New Trends in Inkjet Technology

Printing continues to become more efficient.

By Chris Lynn

Wide-format graphics represented one of the earliest sectors within the colour printing industry to be revolutionized by inkjet technology. This was due to the forgiving nature of long viewing distances for wide-format prints, given the initial delivery of ink was handled by very large-drop binary printheads.

The quality of this early inkjet printing was more than adequate for the industry, compared to the 25 lines-per-inch (lpi) of screenprinting, and value was enhanced by reducing costs for short print runs, as the need for making screens or plates was avoided.

The capability of this technology to produce wide-format prints faster and less expensively has driven a new on-demand business model for the display graphics sector. It seems inkjet printing will

Greyscale printheads can vary the size of each ink drop to attain a smoother image.

continue to dominate wide-format graphics production in the future, too, as quality improves further and as more users and clients explore the potential for customization.

The following are a few ideas of what to expect now and in the near future from wide-format inkjet printing technology.

Trend #1: Greyscale printheads

Inkjets produce graphics by putting down dots of ink which, when viewed from an appropriate distance, visually blend to create a recognizable image or readable text. So, in contrast to screenprinting's lpi, resolution is measured in dots-per-inch (dpi).

Recently, two approaches have been taken to further improve inkjet print quality:

- Small-drop binary printheads.
- Greyscale printheads.

A binary printhead, as its name suggests, is at any given moment either on or off—*i.e.* it either prints a drop or does not print a drop. The drop sizes typically range from 30 to 100 picolitres (pL) for most solvent-based inkjet printers and 2 to 6 pL for aqueous models.

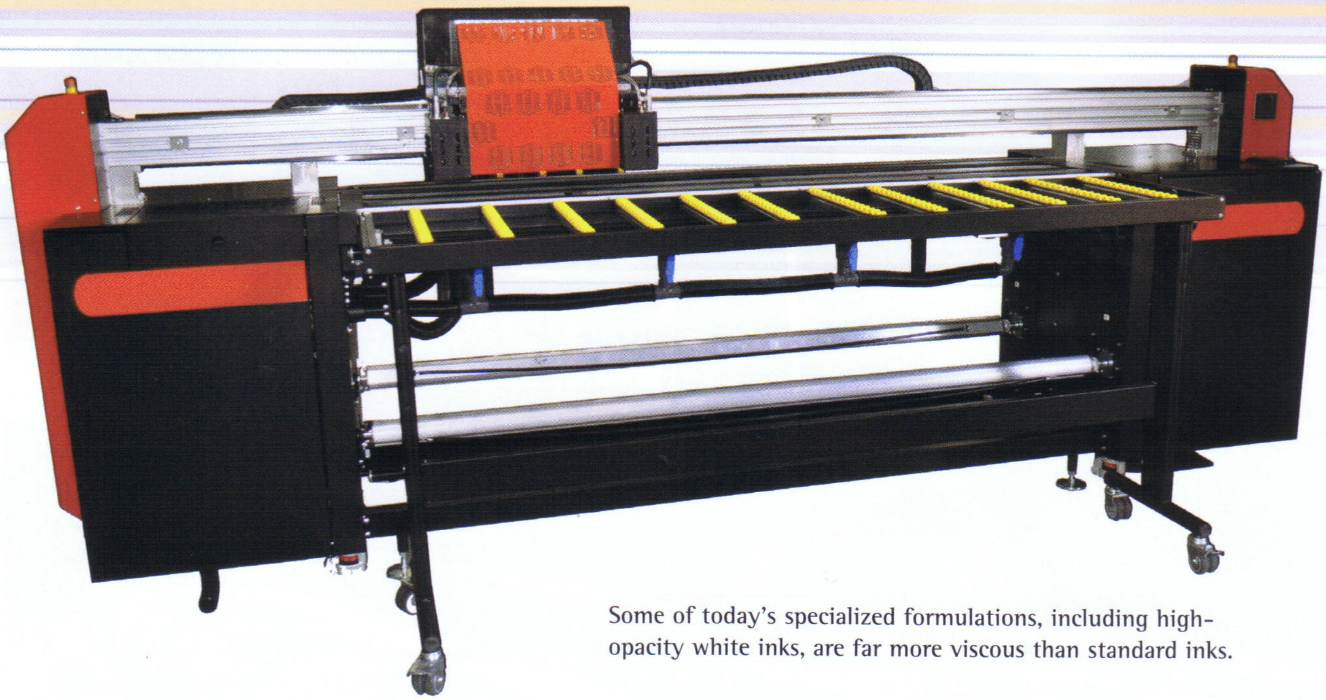
Bigger drops generally mean bigger nozzles, which enable the printheads to lay down more ink per second and therefore become more productive. They also result in lower resolution, however, which may not be a problem for a billboard designed to be viewed from at least 6 m (20 ft) away, but would be unacceptable for point-of-purchase (POP) display materials.

Smaller binary printhead drop sizes, meanwhile, mean multiple passes are necessary to achieve full coverage, as it becomes more difficult to achieve the required ink density within a single pass.

Greyscale printheads, on the other hand, fire ink drops that are typically up to a range of 40 to 50 pL, but are made up of smaller sub-drops of less than 10 pL each. By dynamically varying the size of each drop, a smoother image can be attained. Small drops can be used specifically for the finer details in an image, while large drops can ensure maximum coverage and colour density.

The ability to print with multiple drop sizes means higher productivity can be achieved alongside higher quality, even when using a smaller number of nozzles. Hence, greyscale printheads are typically more cost-effective and productive than small-drop binary printheads.

Smaller ink drops can be used for fine image details.



Some of today's specialized formulations, including high-opacity white inks, are far more viscous than standard inks.

Faster, self-recovering printheads incorporate custom chips.

With binary printing, a resolution of around 1,000 dpi is needed to 'fool' the eye into perceiving an image as perfectly smooth when viewed at normal arm's-length distance. Greyscale technology, on the other hand, enables a printer with only 360 nozzles per inch to achieve the same 'apparent' resolution, with drops that vary between 6 and 42 pL.

When smoother tonal transitions are possible, the need for additional printheads and inks—*e.g.* light cyan and light magenta—can be avoided, saving both hardware and consumable costs. Ink use is also much lower with a greyscale ultraviolet-curing (UV-curing) inkjet printer than a binary printer because the wasteful practice of printing one dot on top of another is greatly reduced.

Trend #2: Higher efficiency

Wide-format printers have used a number of different technologies to become more efficient, with advances not only in printheads and inks, but also in raster image processor (RIP) software, electronics, motor control, mechanical engineering, UV-curing lamps and integrated computers. Printer manufacturers, ink suppliers and printhead engineers alike have all delivered substantial improvements in recent years.

Efficiency is a combination of faster speed and higher productivity. Some new printers, for instance, are bridging the gap between POP-market graphic output and the higher productivity needed for mammoth prints.

The most important components at the heart of any inkjet printer include the printheads and the data-path electronic circuits that drive them. In both cases, costs have been reduced—and productivity improved—steadily over the past decade.

Faster, self-recovering printheads are incorporating application-specific integrated circuits (ASICs), also known as 'custom chips.' Some printers also offer faster carriage speeds and automatic loading and unloading systems.

In general, there has been a trend toward using bigger printheads with more nozzles or arrays of lower-resolution printheads. Improvements in printhead design have followed a stronger understanding of the behaviour of inks under different printing conditions. This is important because the physical properties of inks can be affected by factors related to printing components, *e.g.* the stresses of being pushed through small nozzles within a few microseconds.

Trend #3: Single-pass improvements

Many of today's wide-format printers rely on 'scanning' functionality, whereby the printheads undertake many passes over the substrate to cover it fully with ink and provide the required level of image detail.

One of the major benefits of this approach is it helps make any printing errors—such as those caused by blocked ink nozzles—less obviously visible in the final product. Also, scanning enables the printing of finer dots by interleaving them during multiple passes, which is less mechanically difficult than the alternative of aligning multiple printheads. A reduced number of nozzles helps keep system costs down.

So, compared to single-pass printing, a scanning system is capable of achieving higher resolution. It might make up to 16 passes over the same area and will be more tolerant of missing nozzles.

The downside to scanning, however, is it is relatively slow, because these multiple passes over the same area are needed to provide complete ink coverage, with time lost at each end of the scan for carriage turnaround. Also, scanning can degrade small print features, including text and fine lines.

In single-pass printing, the printheads are fixed in one place and drop ink directly onto a moving substrate, whether this is a web (*i.e.* a substrate mounted on rollers) or a sheet (*i.e.* individual pieces of the substrate on a moving transport system). The primary benefit is higher speed.

Simply put, printing directly onto a moving web or sheet minimizes any time lost between items or pages. For a single pass, the area covered within a fixed period depends on the width of the print swath and the maximum frequency of the printheads.

In the past, single-pass printing entailed high costs for wide-format printhead arrays, as well as visible defects caused by misdirected inkjets or nozzle outages, but the potential for improved productivity is very high. Thousands of square feet per hour are possible.

UV-curable printing continues to represent a fast-growing segment of the industry.

Trend #4: Recirculation systems

An inkjet failure requires a wipe-and-purge maintenance routine to re-prime the nozzles. Given the aforementioned industry demand for speed and quality, 'throughflow' ink recirculation systems are gaining prominence. These help the printheads self-recover from blocked nozzles.

The systems work by circulating the movement of fluid through the printhead, continuously replenishing each nozzle and ensuring the ink's meniscus—*i.e.* its curved 'skin' formed by surface tension—is maintained. Air bubbles or particles that may form and enter the printhead are quickly moved away and captured by an external filter; whereas in traditional jetting systems, their only exit would be through the nozzles, thus risking blockages.

Besides superior reliability, another advantage of these systems is they can keep solids in suspension in today's specialized ink formulations, some of which are more than twice as viscous as standard inks. Examples include high-opacity white inks and new 'metallic' inks.

Also, by circulating the ink, the systems eliminate variances in temperature across the printhead, which in turn provides excellent ink density control.

A reduced number of nozzles helps keep system costs down.

The full impact of this technology has yet to be realized. In addition to outstanding jetting reliability, self-recovering printheads and nearly eliminating the need for frequent maintenance, it has the potential to lead to the development of fixed printhead arrays built out to the full width of the printing area.

Trend #5: Greener inks and curing

As environmental issues continue to motivate print providers to reassess how they conduct business, another ongoing trend is the phasing out of solvent-based inks and, in turn, the increased adoption of UV-curable inks.

In fact, UV-curable inks represent the fastest-growing segment of the industrial printing ink market today. They are considered environmentally preferable because they use no solvents, but another advantage is the whole of the liquid ink is turned into a solid that remains on the substrate. With solvent-based inks, the carrier fluid has to be dried off to leave the colours behind.

Rapid advances are now being made in the development of lamps based on light-emitting diodes (LEDs), which could replace today's mercury arc lamps used for UV curing (see page 42). With their lower costs, longer life and negligible heat output, LED-based lamps are helping accelerate the concurrent development of inks that can be cured under weaker, monochromatic radiation. The technology has some way to go yet, but already looks promising.

Chris Lynn is vice-president (VP) of sales and marketing for Xaar Americas, which supplies piezoelectric industrial inkjet printheads for the graphics industry. For more information, visit www.xaar.com.