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Strategic Assessment

Opportunities for High-Speed Monochrome and Color Inkjet Mounted on Offset Web Presses

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Abstract

There is a sea change underway in the printing market as high-speed monochrome and color inkjet technologies are applied in hybrid on-press and standalone production system configurations. In this document, InfoTrends investigates the on-press opportunities presented by these technologies using Kodak's new Prosper S5, S10, and future color imprinting systems as examples. This document also includes a case history of Wilen Direct, a Kodak customer using the monochrome Prosper S10 Imprinting System.

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Introduction

The production digital print market has been dominated to date by standalone toner-based monochrome and color systems. Toner also dominates two-part processes involving the use of offset-printed shells. With this type of workflow, static information is pre-printed on rolls or sheets of paper by an offset press and a monochrome digital component is added or “lasered” by a toner-based continuous-feed or cut-sheet printer afterward. There are strong signs that toner’s dominance in standalone digital and offset shell workflows will be challenged by inkjet. Over the past few years, inkjet technologies have greatly improved in terms of print resolution, speed, and the ability to print on a range of substrates. Much of the attention to date in the production market has been focused on high-speed web-fed production color inkjet systems. It has become apparent, however, that on-press use of high-speed monochrome and color inkjet technologies brings some remarkable advantages to a variety of print applications. Mounting inkjet heads on web-fed offset presses and finishing lines is not new. Commercial printers and direct mailers have been using high-speed and low resolution monochrome inkjet heads for many years. Yet as quality and speed have increased, the range of applications has grown, as well. The purpose of this white paper is to explore this growing area and the advantages that come from a hybrid configuration.

Reasons to Use a Hybrid Approach

There are many reasons why a print service provider would consider a hybrid inkjet/offset approach:

- **Offset can do some things that digital cannot** – Today’s high-speed digital systems, whether inkjet or toner, are generally not able to produce some special effects that offset is capable of (e.g., printing metallic or fluorescent colors). Using a hybrid approach allows end-users to take advantage of these special effects while also gaining the benefit of targeted or variable messaging and graphics.
- **Taking advantage of the best that each technology has to offer** – One of the main reasons for creating a hybrid system is to take advantage of the unique strengths of the two technologies. Offset printing is a very cost-effective method of reproducing large quantities of static documents. Digital

printing can provide variable data for addressing, personalized messaging, coding, localized elements (such as maps and phone numbers), and targeted or personalized graphics. With recent inkjet advances, it can also provide these things at high speed, high quality, and reasonable cost.

- **Higher resolution is opening up wider format opportunities** – The use of narrow-format monochrome inkjet heads has been a staple of on-press and mailing line applications, but this has been limited to addressing, coding, and smaller personalized elements. The move to 600 dot-per-inch (dpi) resolution, combined with the ability to stitch heads together to go wider than 4 inches, is making print service providers consider using inkjet heads in hybrid configurations for variable applications that require higher quality on larger areas of the page. It also opens up the opportunity to move from a two-step process of web offset print and then toner-based laser imprinting, to a single step process using inkjet heads on-press.
- **Full process color is the next step** – Kodak has commercial monochrome and spot color inkjet offerings today that are opening up new hybrid opportunities because of their speed, quality, cost, and their ability to handle wider print areas. The company has already announced a process color system (the Prosper 5000XL) and can be expected to have a hybrid process color offering before too long. In the same way that 600-dpi quality at high speed has driven the opportunity for the monochrome Prosper S5 and S10 Imprinting Systems, the ability to print high quality color at high speed will eliminate the need for pre-printed offset shells and will open up new print applications.
- **Meeting the growing need for personalization** – The move toward mobile communication devices has heightened consumers’ expectations for information that is relevant to them and available on demand. Digital systems provide that capability in print, yet the running cost of toner-based systems has limited their broad application. Inkjet systems, in hybrid or standalone configurations, can provide high-volume yet variable print with very favorable cost metrics.
- **Versioning is simplified** – Full variable data is not the only application of hybrid inkjet technologies. Versioned documents are another important application. In the case of monochrome, having inkjet heads on the press eliminates the need for frequent black plate changes. The productivity hit and the plate cost implications can make a strong case for the use of inkjet for versioning in targeted, segmented, or regulatory applications. These, in essence, are multiple short run versions of the same document with some text or graphic changes.

Setting the Stage

Some key factors and definitions are important in understanding the opportunity for inkjet technologies in on-press and other hybrid applications. We will start with a definition of hybrid and a look at the implications of cost before we go into the details about the technology and how it is being applied.

A Definition of Hybrid

InfoTrends uses the term “hybrid” to describe configurations that make use of at least two printing or mailing technologies in a single system. The two hybrid configurations that are relevant to this document are:

- **On-press inkjet** – This generally involves the use of one or more inkjet heads mounted on a web-fed offset press, although it is also possible for inkjet to be used in conjunction with a sheet-fed offset press. Hybrid configurations with other press types, such as gravure or flexography, are also possible.
- **Inkjet integrated into a mailing or finishing line** – One or more inkjet heads may also be mounted in a mailing or finishing line. This may be in a roll-fed or sheet-fed configuration, but ultimately the job will be sheeted for insertion and mailing.

The use of a single head versus two or more heads is another interesting differentiator in hybrid applications. As a general rule, one head is used for single field areas, such as codes or addresses, while multiple head implementations typically are used for handling full documents or document subsegments.

In addition, end-users are very creative in how they apply new technologies. You may be aware of other ways that companies are taking advantage of inkjet. Therefore, the definition of “hybrid” is flexible and will likely expand to include other applications over time. For example, inkjet is used on-press for coding and dating applications in packaging, and the use of inkjet in more graphically-sophisticated packaging applications is sure to increase with quality improvements.

Cost, Speed, and Quality Implications for Digital Print

The cost of digital print, particularly color digital print, has been a limiting factor to its broad adoption. Yet there has been an ongoing drop in the cost of color digital print, and InfoTrends expects this trend to continue for color toner products and to be driven even lower for high-speed continuous-feed color inkjet products. There is little or no room, however, to move the cost of monochrome toner products significantly lower. Yet there are productivity and cost advantages to be gained by using digital products (chiefly inkjet) in on-press configurations with web offset presses.

Figure 1: Market Landscape in High-Speed Digital Production Color

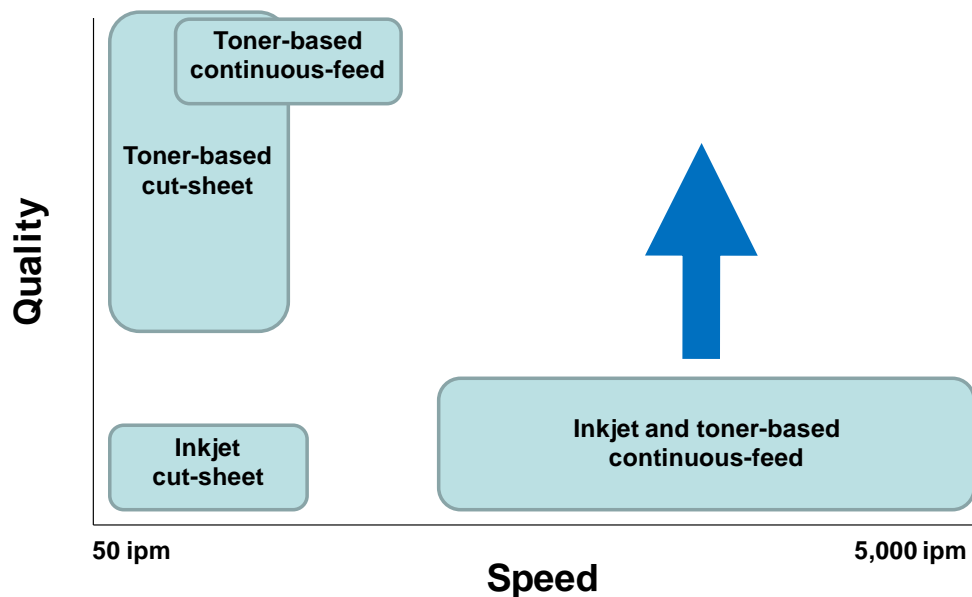


Figure 1 describes the current market landscape in a view of quality and speed. Digital color print quality ranges from a high level of graphic arts quality, as exemplified by cut-sheet toner-based copiers and printers. Speed of the toner-based cut-sheet color class of devices tops out today at around 120 letter pages per

minute, although pairing or clustering multiple print engines together can expand this further. In general, however, InfoTrends does not expect toner-based cut-sheet color speeds to increase much beyond 120 ppm on a per-engine basis. Also at a very high level of quality are toner-based continuous-feed color products. Though these devices are faster than their cut-sheet brethren, their speed is only moderately faster with the top-of-the-line models capable of about 240 letter size pages per minute. At a lower level of quality, but at impressive speed and acquisition price points, are a small number of inkjet cut-sheet devices. With print speeds of up to 150 letter-size pages per minute and acquisition costs comparable to office multi-function copier/printers, this is a category where new entrants and quality improvements are likely. High-speed continuous-feed color products are a new growing category and will drive new opportunities. Although there are some toner-based products at this high level of speed, the inkjet products dominate this category.

As indicated by the blue arrow in Figure 1, expanded ability to print on coated stocks will open up new applications for inkjet. This will raise their ability to print at high quality and will make higher volume variable applications a reality. Today, the high-speed continuous-feed color products tend to focus on transaction documents (like bills and statements), direct mail, and books. As costs drop, new opportunities will be possible in higher volume applications like catalogs, custom publications, magazines, newspapers, and personalized promotional materials. This makes these new high-speed continuous-feed color systems more competitive with traditional methods at higher run lengths, but there is also an opportunity for hybrid systems to take digital into new territory.

As discussed above, cost is a barrier to broad implementation of digital printing systems. High-speed inkjet systems are lowering that barrier, yet there is one solution that leverages the cost metrics of offset while also taking advantages of the variable data capability of digital print. To explore the possibilities of hybrid solutions, we first need to understand the capabilities of the technology. We will look at Kodak's Prosper in detail since it provides a good example of how inkjet is being used on press.

About Kodak's Prosper Hybrid Printing Solutions

Kodak has rolled out its Stream inkjet technology in hybrid configurations and will be rolling out stand-alone system configurations, too. Both types will use the brand "Prosper." The first available products are the Prosper S5 and S10 Imprinting Systems, which are configured as hybrid on-press configurations. The next announced product, which will be available in 2010, is the Prosper Color 5000XL Press. Kodak also announced a monochrome system called the Prosper 1000 Press, which will be available soon. The Prosper Color 5000XL Press and the Prosper 1000 Press are stand-alone systems. Kodak has not yet announced a process color hybrid system.

All of Kodak's Prosper offerings make use of some of the same underlying Stream printhead technology. Kodak announced the Prosper branding for Stream in 2009 and is using that term for all products based on these heads. Prosper S5 and S10 Imprinting Systems use inkjet heads that are 4.16 inches (10.4 cm) wide. The controller can support up to 24 heads for a possible width of close to 100 inches, but in practice typically four heads are stitched together in a single line for a 16.64 inch width. Each inkjet head has 2,560 nozzles, which supports the 600 dpi resolution. During operation, each of these tiny nozzles (10 micron diameter aperture) has a constant stream of aqueous (i.e., water-based) ink flowing through it. The black ink for the Prosper S5 and S10 Imprinting Systems uses pigments (rather than dyes), which contributes to its fade, scratch, and water resistance. Spot color inks are also available. These are dye-based aqueous inks. Announced in 2009, Kodak's Prosper Spot Color Matching Service gives print service providers the ability to match specific logo or brand colors for their clients. The use of Prosper

heads for on-press hybrid process color will be available in the future using cyan, magenta, yellow, and black (CMYK) inks. A lower cost black dye ink for the Prosper S5 and S10 Imprinting Systems will also be available, but it will not have the fade, scratch, and water resistance of the pigment version nor will it be able to print on the range of paper stocks that the pigment ink supports.

About the Prosper S5 and S10 Imprinting Systems

The Table below summarizes the Prosper S5 and S10 Imprinting Systems and compares them to Kodak’s Versamark DS6240 Printing System, which preceded Stream inkjet technology to the market by about nine years.

Table 1: Comparing the Specifications of the Versamark DS6240 and the Prosper S5 and S10

Specification	S10	S5	DS6240
Full product name	Kodak Prosper S10 Imprinting System	Kodak Prosper S5 Imprinting System	Kodak Versamark DS6240 Printing System
Technology type	Continuous inkjet	Continuous inkjet	Continuous inkjet
Rated speed ¹	1,000 fpm (305 mpm)	500 fpm (152 mpm)	1,000 fpm (305 mpm) ² 500 fpm (152 mpm) 300 fpm (90 mpm)
Resolution	600 by 600 dpi	600 by 600 dpi	240 by 240 dpi
Print width	10.56 centimeters (4.16 inches)	10.56 centimeters (4.16 inches)	10.84 centimeters (4.27 inches)
Ink type	Aqueous pigment (black) Aqueous dye (spot color)	Aqueous pigment (black) Aqueous dye (spot color)	Aqueous dye (black & spot color)
List price (U.S. \$) ³	\$443,000	\$354,500	\$461,000
Stitching	Can stitch up to four printheads for a total print width of 16.64 in. (41.6 cm)	Can stitch up to four printheads for a total print width of 16.64 in. (41.6 cm)	Can stitch up to four printheads for a total print width of 17.08 in. (43.4 cm)
Mounting	DC3700 printhead carriage DC3800 printhead carriage	DC3700 printhead carriage DC3800 printhead carriage S5 mail-based mount	DC3700 printhead carriage DS6240 mail-based mount

As seen from the Table, the only item separating the S10 from the S5 is speed. The S10 is twice as fast. What separates the S10 and S5 from the DS6240 is resolution. At 600 dpi, the S10 and S5 have more than twice the resolution of the DS6240. List price is also an important differentiator. As would be expected, there is a price to pay for higher speed. In addition, though Kodak will continue to sell the DS6240, it has aggressively priced the S5 and S10 to drive customers toward those products.

The specifications also help determine the target markets and applications. For the S5 and S10, Kodak identifies the following application types: catalogs, direct mail, inserts, magazines, newspapers, and transactional documents. For the DS6240, the markets are aimed toward variable data imprinting for personalization, graphics, addressing, barcoding, numbering, and logos in markets such as commercial printing, direct mail, forms, packaging, ticket, tag & label, and transactional printing.

¹ fpm = feet per minute; mpm = meters per minute

² The three speeds represent three models of the DS6240.

³ The list price includes a two-headed system with fluid stations and CS410 controller.

Going Wider: Stitching Multiple Inkjet Heads Together

Aligning multiple inkjet heads together to gain a wider print area is referred to as “stitching.” This can be achieved in three levels that speak to the way data is provided to the heads and the level of accuracy associated with the “stitch”:

- **Mechanical stitching** – With this type of stitching, the heads are aligned and overlapped, but not to an extremely high level of accuracy. In the output from a pair of mechanically stitched heads, there will likely be a visible print artifact where the edges of the heads’ print areas come together. This is often referred to as a “stitch line.”
- **Electronic stitching** – This type of stitching has less to do with the placement of the heads and more to do with how the controller splits images between multiple heads. In the case of electronic stitching, the system responsible for image processing takes a single image and splits it across multiple print heads.
- **Seamless stitching** – Seamless stitching elevates the accuracy with which the printheads are aligned to the point where there is no visible stitch line between the adjacent heads. Seamless stitching is a defining aspect of Kodak’s Prosper 5000XL Press and 1000 Press standalone systems.

For applications using multiple printheads in non-adjacent areas of the paper web, stitching is not at issue. Stitching only becomes relevant when image areas from multiple heads print right next to each other and the adjacent image components must align for the execution of the design.

Mechanical stitching imposes some basic limitations to keep the stitch line from interfering with the design. One common workaround in applications such as direct mail is to orient the page so that the stitch line falls between two lines of text. Stitch lines also impose a maximum height or width on any graphic used, though many will easily fit within the 4.16 inch width of the Stream printheads.

Table 2: Stitching on the Prosper Systems

Product	Mechanical	Electronic	Seamless	Comments
Prosper S5 and S10 Imprinting Systems	Yes	Yes ⁴	No	Designers must choose to place the stitch line judiciously
Prosper 5000XL Press and 1000 Press	No	Yes	Yes	There is no need to design around stitch lines

Mechanical and seamless stitching are key to the difference between the Prosper S5/S10 and the Prosper 5000XL Press/1000 Press. Both systems require electronic stitching, but seamless stitching is a standard feature of the Prosper 5000XL Press and 1000 Press systems.

⁴ Only required for multiple head systems

Mounting the Inkjet Heads on the Press

One of the basic questions about the use of hybrid inkjet technology is “How do you put it on the press?” The answer is fairly straight-forward. Mounting systems have been developed for previous generations of technology and are equally suitable for the Prosper S5 and S10. Figure 2 shows a close-up of a Kodak Versamark DC3800 two-rail mounting system capable of supporting eight printheads. The inkjet heads are not shown in Figure 2, though the row of four “buckets” used to hold them are visible across the right hand side at the front of the system above the controller screen. The first bucket in a similar row of four buckets can just be seen between the two orange handles. The two C-shaped devices at the top of the system on each rail are designed to hold and protect the cords and tubing for the electric and ink fluid systems. The red button by the controller screen provides an emergency stop function.

Figure 2: Kodak Versamark DC3800 8-Head 2-Rail Printhead Carriage System



Figure 3 takes us to the next step, showing how the heads are mounted on an actual press. This example comes from drupa 2008 when Kodak showed the S10 heads (then known as the “Stream Concept Printhead”) mounted on a Muller Martini web offset press.

Figure 3: Kodak Stream Concept Printheads Mounted on a Muller Martini Press



In Figure 3, the printhead carriage system is also a DC3800, but in this case it is a two-rail system with four printheads (two are plainly visible with the corner of the third unit behind them). The electrical cords and ink fluid tubing can be seen directly above the printheads. The far end of the press is where the roll feed resides. It is followed by four print units. The DC3800 printhead carriage sits on top of a drying tower for the offset press. The paper web continues to a finishing unit and conveyor.

Strengths, Weaknesses, Opportunities, and Threats

When looking at new products like Kodak’s Prosper S5 and S10 Imprinting Systems, InfoTrends discerns the product’s strengths, weaknesses, opportunities, and threats (SWOT). These factors are summarized in the Table below.

Table 3: SWOT Analysis of the Prosper S5 and S10 Imprinting Systems

<p style="text-align: center;">Strengths</p> <ul style="list-style-type: none"> • Speed (up to 1,000 feet per minute / 305 meters per minute) • 600 dpi resolution • 170 line per inch halftone equivalent • Durable pigment black inks • Broad substrate range with pigment inks • Ability to stitch heads for wider print area • Flexibility for on-press or mail/finishing line use • Spot color matching 	<p style="text-align: center;">Weaknesses</p> <ul style="list-style-type: none"> • Stitched arrays (those who want no visible stitching will be candidates for the standalone monochrome Prosper System) • The width of the Stream printhead is slightly narrower than the DS6240 head • Monochrome and spot color only today (future Kodak Prosper Imprinting Systems will offer process color)
<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> • Expanded application set made possible by 600 dpi resolution inkjet at high speed • Full variable data and versioned applications • Applications previously handled by black plate changes on an offset press • Logo and corporate branding applications using matched spot colors • Simplifying a two-step process (offset pre-printed shell and toner-based monochrome) with a single-step hybrid offset/inkjet process 	<p style="text-align: center;">Threats</p> <ul style="list-style-type: none"> • Expanding range of competitive offerings • Competition from current and future monochrome and color standalone systems • Electronic delivery of variable personalized information

While a SWOT analysis is an interesting academic exercise, it is more compelling to hear about the experience of an end-user of the technology. With that in mind, InfoTrends spoke with representatives of Wilen Direct, a Kodak Prosper S10 user.

Case Study: Wilen Direct

Wilen Direct, a division of the Wilen Group, is based in Deerfield Beach, Florida and is an innovative Kodak customer that was selected to be a beta site for the Prosper S10 Imprinting System. Wilen Direct’s stated goal is to take direct marketing to the next level through its expertise and in-house resources in data mining, printing techniques, and mailing efficiencies. The company is committed to a data driven workflow that transforms data into imaging.

Wilen Direct is one of three business groups⁵ in the Wilen Group (www.wilengroup.com). Wilen has been offering direct marketing and printing services since the early 1970s when it produced the first Home Box Office (HBO) program guide. Wilen Direct’s Deerfield Beach facility was built in 1997. Wilen added lettershop capability in 2004 and, within two years, it had become the second largest United States Postal Service customer in southern Florida. In 2006, Wilen purchased its first Kodak Versamark DS6240 printhead for on-press imaging. By 2007, Wilen had three printing presses on site, all of which were capable of not only on-press imaging but in-line finishing, as well. Over the next few years, Wilen added more Kodak Versamark DS6240 inkjet heads and it had broadened its focus to one-to-one marketing by 2009, all of this with 24 by 7 production capacity.

In describing its service offerings, Wilen Direct provides customers the choice of á la carte services or total turnkey solutions (see Figure 4). These capabilities include brand & consumer strategy, integrated 1:1 marketing, creative services, media planning & buying, printing & mailing, as well as data services.

Figure 4: Wilen Direct Service Positioning



Source: Wilen Group

Wilen believes in the power of data and the mantra that “Measurement Leads to Success.” Wilen helps its customers analyze their data and then works with them to create a data strategy. The next step is to create

⁵ The other two groups are Wilen Media and Wilen Products.

data-specific messaging and use that in producing a relevant and measurable campaign. Applying this in practice is where Wilen’s Kodak Versamark DS6240 heads and Prosper S10 Imprinting System come into play. At 240 by 240 dpi and with speeds up to 1,000 feet per minute (305 meters per minute), the DS6240 head is a high-volume workhorse. The Prosper S10 can achieve the same top speed, but at a 600 by 600 dpi resolution. This changes the possible application set. Figure 6 shows the kind of application that Wilen typically handles with its DS6240 heads. Code numbers, telephone numbers, and bar codes are text elements that can be rendered effectively at 240 dpi. When small text, complex linework, and/or halftones are required, the capabilities of the S10’s 600 dpi resolution become apparent.

Figure 5: Wilen Direct Tracking via Unique Data-Specific Messaging



Source: Wilen Group

As far back as 2004, Wilen anticipated that high-speed inkjet systems would become available at higher quality levels and that this would change their ability to serve customers via a cost-effective and time-sensitive manufacturing process that matched the quality level of toner-based electrophotographic techniques.

Through the beta testing process (now completed), Wilen was impressed with the reliability and productivity of the Prosper S10 heads, which it is running three shifts a day, seven days a week. An example of an application printed using Prosper S10 is a variable data printing inline letter pack, which includes a full color envelope and letter printed on both sides at 600 dpi. Wilen is able to produce more than 80,000 of these inline letter packs an hour. At these speeds, it can deliver 1.6 million direct mail pieces in a day on a single press. When comparing this with a two-step process of offset pre-printing forms and off-line laser imprinting, Wilen Direct estimates that their production time is 40 times faster with the Prosper S10.

Figure 7: Example of a Prosper S10 Print Application

The image on the left shows the offset printed shell. The center and right images have the variable data and graphics imprinted in monochrome along the upper and lower right side of the page.



Source: Kodak (samples used at the JGAS 2009 trade show in Japan)

As Wilen looks toward the future, the next frontier for high-speed imprinting is process color. Spot color capability is available today on the Prosper S10 and a standalone process color system called the Prosper 5000XL Press will be available in 2010. Kodak has not yet said when process color Prosper S5 or S10 Imprinting Systems will be available for on-press use, but you can bet that companies like Wilen will be paying attention when that capability comes along.

Conclusion

Cost, speed, and quality can be inhibitors to the applications suitable for digital print technology. In the case of Prosper, Kodak is removing standing barriers with a technology that can keep up with web offset presses, finishing equipment, and mailing lines to deliver quality output, today in monochrome and spot color, but in process color in the future. The result is liberating, and it points toward more effective print applications that meet today's need for rapid turnaround and targeted delivery of information.

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