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PREPARED FOR:

SCREEN

WHITE PAPER

THE SCREEN TRUEPRESS JET 520HD WITH SC INKS

High-Speed Inkjet on Commodity Coated Papers

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Executive Summary

Many vendors of high-speed continuous feed color inkjet systems have been trying to solve a technological puzzle: printing at high quality and high speed on commodity coated papers. Once achieved, end users will be able to produce print applications that hitherto have been economically unfeasible due to the cost of inkjet-treatments (built into the paper or applied as a pre-coat) that are typically required to allow water-based inkjet inks to adhere effectively to the surface of a coated stock and produce good-looking output. Paper is such an integral part of the cost equation for commercial printers that it is imperative that they be able to use the same lower cost commodity stocks that they use with their offset lithographic presses. With the introduction of the Truepress 520HD with SC inks, Screen has built a compelling argument that its new offering will bring high-speed digital printing into high-quality areas that have been relatively untouched so far by production digital printing methods.

Key Findings

- ♦ **Market experience:** Screen, as a developer and manufacturer of high-speed inkjet systems, has more than a decade of experience since the 2006 showcase of the first Screen Truepress Jet520 system. It has installed over 350 Screen-branded continuous-feed black & white and color Truepress print engines worldwide (over 1,200 when including those placed by its partner).
- ♦ **The next step in high-speed continuous-feed inkjet:** For more than ten years, these systems have had significant success in bills and statements, direct mail, and book printing. These are often lower coverage applications printed on uncoated papers. Cost-effective high-quality inkjet printing on standard matte, silk, or gloss coated stocks broadens the possible application set to include higher quality applications like brochures, catalogs, and magazines, as well as higher value direct mail and books.
- ♦ **Ink cost comparable to current inks:** The Truepress 520HD platform, in combination with SC inks, provides the ability to print on key commodity coated stocks while maintaining similar cost to the current generation of MD inks. This is important, as many of the strategies intended to allow inkjet printing on commodity coated stocks require more expensive inks or inkjet treatments.

Recommendations

- ♦ **Follow the cost implications of any inkjet/paper strategy:** End users looking at high-speed color inkjet printing systems will see many strategies that vendors are implementing to allow printing on coated stocks. It is important to explore the relative costs and effectiveness of these strategies. Inkjet-treated coated stocks can provide excellent results, but they come at a higher cost than untreated ones. Likewise, pre-treatments add to the cost and process complexity.
- ♦ **The role of paper testing:** These are the early days of high-speed color inkjet printing on commodity coated stocks. Success depends not only on strong technology, but on thorough testing between system vendors and paper suppliers. End users play an important role in this equation, as they identify the desired papers and usage requirements. Be sure that your system vendor embraces this partnership.



Introduction

As part of its Truepress Jet520HD system, Screen has developed a means of printing on commodity coated stocks without the use of pre-coatings or inkjet-treated papers. This is possible through a combination of new inks, patented screening methods, droplet shape and size control, and new dryer technology that leverage the 1,200 dot per inch inkjet heads of the Truepress Jet520HD. Printing on the same types of coated stocks used on offset printing presses has not typically been possible with water-based (aqueous) inkjet methods. Screen's development has important implications for the production digital print market, since applications that have not been feasible for economic or technological reasons will now be within reach of high-speed inkjet systems. In this sponsored white paper, InfoTrends explores how Screen is addressing this developing market opportunity for Truepress Jet520HD users.

Figure 1: Screen Truepress Jet520HD



Advances in Inkjet

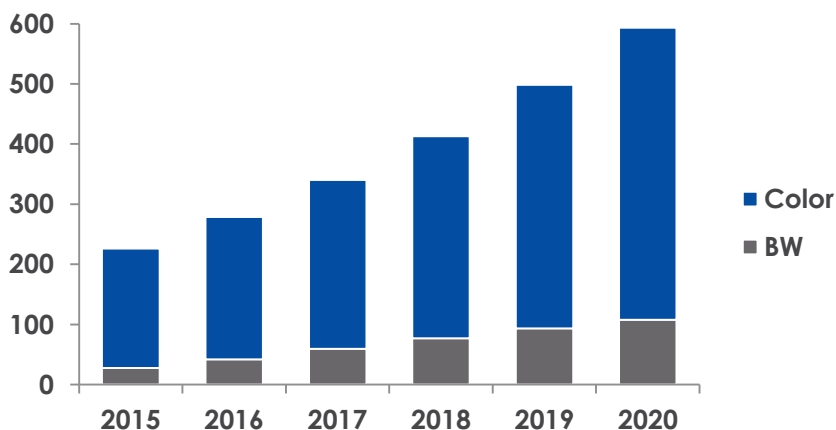
The continuous-feed color inkjet market took off around ten years ago. Systems had been available prior to that time, but low print resolution limited their broad success. Systems providing at least 600 dot-per-inch resolution, combined with high levels of productivity and attractive running cost, have since inspired many service providers to move to inkjet. Placements in this segment stayed strong, even during the economic downturn in 2009 (when many product categories suffered 10 to 20% drops in placements). The types of service providers that bought these systems were typically in transaction (bills and statements), direct mail, and books. The applications they printed were generally low coverage documents on uncoated paper. In addition to strong quality, high productivity, and compelling running cost, these users benefited from digital print advantages like just-in-time manufacturing, lights-out production, and white-paper-in/full-color out workflows that eliminated the two-step process of using offset pre-printed shells and "lasering" on the monochrome variable data with toner-based printers. These inkjet systems also allowed more flexible use of color for messaging or branding. The cost metrics were even attractive enough to allow the printing of monochrome and light-coverage color pages - along with more colorful pages.



These inkjet systems produced a staggering amount of page volume in a relatively short time. Keep in mind that each print engine is capable of printing tens of millions of impressions a month, and that there are two print engines associated with each duplex system. InfoTrends has calculated that the relatively small worldwide installed base of these devices is now producing as much color page volume as the entire installed base of production color toner-based devices. This is an incredible turnaround that speaks to the productivity and reliability of these devices.

In addition, according to InfoTrends' forecast, these page volumes will grow at double-digit rates through 2020. Print volume on color systems will outpace that of black & white, but both types of systems will see significant growth.

Figure 2: Global Production Color Inkjet Print Volume (Billions of A4/Letter Pages)



Source: *Global Production Printing & Copying Market Forecast: 2015-2020*, Keypoint Intelligence / InfoTrends

An Application View

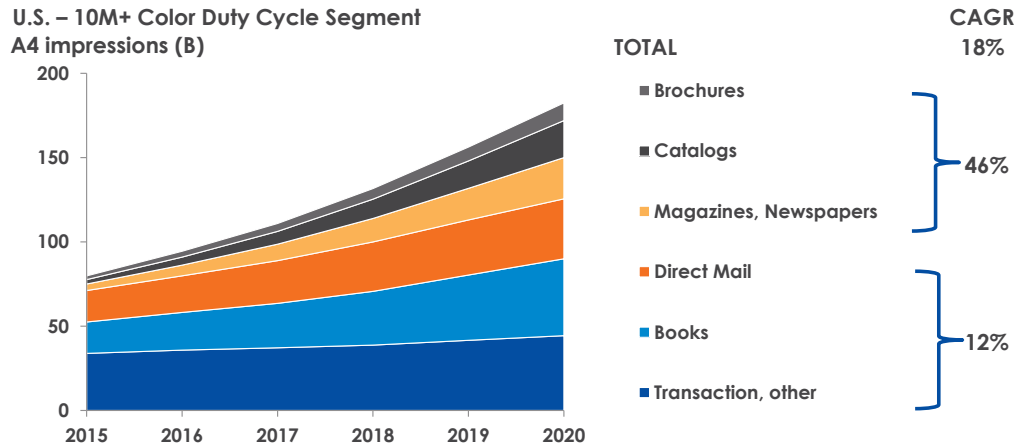
Yet the initial success of these devices was limited primarily to lower coverage applications on uncoated stocks. The water-based dye or pigment inks in use did not work well on the surface of coated matte, silk, or glossy papers. The coating made it difficult for the inks to penetrate the surface and adhere. The result was blotchy, unattractive output that smudged easily. To expand the market for these devices, a solution needed to be found for coated papers. While the growth in transaction, direct mail, and many book applications will continue (see Figure 3), InfoTrends expects other applications to grow dramatically once cost-effective solutions are in place for coated papers.

Overall, InfoTrends expects that print volume in the U.S. for color continuous-feed devices in the highest volume category will increase at a compound annual growth rate (CAGR) of 18%. Continued growth in transaction, direct mail, and books will form the foundation. As developments in system technology improve image quality and make it possible to print



effectively on coated papers, new growth opportunities will arise in brochures, catalogs, and magazines – all of which depend on coated papers.

Figure 3: The Role of High-quality Applications on Coated Papers



Source: Keypoint Intelligence / InfoTrends U.S. Digital Production Printing Application Forecast, 2015-2020

The Role of Paper

Paper plays an integral role in print quality, running cost, and return on investment for any application. For high-speed inkjet, however, the relationship is even more nuanced. Printing on uncoated sheets is generally feasible, though performance may be improved using inkjet-treated stocks. Quite a large number of these stocks are available, and the price differential between untreated uncoated sheets and inkjet-treated uncoated sheets is quickly becoming less consequential. Even so, this presents a dilemma for sites that must then warehouse separate papers for their offset presses and inkjet systems.

Coated stocks have presented a much more significant challenge for high-speed inkjet, where the main option has been inkjet-treated papers. The issue is that inkjet-treated coated stocks are significantly more expensive than untreated ones. In addition, there are not a lot of inkjet-treated coated stocks available. Therefore cost, as well as easy availability, makes it preferable to print on commodity coated stocks. Still, technological barriers remain for effective printing on commodity coated stocks.



Table 1: Print Volume and Paper Cost as a Percent of Overall Cost

	Millions of Impressions per Month					
	5	10	15	20	25	30
Equipment	28%	17%	12%	9%	8%	6%
Maintenance	5%	3%	2%	2%	1%	1%
Click	13%	15%	16%	17%	17%	17%
Ink	13%	15%	16%	17%	17%	17%
Paper	42%	50%	54%	56%	57%	58%
Total	100%	100%	100%	100%	100%	100%

Source: Keypoint Intelligence / InfoTrends

In order to better understand the role that coated paper plays in overall costs, we have provided some cost calculations based on a handful of assumptions. The first assumption is a 20" roll-to-cut inkjet system (priced at \$2 million) that is paid for over five years. Next are InfoTrends estimates of monthly maintenance fees, clicks, and ink cost at 20% coverage. (Note: Not all vendors apply a click charge, but many do.)

Table 1 presents an estimate of the cost impact of paper, related to other aspects like equipment, monthly service, click charge, and ink. A cost of \$0.02 (two cents) per equivalent 8.5" x 11 coated sheet is assumed (which adds a cent per side, assuming a 100% duplex rate). At five million impressions per month, paper is the largest component, accounting for about 42% of the total cost. Not too far behind, at 28%, is the equipment cost.

In general, fixed costs like the equipment and monthly service fee become a smaller part of overall cost as volume increases. Equipment, for example, drops from 28% of the total cost at five million impressions to 6% at 30 million. Variable cost components, such as click charges and ink, go up as volume increases while fixed costs represent a smaller percentage. Both start at around 13% and end up at 17% at 30 million impressions. Paper is the largest cost component, at five million impressions, and accounts for a staggering 58% of the cost at 30 million impressions (though volume discounts for paper could bring this number down a bit).

Using these estimates, overall cost per page drops at about a -6% rate from the five million monthly impression example to the thirty million monthly impression example. At 30 million impressions per month the cost per page is about 70% of what it is at 5 million.

End users know that their cost metrics improve as they drive devices to higher print volumes, but they may overlook the significant role that paper plays in cost. This raises an important question: If you cut corners when you make the device purchase, will you pay for that later through higher paper costs? If expensive inkjet-treated coated stocks are required, then the cost implications can be very large.



System Vendor Cooperation with Paper Mills

System vendors understand the importance of paper. As a result, they have worked with the mills as part of an overall strategy that includes inkjet-treated papers. Over time, the cost of inkjet-treated papers will drop. It is likely, however, that they will always carry a premium, particularly for coated stocks. Availability is another inhibitor. Whereas commodity papers are generally available, inkjet-treated stocks may not be. As mentioned earlier, print service providers also face the issue of having to warehouse inkjet-treated and offset versions of the same paper. So in addition to cost, convenience and availability play a role.

To address the need for close communication with the paper mills and distributors, Screen has paper testing facilities in the United States, Europe, and Japan. Through this work, the company has developed a growing list of suitable papers for the Truepress Jet 520HD.

Inkjet/Paper Strategies

System vendors have approached the issue of printing on coated papers with a variety of strategies:

- ◆ **Direct application of inkjet on commodity stocks** – This is the most cost-effective method but for most systems, this will only work on uncoated papers.
- ◆ **Selective pre-placement via inkjet head of a bonding agent** – This expands the number of possible stocks and improves performance, but also adds cost. As a strategy it is most effective on uncoated stocks.
- ◆ **Inkjet-treated stocks from the mill or distributor** – These provide good performance, particularly for uncoated stocks. Inkjet-treated matte and gloss coated options are also becoming available. The issue with inkjet-treated stocks is that they are more expensive than comparable untreated ones, particularly for coated stocks
- ◆ **Flood application of a primer prior to printing (to allow broader substrate use, mainly for coated stocks)** – This expands the possible stocks and provides greater flexibility in substrate choice. It also adds equipment, operational, and consumable cost, and requires consistent application of the primer. This process may also require reduced production speed to attain acceptable quality levels. Any manipulation of the substrate can also have consequences during finishing (jams in the inserter, for example) if the flatness of the paper has been compromised.

Additional costs are associated with the last three of these. It is why vendors have been investigating new inks, printheads, drop control algorithms, and drying methods to improve performance and to allow printing on commodity coated stocks.



How Does Screen Address Inkjet Printing on Coated Papers?

Screen has developed a combination of technologies, including ink, printhead control, and screening, to allow printing on commodity coated papers at high speed with water-based inkjet inks. These began with the introduction of the Screen Truepress Jet 520HD, which was introduced in September of 2014. This device employs next-generation inkjet heads that allow up to 1,200 by 1,200 dot per inch (dpi) print resolution with four droplet sizes. These variations produce a higher level of detail, to the point that Screen believes it is comparable to 2400 by 2400 dpi resolution. The system's speed ranges from 164 feet per minute (fpm) / 50 meters per minute (mpm) up to 492 fpm / 150 mpm.

Screen uses the letters 'MD' to describe the standard ink set for the Truepress Jet 520HD. The ink that Screen has developed for printing on commodity coated papers is called 'SC.' SC ink was announced at drupa in May of 2016 and was demonstrated at Hunkeler Innovationdays in February of 2017. New additives built into the formulation of the SC inks are part of the reason for its performance on commodity coated stocks. The way that the Truepress Jet 520HD handles the ink has also been adjusted to leverage the difference in the ink formulation.

SC inks have been tested and print well on a range of uncoated and coated papers, and work well on inkjet-treated papers, should those be required. Scratch resistance testing has also been successful.

Screen's experience in dot formation and frequency modulated (stochastic) screening methods are another factor. In addition, the ink has been designed to resist nozzle clogging, which, when undetected, can result in streaks or visible gaps in the printed output.

The ability of the Truepress Jet 520HD with SC inks to run untreated coated papers is being introduced at the 50 mpm / 164 fpm speed but productivity upgrades are anticipated. For example, Screen expects that printing on untreated coated papers at 75 mpm / 246 fpm will be available soon.

Screen's development work so far has been focused on what are commonly described as number 2 and 3 offset stocks. Number 2 stocks include familiar brands, such as Verso Sterling, SAPPI Opus, West Linn Sonoma, and Appleton Utopia. Number 3 papers include SAPPI Somerset and Verso Influence.

Screen reports that the SC inks will be priced comparably to MD inks. This gives Truepress Jet 520HD users the choice of either ink without a significant economic penalty. In addition, a factor that may work in favor of overall ink consumption is that Screen's initial studies have shown that SC ink is somewhat more efficient than MD ink. When combined with the ability to print on commodity coated stocks, this translates to additional cost



benefits. Another cost factor that will be welcomed by end users is how Screen charges for service. Unlike cut-sheet toner systems (and some inkjet systems), which often have a volume-dependent click charge, Screen's Truepress Jet 520 family does not. This helps users drive volume without paying a cost penalty per page. (For details on the full Truepress Jet 520 product line, please see the Appendix.)



opinion

InfoTrends' Opinion

Many vendors of high-speed water-based continuous-feed systems are developing strategies to print on commodity coated stocks. What stands out about Screen's Truepress Jet520HD system with SC inks is the focus the company has paid to the economic aspects of this puzzle. To succeed these systems must, of course, print at required quality levels. The real litmus test, however, is attaining running cost levels that make it economically feasible to use these systems extensively. Paper, since it is such a critical aspect of cost, is a huge part of this. Inks and inkjet treatments add cost as well. By leveraging new heads, inks, screening, and dot control methods, Screen has created an appealing solution that will bring the value of digital print at high-speed, high levels of productivity, and attractive running cost to a much wider range of applications.

Of course, beauty is in the eye of the beholder. For this system to succeed, the print quality must meet the needs of end users. The Truepress Jet 520HD print samples that InfoTrends has viewed to date are impressive and should support the expansion of high-speed color inkjet into new higher quality applications. This is a significant development that will have a positive impact for end users.



appendix

Appendix: Screen's Approach to High-speed Inkjet

Screen's Truepress Jet 520 was first showcased in May of 2006 and was launched in April of 2007. This heritage of more than ten years of supplying high-speed continuous-feed inkjet systems provides a solid foundation for next generation development. Worldwide, Screen has installed over 350 Screen-branded continuous-feed black & white and color Truepress print engines. Add to that the print engines that have been placed by Screen's OEM partner, the figure is even larger, amounting to over 1,200 print engines.

Today, Screen's Truepress line-up consists of a broad range of solutions covering monochrome and color as well as differing volume and application needs. With the Truepress 520HD plus SC inks and the related supporting technologies, Screen has an offering for higher coverage, higher quality applications on commodity coated papers.

All of the Truepress 520 family offerings have some items in common:

- ◆ Web width: 165 to 520 mm (6.5" to 20.47")
- ◆ Print width: 150 to 508 mm (6" to 20")
- ◆ Screen's EQUIOS digital front end and prepress workflow
- ◆ Drop-on-demand piezoelectric inkjet heads with four-level gray-scale printing (while this is a constant, a few different printheads are used in the product line to achieve this)
- ◆ Support for PDF and PDF/VT (native AFP/IPDS is available on some models and other print languages can be handled as an option)
- ◆ Automated cleaning and maintenance
- ◆ Support for Type 1 interface finishing devices (Note: Some non-Type 1 interfaces are also supported)
- ◆ Operating environment (temperature): 18 to 24°C / 64 to 75°F
- ◆ Operating environment (relative humidity): 40 to 60%

Key differentiating factors are summarized in Table 2, which provides an overview of the Screen Truepress 520 product family. These include speed and quality levels, which typically relates to the printheads, their resolution, and the inks used. Supported substrate weights all start at 40 grams per square meter (gsm), but some models support up to 179 gsm while others extend this to 250 gsm. Some devices offer a magnetic ink character recognition (MICR) ink. The daily start-up time is shortest for monochrome version and also for the dye-based inks. Configurations vary from single-engine simplex (SES), single-engine-duplex (SED), and dual-engine-duplex (DED). Screen also offers some product enhancements such as dynamic nozzle shift (DNS), hot air assist, and AIA (Adhered Ink Amount). AIA is a Screen developed method that optimizes the amount of ink laid down on a page. Screen notes that it produces better results than an ICC profile with a set ink limit.



Table 2: The Screen Truepress 520 Product Family

Product	Speed and resolution	Ink type	Differentiators
Truepress Jet520EX Mono	64 mpm / 210 fpm - 720 x 360 128 mpm / 420 fpm - 720 x 360	Water-based dye ink Water-based pigment ink MICR	Mono only, MICR option, stocks supported from 40 to 179 gsm (27# text to 65# cover)
Truepress Jet520EX Color	32 mpm / 105 fpm - 720 x 360 64 mpm / 210 fpm - 360 x 360	Water-based dye ink	Four-color, dye-based inks, stocks supported from 40 to 179 gsm (27# text to 65# cover)
Truepress Jet520S	32 mpm / 105 fpm - 720 x 720 64 mpm / 210 fpm - 720 x 360 128 mpm / 420 fpm - 360 x 360	Water-based dye ink Water-based pigment ink	Four-color, choice of dye- or pigment-based inks, stocks supported from 40 to 179 gsm (27# text to 65# cover)
Truepress Jet520ZZ Advanced	75 mpm / 246 fpm - 720 x 720 150 mpm / 492 fpm - 720 x 360 220 mpm / 721 fpm - 720 x 360	Water-based dye ink Water-based pigment ink	Four-color, MICR, choice of dye- or pigment-based inks, stocks supported from 40 to 250 gsm (27# text to 92# cover), fastest speed
Truepress Jet520NX	75 mpm / 246 fpm - 1200 x 600 120 mpm / 392 fpm - 600 x 600 150 mpm / 492 fpm - 600 x 450*	Water-based dye ink Water-based pigment ink	Four-color, MICR, specialty ink [need specifics], choice of dye- or pigment-based inks, stocks supported from 40 to 250 gsm (27# text to 92# cover)
Truepress Jet520HD (MD Ink)	50 mpm / 164 fpm - 1200 x 1200 Uncoated papers, Inkjet treated coated papers 75 mpm / 246 fpm - 1200 x 600 Uncoated papers, Inkjet treated coated papers 120 mpm / 392 fpm - 600 x 600 Uncoated papers, Inkjet treated coated papers 150 mpm / 492 fpm - 600 x 600 Uncoated papers up to 156gsm Inkjet treated coated papers up to 156gsm	Water-based pigment ink (MD - original HD ink)	Four-color (possibility for more in the future), pigment-based ink, stocks supported from 40 to 250 gsm (27# text to 92# cover), faster speed possible than with SC inks
Truepress Jet520HD (SC Ink)	50 mpm / 164 fpm - 1200 x 1200 Uncoated papers, untreated coated papers 75 mpm / 246 fpm - 1200 x 600 Uncoated papers, untreated coated papers ¹ 120 mpm / 392 fpm - 600 x 600 Uncoated papers, Inkjet treated coated papers	Water-based pigment ink - Can print on untreated coated offset stocks	Four-color (possibility for more in the future), pigment-based ink capable of printing on coated offset stocks, stocks supported from 40 to 250 gsm (27# text to 92# cover)



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