Years of upheaval in the graphic arts – this is not the printing industry of 1985!

by Brian P. Lawler

The business of artwork and copy preparation has changed so radically in the past seventeen years that it could be said we are now in an all-new industry.

Process cameras, once the conduit from the prepared paste-up and photograph to the printed page, are effectively extinct.

Hand film assembly, required for production just a few years ago, is no longer needed in most prepress establishments. Film itself is an endangered species!

It is an amazing revolution that has occurred in the graphic arts industry, from desktop publishing in 1984 to electronic prepress on the desktop today.

Yet, through all this change one thing has remained constant: the need for education.

Let's look at the *good ol' days* of graphic arts production. In order to get an idea into print, we needed a number of specialists:

- Designer
- Copy writer
- Type specifier
- Photographer
- Typesetter
- Scanner operator
- Proofreader
- Keyline artist
- Line/Halftone camera person
- Film assembler/Dot etcher
- Plate maker
- Press operator
- Bindery worker

That's 13 distinct *professions* involved in the production of an average commercial printing job! What an amazing transformation has occurred in the past 17 years. Here is a run-down on the professions involved in today's electronic prepress:

- Designer/typesetter/ scanner operator/ Copy writer/Proofreader/retoucher
- Prepress specialist/Imagesetter operator/Plate maker
- Press operator

Arguably we could combine – or separate – any of these multiple professions (but it wouldn't serve my clever comparison to do so). In simple terms, we have seen the blurring of professions from 13 to just a handful in a matter of years, and that blur is an *accelerating* blur.

It's fun to be in the throes of a technological revolution, but in order to enjoy it to its fullest, we should understand some of the historical elements surrounding production in the graphic arts (this allows us to be nostalgic for the *good ol' days*).

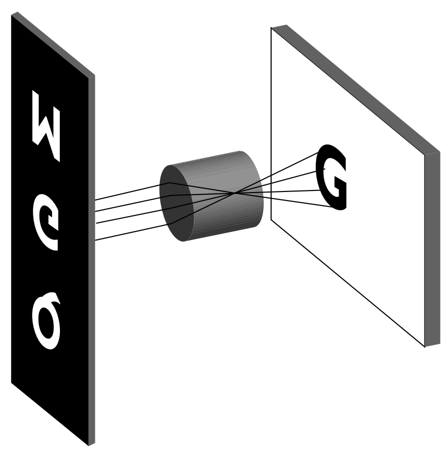
Typesetting

Until the early 1960s, typesetting was done with molten lead and linecasting machines. The linecasting machine, called the *Linotype*, was invented in 1886, and lasted almost 100 years before being replaced by "cold type" which is more correctly named *Second-generation technology.*

"Cold type" was either generated photographically or by strike-on methods (typewriter ball and ribbon). But even the "new" cold type didn't last long!

The evolution of photographic typesetting rolled right past cold type.

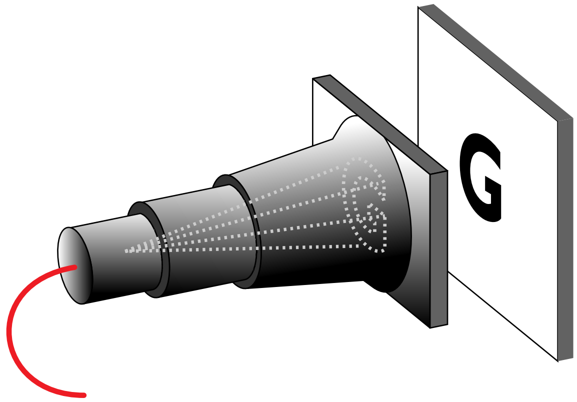
Second generation strike-on technology (similar to a typewriter, but better looking fonts and much better character quality).

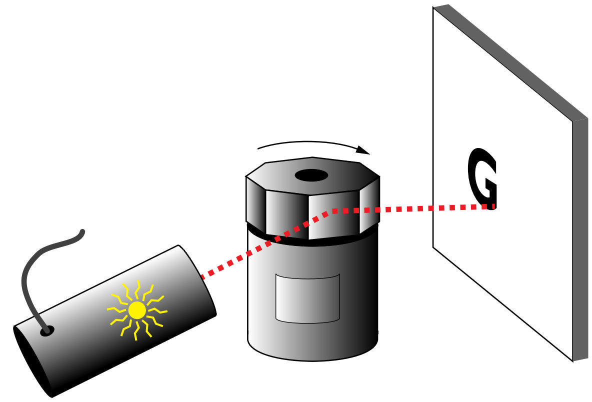


Second generation phototypesetting machines used a strip negative (left), strobe light source (not shown), a lens (center) and photosensitive material (right) onto which the image was exposed. Indexing of the characters was electro-mechanical.

Second generation photo technology

These were usually devices with a strip of film where negatives of the letters in a font was spun in front of a strobe lamp, which would "pick" the individual characters off the film as it went by, exposing the characters onto photosensitive paper.





Third generation phototypesetting machines use a cathode-ray tube (left), and photosensitive material (right) onto which the image is exposed.

Fourth generation phototypesetting machines use a laser beam (left), and a rotating prism (center) to "spray" the laser beam across the photosensitive material (right) on which the image is exposed.

Third generation technology

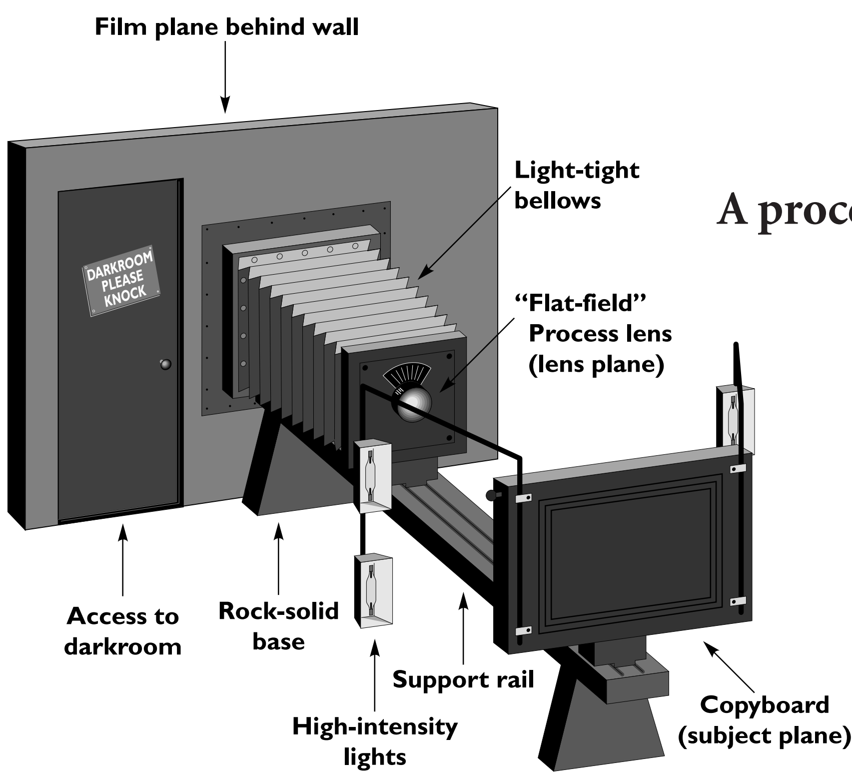
Cathode-ray technology. CRTs are fancy television picture tubes. They were harnessed to draw the letters of the typographic business by painting strokes of light onto photo material – paper or film.

Fourth generation technology

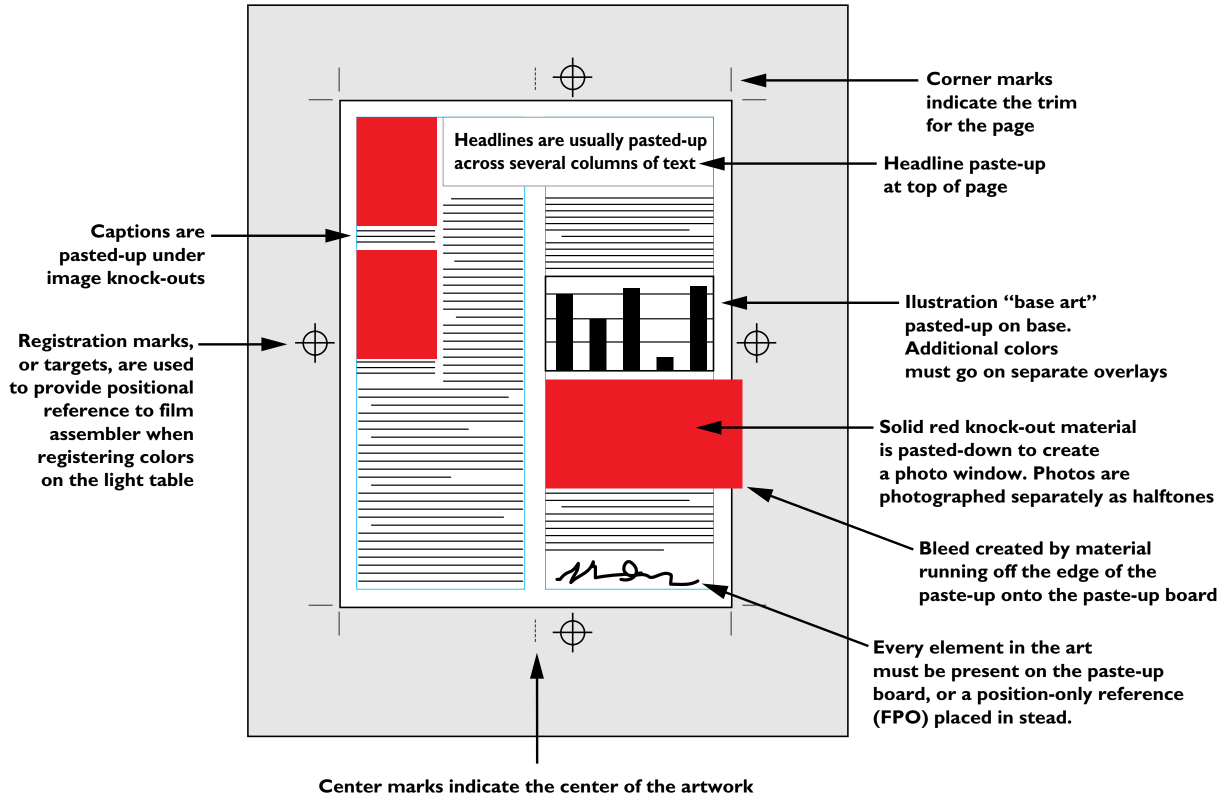
Laser technology. In the late '70s, the laser beam became inexpensive enough to build into a phototypesetting machine, and soon after, CRT technology was converted to laser imaging. The advantages: lasers are brighter, and they produce "harder" images, which look sharper in print.

Fifth generation technology

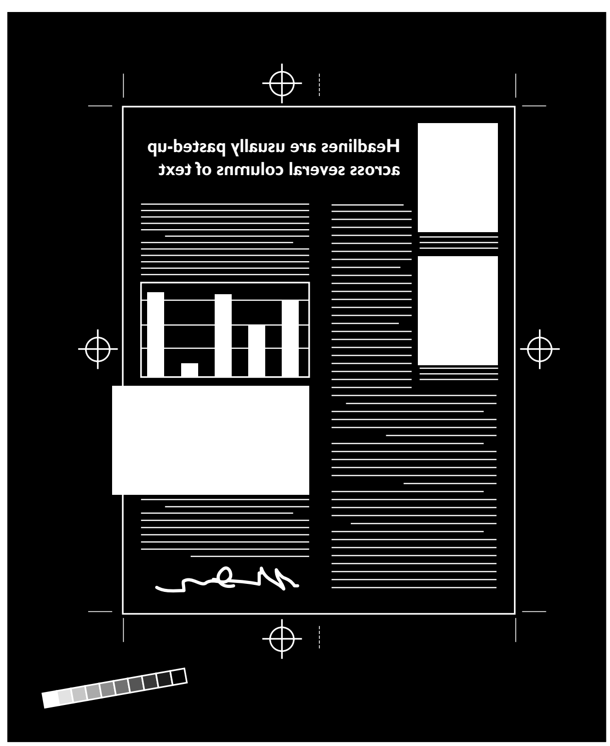
Page description languages. Page description languages were one third of the "primordial ooze" that made electronic prepress possible. Adobe PostScript was the page description language that was in the right place at the right time. Combined with two other elements in the equation, it was the evolutionary environment in which desktop publishing was born. We'll return to desktop publishing later. Now we must continue to discuss life before the desktop computer revolution.



A process camera



The traditional paste-up. Today paste-ups represent a rarity in artwork preparation, and are never seen crossing the doorway of a printing plant. Today's generation of graphic designers has never seen a paste-up or the tools to make one!



The negative of the paste-up converts all the solid reds of the knock-out materials into clear areas, making way for halftones to be inserted later, and simultaneously drops all light-blue guidelines. The camera operator has inserted a gray scale (lower-left) into the shot to measure exposure and processing. Notice that the negative is wrong-reading. The film assembler will usually retouch (opaque) the film on this (emulsion) side before continuing with production. Negatives like this are also very rare.

The camera and its images

Process cameras were used (still are in a few rare situations) to photograph the artwork produced by a graphic designer or paste-up person. There are two types of film made in a process camera: line film, and halftones.

Line film (see the illustration on the previous page) is shot of the typographic and line-illustration material in a printed project. It is limited to the *hard line* material that has no tonality.

Halftones

Halftone film negatives are made from continuous-tone originals (photographic prints, negatives, or transparencies). These original films have an almost infinite variation of densities, from which they get the name *continuous tone.*

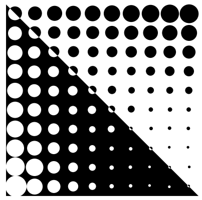
In a camera, halftones are made by exposing the image of an original through a semi-opaque screen with a pattern of lines in it. The light that passes through the screen exposes film and creates hundreds of thousands of tiny dots of varying size. These dots are called *halftone dots.*

Halftone images *appear* to have tonality, but in reality do not. Varying size halftone dots create the *illusion* of tonality by absorbing various amounts of light in halftone dots, relative to the white space around them. Halftones are really complex *optical illusions* created by tens of thousands (often millions) of varying-size dots.

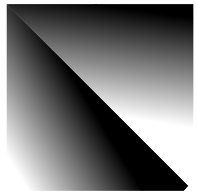
The idea behind halftone dots is that *only one color of ink* is printed on the press, thus tonality must be imparted not by changing the ink color but by changing the size and density of the dots.

To make a good halftone on the camera, the operator makes two or three exposures through the halftone screen onto the film. The first exposure is called the *main.* It establishes the image on the film.

The second exposure is called the *flash,* and it is used to control the *contrast* of the image, expanding its tonality into the shadows so it looks more like the original image.



The continuous-tones of grayscale images (photographs in black and white are considered "grayscale") and their counterparts in color must be converted to halftone dots to be printed.



Halftone dots are each created within a grid of cells which are spaced at the "line frequency" that determines the halftone frequency of the image (lpi).

Dots vary in size from no dot (plain paper) to solid (100%). Intermediate dots create the illusion of tones between the two extremes.

Some originals will call for a third exposure, called a *bump exposure.* The bump is used to change the contrast of an image, moving the midtone up or down the grayscale and changing the contrast of the image.

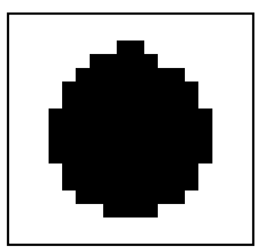
In an electronic world, halftones are made by a clever combination of technology and software. The first part of this system is a scanner, which analyzes the original and reports back to the computer about its tonality as a grid of information about the photo.

The second part of the process is the software, which takes the stream of mathematical values sent by the scanner and converts them into electronically-generated dots on the laser imager (see the diagram, opposite page).

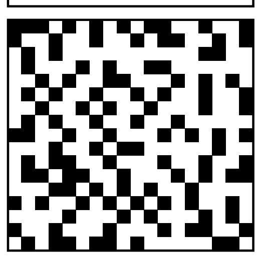
The dots, they are a-changin'

In recent years, significant changes have been taking place in imaging technology. The conventional halftone dots that have been with us since the late 1800s are being challenged by more curious little spots called *stochastic* patterns.

Also known by the name *frequency-modulated patterns,* these halftone elements take the same tonal value as a dot, and then distribute that tonality randomly inside the space of a halftone dot. The

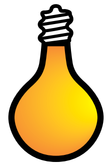


The conventional halftone dot (left) has ruled the reproduction process for continuous-tone images since 1878. It is being challenged today by sophisticated random-dot patterns called *stochastic* patterns.

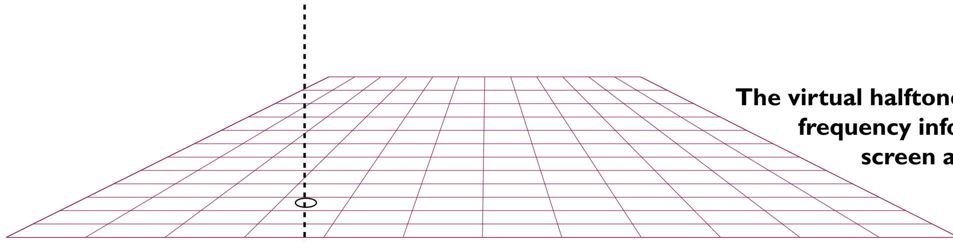


These patterns are equal in reflective tonality, but use the spots of the imagesetter to distribute that tonality around the halftone cell rather than to clump the spots together as with the conventional dot.

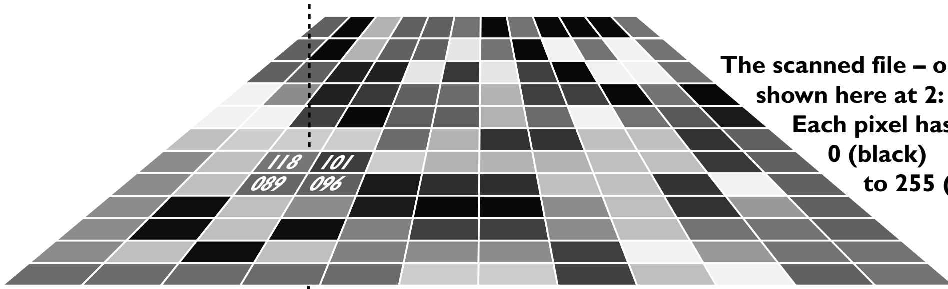
Stochastic patterns are also called *frequency-modulated* screen patterns.



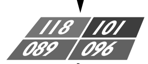
A "virtual" light source shines through a "virtual" halftone screen onto a grid of pixels that were scanned from the original image.



The virtual halftone screen contains frequency information and screen angle.

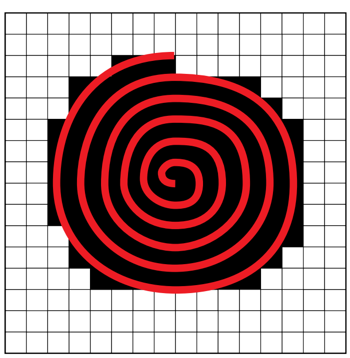


The scanned file – or bit-map – of the image shown here at 2:1 halftone frequency. Each pixel has a numeric value from 0 (black) to 255 (white).



Average of 118, 089, 101, 096 = 101
(or 101/256 or 39.45 white or 38.45% reflective black)

This average value is carried to the halftone generator…

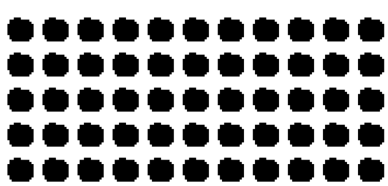


…where a spot function is applied to convert the value into a halftone dot of the required size and shape.

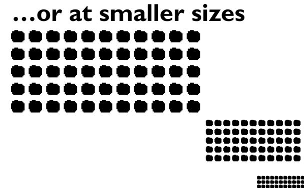
This example shows a spiral-shaped dot, growing from the center out, and the imagesetter spots that will be turned on to mark that dot on the film.

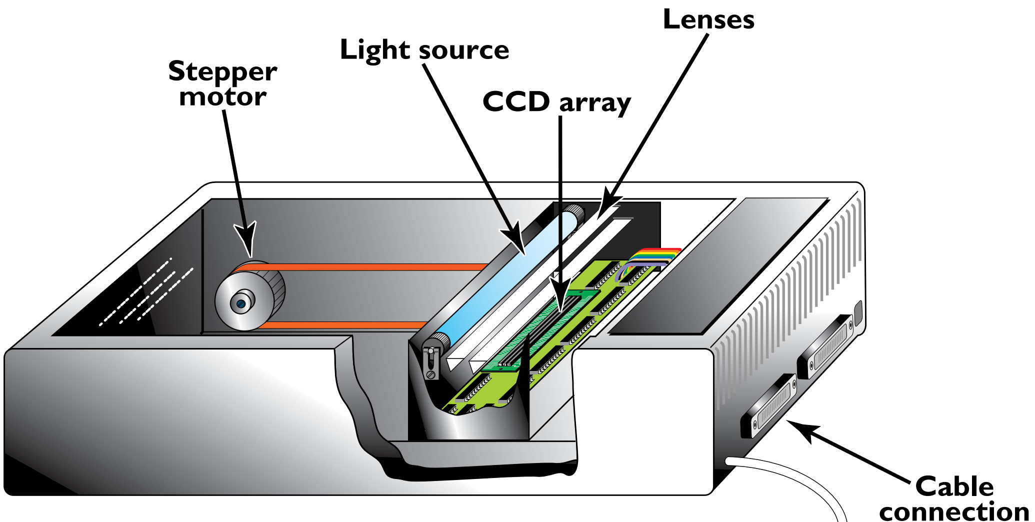
Different spot functions result in different shapes of halftone dots.

A pattern of these dot-formations creates a halftone pattern – the illusion of tonality – when they are small enough to be *confused* by our brain into tones.



…or at smaller sizes





The popular desktop flat-bed scanner. Amazingly capable, these inexpensive devices are useful for reproduction from reflective color and monochrome originals. A few flat-bed scanners are effective for transparencies.

result is better detail, smaller source computer files, and the ability to print in more than four colors without moiré patterns (interference).

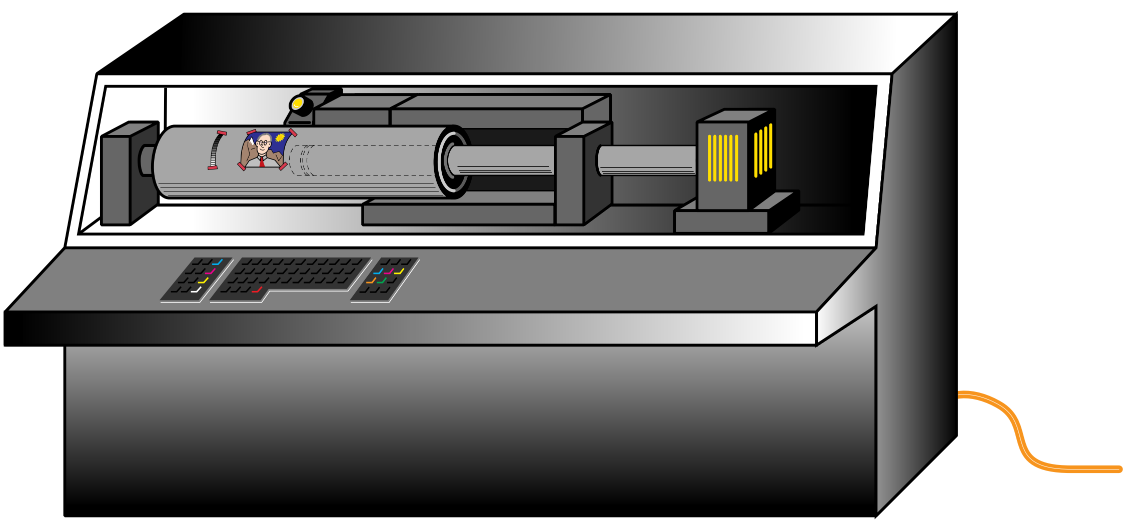
The net result of this is that we can print images today with more faithfulness to the original, both in terms of detail and tonal information.

Color separations

Color separations in the analog era were made by the use of a process camera, enlarger, or a color scanner.

A color scanner analyzes the tonality of the image, as seen through red, green and blue color separation filters, and translates these color tones into electrical signals which are later converted into halftones dots drawn by a laser beam in the scanner's output unit or film plotter.

When making color separations, scanners use red, green, and blue filters to separate colors, regardless of their method of scanning. Drum scanners (as illustrated below) use very capable sensors called *photomultiplier tubes* while desktop units usually use more modern, and slightly less capable *charge-coupled devices* (CCDs). The quality difference between the two has been blurred by technological improvements. Most scanners today use CCDs, and the demand for drum scanners is falling precipitously. Digital cameras are squeezing the scanning business, resulting in dropping sales of desktop scanners and less demand for scanning.



A Crosfield drum scanner. These drum scanners were the leaders of the color separation business until about 1992, when less expensive, but similarly capable desktop devices came on the market. Since that time, the market for high-quality desktop color scanners has exploded while the value of these units has plummeted.

Desktop publishing – primordial ooze

As mentioned on the first page, the PostScript page description language was one element in a formula that created the electronic prepress revolution. The other components were:

- The Apple *Macintosh* computer
- Aldus *PageMaker* page layout software
- The Apple *LaserWriter* printer

The Macintosh was important because it was the first commercially-available (and practical) personal computer that had the ability to display *variable-width* type faces in virtually any size on its screen. The Mac also featured a white screen with black letters. PCs of the era had black screens and green or amber letters of single-width.

The Macintosh offered a platform for software developers to create applications that mimicked the printed page – black type on a white page. Images could also be displayed on the Macintosh screen in the proper position and size.

Paul Brainerd's Aldus Corporation produced *PageMaker,* which brought mainframe sophistication to the Macintosh, and the first page layout application to the desktop.

Adobe's PostScript language was critical in making high-quality printing possible on a relatively inexpensive desktop printer. Apple licensed the Canon laser engine, and the PostScript language, and came to market with the first PostScript laser printer, a critical addition to the components of what would be called desktop publishing.

Adobe also had the foresight to license real type faces from Mergenthaler Linotype Company. Adding *Helvetica, Times, Palatino,* and other *authentic* typographic designs to the printer gave it the ability to be taken seriously by typographers and printers.

These components were all critical to the success of what we now call *electronic prepress.* It took several years for the level of sophistication to reach a point where many commercial printers accepted the technology, yet eventually it happened, and today we use this technology for the finest quality work.

Putting the pieces together

Desktop computer systems consist of a CPU, a monitor, and a variety of peripheral devices. An important peripheral is a disk drive, where images and pages are stored. Huge disks are really valuable.

Disks with capacities in of 120 gigabytes are now available today for about $200. Comparing this to the prices for such devices in the early 1980s, those prices have fallen from roughly $1,000 per megabyte to about 0.3 cents for the same amount of storage.

A *gigabyte,* for the uninitiated, is *one billion characters* of storage. A "character" is a letter or a number. We used to think that billions were only for discussing the number of stars in the sky, but that blue-sky thinking has fallen to the ground with computer technology. *Terabyte* is the new term to learn – it's a *trillion* bytes of data.

Computer platforms

For the years between 1985 and today, the Apple Macintosh has been the leader in computing for desktop graphic arts work.

Over the years, PCs have exploded into all markets, but have not eroded the Macintosh dominance of graphic arts to a great degree; in fact, the Apple Macintosh has a growing share of the graphic arts market today.

Competitors and the media have many times announced the imminent demise of Apple Computer, but the company continues to survive and dominate the graphic arts and video markets with the Macintosh computer.

About 96 percent of prepress installations use Macintosh computers for the creation of art and images for printing. And, it's a very loyal market.

There is a good reason for such market dominance: People who do graphic arts work on computers tend to purchase machines that allow them to get the job done with as little hassle as possible. Macintosh computers deliver this productivity.

Monitors

Big monitors are the norm in the graphic arts, and companies like Sony and Apple lead the market with impressive two-page displays that actually result in more work being done in a business day.

The Apple Cinema Display. Its horizontal pixel count is 1920; it can display an 11 x 17 spread at full size without cropping. It's a productivity booster for graphic arts pros.

A big monitor requires fewer zooms to get in and out of an image, saving time. Also, most display cards offer "firmware" acceleration that makes most graphic arts processes dramatically faster on both Mac and Windows computers.

Apple's *Cinema Display* is the envy of the industry at present, with 1920 horizontal pixels, and a price that is about what you would pay for a used compact car. The prices of these displays are coming down, but they still cost quite a bit of money.

As a user of a Cinema Display, I can say that there is simply no computer display on Earth that compares. Working on one is pure joy!

Networks move pages

Connecting desktop computers to the networks of the world is easier than ever before. Whether that network is a local cable running across the room, or a fiber-optic that runs miles to another facility, the process makes graphic arts work more productive and process speed faster.

Connecting to the Internet is relatively easy in today's computer world. High-speed telephone circuits including DSL, ISDN, and T1, and cable TV lines speed the process of moving information from one location to another. The percentage of files that are submitted for printing as electronic files is very high today. Just a few years ago this was not the case, but high-speed network connections have made it possible for people like you and me to create a large graphic arts document, then attach it to an e-mail message, and send it off for production.

I have worked with several clients whom I have never met face-to-face, working entirely over the Internet on writing and illustration projects.

It's really a different world today, thanks to computers, scanners and other devices. The graphic arts industry has enjoyed the fruits of this labor probably more than any other industry.

Brian P. Lawler
Graphic Arts Consultant
6045 Madbury Court
San Luis Obispo, California 93401
Tel: (805) 544-8814
Fax: (805) 544-8445
Internet: brian@thelawlers.com