# DATA STORAGE IN GRAPHIC ARTS OFFSET PRINTING

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Abstract: Today there are practical concerns relating to data storage and data transmission that make complete electronic systems for graphic arts difficult and expensive. A review of the requirements identifies the data volumes involved as a function of system characteristics and shows that for some time to come a combination of electronic and film systems will be cost effective.

Over the past decade, the graphic arts industry has been undergoing fundamental changes that have important implications for its future growth and profitability. Those changes have involved the application of new technologies--the goal of which has been to help improve quality and productivity and reduce costs. Recent trends in technology--particularly in the application of computers and computer-based systems--have already had a significant impact on many phases of offset printing. Even more recently, significant interest has been generated in the potential of an all-electronic offset printing system--from copy input to press-ready plates.

Before electronic systems can realize their full promise in the graphic arts industry, we all need to have a better understanding of some of the fundamental characteristics involved. I would like to talk about a few of those characteristics today--particularly the information content of images and the associated data storage and data transfer considerations. I will also be giving some consideration to the relationship and potential interface between the traditional graphic arts and the emerging electronic technologies.

First, the subject of image information content and storage. Traditional graphic arts exposures, in either a camera or a contact frame, are parallel recorders of information. That means the entire image is transferred at one time. Electronic information-processing systems, on the other hand, are usually serial or sequential processors of information--they transfer only a small part of an image at one time.

To understand the implications of this sequential data-handling requirement we will look at an all-electronic offset printing system. We will assume that text, halftone material in both black-and-white and color, and line-art and/or standing work are included. Let's further assume that text will be entered as electronic digital data, and pictures and line-art are input via a scanner. Since the final output is a high-quality multipage signature, it's safe to assume that it will be produced by a raster scan system--probably a laser scanner will be used.

In this all-electronic offset printing system there are three points at which the magnitude and the characteristics of the data involved are particularly important. These are during input, during data manipulation and storage, and at final output.

Figure 1 shows this schematically.

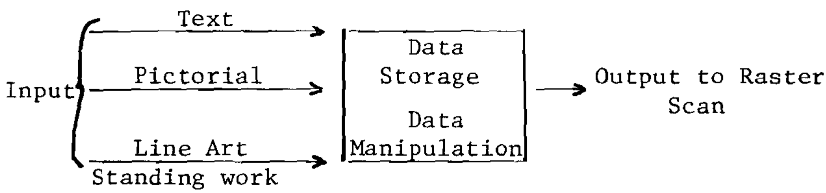


Figure 1. Electronic-System Information Flow.

As we will shortly see, the magnitude and the characteristics of the data involved differ for each of the input options and for the final output. Further, the data storage requirements will depend on when the final manipulation and combination takes place. For example, if a final manipulation and combination takes place just before output, then input data plus instruction must be stored. On the other hand, only final output data need be stored if manipulation and combination occurred immediately after input.

Because in many ways it is the simplest, let's look first at the output end of the system--the laser scanner. Remember we are looking at a total electronic graphic arts system--this means that text, halftones, line-art, etc. are all written at the same time on a raster system and are high-contrast images. The output exposing device therefore requires a simple string of on/off signals that tell the laser to expose or not expose a particular area. The amount of data required is determined by the closeness of the raster spacing. The finer the raster, the more data are required.

Text requirements place a relatively modest requirement on raster spacing. A high-quality digital typesetter probably requires no more than 800 to 1000 ℓ/in. Line-art would also be satisfied at about that same spacing. Halftone data, on the other hand, present a more difficult problem. A general ground rule seems to be that a 1% dot interval is as coarse as most people find acceptable. To divide the area assigned to each dot into 1% elements means that the raster exposing system must scan at 10 times the screen ruling, or 1330 ℓ/in. for a 133 ℓ/in. halftone. Since the raster spacing is fixed, all output must be at the spacing required for the finest element. Simple multiplication shows us that at 1330 ℓ/in. there are 177 million separate exposure areas on a typical 100-square-inch page. Using 8-bit bytes, this converts to 22 megabytes of data that are required to drive the scanner to create a single-page image.

Although text, pictures and line-art are all output at the same time and in the same data stream, they each have different input requirements. Line-art and standing-work probably should be scanned into an all-electronic system as on/off data at or near the final output raster spacing--or 22 megabytes/page of data. Pictorial material can be scanned with a raster that typically corresponds to about twice the screen ruling after any size changes have been taken into account. The individual elements of this input raster are often referred to as pels, pixels or picture elements. Such picture elements must contain the appropriate gray-scale information for each color separation and are <u>not</u> simply the on/off signals we use for line input or raster output. Eight bits (1 byte) for each pixel of each color is typical of the data level used in graphic arts color scanner and separation systems and allows 256 gray levels for each color. Using a 266 ℓ/in. input raster with 8 bits per pixel gives us 7 megabytes per color per page.

Text is a whole different story. If we assume that the electronic system carries all the necessary font and typesetting information, text is at most 40,000-60,000 bytes per page including format and style information (1 square inch of 8-point type set solid is at most 200 characters).

As input for each page we therefore have 60,000 bytes for text or 7 megabytes for pictorial material for each separation or 22 megabytes for line-art and standing-work or some combination of these. At output we must produce 22 megabytes per page from the appropriate combination of the above information. The intermediate data storage requirement is therefore a function of the mix of input information and the logic which defines when and how the input data are combined and converted into the required output format. It should not exceed 22 megabytes per page for a system having the ability to carry 133 ℓ/in. halftone information.

Now we will look at digital data-storage systems. I specify digital because it is important to maintain compatibility between image and text data.

In graphic arts, two kinds of digital data storage are important. The first is random-access storage required for page makeup functions such as image manipulation, assembly and editing. The second is storage of input and/or processed information that will be used for final output.

Of currently available digital magnetic storage technologies, there are only two which logically should be considered for the volume of data in graphic arts applications. These are magnetic disk and magnetic tape.

Magnetic disk storage is available in a number of different forms--all offering random access to the stored data. Magnetic tape, on the other hand, does not offer random access. If you are at one end of a reel of magnetic tape and need information at the other end, you have to run through the entire reel to get it. Because of this, magnetic disk is the interactive storage device used for image manipulation, assembly and editing.

Although magnetic disk systems are available with widely varying storage capacities, another important requirement in graphic arts applications is intermittent access to the stored data [e.g., waiting for approvals]. The most cost-effective disk systems for this type of application are those that have removable disk packs. Currently available removable disk packs have a 300-megabyte capacity and cost about $2,000.

Using as a reference the output requirement of 22 megabytes for each single color image of an 8 1/2 x 11 inch page, you can store three four-color pages (88 megabytes each) on one removable disk pack at a per-page storage cost of about $700. (It should be recognized that magnetic disk packs can be reused once the information on them is no longer required. How long information is required, however, is uncertain.) Although nonremovable magnetic disks of up to 1250-megabyte capacity have been announced, removable disk packs are not expected to grow much beyond the current 300-megabyte capacity.

Now let's look at magnetic tape as a storage medium for processed information. Most existing computer systems record data on magnetic tape at 1600 bytes per inch. You can put 46 megabytes of information on one 2400-ft reel. Based on 88 megabytes per 8 1/2 x 11 four-color page, you could put one page onto two reels of magnetic tape. At $20 per reel, that's about $40 per stored page.

In some advanced systems magnetic tape can be recorded at 6250 bytes per inch. At that rate, you could get 180 megabytes of data or two four-color pages onto one reel of tape. And that translates to a storage cost of about $10 per page.

It should be emphasized that storage on magentic tape is off-line or noninteractive storage. To use the stored data, it must be transferred onto magnetic disk to take advantage of the disk's random-access capability. The fastest information transfer available between tape and disk is about one megabyte per second. At that rate, it would take about 1-1/2 minutes to transfer one four-color page from tape to disk.

Let's look briefly at the cost of traditional graphic arts film as a storage medium. Using $1.25 a square foot as the average cost of a processed piece of black-and-white scanner film, the film storage cost for an 8 1/2 x 11 four-color page is about $3.50.

Before I leave the subject of storage systems, I want to mention optical disk as another storage medium for electronic data. Optical disk offers, perhaps, the greatest potential for the volume of data storage required in graphic arts applications. The technology, however, is still in the advanced development stage. By some estimates, initial availability of optical disk will be within a year or so. However, it is still uncertain how long it will take to integrate optical disk into graphic arts systems as a primary storage medium.

Current information suggests that an optical disk will hold about 12,500 megabytes or 12.5 gigabytes of data and will sell for 50 to 200 dollars. If that information is correct, one optical disk would store 142 8 1/2 x 11 four-color pages at a per-page storage cost of 35 cents to $1.40. That's an attractive range. But remember that integration of optical disk into current systems is still not yet commercially available. Until that time, electronic systems will have to use magnetic-disk and magnetic-tape storage with their presently high page-storage costs.

The cost to record and store information electronically is certainly an important concern. But perhaps an even greater concern is the issue of information transfer. To illustrate the importance of information transfer, let's look at the publication process--involving advertising and editorial color and text. The ads are coordinated by advertising agencies working with clients and are produced in trade houses. Production of the ads involves color separation, image manipulation, assembly, halftone preparation and proofing. Client approval probably involves several alterations. After approvel, the advertising material ultimately flows to the printer through the publisher.

Editorial color and text originate with the publisher. The editorial color probably goes to the printer as full-color film or paper images, and text probably arrives as typeset copy. For simplicity, I am assuming that the printer has responsibility for editorial color separation as well as platemaking and printing. The publication layout--in the form of dummies--also flows from the publisher to the printer.

Today, the common exchange medium for these various elements is photographic film and paper--some of it halftone separations, some color images and some reflection copy. These elements could, however, be manipulated and stored on magnetic media. But what would be required for the interchange of this electronic data?

Computer systems and software designed by different manufacturers often cannot talk with each other. The simplest solution to this problem would be for all trade houses, publishers, and printers to use a system made by the same manufacturer. That's not very feasible. Short of this, a common standard for both data format and electronic exchange media would have to be established to enable information to be transferred between different kinds of systems.

In terms of data format, it would be ideal if the actual raster scan exposing information could be used as such a standard. However, this isn't feasible either because the specific raster scan information required is a function of the printing equipment and conditions existing at each printer. In fact, at this point a common standard is not obvious but will require a great deal of effort to define.

However, assuming that such a data standard could be established, the limited capacity of existing magnetic tape is still a problem in terms of the volume of data that would need to be transferred between sites. Large removable magnetic disks are extremely sensitive to both contamination and mechanical shock and are normally kept only in the controlled environment of a computer room. They are, therefore, ruled out as a data-exchange medium. Optical disk and other advances in data-exchange media could help overcome this problem, so such developments bear careful watching.

Another factor that must be included as we consider electronic data exchange is the subject of color proofing. Changes, for example, in the control or acceptability of "soft" proofs, or technological developments that would simplify the creation of "hard" proofs directly from electronic data would provide a major incentive for standardization. Until such changes in data storage, data transfer and proofing occur and become widely accepted, a common exchange medium is required.

Film is serving the industry well as that exchange medium, and we believe that it will continue to do so for some time to come. Specifically, the effective marriage of electronics and film--taking advantage of the strengths of each--appears to offer the best opportunity for improving productivity and reducing costs in the graphic arts industry. An example of such a cost-effective marriage is the use of electronic manipulation of image data for assembly and editing of specific page elements, and the use of film as a common exchange medium between systems of diverse characteristics.

I want to thank you for inviting me to participate in our program today. I hope that the issues and ideas I've raised will help us in our thinking about the role of and the relationships between electronics and film in the evolving graphic arts systems of the future.