

NEW PATHWAYS IN SILVER HALIDE IMAGING

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It has become clear over the last few years that our industry—the photographic business—is going through a period of transition, driven both by the threats and the opportunities provided by digital technology. Photographic technology based on silver halide is now more than 150 years old and is still unsurpassed as a medium for image capture. Although silver halide has many applications outside traditional still photography, such as diagnostic imaging and motion imaging, the scope of this presentation will be limited to consumer photography.

In spite of its great size, there is still a tremendous opportunity for growth in our industry, particularly in developing markets such as China and Russia, where the use of film averages less than ½ roll per household per year. The potential for increased picture-taking and film consumption around the world is enormous. This is all made possible by the unique properties of silver halide and the ingenious ways in which the supporting technology has evolved over the years to give us high-quality color images at a very reasonable cost.

Pathways to the Present

Consumer photography—photography for the general public—really started in 1900 with the Brownie camera, the first camera that brought photography within reach of the ordinary person. From this beginning, the consumer photography business evolved steadily over the years. From the perspective of Eastman Kodak Company, some key highlights were the introduction of the Negative-Positive system in 1942, cartridge loading in 1963, the leading edge of the digital revolution with Photo CD in 1990, and Advanced Photo System (APS) as a new industry standard in 1996.

Improvements in film technology over the years have clearly enabled higher and higher film speeds. ISO 800 is emerging as a favorite higher speed point for the different manufacturers. It is evident that film performance has improved in terms of image structure, color, and keeping characteristics. Another measure of film efficiency is how much material we need to coat. Two indicators of this are silver laydown and film thickness. In the early 1980s, the silver laydown to give the best performance at ISO 400 was around $10 g/m^2$. With new film introductions this has decreased, with a few hiccups, to the present day. At the moment there is a remarkable convergence of silver laydown to around $7 g/m^2$ at ISO 400 speed among the different manufacturers. This has been accompanied by a reduction in dry film thickness. It is well known that higher speed films require higher silver laydowns because of the increased grain volumes. The current ISO 800 speed offerings require approximately twice the silver laydown of ISO 100 speed film.

Current State

The current situation is that photography is ubiquitous and cheap. Consumer photography is dominated by the Negative-Positive system based on high-speed optical printing on silver halide color paper. Because printing is optical, films have built-in color correction mechanisms, such as masking and DIR couplers. New film offerings continue to show steady evolutionary improvements. Digital still imaging is starting to reach the consumer through electronic cameras, picture CDs, and inkjet printers. The public is becoming aware that there is more they can do with their photographic images.

Silver halide film offers many advantages to the amateur photographer. The most serious disadvantages are delayed access to the image, the inconvenience of wet chemistry, and the need for scanning to obtain a digital record. Comparisons can be made between silver halide film and full-frame CCD arrays both in basic photosensor properties and in "effective pixels per image frame." In comparing standard film formats such as 35 mm, APS, 110, and Disc with CCD sensors up to 6 Megapixels, conventional color film has an advantage because three color records can be accessed per equivalent pixel, whereas CCD imagers use color filter arrays (CFA) and can only provide one color record per pixel.

Conclusions on the current state of technology are that silver halide film has inherently high resolution that is difficult for CCD sensors to match economically, and that high-quality scanning puts silver halide film on the same playing field as electronic capture for image manipulation and "re-purposing."

Pathways to the Future

The scanning or "digitization" of conventional films and papers will become an increasingly important imaging pathway. Our industry has an obligation to provide the final customers with as many convenient options as possible to use their images. It is possible in the future that every film will be scanned as a matter of course after processing. A good analogy for digital image pathways is a highway system where there are "on-ramps" and "off-ramps." On-ramps require products for picture capture, scanning, and storing. For Kodak, Qualex has helped speed the development and implementation of advanced technology for large-scale photofinishing. There are other options for getting photographic images into the digital world. For example, there are more than 15,000 KODAK Picture Maker kiosks in the US in retail outlets, with built-in scanners as well as thermal printers. Desktop storage and sharing are enabled by products like Picture CD, and the Internet provides reach to millions of households. With access to the digital highway, where does the customer want to go? The digital off-ramps provides Internet "neighborhoods" where people can play with their pictures and purchase photoproducts. Hard copy output will be even more important as people learn they can use their images for different purposes. Printing will be available through wholesale, retail, home and the Internet.

We anticipate that high photographic speed will continue to be an important pathway in the future. As long as image quality can be maintained, high speed is a currency that can be traded in ways other than just capturing an image under low light. In addition to improving depth of field and motion blur, it can be traded for enhanced zoom capability and extended flash range. It is convenient to think of the color photographic process as an "imaging chain" containing a number of independent steps:

1. Light absorption
2. Solid state processes leading to latent image
3. Latent image detection
4. Silver development
5. Image dye formation

For the photographic scientist, each of these steps has opportunities associated with it in silver halide crystal architecture and novel materials for sensitization, keeping and image quality. In aggregate, there is still considerable room for improvement against the known theoretical limits.

In addition to digitization and high speed, a third key pathway for silver halide imaging will be more rapid access to the image. This should be done in such a way as to avoid the appearance of wet chemistry. This implies that the processing step is very simple, such as already exists in instant photography, or that there is a highly dispersed availability of processing. Examples would be "engineering" approaches using conventional color chemistry to achieve apparently dry to the retailer or final customer, or "in-film" approaches such as photothermography. Each has its own significant technical challenges to implementation. An interesting example of instant access to the image is found in the recent KODAK ADVANTIX Preview Camera that has a built-in sensor and LCD screen. This is a great example of integrating traditional and electronic photography.

Conclusion

There will be co-existence of traditional and electronic photography in our industry for the foreseeable future. There will be areas where there will be direct competition between the two technologies, such as Digital Still Cameras. There will be other areas where traditional photography is enhanced by digital image manipulation. As always, the customers will benefit by having more choices to make their photographic experience enjoyable and memorable.