MAGIC Drop-On-Demand Inkjet Technology Opens New Applications in Large Format Printing

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Trends & Drivers in Digital Printing

In the SOHO and Color Business Printers market and in the Wide Format Color market, inkjet has been steadily stealing market share from other digital printing technologies. Inkjet's ability to provide better performance at lower costs stem largely from it's being a non-contact printing technique, a fact that removes constrains and limitations in the design stage of equipment and makes for lower cost of ownership. Additionally, inkjet produces a "look & feel" on paper that is considered more pleasing and of better quality (than, say, toner-based approaches).

Aprion's specific flavor of inkjet demonstrates greater cost-performance, large application flexibility and greater robustness than competing inkjets due to a highly unique design. This approach enables very high jetting rates and high reliability. In fact, this combination of characteristics makes it a candidate enabling mechanism for a huge range of industrial applications.

Changing Industry, Changing Business Environment

Electro-photographic digital printers. serve a relatively narrow application field. Digital printing has been slower to penetrate the market than originally expected: to date, only 2-4% of industrial printing is digital. Although growth has been slower than anticipated, there is no doubt that printing will go digital, spurred by evolving needs in a variety of areas: E-commerce, mass customization/ personalization, Cost per page, Inventory control.

Accelerated change in the business environment, the 'information revolution', Just-In-Time management practices and the search for greater efficiency created the need for delivery of print jobs in a matter of days, not weeks, with run lengths in the low thousands or even hundreds, and not tens of thousands.

The following list is a summary of what Printers expect over the next five years:

1. Increased use and development of digital imaging processes
2. Increased use of automation
3. Industry growth, increased international competition & business consolidation
4. More environmentally safe processes, products and consumables being abrasion resistant, Water and Light fast
5. Shorter print runs and lead times
6. Higher speed of the machines, for larger annual print area, and thus reduced cost of ownership

Conventional Versus Digital Printing

In conventional printing, the medium that carries the print image (a printing plate), must first be produced in a complex, expensive process; the cost of this plate (or plates when printing in color) must then be amortized over the print run (hence the restriction to long runs). Digital printing eliminates this expensive preparation stage; data stored in electronic format can be transferred directly onto the paper and printed any number of times. This is not a 'mass production' process; the variable costs of producing each copy are higher than with offset, but the lack of high setup costs makes it more efficient for producing shorter runs. Conventional or offset printing remains a more cost-effective solution above a certain production run length; digital printing is more cost-effective below it. Over time, the efficiency limits of digital printing are encroaching more and more on what can be considered conventional printing turf. This result and the demand for fast turnaround short run printing were the driving forces behind the huge digital print engine R&D budgets of the late 1980s. So-called Digital Printing Presses began to appear in the early 1990s; they suffered from many 'childhood ailments', but created a revolution nonetheless. The products were wholeheartedly embraced; the technology has continued to improve; the variety of approaches used and the competition between vendors has increased ever since.

The largest percentage of printers sold today for small/home office applications are inkjet based. Significant innovations have been made in inkjet technology over the past 3-5 years. Since the inkjet process is non-contact, print quality, speed and cost per page are intrinsic and constitute fundamental inkjet advantages. Inkjet presses will, over time, replace conventional presses for most applications.

Aprion Digital - Background

Aprion Digital Ltd. is a new technology company, a Scitex spinoff incorporated in September 1999 in order to attract the investment capital necessary for accelerated growth. The company has developed novel, patented MAGIC (Multiple Array graphic Inkjet Color)

technology for digital liquid delivery and associated water based, environment-friendly inks, for use in its digital inkjet presses. Development of the Aprion Digital drop-on-demand (DOD) head began in 1992, as part of the Scitex in-house technology incubator. The first 1" prototype head was demonstrated in 1996. A 6" prototype head was demonstrated in June 1998.

Aprion is owned by a group of investors that include top Israeli and US-based firms such as Scitex, Clal, Discount Investment, Israel Infinity, Hapoalim Bank, TDA (Templeton) and CDI (ODD) and is managed by a seasoned executive team with a remarkable track record and employs over 140 people in a broad range of disciplines.

Strategy – From Niche Markets to Mainstream

As a new player in an industry dominated by large multinational companies, Aprion Digital has decided to focus on vertical markets where its technologies have significant advantages. These technologies are uniquely suited to addressing industrial niches where there is a clear need for modernized production tools with no available solution like: Home Furnishings, Packaging and Graphic Arts. Aprion's initial focus is to provide digital printing solutions for these industrial niches with the intention of entering other markets like textile. Aprion Digital has always felt that its products will soon evolve into industry pacesetters.

Over the next two or three years focus will extend to other print markets such as book printing, thus cornering a larger slice of the printing market. This will fuel revenue growth and establish Aprion technologies and products as an ongoing, viable replacement for all printing applications.

In the long term, Aprion intends its technology to completely replace other commercial printing technologies, proving itself competitive in both quality and total cost/page printed.

Technology

Aprion has developed digital printing technologies based on two components:

1. Digital liquid delivery of small, highly repeatable droplets of liquid simultaneously delivered from thousands of nozzles at extremely high speed (currently 25,000 droplets/nozzle/sec with a demonstrated capacity of 100,000 droplets/nozzle/sec under lab conditions). Aprion Digital drop-on-demand heads are extremely flexible: a variety of head designs are easily and quickly accomplished. Testing has proven that these heads have higher operating speeds, enjoy longer life and have a greater tolerance for a much wider range of inks than do other inkjet technologies. This, among other things, makes them well suited to industrial applications, but not necessarily limited to them.
2. A family of water-based, environment-friendly inks that are highly abrasion resistant and are water and UV fast.

There are over 45 patents and patent applications protecting Aprion Digital's products, inks and print head technology, with more on the way.

The technology is the fastest, most flexible, most robust and cost effective available today. Today's digital press based on the above technology is a viable alternative to a conventional offset sheet-fed press in terms of speed and cost/page. As the technology continues to develop, print quality and printing speed will reach even higher performance. Aprion is currently working on the next generation, while implementing the existing one.

Aprion Digital's strong chemical research and engineering team continues to expand the ink portfolio towards a wider range of print applications, including paper, plastics, metal and textiles.

The Aprion Digital drop-on-demand technology has several outstanding advantages over other inkjet technologies:

1. Compared with continuous inkjet, the head is less expensive, of higher quality, reliable and compact.
2. Compared with thermal inkjet, the head tolerates a wider range of ink formulations; has better control over drop volume and velocity (which affects image quality); lasts longer and will work with high-viscosity inks.
3. Compared with other piezo-type technologies, the heads' drop rate is higher (25Khz in the current generation, with up to 100KHz proven in the lab as compared with 10-20Khz); can be configured in very large arrays; is highly reliable and can be manufactured using standard industrial processes (and is therefore less expensive).
4. In addition, the heads' unique characteristics make this technology potentially competitive with electrophotography thanks to its higher performance-to-cost ratio. The table below shows the drop-on-demand inkjet head's basic specifications:

Resolution	True 600dpi
Ejection frequency	25khz
Ink viscosity	5 to 20 centipoise
Drop volumes	20 picoliters
Head dimensions	6" x 0.8"
Structure	Rooftop piezo drop-on-demand; multi-layer structure enables high rate, reduced cross talk and easy manufacture
Ink types	Pigment, water- based

In conclusion, the fact that Aprion Digital owns both a print head technology as well as industrial digital 'speed' inks capable of running at very high frequencies is considered a major industry breakthrough.

Current Markets

The first three market segments to benefit from Aprion's MAGIC (Multiple Array Graphic Inkjet Color) technology are vertical markets that require a wide format, currently serviced by specialized conventional print methods (gravure, flexo and screen printing).

1. Corrugated Packaging: This market needs shorter runs, mass customization and cost containment through inventory control.
2. Home Furnishing: The introduction of digital printing technology will provide a customized, speedy response and will reduce operating costs through inventory control (at the moment, some one-third of revenues is wasted in costly inventory).
3. Signage and Graphic Arts: At the moment, three companies offer relevant industrial strength production tools. Aprion products will offer the highest levels of speed and quality.
4. Additional potential markets will be in Textile Printing.

The fixed array web press is a modular roll-to-roll machine, which is targeted at the book printing market. The machine is based on Aprion Digital inkjet head and maintenance systems, with paper loading and unloading units (which include the paper handling, print heads and ink system) and a control unit. A digital print engine based on this technology has been tested at a linear print speed of 1m/sec (200 ft/m).

Distribution Partners

The Aprion Digital distribution strategy is to bring its products to market through distributors that bring knowledge of the market segment they serve to such a partnership. These distributors purchase equipment and inks from Aprion and will handle all marketing, selling, delivery, installation as well as most training and service functions after initial deliveries.

The following shows markets and territories covered:

| Partner	Market	Territory
Scitex Vision	Signage & Graphic Arts	Worldwide (exc. Japan)
DPS/Polytex	Home Furnishings	Worldwide
LaserComb	Packaging	European Community
Belcom	Packaging	North America
Reggiani	Textile	Worldwide

Products

Industrial Inkjet Press

The Aprion Digital industrial inkjet press is a high-speed, six-color, high-resolution print engine aimed at various industrial market. Six sets of heads print in six colors (cyan, yellow, magenta, black, light cyan and light magenta). The heads are mounted on a mechanism that moves across the print substrate.

There are two basic configurations for the same print engine. They differ only in their substrate-handling mechanisms:

Roll-to-roll: A Home Furnishing version marketed as the DPS 65 and a Graphic Arts version marketed as the SuperJet.

Sheet-fed: This configuration serves the packaging market (corrugated cartons and paperboard printing) as well as the graphic arts markets. In North America the sheet-fed digital press for packaging is distributed under the name Bel2000 and in the European community as the DigiComb 2000.
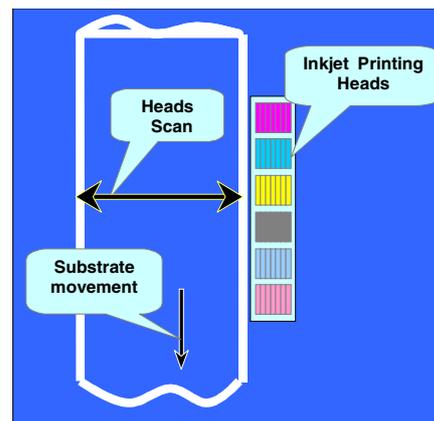

Platform Description: Roll-to-roll

This system can print on a variety of substrates (paper, vinyl and banners), using water-based pigmented inks. The printouts are water- and light- fast and are abrasion resistant. The machine is shown in the photograph below, as it was exhibited in operation during the Drupa trade fair in May 2000.

Platform Description: Sheet-fed

The sheet-fed version of the industrial inkjet press has been designed for the Packaging and Graphic Arts markets. It will print on rigid cartonboard as well as paperboard and other substrates. The print engine is essentially the same as that of the roll-to-roll version.

A z-axis mechanism enables a variable distance between the table and heads, thus supporting various substrate thicknesses. The following chart is an illustration of production workflow: a single blank piece of cartonboard is picked off a pile and fed onto the vacuum table; the vacuum table moves the board in steps from right to left. Between each step, while the board is at rest, the heads move one interval inwards and print the image on the substrate. Following the vacuum table's next advance, the heads print while they move outwards. At the end of printing, the boards are dried and collected in a pile by the unloader mechanism.
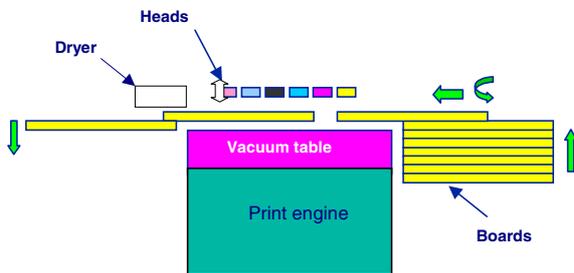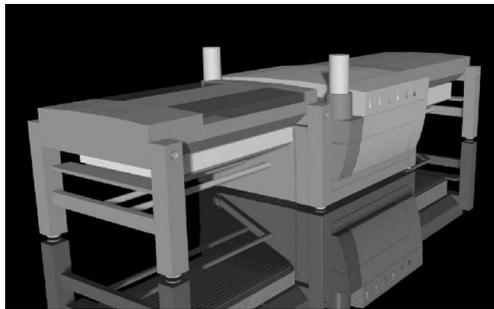
Target Markets: Competitive Profiles

Initially, the industrial inkjet press will be aimed at three markets: the graphic arts (signage) market, the packaging market and the home furnishings (wall coverings) market.

The graphic arts market uses traditional screen printing as well as digital printing: screen printing is very cost effective for long jobs but has a very long response time. Digital printers allow a fast response but are cost effective only for short runs. In addition, their inherently low throughput raises cost of ownership. Since most have poor print quality, use is limited to applications seen from a distance (such as billboards).

The packaging and home furnishing market use traditional techniques almost exclusively: flexo, gravure, rotary screen and offset. No digital printers are used today, especially because of limited speed and reliability.

The Aprion Digital industrial inkjet press runs at high speed and is highly reliable: qualities that make it suitable for these markets. Its speed, cost of ownership

and print quality make it a very competitive digital solution for the graphic arts market as well. Note that traditional print methods show very low ownership costs/area for long runs, and very high costs for short runs.

Specifications

Print resolution	600dpi
Number of colors	Six (cyan, magenta, yellow, black, light cyan, light magenta)
Media width (roll-to-roll)	60 to 165cm (24 to 65 inches)
Sheet size (sheet-fed)	Up to 260 x 160cm (8.5ft x 5.25 ft)
Sheet thickness (sheet-fed)	Up to 10 mm (0.4")
Footprint	Roll-to-roll: 3.5 x 3.5m (12 x 12 ft) Sheet-fed: 3.5 x 10m (12 x 33 ft)
Type of substrates	Paper, vinyl, cardboard and others
Throughput	200 sqm/hr in 'premium' quality mode, approx. 400 sqm/hr in 'standard' quality mode (2000 sft/h)
Input file formats	CT and LW, PS, PDF
Front end	TBD
Inks	Pigmented water-based inks, waterproof, 2-year outdoor fade resistance, abrasion resistant and FDA compliant
Printing costs	Competitive with all other digital printers in this throughput category: break even with conventional printing at 1000-5000 runlength range

Conclusions

Aprion Digital's Core Competencies
Drop-on-Demand Inkjet

The foremost Aprion Digital core competency is the design, manufacture and use of its proprietary drop-on-demand technology. This patented technology allows the creation of digital print engines that outperform existing solutions in targeted markets; Aprion Digital drop-on-demand inkjet is currently faster, costs less per nozzle and can be more fully integrated on a larger scale than competing solutions. Aprion Digital intends to fully exploit these advantages by incorporating them into Aprion Digital products or by, later on, marketing the technology directly to third party manufacturers.

Ink Development

The Aprion Digital ink group has extensive knowledge in developing consumables for digital print applications. This serves as a powerful lever for exploiting drop-on-demand's full potential. Three goals

are achieved by controlling ink formulation and properties: print performance is enhanced (drying speed), specialty niche market abilities are addressed (such as printing on plastic substrates).

Color Imaging and Management

Aprion Digital benefited from Scitex' know-how: its halftone color imaging techniques, color management and calibration software have given Scitex the reputation of a leader in the color field. These abilities are the key to success in some targeted markets; they would not normally be available to the competition.

Significant advances in inkjet print technologies have resulted in vastly improved print quality.

The combination of speed, flexibility and durability offered currently by Aprion Digital, along with a higher print quality, will become in the future, an economically viable alternative to conventional printing methods.

Indeed Electrophotographic engines being fundamentally limited in several critical areas such as print speed, achievable cost per page and variety of printable subtstrates, to name just a few.

Biography

Asa Ziv – Vice President, Marketing

Asa Ziv has been the Aprion Digital VP Marketing since March 1998. Among his department's activities during the last two years are the final definition of new products and marketing plans, establishing Aprion's distribution channels. His industrial background includes ten years of business management and marketing with Israeli Aircraft Industries (electro-optical payloads and unmanned air vehicles for military and civil applications), as well as fourteen years in the electro-optical industry, including the establishment and management of of El-Op's successful laser plant. Ziv has a master's degree in electrical engineering (electro-optics), a BSc in Physics from Tel Aviv University and additional advanced studies in marketing.