



**The rapid evolution in printer technology has left even the industry gasping for breath.**

# Page impressions

**P**rint quality has come a long way in the past two decades. Noisy, expensive and functionally one-dimensional dot-matrix and daisy wheel line printers have been rendered antiques by first laser and then inkjet machines, with prices falling so fast that the ratio of printers per employee has fallen from the tens to low single digits. Now desktop printers are capable of photo quality output and even colour laser printers have become affordable to just about every business.

Even the manufacturers are amazed at the rate of change. "The trend in office printing has been more bang for your bucks, every year getting slightly faster and slightly cheaper. In 1993 our ten page per minute network printer cost over £1,500," says Tracey Rawling Church, head of marketing for printer and copier manufacturer Kyocera Mita. "Now you can get an 18 page per minute printer for less than £200."

How have printer vendors been able to provide such high quality at such prices?

The changes that have brought this about have been a mixture of technology and economics. Improved manufacturing processes and economies of scale have made manufacturing of printers and their cartridges easier. R&D has brought to printers new technologies –

not just laser and inkjet but PostScript, PCL and other printing languages that have mostly eliminated the need for expensive storage and processing capabilities in printers, and interpolation (a way to artificially increase the resolution of the data sent to printers using image enhancement algorithms). As with most industries, these new technologies first appeared at the high end, before moving down into the low end.

Customer drives have been clear: both consumers and businesses have wanted ever-better quality. Consumers want to produce output that's as good as that produced in the office or by their local chemist's photographic service; businesses want high-quality output that is low-cost and rapidly delivered – without recourse to a print shop.

This has led to a focus on print quality at the expense of speed in the domestic market and a focus on speed and other features in the business market (see box, 'Laser versus inkjet').

But the intense competition in the printing industry has been responsible for the price cuts that have made printers with such features so affordable.

"If I'm brutally honest, the hardware is loss-making," says Paul Birkett, Xerox UK business solutions

## LASER VERSUS INK

**Although there are many competing printer vendors, all claiming unique product functionality, the battle in the print market comes down to two technologies: laser and inkjet.**

Laser printers work by projecting an electric charge onto a revolving drum. The printer then beams light onto the drum, usually with a laser although sometimes with an array of LEDs, which cause the charge to leave the exposed parts of the drum. The drum then passes through a bath of very fine particles of dry plastic powder known as toner. The charged parts of the drum attract the particles of powder. The drum then deposits the powder onto paper, which then passes through a fuser. This uses heat and pressure to bond the plastic powder to the paper.

A British company called Intense is working to bring some of the capabilities of high-end laser printers to the low and mid-market. "Historically, anything that uses real lasers has been expensive," says David Lockwood, CEO of Intense. "But by putting multiple single-mode lasers in an array and putting them into a package, we can bring solid-state laser technology out of the super high-end graphic arts market into mid- to low-end markets." The technology will enable a print head the size of a pack of playing cards to incorporate as many as 650 lasers for ultra-high resolution printing.

By contrast, most current inkjets employ a electronic print cartridge with a series of tiny, electrically heated chambers. To produce an image, the printer runs a current through the heating elements. A steam explosion in the chamber forms a bubble, which propels a droplet of ink onto the paper. When the bubble condenses, surplus ink is sucked back up from the printing surface. The ink's surface tension pumps another charge of ink into the chamber through a narrow channel attached to an ink reservoir. Although there have been many contributors to inkjet

technology over the years, HP and Canon are responsible for much of the work and own most of the patents, with the list of other major vendors including Lexmark and Epson.

Epson's printing works differently: it uses a piezocrystal in each nozzle instead of a heating element. The crystal bends when it receives an electric current forcing a droplet of ink from the nozzle. "It's more accurate in terms of how it puts ink on the paper," says Mark Robinson, product manager for inkjets at Epson UK. "The other major advantage is that it can create very large ink jets for printing large areas, yet small areas only receive a small ink drop." It also allows for different ink formulations to be used, other than ones that can withstand the heat required in standard inkjet printing.

A further wrinkle in inkjet technology is currently in development at HP. "Page wide arrays" will replace single cartridges moving across the paper that current inkjets use with thousands of nozzles that print the entire page at once. Big technical challenges remain, but the devices could be cheaper to build than laser printers and at least as fast.

Inkjets have several advantages over laser technology: it's capable of higher resolutions and photographic quality printing on many different media; and the printers have no warm-up period. Laser, however, is much faster than inkjet and requires fewer consumables. The technology available in the two different types of printers differ as well. Large format printing is available in some inkjet printers at relatively low prices, and the printers are generally smaller. Laser printers are almost all capable of double-sided printing; other features, such as stapling, different feeder trays, network cards, binding and collating, are available in most laser printers, too. Inkjets are usually cheaper to acquire but are more expensive over their lifetime, whereas laser printers are more expensive to buy and cheaper in the long run.

manager. "It's become more and more pronounced as features have been added, and the fall in price has been much more rapid than the fall in price of manufacturing costs. In the last three years, there's been more than a 50% drop in prices – it doesn't matter how good the process improvements are, they're not that good."

With competition forcing greater and greater downward pressures on hardware pricing, virtually all printer manufacturers have shifted their business model to accept loss-making hardware that locks consumers into highly profitable consumables (particularly toner and ink cartridges). Manufacturers reckon that if a printer lasts five years, consumables can easily cost up to seven times the original cost of the printer.



**Robin Edwardes, TallyGenicom**

**"Colour laser printers are no longer a luxury item within the office."**

A combination of this business model, competition and R&D has been responsible for the rapidly growing presence of colour laser printers in offices. "Colour laser printers are no longer a luxury item within the office," says Robin Edwardes, EMEA managing director of TallyGenicom. "This explosion of installed colour lasers and component standardisation within the industry has

allowed suppliers to reduce costs while technology evolution is increasing quality."

But colour printing represents an increased revenue opportunity for vendors, and they have been putting considerable marketing investment into making colour attractive to business purchasers.

Moreover, the cost of colour consumables has come down and different colours of ink cartridges are now available separately, rather than as all-in-one purchases; colour page printing speeds are now almost as good as mono print rates; and many mid-range printers now come with colour capabilities built in, leaving it up to the purchaser to decide whether to buy colour consumables to enable the capability. Yet, colour consumables are still more expensive than black ones, making them a bigger revenue source than mono.

Despite the big push for colour, most emphasis in development is now on improved print speeds and additional features, rather than the continued improvement in resolution and quality that drove the industry during the 1990s.

"I believe printing technology is good enough," says Kyocera Mita's Rawling Church. "I'm not saying it won't improve: lots of people want technology for technology's sake and IT purchasers in general do want to have the fastest, best, crispest whatever. But really, for most business purposes, 300dpi (dots per square inch) is ample. Most printers today offer 1200dpi, but even for graphic output 600dpi is more than enough. As soon as someone does 2,400dpi, that will be the new standard, but you're not going to get radical improvement in the effectiveness of the documents, which is ultimately what it's all about."

Xerox's Birkett agrees that the drive for resolution will have a limit. "The end point will be colour laser printing at 2,400dpi for less than £1,000 – you can see some printers with that on the market already. The major hurdle will be local storage. A job like that could require 512MB of [printer-based] storage and processing."

The push is likely to be from the laser end of the market downwards rather than inkjet upwards, simply because of the nature of the two technologies and the fact that lasers already have the business-friendly features needed.

Photo-quality lasers are unlikely, as are hybrid printers, so inkjets will continue to be an occasional purchase for most organisations that need photo quality.

Otherwise, the higher volumes, speeds and affordable consumables of laser will keep it at the forefront of businesses printer purchasing concerns. ■

## INK AND CONSUMABLES

Laser printers use toner to print documents. In its earliest form, it was simply carbon powder, but to improve the quality of the printout, the individual carbon particles are now blended with a polymer, which melts when run through the laser printer's fusing unit.

The original particle size in toner averaged about 12 micrometres, but when laser print engines improved their image resolution to 600dpi (dots per square inch), manufacturers had to reduce the particle dimension to eight micrometres; further reductions in size will be necessary for improvements in resolution.

Alternatives to toner are being worked upon. Solid ink, used by Xerox and Tektronix, consists of blocks with the consistency of crayons that can be dropped into cartridge chambers in the laser printer. The printer heats the blocks to melt them and jets the ink onto the laser printer's drum. Xerox claims that the technology offers far better quality colours and gloss than alternatives; it produces no ozone or waste; it makes colour printing as fast as mono printing; it reduces the number of components that can go wrong; it allows printers to work with poor quality paper; and it allows the user to top up the ink chambers whenever they like, rather than when the ink runs out. To beat even that, Xerox additionally claims that printers that use solid ink can print 30,000 pages before they require attention, compared to 1,212 on a colour laser printer.

Inkjet printers use a wide variety of inks. Some cheaper inkjets use water-soluble inks while others use dye-based inks. These can run when exposed to moisture; spread in the paper, reducing quality; fade when exposed to sunlight; and even make highlighting pens impossible to use.

So manufacturers have begun to use a variety of different techniques to improve quality. Pigment-based inks, for example, coated in bubbles of resin, produce better quality colours, while the resin reduces the damage caused by light and water. The pigment is also hydrophobic, so is not readily soluble in water, and coats the paper with larger particles that take longer to fade in light.

For photo realism, some inkjet printers now use six different ink colours in order to create more subtle blends; colour laser printers and lower-end inkjets still use the traditional cyan, magenta, yellow and black. Others go further still – HP now offers printers with up to nine different ink cartridges to get deeper colours and better greys in mono prints.