

Direct Digital Printing Technology: Beyond the office! Where will it go next?

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Abstract

Ink jet and laser printer have transformed the way people generate hard copy output in the home and office. More than three hundred million of these printing devices have been sold and another three hundred million or more will be sold in the next three years alone. With the billions of dollars now invested in these "digital patterning technologies", where will they be applied next? This paper will explore some of the advantages that these "digital patterning technologies" can offer in combination with advancements in computing power and the Internet. It will compare user needs with these new capabilities. It will explore some of the reasons manufacturers who use traditional analog patterning technologies are scrambling to try to figure out how to join the digital revolution.

Introduction

"Digital Patterning"? Why not just digital printing? Printing connotes producing text, designs or images on a substrate like offset printing, embossing wallcovering or producing photographic prints. Patterning is much more.

With the development of ink jet printing technologies small amounts of fluids may be accurately metered and placed where they are needed. The non-impact, non-contact nature of ink jet opens many new possibilities. Very small amounts of fluids, for example biochemical test materials, are being accurately jetted into containers for rapid microchemical testing. Molten solder is being applied to printed wiring boards by pulsing an ink jet print head containing solder. Flat panel displays are being fabricated from color filters produced by ink jet patterning the colored filter dyes. Edible cakes are being decorated with customized pictorial images using food dyes in ink jet inks in your local grocery store. The applications appear endless.

Evolution of Digital Printing

Both laser and ink jet printing have developed into significant tools for office document production primarily as a result of the development and proliferation of the personal computer. As computer power and speed have increased and prices have fallen hundreds of millions of printers have been placed throughout the world. As people marveled at the capabilities of these devices they also began to look at ways to use these flexible "print on demand technologies" to replace cumbersome inflexible analog technologies. Silk printers are looking at ink jet as an alternative to flat bed screen printing of ties and scarves, tile manufacturers are looking for ways to produce decorated tiles using ink jet. In general where short runs, changing designs or variable information is required or desired digital printing can be an enabling alternative to analog printing.

So What is Next After the Office?

Office printing and copying represents only about 3% of all printing! So 97% of all that is printed is available to digital printing technologies. Will they all convert? Can digital printing achieve the speed and cost of long run analog printing? The answer is of course not! Amortizing the cost of a press, set up, printing plates, ink and paper over the very long runs produced today provides a compelling financial argument against digital printing. The cost of manufacture of digital inks and toners alone can exceed the entire cost of production in long press runs using analog technology. Notice I said ***cost*** not ***price***!

Digital printing will grow at the expense of analog printing, not by replacing it in kind but rather by enabling alternative methods of distribution of the information to the user. "Distribute and then Print" verses "Print and then Distribute" provides a highly desirable alternative since storing and shipping electronic signals is a lot more cost effective than storing and shipping printed paper! The costs associated with the entire process of generating the printed material the customer wants and getting that material to him provides the driver, not the cost or speed of printing.

As more and more customization of information and targeted advertising becomes the norm the less favorable the overall economics of the analog printing process and "Print and then Distribute" business model will become.

So one of the next major applications of digital printing will be print-on-demand, where the customer wants it when he wants it.

How fast does digital printing need to be to satisfy this need? How fast can you read?

Wide and Super Wide Format Printing

Following the development of short run Electrophotographic digital presses like those from Xeikon and Indigo and the implementation if ink jet in industrial marking and overprinting using many years now, what new applications have proven attractive more recently?

Since the development of the first wide format color ink jet printer introduced in 1992 by ENCAD and popularized by Lasermaster as an integrated system solution for graphics, nearly 1 million wide format color ink jet printers are in place[1]. I. T. Strategies[2] predicts that the wide format digital printing market will reach 21 billion dollars annually in 2004! This forecast assumes that the productivity of ink jet printers (95% of the installed base) will increase 10 fold so that a service provider could produce 50-100 posters/day instead of the current 5-15. This is very realistic given the impressive improvements that have been made in both quality and productivity since the early days of wide format ink jet only a few short years ago. The introduction of numerous super wide format printers by Nur, Vutek and Scitex have demonstrated that quality, durability and speed can be achieved at a very affordable production cost per square foot. The billboard industry has been transformed initially by the air brush printers of LAC and Vutek and now by the ink jet printer companies mentioned above. This has all taken place in less than 10 years!

Recently a new digital technology has been introduced adding another dimension to the digital product offerings for super wide format color printing. WireJet®[3] has been developed to produce super wide format prints using paints, inks or other materials currently used in analog printing. It produces marks by using streams of air to blow droplets of "paint" from a wire that has been dipped into a can containing the paint. For the first time digital printing can be performed using very viscous inks or paints which have not been specifically designed for "jetting". In the current product the resolution produced is between ink jet and air brush technologies.

Printing Patterns on Textiles

Textile printing is a huge business. More than 30 billion square meters of fabric are printed each year. This is an area about the size of the state of Maryland! About half is pigment printing and the other half dye printing. Dye printing is principally made up of reactive dyes for fabrics made of materials like cotton, acid dyes for silks and wool, disperse dyes for polyester. Pigment printing is used when cost is more important than color intensity and "hand" or when light fastness is required. Textile products generally require high color coverage and large amounts of a single print. This proves difficult for digital printing in that it hits two of its weaknesses, speed and reliability in a production environment.

Notwithstanding these challenges, ink jet ink and printer manufacturers have focused a lot of their energy on this emerging market. Companies like Stork, Mimaki, Konica, Aprion, Encad and Colorspan have all seen the potential for the conversion of analog textile printing to ink jet digital printing. DuPont, Avecia and Ciba have devoted significant research efforts aimed at developing inks suitable for textile applications. It has come slow so far but with continued persistence, first proofing and strike-offs then short run production will be possible for some textile applications.

Since the textile printing business is highly fragmented, it is often referred to as a large "cottage industry". Textile printing will require different solutions for different fragments of the market. Some of the first to embrace this analog to digital conversion will be designers, accessory makers, auto interior producers and traditional textile printers who need less expensive strike-offs. At least four different ink chemistries are required. Fabrics as thin as voiles and as thick as wool coating must be printed. High color accuracy, a very large color gamut and in some instances high resolution are required. Fabric width requirements as wide as 12 feet and minimum samples as large as 20 meters may be required for sheeting. These pose many challenges for the system and ink providers.

Printing of Photographs

Perhaps one of the single most disruptive events in this digital era is the conversion from chemical to digital photo processing. It is fully underway and proceeding at blazing speed. With many millions of photo capable ink jet printers in the home and the accelerating growth of digital cameras, over the next 5 years digital alternatives will cause a significant reduction in the business of silver halide film and conventional photo finishing. The announcement that Hewlett Packard and Eastman Kodak have formed a joint venture to develop and market micro labs utilizing ink jet printing instead of silver halide for photo finishing is indicative of the kind of activity well underway in the industry. Certainly other similar activities are underway among other providers of photo processing equipment and ink jet printers. This is a huge transformation within a huge industry.

For some time now digital dye sublimation printers provided by Eastman Kodak, Fuji Film and others have enabled consumers to use Kiosks at camera stores and other "1 hour photo processing" to produce digital dye sublimation enlargements. Over time this too will be converted to the more permanent and lower cost ink jet technologies.

First professional photographers then consumers will convert from film to digital cameras. The increasing capabilities becoming available in personal computers, the internet and ink jet printers along with the increasing ease of manipulate photos will encourage more and more people to take and print more photos. This is creating a whole new market for ink jet printers and photo consumables.

The Future

At Drupa (the world's largest printing trade show) this year in the Heidelberg exhibit (the world's largest printing press manufacturer) a demonstration was made utilizing an array of ink jet print heads with more than 7000 ink jet nozzles. They printed with UV curable color ink jet inks to provide variable images using spot color at high resolution on a monochrome digital press at 200 pages per minute. This print head was provided to Heidelberg by Spectra, a print head development company. It suggests the feasibility of high speed printing utilizing ink jet with demonstrated reliability. Xaar (a print head technology company) working with Kyocera (a print head fabricator company), Agfa (a printer development company) and DuPont (the world's leading ink jet ink manufacturer) have announced an alliance to develop a page wide array digital printing press for the graphic arts market. As these efforts combined with the photo finishing and textile printing efforts discussed above come to fruition, the world of printing will be transformed to enable on demand and variable information printing for many markets. The future is full of opportunities and many different companies will work to develop different approaches to enable the analog to digital conversion.

Conclusions

Where will direct digital printing go beyond the office?

Very clearly it is being applied to short run and variable information printing. Wide format printing for engineering and computer aided design has nearly converted completely to digital technologies. Wide format and super wide format graphics applications are growing rapidly. Direct digital technology is being applied to everything from outdoor signage to fine art reproduction. Textile printing applications are just now emerging but will become a huge application for direct digital printing over the next 5-10 years. Chemical photo finishing will convert to direct digital ink jet photo finishing. It will occur both by in kind replacement in commercial photo finishing and by movement down to the consumer in the "Distribute and then Print" model to their desk top ink jet printer. All in all the future looks great for direct digital printing. The challenge is to capitalize on this disruptive technology as it replaces much of analog printing, as we know it today. "Digital patterning technologies" have the advantage as we move into the 21st century

References

1. Lyra Research's Hard Copy Supplies Advisory Service, Analysis 10/99
2. I T Strategies, Digital Queue, Vol. II, Issue 26, June 30,2000.
3. See http:\\www.pixation.com.

Biography

Dr. Work is currently New Business Development Manager, DuPont *i*Technologies. He received a BS in Chemistry from Auburn University in 1966, Ph.D. in Chemistry, University of New Orleans in 1971 and Post-Doctoral Research Fellowship, University of Hawaii in 1972. Since joining DuPont, he held positions in research, research management, business management, product development management and market development management. Dr. Work holds 12 US patents, has published 30 technical papers and is a frequent speaker at conferences worldwide on the subject of ink jet inks and ink jet printing in general.