Xeikon Digital Printing - Applications and Imaging Technology

Dirk Broddin, Danny Smolders, Herman Van de Straete, Eric Soulliaert, and Frank Deschuytere, Xeikon Productline, Punch Graphix, Lier, Belgium

Historical Perspective and Key Markets

At the 10th Conference of Non-Impact Technologies in New Orleans in 1994, Xeikon founder Lucien De Schamphelaere unveiled and discussed the specifications and performance of the DCP1.[1] Both Indigo and Xeikon were at that time simultaneously pioneering the concept of toner based fully digital Short Run Colour Printing. The proceedings of that conference contained the Xeikon contributed paper as a color insert printed on the new press.

The presses initially had a gap to close in terms of stability of press-operation and predictability and consistency of the image quality in long uninterrupted runs. It has taken several years of product improvement on one hand and the development of the market through pioneering applications on the other hand to allow digital printing to grow to significant proportions. Time has told which applications benefit most directly from the features that only the digital presses could offer. The following paragraphs briefly describe the key markets for digital color printing.[2]

Graphic Arts and Publishing

Digital printing is revolutionizing the graphic arts and publishing industries. It offers all the tools for outstanding dynamic print communications that are simply not possible with traditional offset printing. Digitization is a blessing in an ever more globalizing world; print jobs can be sent electronically and printed locally, avoiding costly transportation and import duties. Digital printing allows for variable data printing and therefore truly personalized communication for longer-lasting, more profitable customer relationships. By its nature, digital printing is ideally suited for just-in-time production of the exact quantities required, minimizing waste and warehousing costs. And because it makes shorter runs economical, you can ensure your documents stay up to date. Accurate and current information help you build customer confidence and loyalty. What is more, shorter turnarounds make for faster time to market, providing you an extra competitive edge.

Direct Mail

There is proof to spare: database driven personalised communications dramatically improve response rates, and therefore increase sales and return on marketing expenditure. Personalised mailing is no longer about adding a name to a static message in black and white. It is about adding full-colour, using database information to construct a customised message, with variable text as well as images. A fully personalised direct mailing may be more expensive to produce. But with response rates being multiplied, your mailing will prove to be much more effective in terms of cost per response rate, which is exactly what matters at the end of the day.

Print on Demand

Put simply: print on demand or POD provides customers what they want, when and where they want it - i.e. printed documents in the appropriate form and optimal quantities, within the shortest possible timeframe, at the end point of use. Digital printing means no plates, no films, minimal setup and changeover times and therefore shorter lead times than possible with traditional printing. Being cost-effective for shorter runs as well, digital printing is ideally suited for on-demand printing of documents that are frequently updated and produced in smaller quantities such as catalogues, restaurant menus, manuals, school books, etc. Thanks to its unique capability to print variable data, digital printing not only allows versioning or colour customization but also full-blown personalization. Car owners no longer have to read about the options they do not have. Instead, their car manual can be compiled after they have ordered their car to include only those options they have chosen, and with colour illustrations matching the actual colour of their new buy. The result is less paper wastage, elimination of overstock and better customer service.

Transactional Printing

Billing, bank, loyalty card or portfolio statements, these are perfect examples of variable data documents. And the advantages of digital printing for the production of these high-volume variable data prints are sufficiently well known and fully implemented. That is, the advantages of black and white digital printing. At best, a tinge of colour is added by using pre-printed forms carrying the company logo. Still, even newspapers have colour nowadays and colour has well found its way to standard office documents such as presentations, reports and memo's. Colour is simply everywhere, raising expectations that most documents should be in colour. But for colour to really make it in the highly cost-driven market of transactional printing, it will have to earn its keep. So far, companies have been sending their customers statements, promotional material, newsletters and other marketing information via separate mailings. In today's hectic world with its almost proverbial information overflow, the one document that will certainly get looked at is the (billing) statement. Digital colour printing, and especially variable colour printing, can turn a plain billing statement into a powerful, value-adding marketing communications tool.

Industrial Printing: Packaging and Label Printing

In today's ever-more digitized world, the package has become an essential part of a product's appeal. Packaging sells! There is a definite market pull for visually attractive and distinctive, even personalized packaging. At the same time, product life cycles are becoming ever shorter, target audiences increasingly fragmented and consumers more demanding. Smaller runs, customized

versions and shorter lead times at little or no extra cost are the challenges to overcome, without jeopardizing profitability.

Xeikon 5000 and Beyond: A Winning Concept on a Solid Basis

Stability, consistency, up-time and competitive consumable pricing, together with the availability of a versatile high productivity digital front end are the key factors enabling costumers using digital presses to support high added value applications at an attractive cost per page. At Drupa 2004, Xeikon presented the Xeikon 5000 and the X-800. The Xeikon 5000 is a complete design from scratch of the same proven concept of the original DCP-1, leaving hardly any part unchanged. The Xeikon 5000 is equipped with the completely new, high power, full variable data enabled X-800 front end solution.

The current presentation deals with the latest step that was still missing to prepare the press concept for anticipated boosts in productivity throughout the remaining of this decade: a new generation image exposure system based on high bandwidth multiple bit per spot 1200 dpi imaging. It is provided with new generation electronics, powerful enough to enable running in the m/s range at the typical 500+ mm imaging width.

LED Based Image Exposure for Electrophotography: Speed, Resolution and Uniformity

The 600 dpi multiple bit per pixel LED exposure system of the DCP presses has been amongst the key components that differentiate the image quality from that of competitor systems. The grayscale capability of the drivers enabling multiple exposure intensity levels for each addressable pixel is used with special target multilevel halftone screens to result in screened separations comparable to those used in conventional offset as illustrated in Fig. 1.

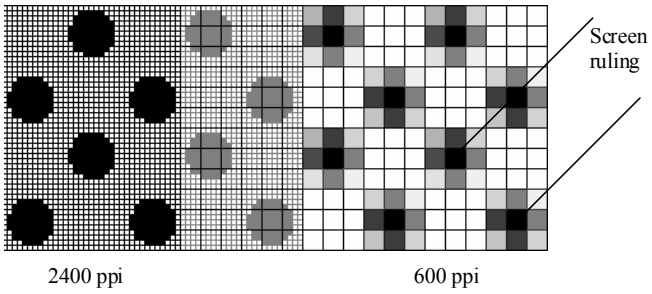

Figure 1. Simplified scheme for multilevel halftone screens

A discussion of the "equivalence" of 600 dpi with 4bit per pixel (15 exposure levels available) to a binary 2400 dpi system was presented by Tavernier and coworkers in their contribution to NIP11.[3] For the new 1200dpi LED based system full speed data buffering is performed at 2 bit per spot (3 exposure levels available).

A distinctive advantage of using a set of full page line arrays in a tandem architecture printer compared to laser scanning based solutions is the convenience to preload line data for each of the line buffers while synchronizing the actual firing of the exposure pulses with the positional information of the paper-web (or intermediate belt) as described in US5499093: "Electrostatographic single-pass multiple station printer with register control".[4]

Manufacturing specifications for array length and alignment of the +25K light-sources on a theoretical line are discussed below. The near ideal line sources can then be adjusted in the engine and combined with precision encoder triggering to guarantee inter-colour registration at adjustable web speed without any issues of scan-line bow or magnification distortions. Such issues are well known with laser polygon scanning systems comprising optical assemblies with moving parts rotating at high speeds.

Print architectures relying on high end laser polygon systems[5] have been avoiding the tandem architecture, preferring a single exposure system for the images to be superimposed. The main issue to be addressed for the line array systems is uniformity. Basic concepts for uniformity had been developed around 1990 for the DCP1.

Temperature Control and LED Efficiency

Sophisticated cooling is essential to achieve stable control of the diode emission strength, maximizing lateral heat exchange to flatten out image dependent heating effects as described in US5751327: "Printer including temperature controlled LED recording heads".[6] Therefore the new 1200 dpi design has an improved water based cooling system, dissipation balancing between LEDs and drivers, while any residual temperature effect across the width of the array are sensed for compensation purposes.

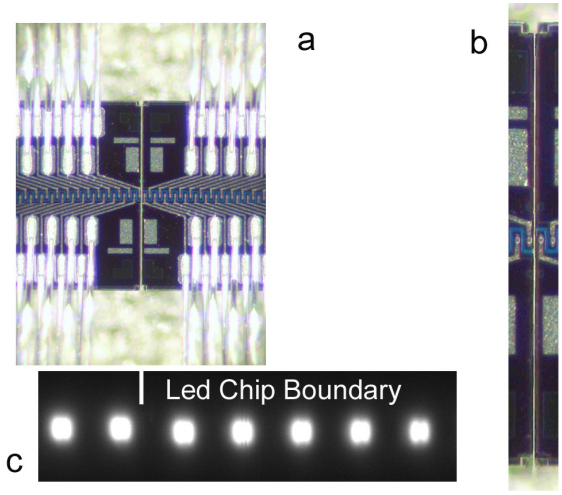

Figure 2. a) Abutted dies b) Detail of gap c)1-0-1- pixel image

Uniformity Compensation

Uniformity compensation at the pixel level is performed through duty cycle modulation. An initial table with duty cycle data (typically 9 bit) is based on the data from an optical measurement system that collects the emitted intensity at the image position. Such system does not necessarily take into account the effect of misalignment and defocused imaging that can result from

imperfections in the SELFOC fiber alignment. A proprietary multi-step approach has been proposed based on secondary corrections to the table that derive from actual printed results as described in "US5640190: Non-impact printer with evenness control".[7]

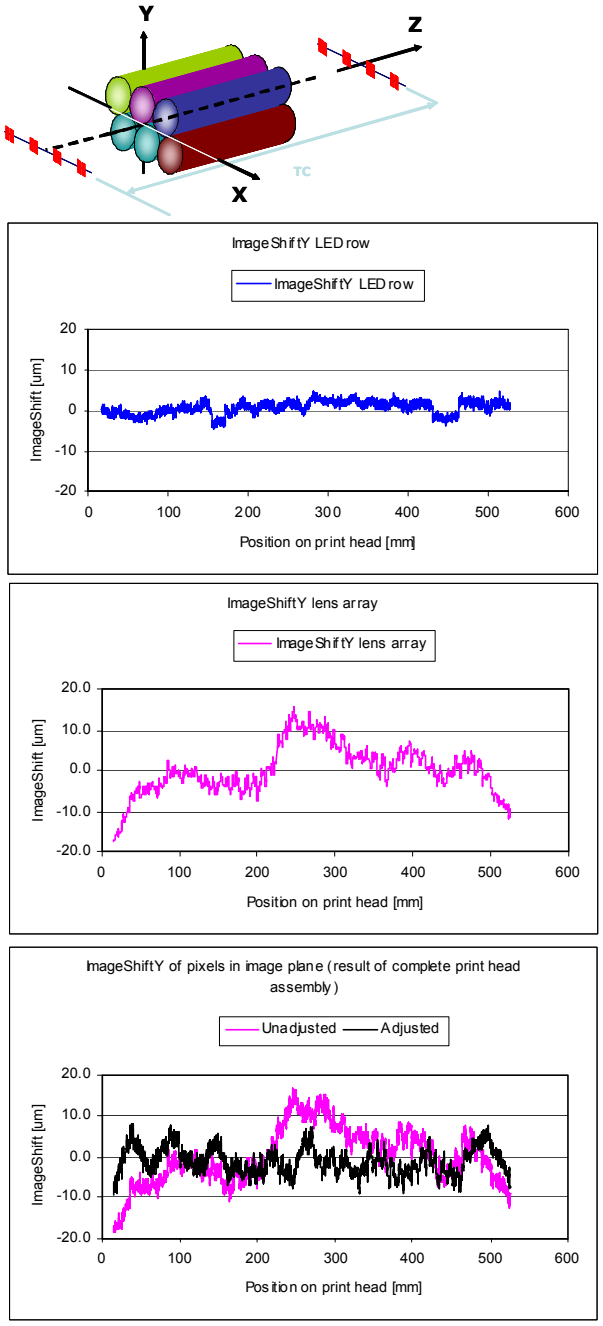

Figure 3. torsion control to minimize delta Y errors

Positional Accuracy of the Light Sources

Reference 1 states a geometrical accuracy of 5 micron. The current design and implementation achieve better than 2 microns for the position along the LED rows requiring sub-micron vision accuracy and positioning algorithms. The deposition exercise in the LED-die mounting can be compared to have a crane lower 10 meter blocks of concrete with a positional accuracy of 1 millimeter with 2 to 3 mm gaps in between.

Positional accuracy in the Z-direction is based on height control after precision machining of substrate as a mounted assembly and controlling thermal expansion effects by appropriate selection of thermal coefficients of expansion.

Positional Accuracy of the Pixel Images on the OPC

The new mechanical design uses a sophisticated mounting system for the flimsy >500 mm SELFOC array that allows implementing controlled distortion to minimize slowly varying effects of pixel image misalignment in the Y direction. Moreover, any residual delta Y effect can furthermore be compensated by offsetting the drive pulse in a window of +/- 10 microns.

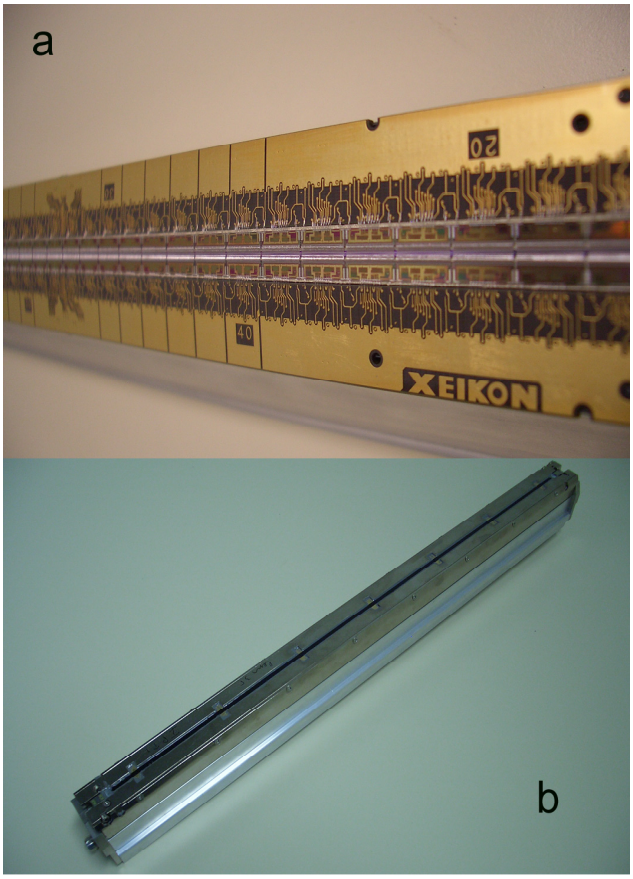

Figure 4. Photographs of prototype 520 mm array a) without lens system b) with Selfoc lens mounted

Print Test

Evidence is accumulating that the higher resolution imaging system not only brings better resolution but also improved reproduction of halftone images, resulting in flat fields of uniform grays with reduced image noise. The halftone screens have better definition and can have a higher contrast. Compared to 600dpi printing, image noise was found to decrease already with the use of

standard 8 micron toner. Figure 5 shows a micrograph with a rounded 6 micron toner where the quality increase is even clearer.

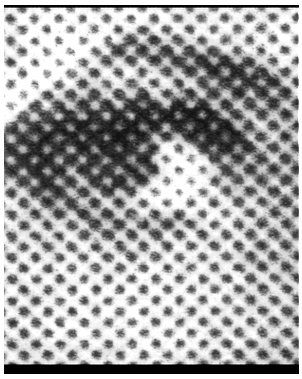

Figure 5. Micrograph of printed image (screen ruling 212 lpi)

References

1. Lucien A. De Schamphelaere and the Xeikon Team " Digital Cor Presses Applications and Technologies" IS&T 10th Conf. Non-Impact Techn., New Orleans 1994, pp 516-527
2. Jan Van Daele, "Toner based Digital Printing Technologies for Commercial, Transactional and Industrial Printing", IS&T's NIP16; 2000 International Conferences on Digital Printing Technologies; Vancouver, B.C. Canada; pp 422-424
3. S. M. F. Tavernier, L. Alaerts and H. Debie, "Offset Quality Short Run Colour Printing Using a Dry 4-Colour Bi-Component Electrophotographic Process" , IS&T's NIP11; 1995 International Congress on Advances in Non-impact Technologies; Hilton Head, South Carolina; pp 113-117
4. R. Aerens, et al.; US5499093: "Electrostatographic single-pass multiple station printer with register control", filed 1994
5. Haim Livne and Michael Plotkin, "High Speed Laser Scanning Unit Using 12-Beam Laser Diode Array and Image Tracking System (ITT) for High Quality Color Printing", IS&T's NIP19: International Conference on Digital Printing Technologies, New Orleans 2003; p. 472-475
6. Etienne Marie De Cock, Lucien De Schamphelaere, Grobben Amede, and Jakob Alfons, US5751327: "Printer including temperature controlled LED recording heads" filed 1994
7. Erik Bollansee, Lieven De Clercq, Lucien Schamphelaere, and Koen Van Hulle, "US5640190: Non-impact printer with evenness control" filed 1994

Author Biography

Dirk Broddin holds a senior research position in the Xeikon team, the Digital Printing Technologies branch of Punch Graphix in LIER, Belgium. He leads Marking Processes and Technology Development teams.

Dirk received his PhD in Physics from the University of Antwerp (Belgium) and began his technical career in electrophotography in 1990 at Agfa where he worked on Imaging Science, Marking Processes and Halftoning Technology. He joined the Xeikon R&D in 1998. He holds over 20 patents worldwide.