

High Speed Digital Photofinishing for the Internet Era

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Abstract

The photographic industry is in an inexorable transition to digital technology – driven by the widespread use of digital photography and the Internet. The market now needs high performance, cost effective digital photofinishing alternatives to existing conventional technology. The newly developed Indigo Photo-e-Print printers offer extremely high quality and high speed, combined with a low cost per print, to photofinishing establishments. The Photo-e-Print range includes products for retail and professional photographic labs, as well as centralized wholesale photofinishing operations. This article describes the Photo-e-Print technology and its unique benefits.

Introduction

Ever since Henry Fox Talbot suggested in 1852 that gauze could be used to break up pictures into dots, photography has solved problems for the printing industry. Two years later, photography began to transform the production of wood engraved illustrations for magazines and newspapers. Photo-engraving, powderless etching and color separation all had their roots in photography.

Now it is printing's turn to solve the biggest problem facing the photographic industry: how to mass-produce digital photos.

The Digital Photofinishing Revolution

One important lesson we learn from the past is that whatever *can* become digital *will* become digital. Photofinishing is no exception.

There are strong driving forces, which trigger the transition of photofinishing to digital:

- Accelerated growth of digital camera adoption.
- Increasing popularity of Internet based photo sharing communities, which increase the motivation of either capturing the photos digitally or scanning (digitizing) analog films.
- Growth of broadband communications infrastructure and performance, which will enable the rapid transfer of large digital files over the Internet.
- Advanced digital printing solutions, which provide high speed and quality with a low cost per print.

- Higher revenue and profit opportunities for photofinishers who embrace digital technology, from new added value services they can offer their customers.

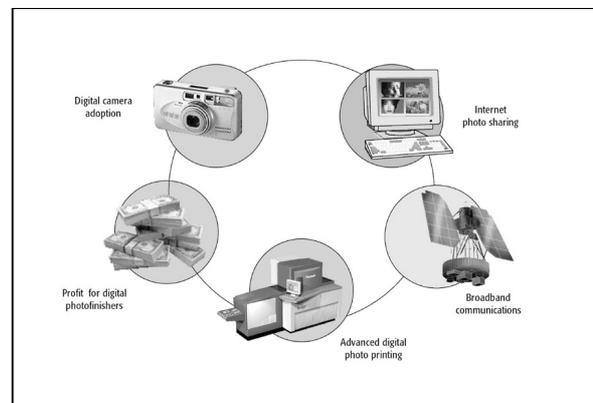


Figure 1. Driving Forces of Transition to Digital

Once customers demand digital images, the fulfillment or printing - of these images will become digital too.

Indigo recently introduced an entirely new concept in digital photofinishing: the Photo-e-Print family of printers. The prints produced by these printers have a quality which matches Silver photographic (AgX) prints and even surpasses some of their quality and durability attributes.

The product line introduced by Indigo for digital photofinishing includes:

- The Photo-e-Print ProLab - operates at a process speed of 120 feet per minute and produces cut sheet prints in various cut lengths (up to 18") at 680 prints per hour using the maximum size of (12" x 18"). The ProLab is targeted at professional labs for printing portraits and for other professional applications.
- The Photo-e-Print MetroLab - operates at a process speed of 120 feet per minute. It produces cut prints and supports all standard formats (e.g., 3' x 5", 4" x 6", etc.). Operating at a speed of 5,440 4" x 6" cut prints per hour, the printer is targeted at high-end minilabs and "city labs".
- The Photo-e-Print CentroLab 5K - produces rolls of various strand widths in all standard formats (e.g.,

3", 4", 5", 6", etc.) at 5,440 printers per hour. The printer is targeted at medium volume central labs and wholesale environments.

- The Photo-e-Print CentroLab 10K - operates at a process speed of 240 feet per minute and is targeted at high volume central labs and wholesalers. It produces rolls of various widths in all standard formats at a speed of 10,880 4" x 6" prints per hour.
- The Photo-e-Print CentroLab 20K - a twin-engine printer, producing the same output format as the CentroLab 10K, however at double the speed. Targeted at very high volume central labs and wholesalers, it prints at a speed of 21,760 4" x 6" prints per hour.

Each of the Indigo Photo-e-Print printers is an entire self-contained photofinishing factory in a compact product, occupying little more floor space than a minilab.

The Photo-e-Print Technology

Indigo's range of digital photofinishing printers, based on its ElectroInk process, offers a unique combination of high quality prints and high speed.

We will now describe the ElectroInk-based printing process, and its unique features.

The Printing Process

The Indigo printing engine performs the following operations sequentially:

1. Exposure of the electrostatically-charged electro-photographic Photo Imaging Plate (PIP), which is mounted on the imaging cylinder, by a scanned array of laser diodes. These lasers are controlled by the raster image processor that converts instructions from a digital file into 'on/off' instructions for the lasers.
2. Inking of the PIP and removal of ink from non-image areas by the electrically biased developer roller.
3. Removal of excess liquids and ink particles from the non-image areas on the PIP surface.
4. Removal and re-circulation of the excess carrier liquid from the image and non-image areas of the PIP surface.
5. Transfer of the ink image to the blanket cylinder.
6. Heating of the ink image on the blanket.
7. The above operations are repeated six times - once for each color separation in the image - while the blanket collates all the images in perfect register.
8. Transfer of the heated ink image to the substrate in a one-shot operation.
9. Applying an ultra-gloss clear layer on top of the printed image.
10. Finishing the printed image by slitting, cutting and delivering the final prints.

The Photo-e-Print Core Technology

After describing the process, let's address the core technologies.

The three core technologies of Indigo's ElectroInk-based process are:

- ElectroInk
- Thermal offset transfer technology
- On-the-fly color switching.

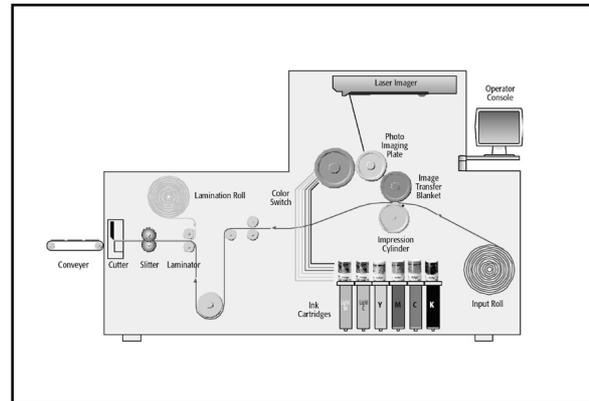


Figure 2. The Photo-e-Print MetroLab

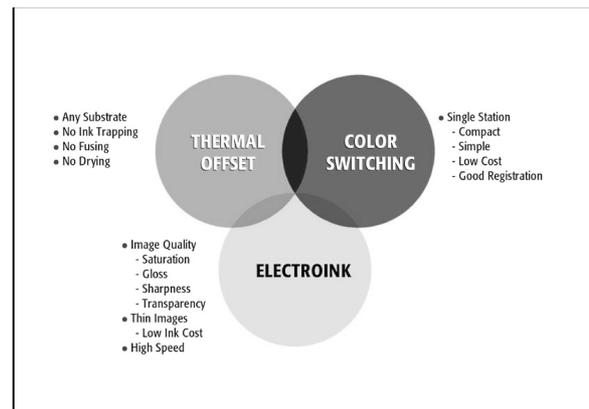


Figure 3. Photo-e-Print: Core Technology Components

ElectroInk

All Indigo digital presses use ElectroInk, Indigo's unique liquid ink. ElectroInk contains electrically charged ink particles, in an oil carrier. Unlike powder toner xerography, ElectroInk enables very small particle size, below 1 micron. This small particle size enables high resolution, high gloss, sharp image edges, and very thin image layers.

Thermal Offset

Known as Thermal Offset, the Indigo process uses a blanket heated to approximately 100°C. This causes the specially shaped pigment-carrying ElectroInk particles to melt and blend into a uniform film. The blanket heat is not high enough, nor is the dwell time long enough, to heat the paper as it comes into contact with the blanket. When the heated ink contacts the cooler substrate, the

ElectroInk immediately solidifies, strongly adhering to and transferring to the substrate. The print is effectively dry as soon as it leaves the blanket, eliminating any risk of ink 'set-off' marking other copies. Print finishing can be performed immediately.

Color Switching

Indigo's Digital Offset Color printing technology enables printing of all color separations in a single station. After one color separation has been created, the next one (a different color) is created in the same station.

Single station printing has several advantages, including compactness, reduced hardware cost, and improved mechanical accuracy, which translates, for example, to virtually perfect registration.

The Photo-e-Print Value Factor

The Photo-e-Print product line provides high added value to the photofinishing industry. This added value, some of which is common to all digital photofinishing and some unique to Indigo, can be presented by the "Photo-e-Print Value Factor" chart, highlighting the following benefits over conventional silver-halide processes:

- All-digital workflow
- High speed
- High quality
- High durability
- Low cost per print
- Environmentally friendly

Now we will elaborate on each of these added value features:

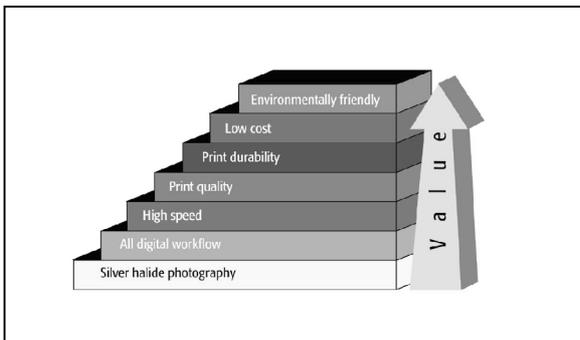


Figure 4. The Photo-e-Print Value Factor

All-Digital Photofinishing

Images are captured either by film cameras or by digital cameras. In the first case, the film is digitized by scanning the image. From digital cameras, the images are sent directly to the Image Management System via local network, the Internet, or other digital media (floppy disks, CD ROMs, memory sticks, etc.). The Image Management System stores the images, defines the job size, configuration and layout. It also performs fully

automatic image enhancement and removes image artifacts, such as red eye, scratch and dust lines, and performs other image quality improvements. The image Management System transmits the data to the digital printer, which prints and finishes.

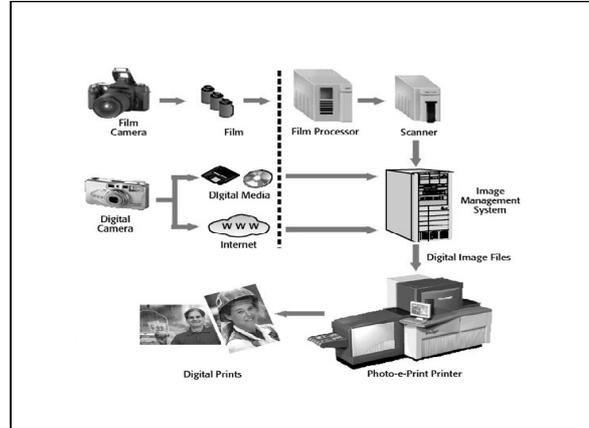


Figure 5. All-digital workflow

High Speed

To put speed into perspective, let us define terms:

- **Microlabs.** These distributed photo printers are suited for very low volume retail shops. Printing is limited to a few hundred prints per hour.
- **Minilabs.** These familiar photo printers print up to two or three thousand prints per hour.
- **City Labs.** These establishments produce more than three thousand prints per hour. For this market, Indigo offers the Photo-e-Print Metrolab, which prints at over 5,000 4 x 6" prints per hour. Its sister product, the Photo-e-Print ProLab, prints at the same process speed, but offers larger formats.
- **Photo-e-Print CentroLab.** These are the photo printers for central wholesale labs. The Indigo product offerings in this class are the CentroLab 5K, producing 5,440 prints per hour, the CentroLab 10K, producing 10,880 prints per hour, and the CentroLab 20K, printing at the staggering rate of 21,760 4 x 6" prints per hour.

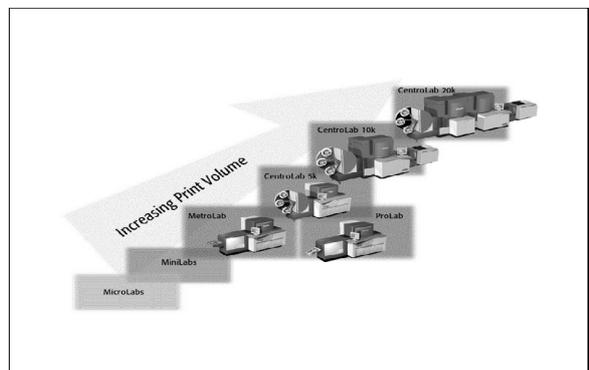


Figure 6. Photo-e-Print range of speeds

High Quality

Over the past few years, the quality of Indigo digital printing technology has come a very long way. When Indigo first launched its products, print quality was comparable to xerography. Over the years, the quality improved dramatically, first surpassing xerography, then in most respects, surpassing offset printing. Now, with the development of the Photo-e-Print, the level of Photo-e-Print print quality is characterized by:

- High resolution imaging: 800x2400 DPI.
- Six color printing: Converting RGB images into the six color process of CMYKC*M* (cyan, magenta, yellow, black, light cyan, light magenta) expands the color gamut and enhances continuous tones. ElectroInk produces vivid colors. The blacks are blacker and the whites are whiter than silver photography.
- Ultra-gloss images: Photo-e-Print prints are laminated by an ultra-gloss clear layer. One can easily switch between gloss and matte surface finishes without switching substrates. Such flexibility is unique to the Photo-e-Print.
- Color consistency: The Photo-e-Print automatically adjusts the optical density and dot size so that images appear the same, print after print. Optical density of the printed image can be electronically set by the operator over a wide operational range.

Once set, a proprietary closed loop controller monitors and regulates print density in real time. This feature enables unprecedented color consistency and repeatability that is virtually impossible to achieve with silver photography.

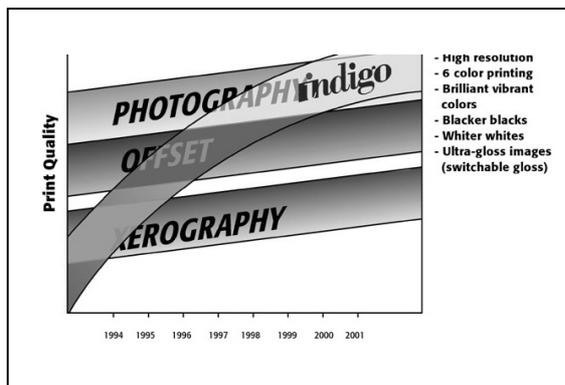


Figure 7. Photo-e-Print quality scale

High Print Durability

- **ElectroInk.** There are no chemical reactions in the ElectroInk process, which is entirely silver-free. The encapsulation of the pigment particles within the ElectroInk polymer resin protects the pigments from oxidation and relative humidity effects. Being

pigment-based, Photo-e-Print prints have excellent lightfastness compared to dye-based silver prints.

- **Base paper.** The images are printed on a multi-layer base paper, which is back-sealed and humidity insensitive. It is also pen-writable.
- **Ultra-gloss clear layer.** A top layer protects the print and makes it resistant to abrasion, waterproof, and fingerprints are wipeable.

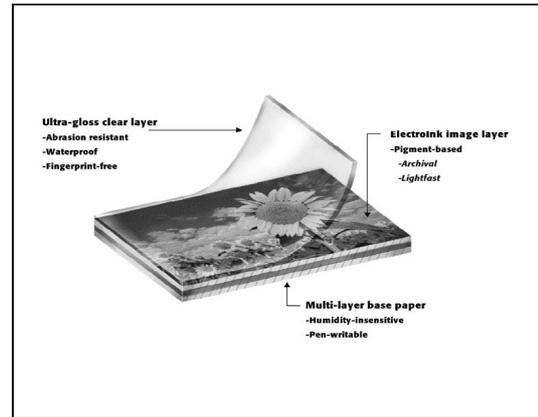


Figure 8. Photo-e-Print high attributes

Low Cost Per Print and Environmentally Friendly Solution

The Photo-e-Print is environmentally friendly and offers photofinishers a lower cost per print than silver-halide. This is because there is:

- no photosensitive emulsion
- no chemical disposal
- no silver processing or recovery

Conclusion

Photofinishing is about to become digital. We believe that non-silver processes, such as Indigo's ElectroInk, will play an important role in tomorrow's digital photofinishing market, bringing high quality, low cost, and environmentally friendly solutions to the retail, professional, and wholesale photofinishing establishment.

Biography

Yishai Amir received his B.Sc. and M.Sc. degrees in Electronics Engineering from the Technion – Israeli Institute of Technology, and his MBA from Tel-Aviv University in Israel. Since 1995, he has held various management positions in Indigo, including Director of Industrial Printing Products. He is currently Vice President of Marketing for the Indigo Photo-e-Print enterprise. e-mail: amiry@indigo.co.il; Phone: +972-8-9381345; Fax: +972-8-9381339.