oxygen, Getty.

Exploring Computer-to-Screen Technology

The different options and advantages, and what's next for computer-to-screen equipment.

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Computer-to-screen (CTS) technology — systems that image screens directly from a digital art file — has helped screen printers keep pace and remain competitive in this digital age. With the introduction of even more CTS equipment recently, there are several important considerations to be made before deciding which system best fits one's needs. Understanding the advantages and possible limitations of each type of CTS system will help assure the functionality and compatibility for particular applications.

Generally speaking, there are two classifications of CTS technologies: inkjet and light-based digital direct exposure. These may be thought of as masked and maskless systems, respectively, as inkjet systems image a screen by applying an opaque mask to the emulsion and digital direct exposure systems do not.

Geoff McCue, a creative thinker and industry veteran, first conceptualized the idea of using an inkjet printer to mask an emulsion-coated screen in the late 1980s. He was granted a patent for this process, which he subsequently sold to Gerber Scientific, and the CTS era began. The first unit was introduced to the market in 1993.

SignTronic AG introduced the first digital direct exposure CTS system in 2004, which uses digital light processing (DLP) technology, as seen in Figure 1. One may recall this technology from the old projection TV days. It utilizes a digital micromirror device (DMD) developed by Texas Instruments with nearly a million or more micromirrors. Each mirror represents one pixel and can direct light from a source toward or away from the screen, which provides this technology the ability to image and expose as it scans the surface of the screen without the need of a film positive, as seen in Figure 2.

As with many new technologies, the market was slow to catch on. The idea of imaging a screen without a film positive was foreign to most screen printers. Fears of how to proof an image or register a job without film positives were common in the early days. With few wanting to be the guinea pig with an emerging technology, it took a decade to really gain a foothold in the marketplace.

One early adopter of the inkjet technology though was Mark Coudray, as he clearly saw the advantages of the new technology. The consumable cost savings of ink/wax over film positives alone justified a return on investment (ROI) between 12 and 18 months in most cases. Early on, this was the primary selling point emphasized by most CTS equipment manufacturers. Coudray, however, saw beyond the consumable savings to the myriad workflow advantages that were as equally, if not more, important that allowed him to significantly increase his production capacity and reduce turnaround times without increasing personnel.

CTS Advantages

Thanks to the likes of Amazon, print buyers expect fast turnaround and delivery times, and this is where the significant increase in the efficiency and quality provided by CTS equipment shines. CTS systems eliminate vast amounts of time spent outputting, cutting, tagging, transporting, repairing, and storing film positives. Additionally, the physical space to store film positives is no longer required, nor is the need for a vacuum frame used to seal the film to the emulsion. Since a film positive cannot conform to every peak (mesh knuckle) and valley (mesh opening) of an emulsion-coated screen, a perfect seal is never achieved, and some light scatter and undercutting is inevitable. By jetting the mask directly onto the surface of the emulsion, its absolute contact with the emulsion provides a better seal than film positives even under very good vacuum.

Further time savings is realized by removing the need to clean positives and the vacuum frame glass before each exposure and waiting for the vacuum blanket (often contaminated with ink) to draw down. And since the film and glass combined absorbs/filters nearly 45% of the UV, exposure times are reduced by 45%. Pinholes caused by debris on the film positives and glass are reduced, if not eliminated. Decreased contamination reduces rejects and remakes, and increases quality. Moreover, precision image placement through a CTS system significantly reduces setup and registration time on the press.

Assessing Options

Inkjet systems apply an opaque ink or wax onto a coated screen, forming the UV mask traditionally created by a film positive. Screens are then exposed conventionally off-line with a standalone UV light source or in-line as an integrated step of the imaging and exposing process.

Digital direct exposure systems image and expose in a single step utilizing DLP technology or by a direct laser array. Unlike inkjet masking, digital direct exposure systems do not apply a mask in the area of the positive image, but instead expose the negative non-image areas, which requires scanning the entire emulsion-coated surface of the screen.

Inkjet Systems

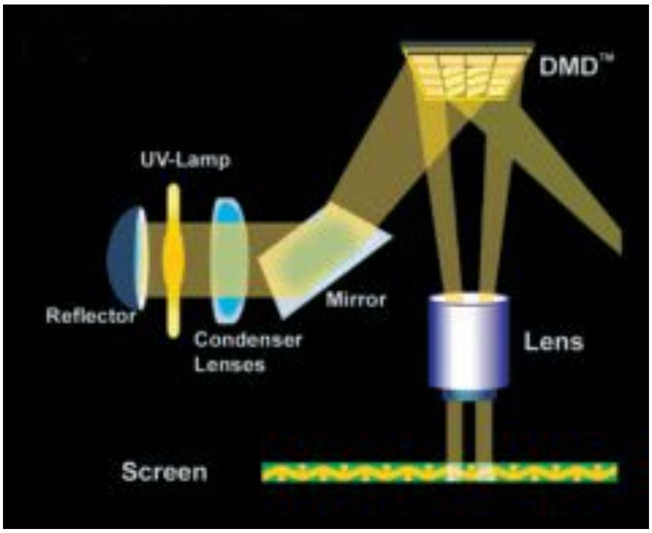
These systems have a lower initial cost, but have an additional consumable expense in the ink or wax. Size and resolution are limited with these systems, as they are developed primarily for T-shirt and limited graphics printing, while digital direct exposure systems are available in larger sizes and higher resolution. Resolution of inkjet systems typically ranges between 600 and 1,200 dpi, while direct exposure systems typically range between 1,200 and 2,540 dpi, with the capability of interpolating up to 2,540 or 5,080 dpi, respectively.

The two basic types of inkjet CTS equipment are differentiated by the type of printhead used; one jets water-based ink and the other jets wax.

Water-based Inkjet

The heads and ink provided with water-based systems are less expensive than wax-based systems but ▸

Figure 1 (left): DLP technology illustration.
Figure 2 (right): Digital direct exposure system.



come with less robust RIP software capabilities. If processing speed is important, an option to add an additional one or two heads is available. However, doing so may negate the replacement cost advantage of the water-based inkjet heads.

Water-based inks are not compatible with all emulsions. Thorough testing of currently used emulsion will determine if the emulsion is compatible or if alternative emulsions may be required. It depends on the hydrophobic, hydrophilic, and surface tension properties of the emulsion as well as the surface tension of the ink. These are physical properties that alter how water-based inks behave when adhering to the emulsion surface. Surface tension incompatibilities may result in poor opacity by beading up, leaving small "crevasses" on the masked surface as seen in Figure 3, which result in the inability to wash out the image properly, as seen in Figure 4. This was not an intended crackle effect. Or, poor edge definition results if the ink wets out too much, as seen in Figure 5.

Figure 3: Crevasses resulting from incompatible surface tension.

Figure 4: Image that has not been washed out properly.

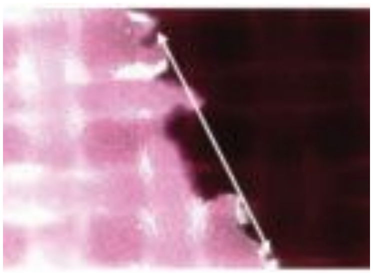


Figure 5: Water-based inkjet bleeding.

Figure 6: Wax-based ink.

Figure 7: Water-based ink.

Wax-based Inkjet

Wax-based inks are 100% solids and convert to a liquid for jetting by heating the head. The wax cools as it is jetted and reverts to a solid by the time the wax lands on the screen. Screens with higher Rz values (typical of coarser meshes) have little to no impact on the shape, size, or density of the deposited wax-based ink. Wax-based systems image screens in the vertical position, which saves floor space, while water-based systems image screens horizontally to help prevent the ink from running after contact.

Digital Direct Exposure Systems

These CTS systems can be differentiated by their source of light: conventional UV bulb, LED, or laser. All three types offer resolutions up to 2,540 dpi or higher depending on the application requirements. Prices vary considerably from around $85,000 to $150,000 depending on the system, size, and features offered. While all can expose slower diazo-photopolymer emulsions, most customers use faster exposing SBQ-photopolymer emulsions to satisfy production throughput requirements.

Conventional UV exposure units deliver a wide spectral output between 350 and 420 nanometers (nm), matching the spectral sensitivity of emulsions. However, the bulbs lose power with age so power and/or speed adjustments need to be made to compensate accordingly. Therefore, it is recommended to replace them at approximately 600 hours of use.

Unlike conventional bulbs, LEDs output a narrow UV spectrum, so to help compensate, LEDs with two different wavelengths — 385 and 405 nm — are at times used. LEDs generate less heat, are more energy efficient, and provide consistent UV output over their very long life of 5,000-10,000 hours, according to the manufacturers.

Laser exposure systems are making a comeback since the days when there was primarily one supplier marketing mainly to large-format graphics printers. Today, a few companies offer them in sizes and prices designed to attract the T-shirt printing market. It is believed that most use 405-nm blue light lasers, as seen in Figure 8.

While the UV source differs among these light-based CTS systems, all but one of the major suppliers utilize the previously mentioned DLP DMD chip to project the image onto the screen, which allows for easier control and calibration. One of the laser systems utilizes a 96-128 laser array to expose directly onto the screen without first passing through a DMD.

Figure 8: Laser CTS. Courtesy of Lüscher Technologies AG.

All three systems are capable of imaging and exposing a 23x31″ screen in approximately two to three minutes depending on the mesh count and using pre-sensitized SBQ-photopolymer emulsions.

Important Considerations

The challenge of optimizing exposure is that it is a compromise between resistance and resolution. It is universally accepted that exposing emulsion long enough to maximize chemical and mechanical resistance on press may sacrifice resolution primarily of the finest detail. Two issues pertaining to this as it relates to CTS systems are potentially poor opacity with inkjet systems, especially on coarse mesh counts and the effect of stray light with respect to direct light exposure systems.

With inkjet systems, poor coverage or mask density may cause one to undercure emulsion to help resolve fine details or to develop screens easier. Exposing more completely to maximize resistance, say for a large water-based ink job, may cause light to penetrate through the mask, causing difficulty when developing the screen. This is especially true if using an automatic developer with insufficient water pressure to punch through the partially exposed emulsion. Printers may reluctantly find they have to image the screen a second time to achieve sufficient opacity when using low-solid inkjet inks.

As digital direct exposure systems do not require the use of an opaque mask, at times stray light spilling into the image area may cause similar issues as previously described. Slowing the exposure head speed to fully cure emulsion through to the squeegee side compromises resolution fidelity. Figure 9 shows a five-step exposure test using a digital direct exposure system. From left to right each step was imaged using a progressively slower exposure speed. (Note where emulsion was able to be rubbed off of the squeegee side at the bottom of the screen during developing in three of the five exposure steps and to a lesser degree in step four.) Good cure through was achieved at step five, however, the best resolution was achieved at step three.

Figure 9: Exposure calibration test.

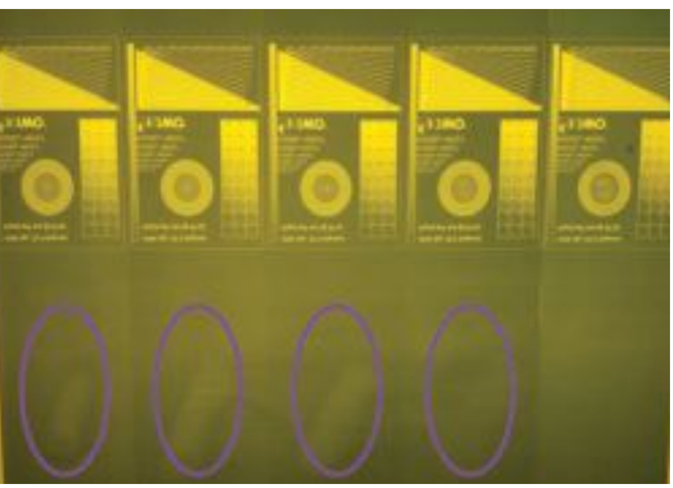


Figure 10: Exposure calibration.

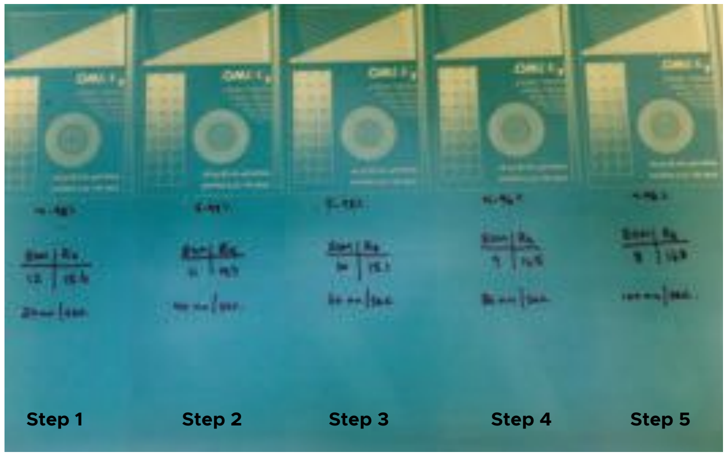


Figure 10 shows another example that includes the tonal range resolved from step to step, the emulsion-over-mesh (EOM) value, the Rz value, and the exposure speed used in imaging a diazo-photopolymer emulsion. The slowest exposure step on the left (20 mm/second) held a tonal range of 10-98% and measured 12 microns EOM. (Note each subsequent exposure step lost one micron EOM, respectively.) This indicates uncured or partially cured emulsion is rinsing away on the squeegee side, leaving a thinner, less resistant stencil, as evidenced by the ability to rub emulsion off of the squeegee side of the screen.

Some of these issues can be compensated for with adjustments made in the artwork after printing control tests to measure the amount of compensation required to optimize resolution without sacrificing resistance. Experience with the types of inks used and the job size will help one determine the level of compromise required either way. Simply speaking, inks containing liquid more aggressively degrade the stencil (e.g., water-based inks and solvent-containing water-based inks). Therefore, these inks — especially if used for big jobs — require extra screen making discipline and screen room management.

Those who take time to gain a deeper understanding of the screen making process and its impact on the production process will be better prepared to implement effective procedures and working parameters. And with the help of new technologies, they will be well positioned to compete successfully in this dynamic marketplace.

CTS technology is not the future; it is ubiquitous, as is evidenced by the sheer number of printers utilizing it today. The technology has become more affordable, allowing even small shops to enjoy its benefits.

What the future holds for CTS technology is difficult to say, but one might imagine CTS systems to be the foundation from which increased investment in in-line automation is built. Expect laser CTS systems to gain market share in the next several years just as inkjet systems did the past half-decade, while existing technologies continue to improve. ■

Dave Dennings oversees KIWO's applications laboratory and screen making product development. Dennings is a two-time Swormstedt Memorial Award nominee and was inducted into the Academy of Screen & Digital Printing Technologies in 2006. He served on two PRINTING United Alliance committees and helps instruct the screen making workshop.