of copier-based machines which are fast (up to 50 ppm) but which do not produce images whose quality can match Indigo's. The Canon machines are widely used in corporate and quick-print environments.

Xerox, too, offered copier-based printing to the corporate market. But with its introduction of the DocuColor series in the late 1990s, it began to focus more seriously on high-quality publishing markets in which it would be competing with Indigo. It took a further step in this direction with its iGen3 printer, a machine designed specifically to compete with offset printing. It was shown as a prototype at Drupa, the major international printing trade show, in 2000, and officially announced the following year. As of the end of 2002, volume production of this 100 ppm machine is just getting started.

In parallel with Xerox' development of the iGen3, Heidelberg and Kodak were also working on a machine to address offset markets, the NexPress 2100. It was first shown at Drupa 2000, and shipments of this 70 ppm machine began in 2001.

Meanwhile, Indigo had not been sitting still. It had made speed and quality improvements and had introduced a roll-fed model and a machine designed for printing on flexible plastic. But the biggest milestone for Indigo came in the fall of 2001, when it was purchased by Hewlett-Packard. This provided new financial and marketing resources, and it held the promise of streamlined, low-cost manufacturing in the future.

Thus, by the fall of 2001, the basic structure of the sheetfed digital printing market of today was in place. HP Indigo, Heidelberg, and Xerox are competing with each other for a share of the market that has traditionally been held by offset printing. These three vendors have deep pockets, broad market access, and expensive machines with very high image quality. Then comes a second group of companies, dominated by the copier vendors Canon, Sharp, Konica, Oce, and Minolta, among others. They are focused on the corporate market and the lower-quality segments of the offset market.

These are all toner-based machines. (So far, no sheetfed inkjet machines are fast enough to compete for production work, although they are widely used for low-volume tasks such as proofing and book-cover printing.) Almost all of them use a photosensitive drum or belt, with a laser or LED array to create the image. The exception to this is the Oce CPS700, which uses circular electrodes embedded in its imaging drum to attract toner. This machine, which is also unusual in utilizing seven different colors of toner, produces excellent images. But its market has been limited so far by its relatively low speed (25 ppm) and high price.

(ii) ROLL-FED DIGITAL PRINTING

For really fast printing, a roll-fed (or "web," to use the traditional printing term) machine is needed. Paper-handling difficulties put an upper limit on how fast a sheetfed printer can be. So far, no sheetfed machine has been able to print faster than 180 letter-size pages per minute. But roll-fed machines can go much faster. Some of them print at speeds of 750 or 1,000 feet per minute which (depending on the maximum width of the roll) can be the equivalent of over 2,000 letter-size pages per minute.

But the use of paper in rolls has its disadvantages as well. Only one kind of paper can be loaded at a time (sheetfed machines can have as many kinds as there are paper drawers), and changing paper generally requires heavy equipment and several minutes of downtime. Once the new roll is loaded, though, the machine will be able to run for hours without attention.

Roll-fed machines, especially the fastest ones, present special data-processing challenges. These days, most publishing-oriented pages are printed from ***PostScript*** or ***PDF*** files. But it can take a second or two for a fast processor to take each PostScript or PDF page and "rasterize" it—break it down into the individual dots that the printer will ultimately image. Photographs, in particular, require a lot of processing power. If the processing takes, say, a second per page, but the printer is capable of printing ten or more pages per second, then the rasterizing process becomes a major bottleneck. The speed of transfer of data from the host computer to the imaging part of the printer can also be a bottleneck.

Various solutions have been devised to help with this—multiple processors working in parallel, parallelism in the transfer of data, rasterization and compression of images ahead of time, and so on. The use of simpler languages than PostScript and PDF can also help. Xerox Metacode, IBM AFP/IPDS, and Hewlett-Packard PCL are all much faster to rasterize than PostScript and PDF (although they are far less flexible), and so they are still widely used, especially in non-publishing applications (e.g.; statement printing). This problem will gradually solve itself, since the processing speed of the average computer chip is increasing faster than the printing speed of the fastest printers. Eventually, the chips will be fast enough to keep up without difficulty.

While sheetfed printers have a lot in common with copiers, and are frequently based on copier designs, roll-fed machines are much more diverse. They use a variety of printing technologies that are not found among the sheetfed machines.

1. Monochrome machines

Most roll-fed printers installed so far are monochrome machines. They have been used for many years in statement printing (e.g., phone bills, credit card statements, brokerage account reports). But centralized statement printing is not a growth market, and all the companies that supply roll-fed machines have been seeking out additional markets. In recent years, a lot of emphasis has been placed on short-run printing of books. Other important markets have included personalized direct mail and printing of numbered or personalized documents (such as tickets and credit cards).

1. IBM

For many years, IBM has been active in this market. At one time, it was a dominant force in data-center printing. In recent years, IBM's Printing Systems division has focused increasingly on sales where printing is only one part of a solution that also involves consulting, software development, and integration. This has often meant that IBM has chosen not to bid on projects where the focus was the straightforward purchase of a printer. IBM's latest roll-fed system, the 4100, prints at up to 762 ppm and is a good fit for book printing.

2. OCE

IBM's narrow focus has opened up some opportunities for Oce (formerly Siemens), which originally made its mark selling IBM-compatible printers in the mainframe environment. It now sells roll-fed machines into a variety of applications, including book printing, and has become the leading vendor of roll-fed printers. Oce's VarioStream products run at up to 1,273 ppm and are used in a number of book-on-demand production facilities.

3. XEROX

Xerox, though it concentrates on sheetfed machines, also offers roll-fed ones. It offered machines built by Delphax (see below [8.4.2.1.5]), of which it was part owner, then switched to machines built by a Japanese subcontractor when Delphax was bought by Check Technology. The Xerox CFD models print at up to 1000 ppm.

IBM, Oce, and Xerox all offer roll-fed machines that use the traditional approach of creating the image on a light-sensitive drum or belt with a laser or LED array. But other roll-fed machines use more unusual technologies.

4. NIPSON AND MAGNETOGRAPHIC PRINTING

Nipson, a monochrome specialist, uses a unique technology called "magnetography" in its printers. A writing head, analogous to the head of a disk drive, creates magnetic spots on the surface of steel drum. Toner containing iron particles sticks to the magnetized spots, forming the image. The toner is then transferred to paper. Nipson's fastest machine, the Varypress, prints at 1,616 ppm. Nipson's main specialty is printing on all sorts of substrates (such as plastic credit cards and heat-sensitive materials) that other printers have difficulty with. But it is also active in direct mail printing and, in recent years, has begun paying more attention to book printing, especially text-only books. Nipson's magnetographic technology is unsuitable for color printing, since the materials that would be needed to make toners that have both the necessary magnetic characteristics and the required colors do not exist.

5. DELPHAX AND ELECTRON-BEAM IMAGING

Delphax was originally a joint venture of Xerox and two other companies, and then became a Xerox subsidiary. It was sold to Check Technologies in December 2001. Its printers utilize a unique electron-beam imaging technology. An alternating current knocks electrons loose from the air in tiny holes in the print head. The electrons are deposited on the surface of the nearby imaging drum or belt, and the resulting negative charge attracts toner. The technology is fast, simple, and rugged. Delphax has incorporated it into a sheetfed check printer (the Imaggia, mentioned earlier [8.4.1.1.4]) and a line of roll-fed devices, the fastest of which prints at 1300 ppm. The machine would be suitable for book printing. All the Delphax models are monochrome, but the company has begun development on a full-color machine for introduction in 2005.

6. SCITEX DIGITAL PRINTING AND VERSAMARK

The fastest of the monochrome printers is the Versamark press from Scitex Digital Printing. This is a high-speed inkjet machine (up to 750 feet per minute, or over 2,000 pages per minute). Its key features are its speed and low cost per page. Its print quality is limited, but its other features make it well suited to the production of materials where the highest quality is not an issue. And a new generation of printhead technology, shown in prototype form in the fall of 2002, will close part of the gap in image quality between this technology and the toner-based machines.

7. ELCORSY ELCO 400

A newcomer, just reaching the first customer site as this is written, is the Elcorsy Elco 400. This machine also features high speed (400 feet per second, or about 870 letter-size pages per minute) and low cost per page. The novel technology used in this machine is called "electro-coagulation." A special fluid, containing a pigment and a polymer, is passed between a rotating metal drum and an array of electrodes that is very close to the drum's surface. Whenever one of the electrodes is turned on, a spot of pigment is deposited on the drum. As the drum turns, it comes into contact with paper and the pigment is transferred. The technique should be capable of quite good quality. Early samples showed streaking problems, but these seem to have been fixed by a redesign of the imaging head. A special attribute of this technology is that it is able to print ***grayscale*** (8-bit) images, thus achieving high image quality compared to other digital printers. The machine's initial installations will be monochrome (or monochrome with spot color), although the technology is suitable for color printing as well.

2. Color machines

Two of the vendors of monochrome roll-fed systems (Scitex Digital Printing and Elcorsy) also have (or, in Elcorsy's case, plan to have) color machines. The Scitex Business Color Press is the speed champion, at 500 feet per minute. Elcorsy's competing product, when available, will run at 400 feet per minute. Both are far faster than the toner-based competition. The image quality of the Scitex product is significantly inferior to most toner-based printing, but may still be suitable for some books. The Elcorsy device is expected to have good image quality, and the prototype machine is promising, but the image quality issue will only be completely resolved by production use at customer sites.

Meanwhile, toner-based roll-fed color machines are available from Xeikon and HP Indigo. Xeikon started out in 1993 with a roll-fed color printer and, after dabbling briefly with a sheetfed model, has decided to remain a roll-fed specialist. Its two main products are the DCP 500D and the DCP 320D, which accept maximum paper widths of 20 inches and 12.6 inches, respectively. They each use eight imaging stations (four on each side of the paper) to print both sides simultaneously at up to 130 ppm. In digital book-printing operations, the Xeikon printers (which are also sold under the IBM and MAN Roland names) are often used for printing color covers and jackets.

HP Indigo initially offered only sheetfed printers, but has added the roll-fed w3200 model that prints 133 ppm. Among the roll-fed printers, it is clearly the leader in image quality.

For now, these are the only vendors active in color roll-fed printing for publishing applications. But others will probably enter the market. Several inkjet specialists have shown interest, and one of them, Aprion, showed a mockup of a self-contained book-on-demand printing system at a trade show in 2000. Another inkjet vendor, Dotrix, is actually selling a fast roll-fed machine that could in principle be adapted for publishing use. But so far, the company is marketing it as a machine for printing labels, plastic cards, packaging, wall coverings, and other non-publishing applications.

(iii) CLUSTER APPROACHES

It is possible to use several relatively slow printers, working simultaneously, to duplicate the throughput of a single fast machine. There are several reasons why this approach is attractive. You can start small (with one or two printers) and build capacity incrementally as required. You have a measure of redundancy, so the failure of a single printer does not stop the whole production operation. You may be able to save money, both on your initial investment and on your running costs, because of what might be called a "dis-economy of scale" in the printer market. For example, the price of a 120-ppm printer is more than the cost of four 30-ppm printers, and the cost per page is often higher on the faster printer as well.

One vendor in particular, T/R Systems, has specialized in cluster systems and has sold many of them. Some have been used in book printing. But interest in cluster systems has declined in recent years. One reason is that both the initial investment and the cost per page of fast printers has been declining, making the economics of clustering less attractive. But a more important reason is the new class of enterprise printer-management software that has become available. This software monitors printer use and printer failures throughout an enterprise, routing jobs to an alternative printer in case of machine failure, splitting large jobs among multiple machines, and handling internal accounting and billing. It provides most of the features of cluster printing as a subset, so there are fewer potential customers for software that is restricted to cluster printing. In addition to these enterprise-wide packages, many of the printer vendors now offer print-management software of their own that includes clustering features.

8.5 SALES CHANNELS FOR DIGITAL BOOK PRINTING

As digital printing becomes a common approach to book production, it is changing the business practices of the book-printing industry. Existing book printers find they have to make adjustments to allow for more frequent, but shorter, print runs. And many companies that were not previously involved in book printing are joining the competition. The new digital technologies have changed the market at two levels: they have led to a dramatic drop in the cost of the equipment required to become a book printer (it can now be done for a cost of under $20,000 if you are producing only a few dozen copies a day), and the minimum length of a print run has also dropped (in some cases, to a single copy).

(I) BOOK AND JOURNAL MANUFACTURERS

Many existing book and journal printers are embracing the digital technology. Typically, they do not offer a true "book-on-demand" service. Rather, they focus on short-run printing of from fifty to five hundred copies. Short print runs can often be handled within their existing production and job-tracking processes, and the adjustments to their sales and billing processes can be kept to a minimum. They can sell digital printing as an additional service to their existing book-publisher customers (who can still be expected to buy offset printing when the runs are longer).

(II) BOOK WHOLESALERS AND DISTRIBUTORS

In some cases, book distributors and wholesalers are in a good position to implement digital book-on-demand services. They have to keep books in stock to supply their bookstore customers, so they know when a book goes out of print. They also know when there is demand for a book that is no longer available. So they are in a good position to sell publishers a service that would allow small numbers (or single copies) of slow-moving books to be produced in response to market demands. The most aggressive efforts in this direction to date have been Ingram's Lightning Source operation (based on IBM equipment) in the U.S. and Libri's similar service (based on Xerox equipment) in Germany. Both are set up to print single copies efficiently, though they also offer short runs.

(III) VANITY PRESSES AND SELF-PUBLISHING SERVICES

Vanity presses (publishers who are paid by authors to produce their books) have been around for centuries. But the traditional book-printing technology has not been a good match for the very short runs that self-published authors often require. Vanity presses have therefore embraced digital technology, and today digital printing is often used for the books they produce. In addition, dozens of book-production services for self-publishers have sprung up in recent years, based on the availability of digital printing. These services—which are often indistinguishable from vanity presses, except that they generally do