Adobe Supra: Adobe's High-Performance Raster Image Processor (RIP) Architecture for Print-on-Demand Systems

Wiegert Tierie

Adobe Systems, Amsterdam

During the last decade, the graphic arts and publishing industries have witnessed profound changes nearly tantamount to the revolution spawned by Johannes Gutenberg with his printing press in 1455. Dynamic technological advances in personal computers, workstations, open systems, desktop software applications, and networks produce finished documents faster and at lower prices. Document authoring and distribution tools from Adobe and other vendors enable organizations to create, access, distribute, and print pages and documents electronically. Indeed, the technologies are converging to create fresh opportunities and new markets, thus unleashing the Age of the Digital Document.

A significant number of pages are now produced completely digitally. The arrival of digital printing, which eliminates film altogether, dramatically affects the prepress and production world. With paper and distribution costs rising, the advent of the digital press makes quick turnaround of short-run,high-quality color jobs a real possibility and supports customized printing in which each succeeding page on the press can be different from its predecessor. Distributed printing — in which materials are sent electronically over telephone, the Internet, or satellite links for printing nearby destinations — saves distribution costs.

Developments such as digital presses are revolutionary. Their adoption rate by the printing industry may be a function of the rate at which printing companies are willing and able to make capital investments and re-engineer workflow. Companies looking for a more evolutionary approach can turn to the new generation of large-format imagesetters and digital platemakers. These devices can help reduce labor and materials costs, shorten production cycles, and reduce the environmental impact of chemical processes. All these factors can assist printing companies in remaining more competitive with digital presses for fixed-content jobs.

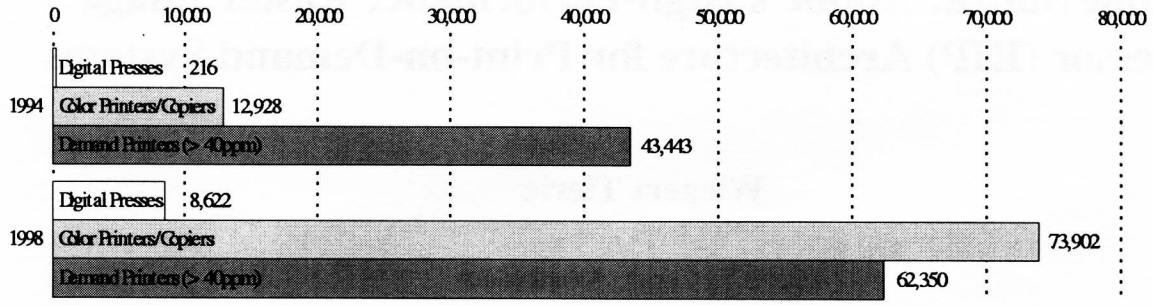
Adobe and its PostScript page description language OEM customers recognize the potential impact that large-format imagesetters, digital platemakers, and presses will have on the printing and publishing industries, and they are working to make those benefits widely available.

Market Outlook

As with any new market, the business models, cost structure, and real benefits of digital presses continue to evolve. The business opportunities for digital presses are ripe and potentially huge, but they are largely untapped at this point. That will change.

According to the market-research firm BIS Strategic Decisions, the market for electronically produced, short-run color pages is expected to grow significantly. In 1993, the group noted that the short-run commercial printing market for both electronic monochrome and color printing of 5,000 pages or less was $31 billion. By 1998, BIS projects that 49 percent of the short-run commercial printing market will be full-color output, 29 percent will be two color, and 22 percent will be one color.

Two years ago, digital presses were a concept. But by the end of 1994, more than 200 had been installed worldwide. IT Strategies, a market-research firm, projects that this number will grow to more than 8,600 devices worldwide by the end of 1998. But these are not the only contenders in the print-on-demand market. IT Strategies predicts that the number of color printer/copiers will increase from 13,000 to about 74,000 in the same time period, a growth rate of 55 percent per year. Also, high-speed printers (more than 40 pages per minute) will increase from 43,000 to 62,000. Many of these devices will be upgraded to support additional colors and graphic arts capabilities (they will contain the PostScript language).



Installed Base of Print-on-Demand Devices, Current and Projected Source: IT Strategies

It is difficult to predict the impact of the Internet. World Wide Web data delivery increases by a factor of 10 every 9 or 10 months. This trend may accelerate as mechanisms are put in place to make commercial publishing viable on the Web.

In short, there is a convergence of three market thrusts: short-run color, demand printing, and distributed printing. Short-run color has been on commercial print buyers' wish lists for years. Demand printing can be thought of as the high-volume printing coming from MIS departments and data centers. And distributed printing is the new 'distribute and then print' metaphor enabled by our global communications network.

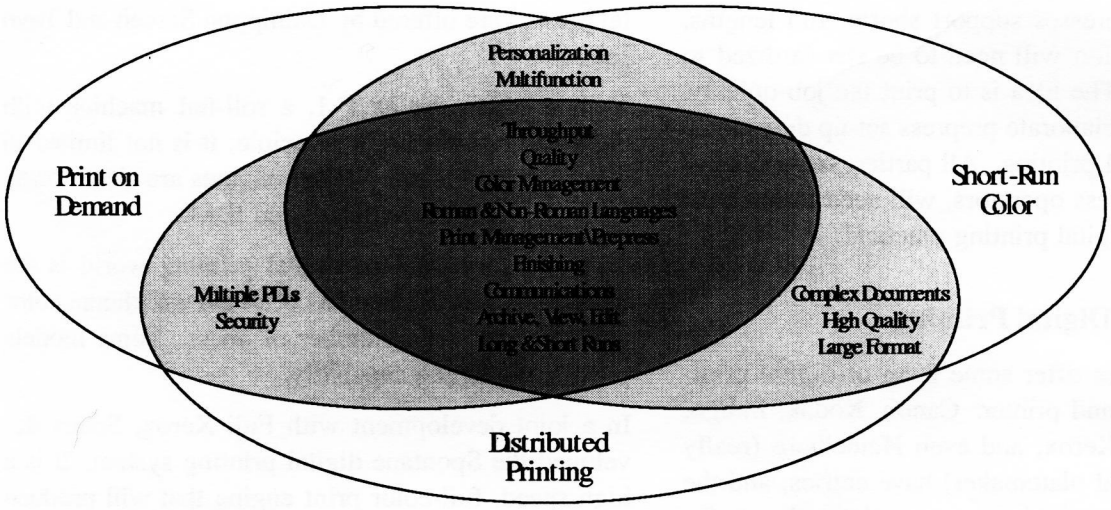
Below is a sample of the implications to these initiatives.

- From the BIS statistics above, the color content of pages will continue to increase; Adobe believes, by inference, that the graphical content will also.
- Documents will be formatted for multiple delivery options, such as print, on-line, and CD, and this activity will continue to fuel the growth of these alternative delivery mechanisms.
- There will be an explosion in the number of publishers on the Internet. Anyone with a PC, a modem, and a page layout program can become a publisher.
- There will be increased deployment of large-scale, graphical document databases. Whether centralized or distributed, document management and search techniques will be the keys to making the information usable and accessible.
- Demand for color printers will be driven by the increase in color pages and the broad use of color on the World Wide Web, an increasingly important source and repository for digital documents.
- System-level, device-independent color through International Color Consortium (ICC) standards will become the preferred way to obtain reliable and predictable color, especially when it is not known which printing device or technology will be used at the destination. (Adobe was one of the founders of ICC. The ICC standards are compatible with PostScript Level 2, which was defined three years before the standards themselves.)
- To reduce transmission time on networks, data and image compression will be used.

As digital documents become the norm, the demands of printing markets that were previously separate now overlap and intersect. The print-on-demand market, short-run color market, and distributed printing market now have similar requirements for factors such as throughput, quality, color management, finishing, and print management. Indeed, these requirements represent the dimensions to the challenge. The need is clear for an integrated system that will enable users to manage document printing and distribution efficiently in the new print-on-demand world.

Who Will Benefit From Digital Print Advances?

To fully realize the benefits of digital print advances, one must embrace a totally desktop-based digital workflow. Digital documents alone provide numerous advantages. Typically, desktop systems require less space and power than traditional graphic arts processing equipment, and they are more cost effective than proprietary color electronic reproduction systems. Traditional color reproduction requires tremendous quantities of expensive film and chemical processing. The closer one gets the image to the actual press, the better the image quality and the greater the reduction in labor content, supply costs, and environmental impact. All of these factors lead to reduced cost. But the digital document also implies reusability, which will further reduce costs.



The Merging and Intersection of Key Markets

One of the hidden benefits of the digital document is what it can imply in the review and sign-off phase of projects. Many companies are already using Adobe Acrobat and the Adobe Portable Document Format (PDF) for this purpose. PDF, with roots in the PostScript language, supports the full range of high-quality typography, graphics, images, and color. PDF files can be created from virtually any desktop application. Adobe provides Acrobat readers on all major desktop computers. PDF files are ideal for passing from one location to another because they are concise (image and data compression) and because Acrobat contains sophisticated font substitution technology that produces accurate renditions of fonts even when the destination computer does not have the document's original fonts. Reviewers can see a graphically accurate version of the job. The ability to make annotations and to respond over computer networks and modems significantly reduces the time for sign-off cycles.

But anyone who uses paper will benefit from digital printing technology. Further, anyone needing short-run production of 5,000 or fewer pages or copies, quick turnaround, and some degree of customization will want to turn to a digital press for output. Digital presses and new-generation presses with on-board, direct-to-plate capabilities now make it practical to print short runs, which were not economically feasible before because of the make-ready for an offset press. The trade-offs are between getting exactly what you want and the number you want versus the speed and low unit cost of volume printing, but with the associated schedules, inventory, obsolescence, and waste issues.

For businesses and consumers, digital technology offers the opportunity to print customized short runs of color documents, potentially on any print medium. The Indigo Omnius system, for instance, can print on packaging materials such as soda cans, foam, mylar, and aluminum. Real estate professionals, marketers, advertising agents, and even restaurant owners can personalize their materials in a cost-effective manner. Imagine the impact if your realtor showed you a flyer of your 'dream house' with your family standing in the front yard. The possibilities are endless for targeted marketing, direct mail, and publishing.

Digital presses will also encourage 'distribute and then print' applications. For example, book publishers may no longer need to print many thousands of books and then absorb expensive inventory and distribution costs. Files can be distributed digitally and printed in the quantity needed for each local market. This method becomes particularly important for printed materials distributed internationally so that shipping and customs delays can be avoided.

Traditional commercial printers can expect to see benefits when this technology is applied to large-format imagesetters and platemakers. Not only does the added processing power allow shorter production cycles and 'rush' processing, but it can help address a potentially costly problem. When a printing plate is defective (often not discovered until the job has started running on the press), a new plate must be generated rapidly while the press is idle. Every minute that the press is idle represents lost profits to the printer. Often a plate is rendered defective because a telephone number or a price is wrong. In these cases, the appropriate flat must be re-RIPped.

Because digital presses support shorter run lengths, prepress preparation will need to be standardized to be economical. The idea is to print the job quickly, so time spent on elaborate prepress set-up defeats the purpose of digital printing. All parties, from designers through prepress operators, will need to work together to make digital printing practical.

Contenders in Digital Printing

Several companies offer some form of digital printing press or demand printer. Canon, Kodak, Indigo, Scitex, Xeikon, Xerox, and even Heidelberg (really an on-press digital platemaker) have entries, and the PostScript language is the common denominator for page description. Indigo has continuously set the standard for print capabilities, particularly with color, paper stocks and weights, media types, and finishing options. Xeikon was the first digital press system for roll-fed applications. Adobe is the largest supplier of RIP software with its Configurable PostScript Interpreter (CPSI) for the broad set of technologies that service print-on-demand applications.

Additional technologies offer useful subsets of the total print-on-demand feature set and are moving to in-crease their capabilities. Color printer/copier vendors are increasing speed and quality. Some already have duplexing, or printing on both sides of the paper. These vendors include Canon, Kodak, and Xerox. Often the RIP technology for this class of device has been provided by COLORBUS, Electronics for Imaging (EFI), and Radius using Adobe CPSI. Demand printer manufacturers already have fast machines and are trying to add color, increase resolution, and provide graphically rich page formatting through the PostScript language and the Adobe Portable Document Format (PDF). These vendors include IBM, Kodak, Nipson, Siemens, and Xerox. Over the past nine months, new color laser printer product introduction shave come from Apple, Hewlett-Packard, Tektronix, and Xerox.

Indigo makes three machines that can be categorized as digital presses. The E-Print 1000 uses liquid inks and is sheet fed. It uses a single cylinder for up to six revolutions per side in which a different color is applied on each revolution. As many as 100 A3-size pages can be printed, folded, and stapled into booklets. The Mobius is a duplexed roll-fed, electro-ink device. The Indigo Omnius, mentioned earlier, will print on packaging materials. In Japan, Indigo digital presses are offered by Dainippon Screen and Toyo Ink.

Xeikon offers the DCP-1, a roll-fed machine with eight toner stations. In principle, it is not limited to a fixed paper length. Xeikon engines are also offered by Agfa, AM International, and IBM.

Canon's entry into the digital printing world is the CLC. This product line has been the workhorse color printer/copier for a number of years. Some models provide duplexing capability.

In a joint development with Fuji Xerox, Scitex developed the Spontane digital printing system. It is a high-speed, full-color print engine that will produce up to 40 full-color A4 pages per minute. Scitex also offers Scitex Digital Printing, alow-resolution color digital press that can run at 200 feet per minute using continuous inkjet technology.

Heidelberg has entered the market with two on-press platemaker systems: the GTO-DI and Quickmaster DI. Although good for short-run jobs, they are not true digital presses, because they still use a master plate to print all the copies. The Quickmaster actually has plate material in the machine so that when one plate is done, it rolls forward and then, for the next job, the next flat is imaged right on the machine.

Supra-Adobe's High-Performance System Architecture

Adobe Systems has developed a strategy for meeting the needs of this emerging on-demand market — a strategy that includes a new system architecture called 'Supra', an extension of the PostScript language and PDF standards, and collaboration with key printer OEMs and workstation system vendors. Supra takes a systems perspective within an integrated workflow, rather than addressing requirements piecemeal and ending up with a series of point solutions that may not mesh with customer systems environments.

The architecture is supported by all the desktop prepress tools needed to prepare digital documents for production. Adobe and others provide desktop and server solutions for preflight and color separation, trapping, imposition, and high-resolution picture replacement. Adobe believes that prepress functions should be available for 'desktop server and RIP' integration to support the broad spectrum of workflows while providing consistent results.

This architecture is applicable to not only digital presses, demand printers, and color printer copiers, but also to large-format imagesetters, proofers, and platemakers. All these devices share a common requirement: to deliver a large number of color separations per unit of time to the marking engine in the right order. Currently, digital presses tend to produce lower resolution but higher page speed, while imagesetters operate at higher resolution but lower page speed.

The architectural objectives include:

- **Scalability**
  Adding processing power and system resources to increase throughput.
- **Configurability**
  Selecting and including only those pieces needed to meet the system requirements. (In some cases, this implies including some of Adobe's Supra modules within existing systems.)
- **Multiplatform**
  Implementation of the architecture using different computer platforms.
- **Openness**
  As interfaces and data structures are solidified and verified for system performance, Adobe will open them up for OEM and third-party development.
- **Quick to market**
  Efforts will be made to use existing Adobe and OEM technology to bring products to market sooner.
- **Extensibility**
  Evolving the architecture for greater performance and functionality.

End user expectations guide the Adobe architectural approach. First and foremost, the architecture must be *high performance;* it must support *fast turnaround* and *production volumes* whether it produces many copies of static content or many unique pages. The maximum run length should be limited by the cost of this print technology versus the cost of printing using a different technology, such as offset lithography. Each page should be customizable with everything from different textual content to personalized images and charts. Additionally, the architecture must enforce guaranteed delivery, implying the need for sophisticated error handling and recovery.

The above diagram shows a portion of the Adobe Supra architecture. To achieve the desired processing rates, Supra employs a multiprocessor architecture. For this scheme to be successful, independent pages must be passed to each RIP process.

Key features of the architecture include:

- PostScript and PDF workflows
- Enforced PostScript page independence so that multiple processors can work on the job simultaneously,
- Overlapped RIPping and output
- High-speed merging of graphically rich customized data
- Interfaces to non-PostScript printing environments, page description languages, and databases
- Job control, sophisticated error handling, and control of finishing options
- Automation of prepress processing and 'reflow' document assembly through workflow systems
- Viewing, editing, and archiving with PDF files

The Role of Adobe

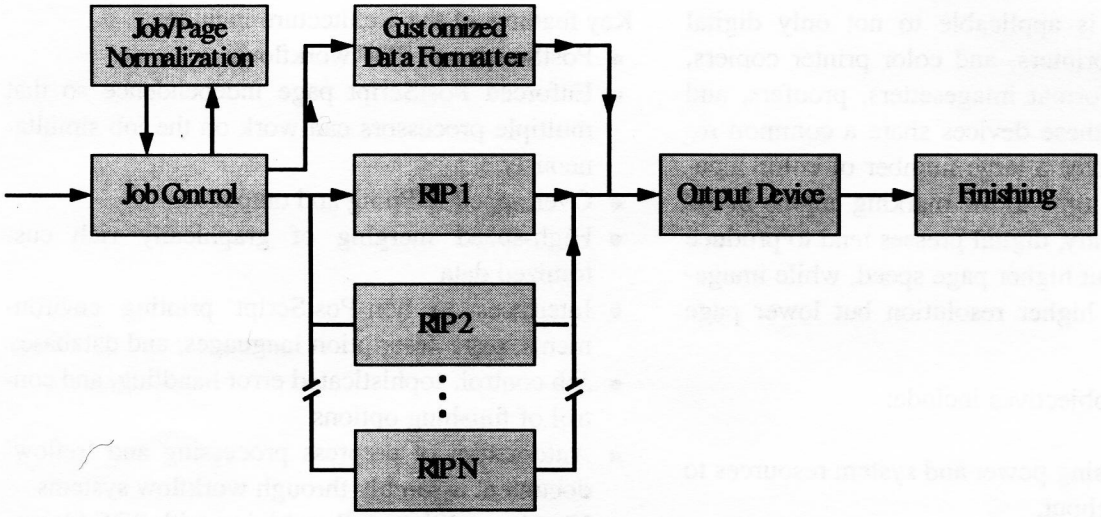
The PostScript language will continue to be the primary format for print production. Because it is a true programming language, pages can be arbitrarily complex and sophisticated. The Adobe Portable Document Format (PDF) is increasingly becoming a standard for cross-platform document communication, viewing, and archiving. Adobe is committed to adding significant functionality to the PostScript language and PDF standards to serve market needs.

In collaboration with a number of its OEM suppliers of output devices and workstation system vendors, Adobe is evolving the Supra architecture and is establishing interfaces and data standards to develop the print-on-demand market.

Adobe is working on an open standard for variable data for all of its applications, drivers, and RIP technology, and will offer its products broadly. The company plans to integrate standards that specify press functions such as color control as well as finishing options.

The Future

Digital presses will surely reshape the printing and publishing industries, just as electronic platforms have revolutionized traditional page layout and prepress. The potential impact should not be ignored. The tools and technologies for viable products exist, but there is still some distance between the current array of products and standardized, automated production. Digital printing, to be effective, should not be considered a stand-alone solution. A total sys-



tems approach is needed, with workflow and printing strategies considered.

Just as RIPs are an essential element in the equipment architecture today, finishing capabilities will expand future options. Control of the press and post-press functions will be specified as a prepress step prior to RIPping. Eventually, all aspects of production will be controlled from the desktop.

But the net benefit of digital printing will be a printing industry that is more responsive to the needs of its customers.

The digital document will become synonymous with getting the content, image, customization, and quantity when and where you want it.