GETTING TO THE FINAL PRINT – The Technology Of A Digital Workflow.

Over the past ten years, continual advancements in scanner, printer and media technologies have had a significant impact on digital image performance metrics, including speed, resolution, color fidelity and overall print quality.

■ Scanners.

Film scanners are computer peripheral devices that generate digital files from exposed and processed film. Scanners are connected to a host computer, which typically provides operator control.

A scanner's functionality is highly dependent on the model. Each scanner is designed to accommodate selected combinations of single image frames, strips of film, or rolls of film. Scanner models will accept various film formats. Currently, no single high-speed scanner is optimized for all formats.

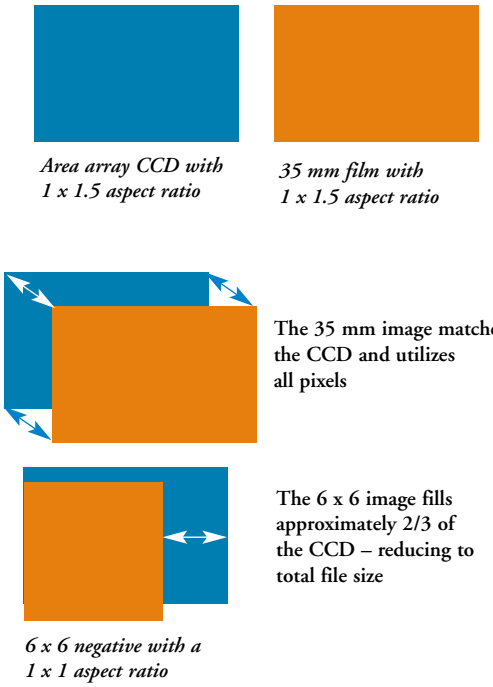
How Scanners Operate

Film images are focused on an area array or linear array Charged Coupled Device (CCD) which converts light to an electrical signal. The CCD consists of pixels filtered for red, green and blue.

Each pixel is exposed to a corresponding segment of the image. Exposure time is a function of the sensitivity of the CCD, the amount and spectral distribution of light from its source, the lens aperture, and the magnification factor. Exposure time is electronically controlled.

Types Of CCDs

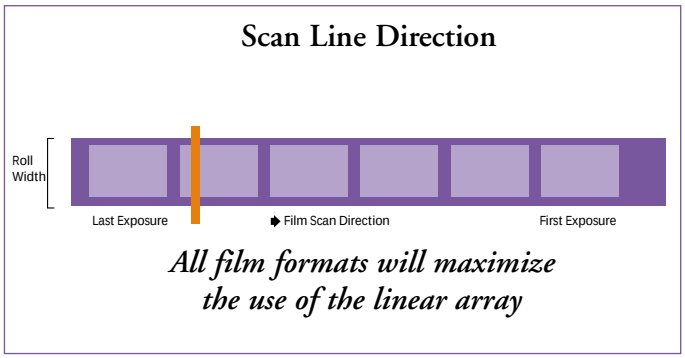
Area array CCDs are comprised of rows and columns of pixels, comparable to film grain. Generally speaking, an area array scanner is well suited for scanning small files less than 5 MB. (This may correspond to school photography service items.) At the same time, the aspect ratio of the CCD limits file sizes on selected film formats.



Examples of why a scanned 35 mm frame will yield a larger file than a medium format (6 x 6) frame when scanned on the same scanner with a 1 x 1.5 aspect ratio

Scanners

By comparison, linear array CCDs feature rows of pixels, and capture an image one line of pixels at a time. Typically the film is moved past the CCD. Linear array scanners are well suited to capture larger file sizes – file sizes often associated with sports and wedding and portrait photography.



All film formats will maximize the use of the linear array

Other Optical Elements

In addition to the CCD, scanners incorporate an illumination system that provides the light to project the image onto the CCD. The illumination source can be quartz, halogen, LED or fluorescent. Regardless of its source, light is filtered to remove the IR (infrared) component. Additional filters may be used to provide the correct color balance for negatives or transparencies.

> *"With the HR 500 Film Scanners our staff no longer handles individual negatives."*
> *~ David Howard*
> *President, LustreColor*

A lens is used to project the image onto the CCD, mounted and positioned relative to the CCD. The distance between the lens and the CCD can be adjusted to provide a range of magnifications that allow scanner resolution to be optically varied. Optical magnification changes make it possible to optimize the relationship between film scan area and the number of pixels used in the scan. (This can also be electronically achieved where pixels are created or ignored.)

Guideline For Determining File Size Using Print Size And PPI Output*

Print Size	Output Device Resolution 250 ppi	300 ppi	400 ppi
3.5" x 2.5"	2 MB	2 MB	4 MB
3.5" x 5"	3 MB	5 MB	8 MB
4" x 5"	4 MB	5 MB	10 MB
5" x 5"	5 MB	7 MB	12 MB
5" x 7"	7 MB	9 MB	17 MB
8" x 8"	12 MB	17 MB	31 MB
8" x 10"	15 MB	22 MB	38 MB
10" x 10"	19 MB	27 MB	48 MB
11" x 14"	29 MB	42 MB	74 MB
16" x 20"	60 MB	86 MB	154 MB
20" x 24"	90 MB	130 MB	23 MB
20" x 30"	113 MB	162 MB	288 MB
30" x 40"	225 MB	324 MB	576 MB

** These are 1:1 scan-to-print match file sizes. Many labs have tested different file sizes for the different products they offer. Similar to a lab running a color or focus ring-around in the optical workflow, it is suggested that a lab run a resolution and scanner-to-printer ring-around for its digital products. Additionally, different amounts of compression and different compression algorithms are used to achieve overall production and storage considerations in the lab.*

Note: Highlighted area indicates the most common file sizes used in portrait workflows.

*Note: See the **Storage** Chapter for instructions on how to determine file size.*

The optical quality of the lens will have an impact on the ultimate quality of the scanned image; so will the design of the optical platform that isolates the lens, CCD, and light source from the rest of the scanner to minimize vibration – one of the leading causes of blurred images.

Managing For Quality And Productivity

A typical 18 MB scan (linear array scanner) from a 35 mm negative is comprised of approximately 2,000 pixels across the width of the film and 3,000 pixels across its length. This multiplies out to 6 million pixels for each color – red, green, and blue – for a total of 18 million pixels (18 MB) for the 35 mm negative.

A full resolution scan will use every pixel in the specified image area to maximize image quality, but it will increase scan capture time. Alternatively, sub-sampling every other pixel or every fourth pixel in both the horizontal and vertical directions will reduce scan capture time, but can also reduce image quality. Meanwhile, interpolated/dithered files use existing pixels to create additional data that makes an existing file size larger.

The only way for a lab to optimize both scanner productivity and image quality is to make test prints from full-res scans and sub-sampled files, and visually determine the point at which quality expectations are no longer being met. (Similar to creating focus or color ring-arounds in the optical world.)

The ability of selected scanner models to automatically correct for the visual consequences of dirt, dust and scratches on the film, through special software, can save hundreds of hours each week in re-makes and retouching; although, throughput is slightly compromised. While remarkably effective, defect-removal algorithms are still no substitute for good housekeeping in the lab.

Film Handling

Film – in a variety of formats – is sent to a lab as cut negatives, mounted on aperture cards, short and long strips, and long rolls, necessitating that the chosen scanner must incorporate flexible film handling characteristics to accommodate the specific needs of the lab. Film handling capabilities will vary by model and manufacture, and should be carefully compared and evaluated in the selection process, given the potential impact on total scanner productivity.

- Single frame film carrier is used for scanning single frames or very short strips.

- Some scanners provide long-roll transports for up to 400 feet of edited film. Sensors detect the edit marks on the film, the presence of film in the aperture, the actuation of the film clamp, and the type of film carrier in use.

- Strip feed carriers permit automatic scanning of film strips. Carriers are either integrated into the scanner or sold as separate accessories. These devices use a variety of methods to determine the frame positions on the film.

- Slide carousels and slide carriers for mounted transparencies.

Host Software

Keep in mind that the host computer in the lab controls all of the functions of the scanner following power-on initialization. Host software provides the image processing required to transform the raw data from the scanner into properly color balanced images suitable for printing.

The software provides links into the lab system to extract video analyzer data (if available) to aid in color balancing, as well as the data needed to determine which frames to scan when operating in a long-roll mode. In addition, host software controls all diagnostic functions of the scanner.

Based on this information, a lab should select the appropriate scanner(s) that will meet their desired workflow requirements.