WHITE PAPER

THE BENEFITS OF NEW INNOVATIVE CURING TECHNOLOGIES

REVIEW OF UV CURED & LATEX INKJET

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INTRODUCTION

For several decades now, opportunities for wide format printing technology and services in the North American market have presented a rich growth opportunity for sign companies and print service providers (PSPs). This installed base of nearly 300,000 wide format printing systems produces a broad range of applications and consumes countless litres of ink and millions of square metres of media.

In the past few years, however, inkjet technology has evolved and a range of new products and capabilities are energising the market and creating new opportunities. These devices offer wider print widths, flexible configurations, and a range of ink types to suit many needs.

Each of these solutions has its own set of characteristics in terms of printable media types, print speeds, colour gamut, finishing options, and total cost of ownership. In an ideal world, a single printer configuration would be able to efficiently print on rolls, sheets, or even rigid boards of many different materials. The ink would simply stick to the surface being printed, regardless of the end product. In the real world, of course, things don't always work out that way.

Today's sign companies and print service providers are searching for new revenue sources as well as improved production efficiencies. New products with UV curable inks and latex-based inks present a growth opportunity.

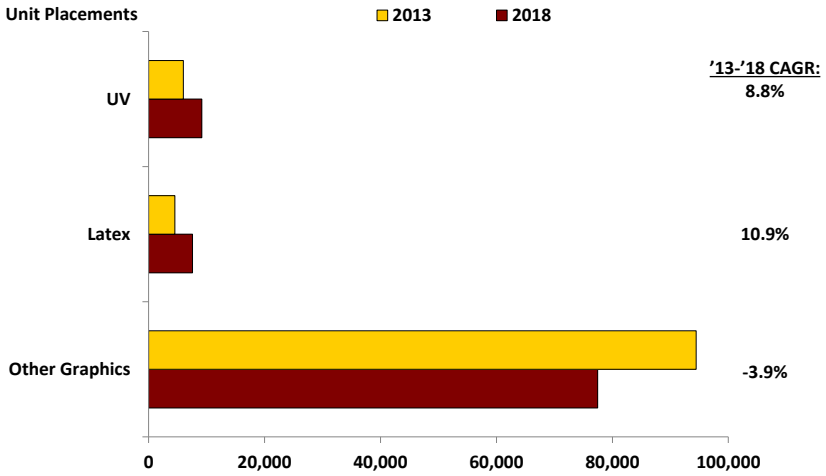
In this white paper, InfoTrends will:

- Examine market trends and opportunities in wide format printing
- Describe the benefits of UV curable and latex ink technologies
- Examine two successful case studies of end-users that have implemented these technologies

MARKET TRENDS & OPPORTUNITIES IN WIDE FORMAT PRINTING

Of the nearly 300,000 wide format printing systems installed in North America, most of them are aqueous-ink systems aimed at printing on porous substrates (typically with dye or pigment inks). Using data from InfoTrends' *2013-2018 Wide Format Industry Forecast*, some major trends emerge as dominant in the market place. First, it is clear that placements of UV and latex wide format printers are accelerating. There are significantly more placements of other types of wide format printers, but the numbers of those are expected to decline by about 4% (CAGR 2013- 2018).

Figure 1: Worldwide Shipments of Wide Format Printers

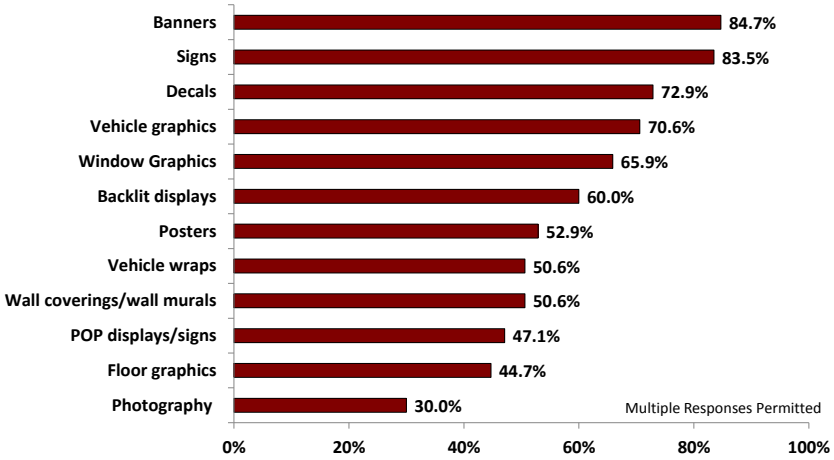


Source: InfoTrends' Wide Format Forecast (Note: UV includes desktop devices)

Second, a closer look reveals that the market and technology for printing with aqueous and solvent inks is mature. The decline in unit placements is based to some extent on market saturation, but more importantly on user migration to wider and more productive units. The ongoing need for sign companies and print service providers to enrich their product offerings, deliver their output in a shorter time window, and improve their profitability is a key driver.

A recent InfoTrends survey with ISA members indicates that the number of applications produced is vast, so purchasing decisions tend to guide sign companies to products that can address a wide range of applications.

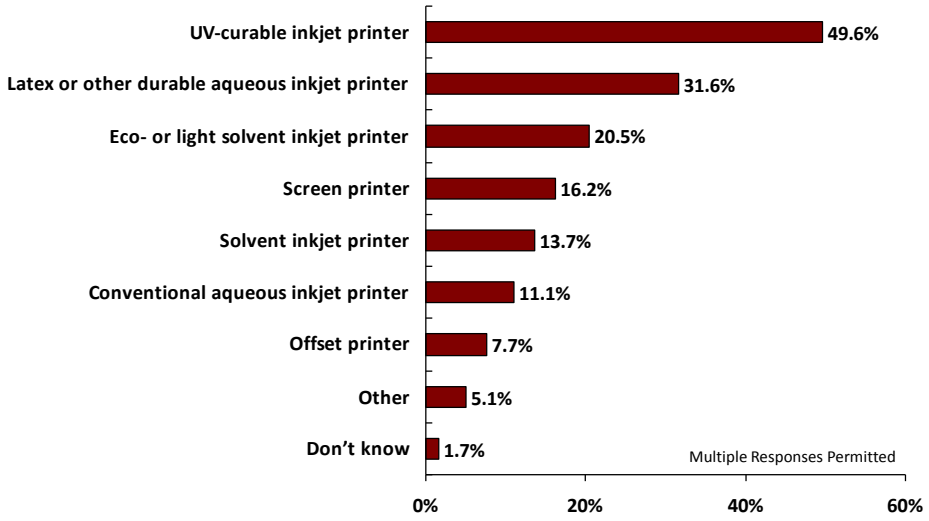
Figure 2: Top 12 Applications Regularly Produced on Digital Wide Format Printers



Source: 2014 ISA Wide Format Print & Media Mix

During our 2011 and 2012 research, it was evident that PSPs have started shifting their buying preference towards UV & Latex-based inkjet printers. As illustrated in the chart below, 50% of respondents indicate intent to purchase UV curable inkjet printers while 32% indicate intent to purchase latex or other durable inkjet printers. As noted earlier in this document, these early signs of intent have manifested themselves in the product placement actuals.

Figure 3: What type of wide format printer do you plan to invest in?

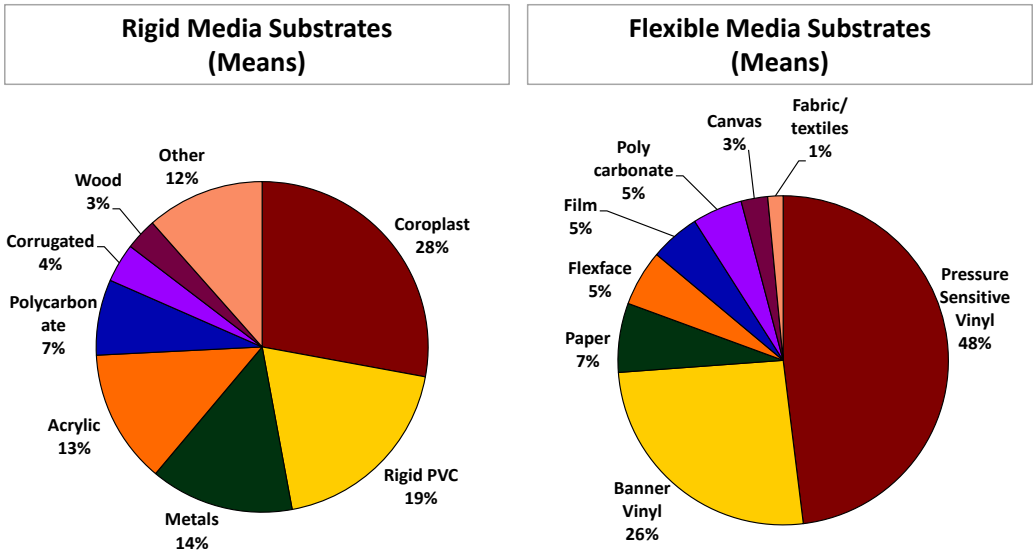


Source: Who Buys Wide Format? InfoTrends, 2011-2012

MARKET OPPORTUNITIES FOR UV CURABLE & LATEX INKJET

UV and LED UV product sales have seen a surge in growth as customers seek speed and versatility in the media types that they print upon. The “new normal” for media choices includes printing on a wide range of materials as well as customising the output for customer needs. In recent research conducted with ISA members, respondents indicated that about 85% of their output is done on flexible media, while 15% is done on rigid media. While traditional display applications, such as banners and indoor/outdoor signage, continue to be a mainstay for hybrid UV or latex printers, other factors play into the media mix. Thin film media, clear products, and metallic foils are well-suited for LED UV printing because its curing technology does not damage these types of heat-sensitive substrates. Latex is preferred for vehicle wraps, in large part because of its flexible nature, which allows the output to follow the contours of the objects it is applied to. Newer developments in ink have now made UV printing flexible, so this is no longer a factor.

Figure 4: Wide Format Users Cover a Broad Media Range



Source: 2014 ISA Wide Format Print & Media Mix

UV INKJET PRINTING TODAY

UV-curable inks react to a light source that emits UV radiation. Curing lamps or LED curing devices emit ultraviolet light within a carefully controlled bandwidth, usually just after the ink is applied to the media surface. Curing is a chemical reaction of the monomers and active binders in the ink. The end result is that the ink is fully dried or “cured” immediately.

It is generally possible to print faster using UV ink than with aqueous and solvent inks. This is particularly important for high-production applications. Nozzle clogging is also less frequent with UV inks because of

the way they are dried. Methods are also available to ensure that the thickness of the applied UV-cured ink can be controlled within tighter tolerances.

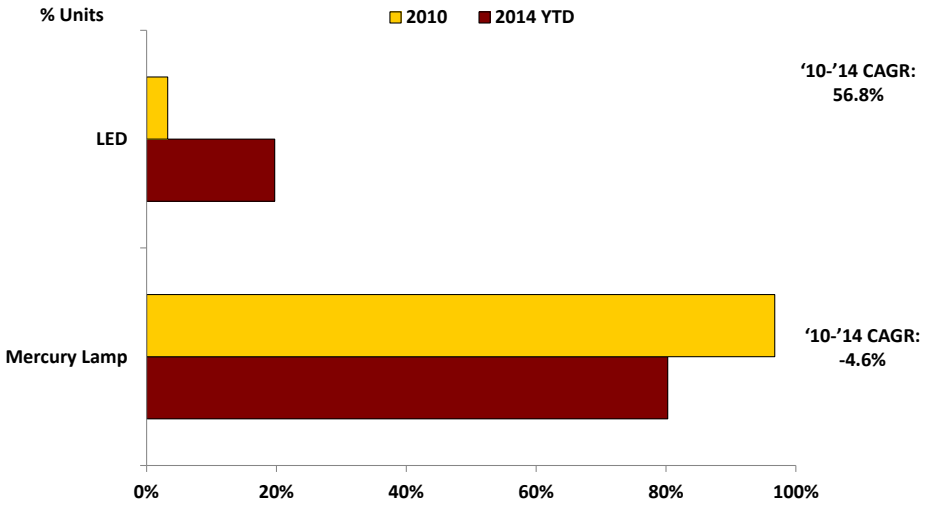
The introduction of a new generation of flexible UV inks, such as SuperFlex (co-developed by EFI™ and 3M), gives the needed flexibility for printing vehicle and fleet graphics. Additionally, UV curable inks are suitable for direct printing on rigid materials which will not require a self-adhesive layer.

This newer generation of UV curable ink offers low volatile organic compounds (VOCs) and the flexible properties required to greatly expand their applications.

Mercury Vapour vs. LED Curing

Traditional mercury vapour UV lamps produce light via an electric arc that passes through vaporised mercury. UV LEDs (light-emitting diodes) produce light by creating a potential across a solid-state semiconductor device. The two technologies have been used in wide format printers but recently UV LED-based devices have shown the most growth. Based on data from InfoTrends' wide format market tracking program, between 2010 and 2014 the use of LED curing technology has increased by a 57% compound annual growth rate (CAGR). The mercury UV based systems for the same time period have declined at about a 5% CAGR.

Figure 5: 2010-2014 (year to date) Worldwide LED versus Mercury Lamp Wide Format Printer Placements



Source: InfoTrends' Wide Format tracking program (Note: UV includes desktop devices)

Several key characteristics drive the growth in LED UV curing adoption, including a significant reduction in operational cost as well as a wider range of applications that can be produced.

Improved Energy Consumption with LED UV

A recent study published by the German research group FOGRA (Forschung im grafischen Gewerbe) compared a range of wide format printing systems using UV curing technologies and assessed the efficiency and cost effectiveness of mercury- and LED-based systems. The research concluded that an LED-based UV curing system (as tested on an EFI VUTEk® superwide format printer) showed 82% less energy consumption than a similar system using a mercury lamp. One factor contributing to this differential is that the mercury lamps must remain turned on at all times for production. This means that standby energy consumption is 77% higher than an LED-based system. With the LED-based system, the lamps are turned off while the device is in standby mode. FOGRA carried out a variety of evaluations that employed its "Image Quality Test Suite" for printing, with typical production and standby/print ready modes. The conditions were configured to emulate highest productivity as well as greatest quality, incorporating the relevant machine combinations for accurate results. According to FOGRA, these factors contribute to overall energy savings in operational cost of approximately € 20,000 annually in a typical production environment.

Additionally, based on a *Paint & Coating Industry* magazine article (Aug 2014), LED UV Curing has additional operational benefits, namely effective lifespan of the curing units. Where a typical mercury base unit has a usable life of 500-2,000 hours, LED units are typically rated for 10,000 to 20,000 hours. Moreover, mercury lamps degrade by about 50% over their lifespan, while LED units typically only suffer an estimated 5% degradation in UV production.

Benefits of LED UV for Heat-Sensitive Media

In addition to the role of energy consumption in overall cost, mercury vapor lamps create a lot of heat during the curing process, which makes it difficult to print on media that is heat-sensitive, such as thin film acetates, paper and cardboard, plastic, metal, and glass. This is not the case with LED UV curing, and that allows it to be used for printing on media that might be damaged or destroyed during the curing process. (Please refer to chart Comparing UV & Latex Attributes.)

Examples of LED UV Wide Format Printing Equipment

EFI was one of the first vendors to innovate UV printing systems using LED curing. EFI's LED curing product line includes EFI Wide Format and VUTEk models, a few of which are shown below (the full line includes VUTEk GS 2- and 3.2-meter hybrid printer models with and without 7 pL UltraDrop™ Technology, VUTEk GS 3.2- and 5-meter roll-to-roll printers, and a 1.6 metre EFI Wide Format printer)

Table 1: Selected EFI LED Wide Format Products and Key Specifications

Model	Productivity	Resolution / PCL	Width	Colors	Media	Comment
EFI VUTEk GS5500LXr Pro	260,1 m^2/h Draft 88,2 m^2/h HQ	1,000 dpi @ 7 PCL or 600 dpi @14 PCL	5 metres	8 + White (optional) CMYK, ly, lc, lm, W	Rolls Up to 5.18 m wide and 399 kg.	Multi-roll capability (up to three 1,52 m rolls), optional double-sided printing
EFI VUTEk GS3250LX Pro with UltraDrop Technology	222,9 m^2/h Draft 83,6 m^2/h HQ	1,000 dpi @ 7 PCL or 600 dpi @14 PCL	3.2 metres	8 CMYK, lc, lm, ly, lk, 2xW	Hybrid flat and roll-fed up to 5,08 cm thick; rolls up to 181,4 kg..	
EFI H1625 LED	42,5 m^2/h Draft 12,3 m^2/h HQ	1,200 x 600 dpi	1.6 metres	4 + White CMYK, lc, lm, 2xW	Roll & Flat 45,3 kg	Hybrid rigid and roll-fed up to 5,08 cm thick

Figure 6: EFI VUTEk GS5500LXr Pro LED Printer

Figure 7: EFI VUTEk GS3250LX Pro with UltraDrop Technology LED Printer

Figure 8: EFI H1625 LED Wide Format Printer

Source: EFI

LATEX PRINTING TODAY

Latex wide format printers use a resin-based ink with an inline heat process that fixes the inks onto the media. "Latex" is a general term for a water dispersed polymer ink. These are synthetic polymers (as opposed to the latex associated with the natural rubber made from trees). A more technically correct term for the ink would be resin or polymer ink, but the word latex has certain advantages from a marketing perspective. Latex inks do not have the strong smell associated with solvent. UV inks have their own distinct odour as well. Latex inks are low in volatile organic compound (VOC) content, which is definitely a big advantage for printers that are used in an office setting or a retail print shop.

Heat is required to evaporate the water content of the latex ink to make it adhere permanently to the surface of the substrate. Convection adds air movement and also concentrates the heat, in turn requiring less power to dry the ink. Today's latex printer technology is much improved in evaporating the water content of the ink, which directly favours higher print speed. Latex printers themselves have become more stable and user-friendly and consume less energy to operate over time. Latex is considered a green printing technology because of its low VOC content and quick dry-time.

Latex Inkjet Benefits

One important advantage of latex is that it is quick drying. In the case of printing on vinyl based laminates for applications like vehicle wraps, manufacturers typically recommend a 24-hour drying time when using solvent-based wide format printers. This gives time for the solvent to "gas out" before the vehicle wrap is laminated and applied to the vehicle. Latex wide format printers allow the user to react faster to client demand for shorter turn-around time. Based on InfoTrends research, 73% of print buyers want their print delivered within 24 hours, while 44% want their prints within 48 hours.

Indoor and outdoor pigment permanency for latex inks depend on location as well as exposure to sun and the elements. Indoor images can last between 5 and 200 years without lamination, while outdoor images can exist up to 3 years without lamination and 5 years with. Like other print methods, however, lamination is required for full protection from the sun's rays. Latex units give sign companies a great deal of flexibility in printing a wide range of applications using a single inkjet technology.

Some vendors offer latex inks in special colours such as orange, green, and white. These colours can be used for special effects and can also be useful for labeling and window display applications.

Latex printers can print not only polyvinyl chloride (PVC), PVC-free, and self-adhesive vinyl, but also a wide range of media, including papers (uncoated and coated); films; canvas; wall coverings; backlit media; and even fabric media for temporary use, such as exhibits and event graphics.

Examples of Latex Wide Format Printing Equipment

Though there are several products available in the market today that are using Latex inks, we have elected HP to illustrate the range of products available. HP is the dominant player and commands the lion's share of units in the market. Nevertheless, Mimaki and Ricoh also offer latex wide format printers that use a Ricoh Piezo print head; these units will ultimately add to the market diversity as Latex printing grows. The table below lists the third generation of HP's Latex printers.

Table 2: Selected HP Latex Wide Format Products and Key Specifications

Model	Productivity	Resolution/PCL	Width	Colors	Media	Comment
HP3000	181,1 m^2/h Draft 77,1 m^2/h HQ	12 picolitre drop size Up to 1,200 x 1,200 dpi	3.2 m	6 colours + optimiser CMYK, lc, lm	Roll 1 x 158,7 kg 2 x 70,3 kg.	Double-sided Printing
HP360	91 m^2/h Draft 17 m^2/h HQ	12 picolitre drop size Up to 1,200 x 1,200 dpi	1.6 m	6 colours + optimiser CMYK, lc, lm	Roll 41,7 kg.	Double-sided printing; take up reel supplied
HP 330	49,9 m^2/h Draft 13 m^2/h HQ	12 picolitre drop size Up to 1,200 x 1,200 dpi	1.6 m	6 colours + optimiser CMYK, lc, lm	Roll 41,7 kg.	Take up reel supplied
HP 310	48 m^2/h Draft 11,9 m^2/h HQ	12 picolitre drop size Up to 1,200 x 1,200 dpi	1.3 m	6 colours + optimiser CMYK, lc, lm	Roll 24,9 kg	Take up reel optional

Figure 9: HP 3000 Latex Printer (shown printing two 1,54 m Banners)

Figure 10: HP Latex 360 Printer

HP's Latex 300 Series devices are available in three different configurations with widths from 1,30 m to 1,62 m. All of the devices use roll-type media. The model 360 is the highest speed model and can print on fabric media for tension displays.

COMPARING UV CURABLE & LATEX PRINTING

The table below lists some types of materials suitable for printing with both UV Curing and Latex inks. The range of materials noted earlier in their document is wide; however, the methods for printing or applying the final output to the surface vary based on the printing technology. In certain cases a pre-coat is needed; in some, a self-adhesive laminate is used to mount the graphic to the rigid substrate; and yet in other cases, direct to rigid substrate printing is possible.

Table 3: UV Curable and Latex Material Matrix

Category	Material Type	UV Curing Ink	Latex Ink
	Styrene	Direct Print	Requires Mounting
Rigid	Coroplast	Direct Print	Requires Mounting
	Rigid PVC	Direct Print	Requires Mounting
	Metals	Direct Print	Requires Mounting
	Glass	Direct Print w/Precoat	Requires Mounting
	Digital Acrylic	Direct Print	Requires Mounting
	Polycarbonate	Direct Print	Requires Mounting
	Corrugated	Direct Print	Requires Mounting
	Wood	Direct Print	Requires Mounting
Flexible	Pressure Sensitive Vinyl	Direct Print	Direct Print
	Banner Vinyl	Direct Print	Direct Print
	Paper	Direct Print	Direct Print
	Flexface	Direct Print	Direct Print
	Film	Direct Print	Direct Print
	Polycarbonate	Direct Print	Direct Print
	Canvas	Direct Print	Direct Print
	Fabric/textiles	Direct Print	Direct Print

USER PROFILES

AlphaGraphics: UV Printing on Innovative Materials

AlphaGraphics (Suwanee, GA) has installed an EFI H1625 LED wide format printer. The production printer model is a four-colour hybrid roll/flatbed device that comes standard with white ink and has EFI's cool cure LED inkjet technology. The EFI H1625 LED printer helps companies develop more creative business opportunities by printing at high quality on a broader range of substrates compared to traditional UV or latex inkjet printers.

Figure 11: The Akins, Owners of AlphaGraphics (Suwanee, GA)

On a recent visit to AlphaGraphics, Steve Urmano (Director of Wide Format at InfoTrends) and David Lindsay (Public Relations Manager at EFI) met with Alan Akins (Owner and President at AlphaGraphics) to discuss how cool curing has helped him in working with a wide range of substrates to pull in new customers. Although not all AlphaGraphics sites are active in the sign graphics marketplace, Alan explained that his roots were in the sign-making industry for over ten years.

Recently, some film and video companies have been setting up shop in Atlanta. Popular series (such as the Walking Dead, Vampire Diaries, and even the Hunger Games) are bringing work to companies like AlphaGraphics, which is based in Suwannee (a northern suburb of Atlanta). When asked about the regional scope of his business, Akins stated that he has been able to do work for a medical firm as far away as Baltimore.

The AlphaGraphics EFI H1625 operator was printing acrylic Christmas ornaments using white ink and a variety of colour schemes during our visit. One surprising material was newsprint, which was set to be used as a movie prop where the thin paper was imaged on without any burning or yellowing effect, giving the desired print quality. Other applications include movie backdrops and exhibit graphics.

Akins states, "We have been able to add wholesale work for other AlphaGraphics centers in Atlanta to our mix, and we have been really pleased with the ability to print backlit materials and do direct printing on black boards. This is something we couldn't do before. We've experimented with just about everything,

including black neoprene and metal side pieces for equipment such as x-ray machines. Another new opportunity is the ability to print on 9 kg roll paper. This helps us compete with the latex printers out there, and we can do a lot of things that they can't because this printer is extremely versatile."

Some of the printed materials can be classified as ad speciality, while others are industrial print (i.e., the operator is printing on electronic panels and associated cabinetry). The printer's cool cure LED technology handles roll or flatbed media that cannot withstand the heat of other curing or drying processes. Additionally, the instant on/off LED lamps provide more consistent curing/imaging with fewer wasted prints.

Akins and his team evaluated a number of different offerings before making a final decision. "One of the things that moved us toward EFI is the quality of the white ink," Akins explained. "It is so much better than everyone else's—a true white without the blue tones you find in other wide format printers, and it's a much denser ink."

"We've been in the printing business since 1990, and joined the AlphaGraphics network about three years ago," Akins concluded. "Since that time, we have tripled our business to $1.2 million in annual revenues with 11 employees. Our new EFI Wide Format printer will be a key factor in helping us continue that growth!"

Portland Vital Signs: Pioneering Choices for Clients

Portland Vital Signs (PVS) in Portland Oregon has in-house manufacturing capabilities for large-format digital and screen printing, and offers services for vinyl graphics, dye-cutting, finishing, and fulfillment. It has 28 full-time employees and a 2 787 square metres facility located in the northwest corner of Portland. With two EFI VUTEk printers with LED UV technology, PVS can manufacture signs and displays for retail stores nationwide. According to General Manager Wes Shinn, "The new LED technology with its low heat allows us to print on a variety of thin materials not previously available to us. Its low power consumption has given us a distinct advantage in the market place. We are always striving to find ways to be more environmentally sensitive and this new technology allows us to do just that."

Founded in 1991 with $500 in startup capital, the company's first investments were a vinyl plotter and the rent on a 3,6 m by 3,6 m back room to put it in. In 1994, PVS rented a 325 square metres warehouse and started a screen-print department, followed by the digital printing department in 2001. Shinn notes, "We have been investing in the latest and greatest digital equipment ever since. We have positioned ourselves as one of Oregon's premier large format printing houses while retaining our roots in both plotter-cut vinyl and screen-printing."

With these capabilities, PVS has done extremely well with a range of customers, including many in the outdoor/sportswear market.

PVS is focused on in-store retail presentations. Its primary clients are high-end retailers who concentrate on elevated product stories. Shinn adds, “We use our digital printing, 3D fabrication, and intimate knowledge of materials to bring this to life. For the future we intend to focus on expanding our client base with new and innovative technologies and processes to support premium retailers.”

INFOTRENDS’ OPINION

The wide format digital printing market is large, with some key new areas of growth that build on the ability to provide high quality and customised output at affordable prices. One factor driving the adoption of these products is their support for printing on a range of rigid and flexible surfaces, which helps expand opportunities beyond signs and banners and opens up other applications as well. Ongoing developments with UV and latex digital inks allow printing on a broad range of media, not just the porous substrates typically used with aqueous digital inks. This presents users with new levels of quality, efficiency, cost effectiveness, and perhaps most importantly, the ability to leverage digital printing’s ability to mass customise and help the end customer meet their market needs.

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