Your guide to a successful inkjet development project

XAAR

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Our three top tips:

1 Evaluate your fluid

2 Have a clear development pathway

3 Work with a partner who will provide you with expertise and support along the way

Using inkjet for the first time can be daunting and downright overwhelming. What printheads, what fluid, what datapaths and are they are compatible with each other? It's important to have the right products, expertise and technology along with a good plan before you're in too deep.

At Xaar, we understand that the importance of getting new products to market efficiently is crucial to maximising your return on investment and minimising your time to market. We have over 30 years of expertise in inkjet, which has led to two major industry transformations and have a team dedicated to developing new applications for customers.

As every one of our customer's application is in some way unique, whether it be the fluid, the jetting requirements or the system it needs to be integrated with, we have learnt that experience is essential when developing for the first time.

That's why we've created this guide – to help inform your inkjet development journey and hopefully it will mean you are more likely to have a successful outcome with the quickest possible time to market.

Inside, we'll answer some common questions:

- **Why digital inkjet?**
- **What fluid do I use?**
- **What system components do I need?**
- **What do I need to start up my development project and scale up?**

1 Why digital and why inkjet?

So, you're thinking of using digital inkjet for a particular task? Perhaps it is to replace another, analogue, printing process – pad-printing, screen-printing or offset. Or perhaps it is to use as part of a new product manufacturing process. Before we delve in, let's go back to the basics of understanding why digital and why inkjet.

Digital manufacturing is a term used when digital technologies are used as a centred approach, such as a computer system. Typically, this is seen as when a machine is able to read a CAD (computer aided design) file and can prototype, produce and fabricate moulds within a few hours. It also enables the use of real-time data analytics by having a factory that is connected and fully integrated. This enables greater optimisation to ultimately reduce inventory, improve quality, shorten time to market, meet customer demands and increase productivity, all in a more sustainable and efficient way.

Taking 3D printing as an example, the same technology is used to prototype, develop and mass manufacture, taking you from a design, to an object within just a few hours.

Another example, is the transformation of the ceramic printing industry. Just over two decades ago, the only way to decorate ceramic tiles was using traditional printing methods, the most common of which was screen printing, and the industry as a whole had little use even for computers. Screen printing was a mature technology with limited scope for innovation.

Most of the tiles produced were either plain or unsophisticated with simple and repetitive patterns. It was difficult for manufacturers to make their tiles stand out from the competition and differentiation was mostly down to price. The decoration process had other disadvantages, including high set-up costs, long production runs, and the difficulty of exactly matching tile colours on repeat orders.

Step forward to today however and, digital inkjet is the 'must have' technology for ceramic tile manufacturers. It is no longer a case of offering digital tiles as an 'optional extra'; digital capability is expected, and digital inkjet is the only viable print option.

> Inkjet is an extremely versatile non-contact technology; it can be used to apply a wide range of fluids with precision accuracy to a range of different applications.

There are two key types of inkjet printing – Continuous Inkjet (CIJ – continuous flow of fluid) and Drop-on-Demand (DOD – a drop of fluid is only produced when it is needed). Xaar uses Drop-on-Demand inkjet technology.

DOD inkjet is divided into three classes – Valvejet (which uses needle valves and solenoids to control the flow of fluid); Thermal inkjet (a current is applied to a tiny heating element which heats up rapidly as a result, causing the fluid to vaporise and bubble within the printhead chamber, forcing the fluid out of the nozzle); and Piezoelectric inkjet, which is Xaar's specialism.

Piezoelectric inkjet technology uses piezoelectric material as a key active component within the inkjet printhead. Piezoelectric material exhibits a phenomenon called the piezo effect – i.e. when force is applied to certain (natural) materials, a charge (electricity) is produced. Another effect – the reverse piezo effect – occurs when you apply electricity to the material – in this case the material deforms (ie moves). Piezoelectric printheads incorporate PZT, which is a manufactured and poled piezoelectric material. All piezo printheads work in the same way. The material is deformed in order to fire a fluid drop.

The printhead is the part of a printing system that contains nozzles for jetting fluid. Piezoelectric printheads are made up of an active component called the 'actuator', a series of pipes and channels collectively known as the 'fluid path' and some electronics to control the individual channels. The actuator contains a series of parallel walls, made of PZT, that make up the channels. In Xaar's Bulk technology printheads, the electrical current is applied to the walls of the fluid channels and the walls move as a result. Movement of the channel walls creates acoustic pressure waves which in turn eject fluid from the nozzles at the end or side of each of the channels. Thanks to Xaar's unique architecture and TF Technology ink recirculation, Ultra High Viscosity Technology allows highly viscous (for inkjet) fluids (up to 100cP at jetting temperature) and highly particle loaded fluids (up to 60% by weight) to be jetted. However, the quality of the fluid is hugely important to the quality of jetting. Like poor fuel in an engine, it can work. But not well, although Xaar's printheads have a particularly wide range of capabilities.

Read our white paper on high viscosity printing here:
xaar.com/en/resource-centre/pushing-the-boundaries-of-inkjet-technology-with-high-viscosity-printing/

So why use digital inkjet?

No plates, no waste

In analogue printing the first step is always to make plates, screens or printing cylinders (we will just say plates from now on for brevity) that are used to print the image on the substrate over and over again. This traditionally involved making films in order to make plates but with digital printing this is eliminated. This saves cost and time as well as waste, as there are no plates to be scrapped. Another limitation of the analogue process is that the size of the printed image is constrained to the maximum size of the plate; with digital printing onto a continuous roll of paper or plastic there is no such limit, meaning that images like decorative patterns can be longer and less repetitive.

The proof is the real thing

Buyers generally like to see at least one proof to judge what their job will look like after printing. In fact they may ask to see more than one, if the first trial doesn't live up to their expectations. With digital printing, the same equipment can be used to print the proof, or proofs, giving the buyer confidence without incurring any additional costs. With conventional printing, by contrast, the buyer has to accept a digital proof, a digitally printed equivalent, or a 'press proof', which means that the printer has to actually make plates and print. A digital proof is only an approximation of the final job, but the lead time and cost of making a press proof is significantly higher.

High resolution and mass customisation

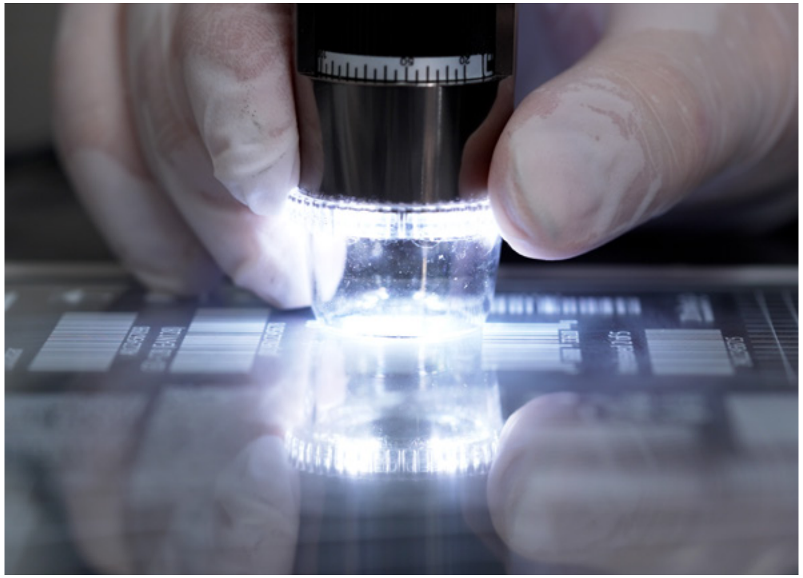
Digital inkjet printing has a number of creative benefits. There is no roller, so there is no forced limit to the pattern size – the size of the pattern is only limited by the size of the memory in the printer electronic sub-system.

Inkjet printing can also apply designs of the highest quality and in the finest detail, creating extremely high resolution graphics, fine details and features. For example, the 720 dpi resolution and greyscale technology used in the Xaar 2002 printhead can reproduce an effective resolution of more than 1000 dpi, which is as much as the human eye can distinguish.

Not only can high resolution printing be achieved, but mass customisation and variable data printing, in which elements such as text, graphics and images may be changed from one output to the next without stopping or slowing down the printing process is also possible. For example, a different name, address, barcodes, language, birthday and lots more! This allows companies to personalise their product and add value to their customer, generating greater interaction and an increase in attention.

'Make-ready' means make more

In all printing, once the image is prepared for print, the production line must be set up. This is often referred to as 'make-ready'. In both analogue and digital printing, the substrate has to be aligned, and the ink system prepared and tested. In analogue printing in colour, the plates (one for each of the printing process colours: cyan, yellow, magenta, and black) also have to be mounted and positioned – this takes some skill and is usually verified by running the machine for a short period of time so that you can be sure everything lines up properly – what printers call being 'in register'. The amount of ink transferred to the substrate must also be carefully adjusted to ensure good reproduction. All of this takes time and wastes materials. With digital printing, make-ready is a much shorter process which can be reduced to virtually zero and consequently benefits from much less waste.



Digital's shortcut

Most printing is still analogue, and traditional methods still offer the lowest cost per print for long print runs, but there is a breakeven point where digital jobs are less expensive per copy. Although this breakeven point varies depending on the type of print job, the setup costs involved in analogue printing mean that, for short print runs, the costs per copy are typically higher than for digital printing. Until the breakeven point is reached, digital printing can be much less expensive per copy.

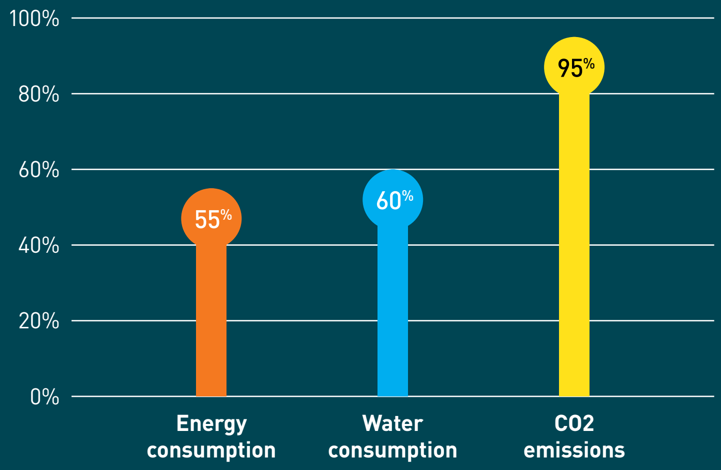
This ability to print short runs economically has a lot of advantages:

- It opens up new markets for industrial printing, such as personalising a direct mail pack (a run-length of one!), customising a product with the local retailer's name, printing promotional items, or in local languages on low-volume product labels
- It makes 'just in time' delivery of printed items possible, because there is no set-up time
- It avoids waste, because you only need to print what you want, instead of printing X,000 copies because any lower quantity is not economical – which saves money and helps the environment
- It potentially allows businesses to improve the efficiency of their supply chains, both because of the reasons above and also because they might be able to bring printing in-house.

Kinder to the environment

As well as being able to only print what you need, digital print methods are inherently more environmentally friendly than analogue techniques. Research shows that, compared to analogue alternatives, digital has a huge impact in reducing energy consumption (by as much as 55%), water consumption (by up to 60%) and CO2 emissions (by up to 95%), but also in reducing pollution and waste materials.

Digital printing compared to analogue reduces consumption of up to:



Different types of digital printing

Colour printing with electrophotography (i.e. industrial-scale colour laser printing) has been around for a couple of decades, improving in quality and reducing in cost all the time. The technology is now relatively mature, and is widely accepted for short-run printing onto paper. Products like the Xerox® PrimeLink®, HP Indigo and Kodak Nexfinity are examples of electrophotographic printers that use toners instead of printing ink for high volume printing.

Industrial inkjet as an industrial process – outside of wide-format imaging and bar-coding – is still in its infancy; but it is maturing extremely fast. Its key advantage over toner-based laser printers is that inkjet is non-contact: the printhead does not touch the substrate at all. This means that inkjet printers can be engineered to deal with a wide variety of substrates not open to laser printers – rigid board, thin films, wide sheets of vinyl, 3-dimensional objects and so on. It also means that no mechanical pressure is put on the substrate – important if you are printing onto fragile objects and want to increase your yield!

Also, inkjet printers can deal with a wide range of different fluids. These can be formulated to be optimised for different substrates e.g. glass or plastic, paper or ceramic tiles. This flexibility is the driving force behind the rapid acceptance of industrial inkjet printing.

In summary, neither the fastest inkjet nor electrophotographic printers can match the production speed of the fastest conventional presses, but both techniques have the 'digital advantage' of offering fully variable data printing and having almost no set-up time, and both offer a print quality that, at its best, can equal analogue printing. Where the technologies compete head to head, in promotional or label printing, for example, the argument tends to be about economics – which usually favours inkjet. In other applications, the flexibility of inkjet wins out.

2 Application ideation

So you know the benefits of digital inkjet and you think inkjet could be the way forward for what you want to achieve, but how do you figure out if it will work? Where do you even start?

We believe the key to minimising time to market and development cost is to start with understanding exactly what the requirements are.

In an ideal situation, choosing your fluid in partnership with your printhead based on your requirements for your application is the best method. The most fundamental question of all you need to answer and also in the quickest amount of time is, 'can I Inkjet print this?' – yes or no. This will ensure you achieve maximum return on investment. Xaar can help here with our 'five step customer process for fluid evaluation' which we go into more detail later on into the guide.

Firstly, what are your requirements? This could be resolution, print speed, orientation, adhesion or print width. This will help to figure out what printhead capabilities and fluid specifications are needed – arguably the two most important things to consider when developing with inkjet. Or, for a technical application, you may want a very specific outcome to suit the product that is not optimal for the inkjet performance. We can understand that and 'tune' our products' performance to not only suit your fluid, but also the application you are using the fluid for.

As inkjet printing can be used for such a wide range of application, using a wide range of fluids, you'll need to keep in mind if you're application requires a specific type of fluid and/or condition that could potentially harm the printhead itself, such as particularly aggressive solvents or at a very high temperature. If so, consider printheads are that developed using materials selected for their resistance to chemical attack and that can withstand specific conditions.

3 Choosing an inkjet fluid

The choice of fluid is probably the most critical decision in any new industrial inkjet application. It is essential to choose a fluid that is well-suited to the application and that has the right appearance on the full range of substrates to be printed.

The main components of a fluid is the functional ingredient and carrier. The functional ingredient can be a pigment, a dye or any component that forms a function after or during the droplet ejection such as a metallic, ceramic, catalyst or reactant; the carrier fluid may be aqueous, solvent, oil-based or something else. Other components are added to a fluid to improve their usability, for example: surfactants to control the surface tension of the fluid drop to improve its behaviour in flight and when it impacts on the substrate; binders to improve the elasticity of the fluid; dispersants to aid the dispersion of the additive in the carrier fluid.

Many people have experimented with inkjet printing in applications that are not traditionally and inkjet application, such as decorating or marking a product, or text. In these applications we call the 'fluid' a Functional Fluid as it has a secondary function to perform when laid down on the substrate.

One example is where metallic or conductive functional fluids are printed to form electronic components and circuits. In this case the functional fluid consists of nanometre size particles of conductive metals such as silver or copper held in suspension in a carrier fluid. Once printed, the fluid is then sintered (heated until the tiny particles adhere to each other) enabling the construction of conductive tracks for electronic components and circuits.

Other functional fluids include solders, epoxies, optical polymers, conductive and semi-conductive polymers, transparent conductors, dielectric and resistor materials. Materials for 3D printing such as functional UV Photopolymers, Binders and others.

The advantages of inkjet in these applications can include the reduction in waste and toxic materials. For example, the standard procedure for printed circuit boards (PCBs) requires the whole board to be coated, then masked and etched, which is wasteful and therefore more expensive. Inkjet also allows multiple materials to be dispensed at the same time in a smaller space than most analogue processes.

Choosing or developing a fluid

With such a wide variety of fluid around, how do we choose a suitable solution?

Generally the first item to consider is the purpose of the final product. If we are talking about an outdoor poster that has to withstand sun, wind, rain, hail or other natural phenomena, we need a final result that can withstand these conditions: probably a pigment-based solvent fluid. Conversely if we are talking about low-cost transactional printing, then we are more interested in getting fine printing on a paper substrate where the fluid doesn't bleed.

Because industrial inkjet printheads are precisely manufactured products with ultra fine nozzles, the composition of the fluid must be matched carefully to the printhead to ensure that the fluid can be jetted reliably and consistently. Most printhead manufacturers fine-tune the way the printhead fires the drop for each of their approved fluid to ensure optimal jetting performance for each specific application, or they provide tools to enable their customers to do this. At Xaar, we can develop this with you as part of the jetting optimisation based on your needs.

We have developed a Fluid Formulation Guideline for each of our printheads. These act as a means of conveying the learning that Xaar has amassed during printhead development and from jetting several hundred fluid types across a range of applications. The Fluid Formulation Guideline looks at the physical properties of the fluid. Based on these physical properties and material compatibility, we can give you an indicative result of the compatibility of the fluid with the printhead.

Fluid outside these guidelines may function for specific applications but with compromises in printhead performance. If you're unsure, we can provide materials compatibility test kits to allow screening of formulations before submitting them for testing.

If you know what fluid you're using, then you're one step ahead but if not, then our dedicated Fluid Division can help find and supply a fluid as part of a customised all-in-one fluid package so you only have a single point of contact, saving time and simplifying the development process. We work with leading fluid manufactures to fully optimise the fluid for the best print performance, not just in the printhead testing lab, but also throughout the machine development programme, through to user integration and beyond.

Our five step process for fluid evaluation is a flexible route for the development of jettable fluid, whereby we will test the compatibility of the physical properties and how that fluid performs in relation to jetting on a lab scale as part of fluid approval testing. Step one only requires a maximum of 300ml, which makes evaluating Xaar technology extremely accessible for applications with expensive or exploratory fluid types.

We've included this below, but you can use it as more of a checklist to help guide your development journey.

1 Fluid evaluation

- Complex rheology testing
- Ink development guidance
- Fluid physicals measurement
- Materials compatibility testing

2 Jetting optimisation

- Printhead waveform configuration
- Application and fluid optimisation
- In-flight droplet visualisation

3 Sample production

- Pre and post jetting treatments
- Measurement of sample properties
- Drop deposition configuration options

4 Applications development

- Provision of Xaar Inkjet Development System
- Laboratory scale integration and testing support
- Education and training

5 Continued support

- Application improvements
- Product support and advice
- Application evaluation and testing
- Future development and enhancement support

Fast forward and once you've had the green light and you know your fluid is compatible, the best way to progress is to produce samples to prove it is all possible.

All of the above is evidence to help you answer that fundamental question we talked about earlier, 'can I inkjet print this'.

Choosing a printhead

Firstly, you will need to choose how you wish to print (greyscale, single-pass or scanning etc.) and how many different fluids you want to use. That will determine what type of printhead and how many printheads you will need in your print bar. Extra printheads might be added for a greater print swathe or for increased resolution. Cost of course is a consideration, but, in general, the more printheads you use the more productivity you get.

Ink recirculation has become an essential feature for a significant number of market sectors and applications, such as glass printing with frit inks, high opacity white pigment ink printing for labels, heavily loaded conductive inks for printed electronics, and highly loaded pigment inks for textiles with vibrant colour.[1] Consequently, end users are faced with a variety of different approaches to recirculation. Whilst variety and competition are welcome, they make choosing the right printhead more difficult, because each design has its own characteristics, advantages and disadvantages.

Read more on ink recirculation here:
xaar.com/en/resource-centre/tf-technology-what-goes-around-comes-around/

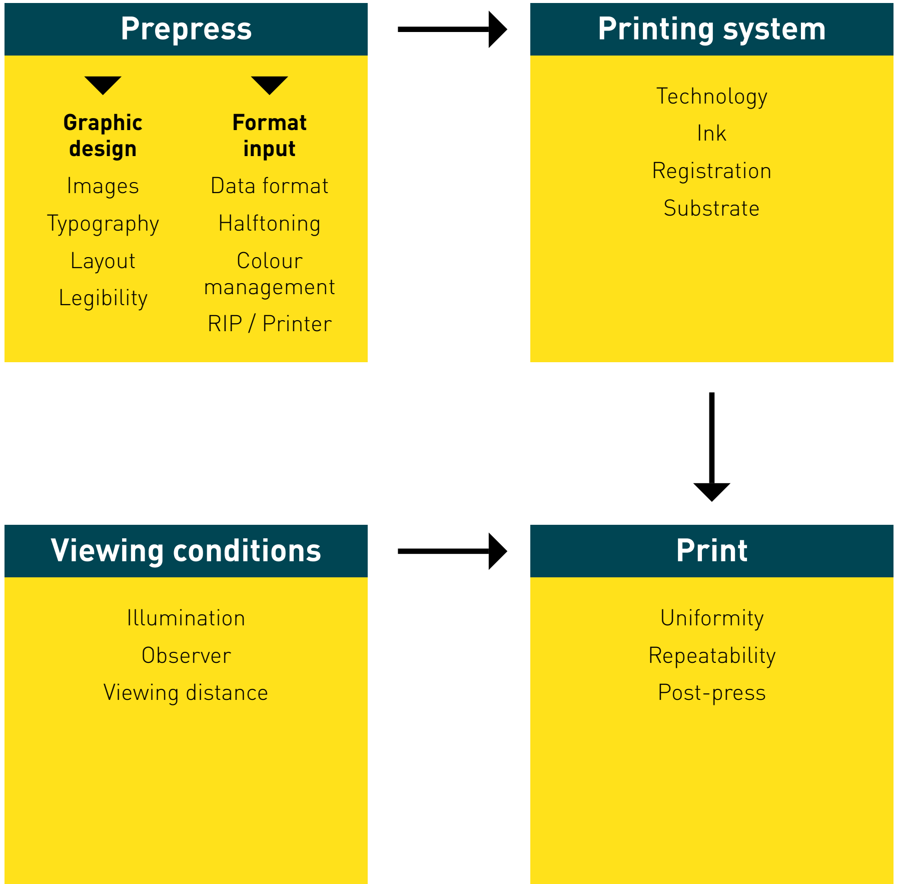
[1] Handbook of Industrial Inkjet Printing, Editor Werner Zapka, Published by Wiley, 2018

Xaar's TF Technology ink recirculation together with the unique Hybrid Side Shooter architecture leads to a high reliability through self-recovery of the printhead. The continuous recirculation of the fluid allows for the jetting of higher viscosity fluids, and/or heavily pigmented fluid(s) and an extremely fast start up time.

Watch our video to see an un-primed printhead being installed and printing in under 2 minutes here: **xaar.com/en/resource-centre/instant-start-up/**

Ink recirculation is particularly important if you are printing onto a curved or shaped surface in both horizontal and vertical 'skyscraper' mode, making Xaar printheads compatible with many production line handling systems and even on a 6-axis robot as an end effector.

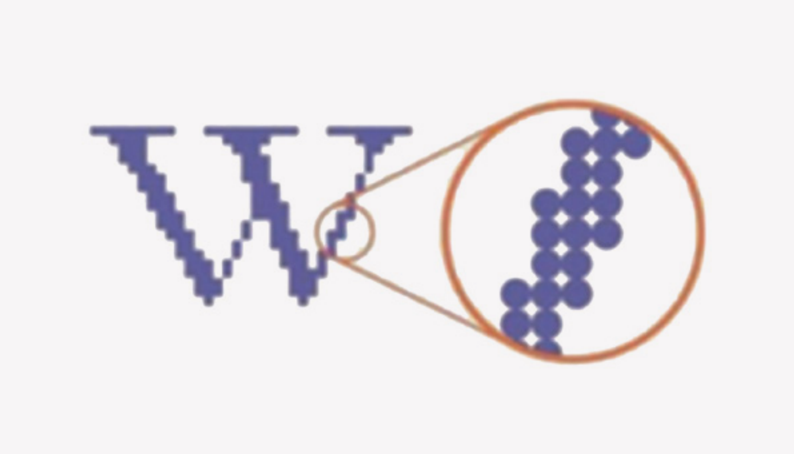
Considering the drop size from the printhead is another important consideration. The general rule of what drop size to use will differ depending on a number of factors as detailed in the diagram to the right.

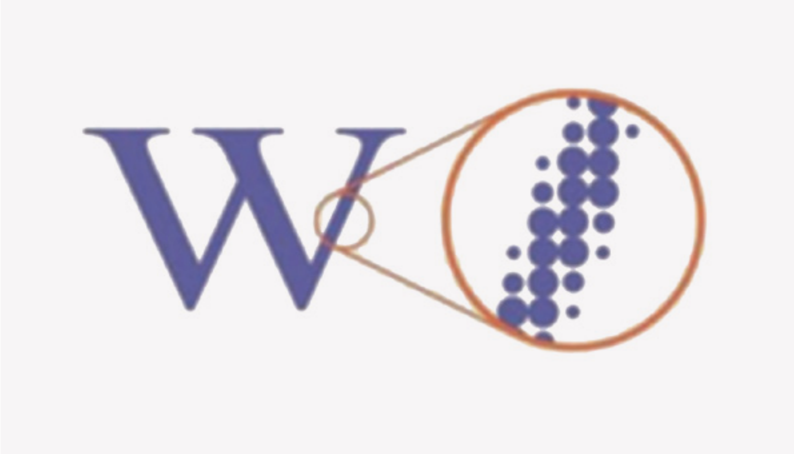


The size of a printed dot is a function of the drop volume jetted by a printhead and is influenced by the ink and substrate characteristics. A smaller drop size gives a smaller printed dot which results in a lower colour density, thus improving image highlight areas. However, this does not necessarily mean that smaller is better. An array of printed dots which do not fully overlap and have white space between them will not be suitable for printing solid areas or bold text. A larger dot size can ensure that full solid coverage and stronger or higher opacity colours are achieved. This is a distinct advantage for prints that are designed to have a high visual impact.

To achieve clean edges on graphics and text, especially on diagonals, a high print resolution is necessary. The image below shows how the variable dot size can be used to clean up edges on fine text so that its smoothness is improved.

Generally, drop sizes range from 3 pL to 40 pL. For example, a discreet line may be better served by a 3 pL drop and a coating would be with more suited to a much larger drop ensuring droplet merging on media.





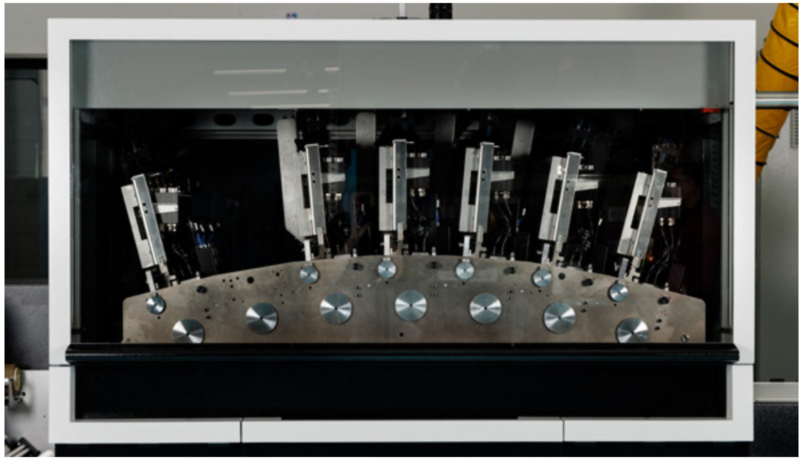
4 System components

So you have your application requirements, you've selected your fluid along with your printheads and you've had samples produced which proves it's all possible – what are the next steps to turn it into a reality?

This is when you could either begin to choose your system components to build an industrial inkjet printer or opt for an out-of-the-box, ready-to-go integrated system that can used for developing an entirely new system or adding to an existing one.

Let's start with explaining what is needed to build an industrial inkjet printer.

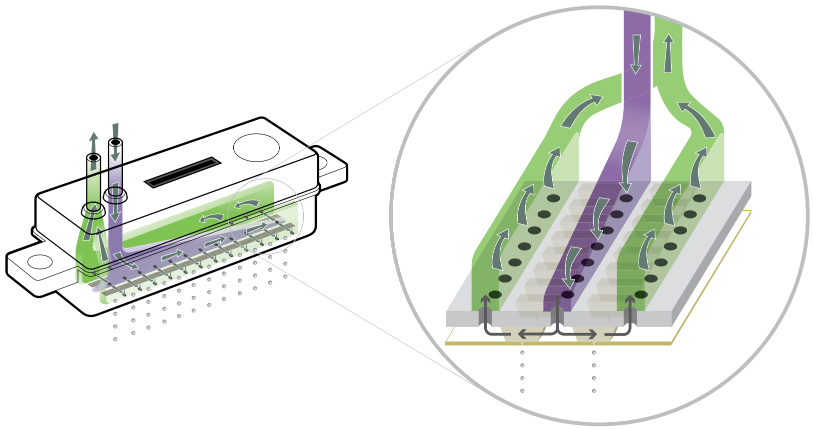
An industrial inkjet printer is much more than a set of printheads and a well-chosen fluid. There are many other components to a well-designed system and they all have to work well together.



Fluid delivery system

The printhead works by using a small amount of energy in each nozzle to eject a drop of fluid. This breaks the meniscus at each nozzle. (The meniscus is the curved surface of the fluid formed at the nozzle orifice by surface tension. Imagine a glass of water filled to the very brim. Look at it carefully and you will see that the surface of the water forms a convex curve slightly above the top of the glass. This is a meniscus.) The drop is held back in the nozzle by a slight negative pressure until the energy pulse is applied. If it were not, it would dribble out! The main function of the fluid supply system is to ensure that the correct negative pressure in the system is maintained, while ensuring that the printhead does not get starved of fluid when printing. Too little fluid, and you will see gaps in the printing; too much fluid, and the nozzle plate might get flooded, causing irregular jetting, again compromising print quality.

The fluid supply needs to do several other things: it will filter the fluid to minimise the chance of particles clogging the nozzles; it might 'de-gas' the fluid to remove air bubbles; it might heat the fluid to ensure that it is at the right operating temperature; and in the case of a 'fluid recirculation' printhead like the Xaar Nitrox (which has TF Technology), it will continuously circulate the fluid through the printhead past the back of the nozzle as in the schematic below.



Above illustration: The fluid flow through Xaar's Hydrid Sideshooter Architecture. Purple indicates the incoming fluid and green the outgoing fluid either side of the nozzle

How much fluid will I need?

In industrial inkjet machines, the fluid is usually supplied in 1 or 5 litre bottles, but how long would this last on a generic graphics printer, and do we need to worry about the fluid drying up? If we take the Xaar Nitrox GS6 Elite with 1000 channels, this has a maximum drop size of 40 pL and a maximum firing frequency of 48 kHz. If we set the machine up to jet continuously then it would use:

(1000 nozzles x 42 pL x 7 kHz) = 1.06 L/h

In practice though, we would rarely have an image that is 100% covered in a single fluid, it's usually made up of different colours and shades plus on a scanning machine there will be flyback time and more often than not there will be a white space around the image.

In any case this gives some idea of the amount of fluid an industrial machine can use.

Drive electronics

The drive electronics form a key element to the success of the digital inkjet process, providing the conduit between the processed image data and the printhead.

The printhead needs electronic signals to control where the fluid will be applied. This delivery of signals is dealt with by the drive electronics, which take the digital image file and translate it into electronic signals that the printhead can understand.

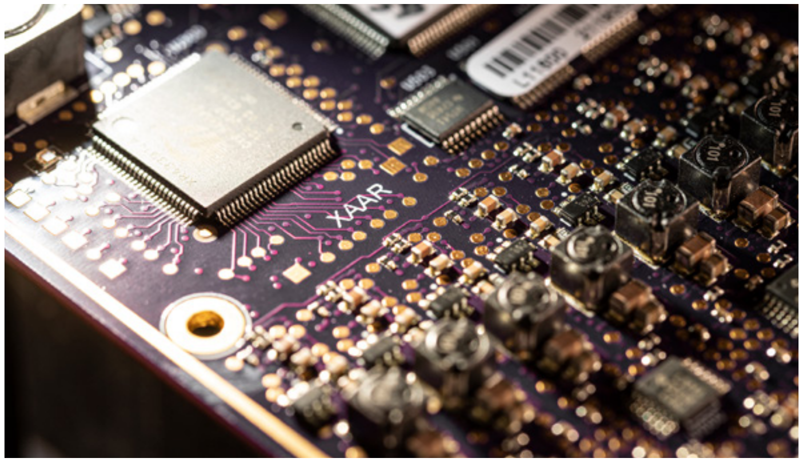
In general, some electronics are built into the printhead itself providing the correct voltage and current to actually drive the printhead.

The drive electronics are contained within the box that communicates between the PC that provides the image to be printed and the electronics on the printhead itself. In some cases vendors refer to Head Personality Cards (HPCs). These allow connection of different printheads to a set of common drive electronics. The HPC converts the generic information from the drive electronics into the specific signals that particular printhead type requires.

The signals drive the piezo actuation (for printheads like the Xaar Nitrox or Xaar 2002) or the thermal activation (found in other manufacturer's printheads).

The required pattern of coloured dots making up the image determines which printheads receive what signals, at what timing, while the substrate is passing underneath them.

Various printhead manufacturers offer their own designs of drive electronics. There are also a small number of independent suppliers, or the drive electronics can be provided by a systems integrator or the printer manufacturer itself.



Software

In the digital age, the starting point for print is inevitably a digital file: a BMP, PDF, JPEG, TIFF or EPS (encapsulated Postscript™) file containing the text, graphics and photographic images to be printed.

The job of the software and datapath electronics in an industrial inkjet printer is to take this file and translate it into instructions to place drops of fluid of the right size in the right place on the substrate to give the best possible reproduction of the image to be printed.

This might involve:

- Scaling the image to the right size, and possibly 'tiling' it, if it must be printed in multiple sections
- Adjusting the resolution
- Optimising the dynamic range of the image (from shadows to highlights)
- Neutralising any colour casts
- Colour management, or adjusting the image to compensate for the colour profiles of the input and output devices
- Adjusting sharpness
- Colour-separating the image into the printing main colours – typically cyan, yellow, magenta and black, but possibly including white, and light versions of cyan, magenta and black, or 'extended gamut' colours like orange and violet. When separating colours, the software might make small adjustments where colours overlap, to overcome mechanical registration errors in the printer. This is called 'trapping'
- In the case of variable data printing (e.g. a variable barcode, or personalised mailing), this must be integrated in some programmatic way with the template for the rest of the image.

These functions, and often many more, are carried out in Raster Image Processing, or 'RIP' software, and we often speak of 'RIPing' a file to create an output 'bitmap' – that is the raw data that specifies for every pixel location on the image whether or not a drop of fluid of each available colour is to be placed there. Before the advent of 'greyscale' or variable drop printing, this file was binary – one bit per pixel, '1' or '0', a drop or no drop. With 8-level greyscale however, 3 bits/pixel have to be specified; and with 16-level, 4 bits/pixel. Whether binary or greyscale, the datapath electronics have to take the value for each pixel and interpret that in terms of the layout of the printheads, the speed of the printheads over the substrate, and timing of the start of printing. The pixel data is typically 'buffered' in memory and 'print swathes' are streamed to the printheads. The printhead drive electronics therefore needs a 'product detect' signal to start printing, and an encoder signal, giving the speed of the substrate relative to the printheads.

All these functions and adjustments are controlled via a Graphical User Interface or GUI, typically on a PC.

Integrated products - print engine

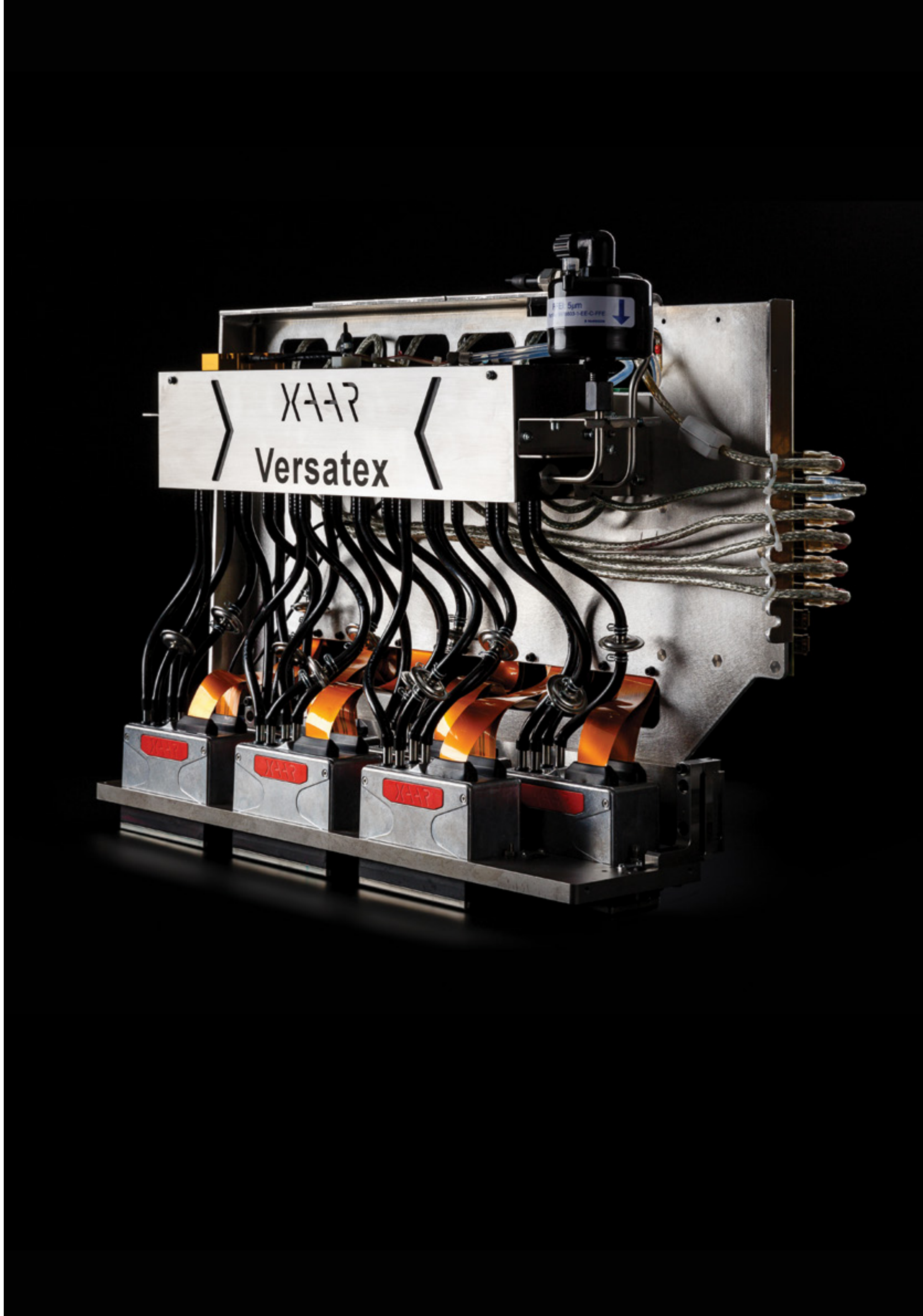
To accelerate your time to market and reduce development costs, you could decide to use an integrated product like a print engine such as the Xaar Versatex and take advantage of an already proven ready-to-market product.

For first time developers, using an already integrated solution provides a fast track route into using inkjet technology with minimal development effort and greatly simplifies the deployment of printheads, ink delivery, software and workflow systems.

The Xaar Versatex includes a precision aligned array of printheads already mounted in a bar, an industrial quality recirculating ink delivery system, full datapath electronics to drive the printheads, a software suite including image workflow, colour management and ink system control all incorporated into a single graphical user interface for easy control and management. Plus, with the Xaar Versatex, you will receive access to invaluable inkjet expertise from our global support team providing consultancy, training and application expertise, to shorten your development time even further.

Depending on the features of your print engine or if you have chosen to develop the full system yourself, you will also need to consider the following components to complete your print solution.

Read more on the Xaar Versatex print engine here:
xaar.com/en/products/print-engines/xaar-versatex/



Frame and transport system

Another challenge with inkjet printing is getting the fluid near to what you need to print on. You must decide how to handle your substrate to get it and your printbar and fluid close enough to print in a regular pattern. This depends on the type of printer you use as illustrated here in graphics printing:

- On a scanning inkjet printer, the frame needs to be strong and sturdy enough not to vibrate or move during printing. The material transport mechanism is fixed onto this frame
- A roll to roll printer will need a roll spindle on the back to feed the material into the print section and a roll spindle to collect the printed material, with a mechanism on both rollers to maintain steady tension so the material remains stable. Some machines simply have a feed roller and the printed material collects on the floor. Others include a horizontal cutter at the delivery end so that the graphics can be cut to size as they are finished
- A flat-bed printer needs a flat surface on which the sheet material is placed ready for printing. To ensure the material doesn't move during printing, you can also add a vacuum system under the bed that draws a vacuum through small holes in the bed. This table will either be fixed with the printing gantry moving across it, or moving table with a fixed gantry and moving printheads
- A hybrid roll/flat bed printer needs to incorporate all these mechanisms.

Curing and drying system

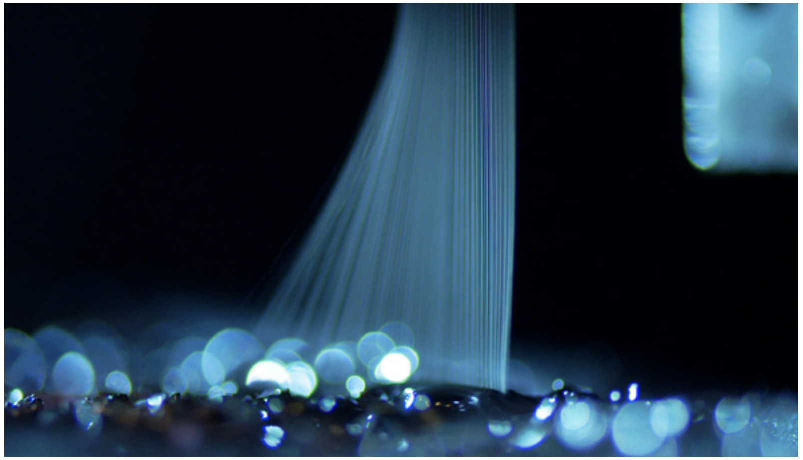
A critical factor determining the speed of a printer is the fluid drying time. There are essentially four drying options:

- Latex fluid: needs a pre hot air drier to soften fluid before use and a post dryer to fix it
- Solvent fluid: needs a hot air post drier or radiated heat (such as LED or infrared lamps)
- Aqueous fluid: needs a hot air post drier at great temperatures to encourage a rapid evaporation of the water within the fluid
- UV fluid: where the fluid is fixed using UV curing lamps, either mercury arc or LED. Some designs of printer use an LED lamp for 'pinning' after each colour is printed, followed by an arc lamp for the final cure.

In the case of aqueous and solvent fluid, heat is applied to the substrate after printing to drive off the carrier fluid, leaving only the pigment. As noted above, UV-curable fluids need to be exposed to a short burst of intense UV light to cause them to 'polymerise'.

The light source has usually been a mercury arc lamp designed to emit light at a specific range of wavelengths corresponding to the sensitivity of the photo-initiators in the fluid. UV LED (light emitting diode) light sources are gaining increasing acceptance, despite some disadvantages. They typically operate at a narrower band of wavelengths, so the fluid needs to be 'tuned' for use with LED-curing, and they put out less power than mercury lamps. However LEDs have longer life, consume less energy, throw off less heat, and avoid the environmental hazards of mercury.

One use for UV LEDs in single-pass printing applications is to 'pin' or 'freeze' fluid drops on the substrate after each colour is jetted. That is, to prevent the fluid drops from spreading while all four colours are printed, before the main UV lamp fully cures the fluid. A 'pinning lamp' after each colour freezes each drop in place before the next colour is jetted. This can improve the print quality.



Maintenance

As anyone who has owned a desktop inkjet printer knows, occasionally it is necessary for a printhead to clear its nozzles by jetting a little fluid, and in extreme cases, to manually wipe the nozzles to recover a blocked jet. Similar strategies are used in industrial inkjet printers for the same reasons – nozzles can become blocked by air bubbles, particles, or dried fluid. Regular maintenance, either automatic or by the operator, can reduce the incidence of these blockages.

In the case of scanning printers, especially those using solvent fluid which can dry out in the printhead, it is common for the printer software to instruct the printheads to 'spit' at regular intervals to ensure the nozzles remain clear. This is less important in the case of UV-curable fluid, because the fluid can remain in the nozzles for hours or even days without ill effects, as long as they are not exposed to UV light or too much heat. Also, because a scanning printer might use eight or more passes to build up the image, a single nozzle outage can be easily disguised.

In a single-pass printer like a narrow-web label press, a single nozzle out, or 'line down' is immediately visible in the print. This is why 'self-recovering' printheads like the Xaar Nitrox and Xaar 2002 are particularly useful when used in these applications. Although these printheads are less susceptible to 'lines down' than conventional non-recirculating printheads, manual or automatic maintenance by jetting, wiping, or vacuum purging is still required approximately once per shift. Different machine manufacturers take different approaches to this. One key difference from desktop printers is that industrial inkjet printheads are designed to last many months and years.

Take a look at Sure Flow, our ultrasonic self-cleaning printhead mode, to help prevent and clear blocked nozzles

xaar.com/en/resource-centre/sure-flow-keeps-xaar-printheads-at-their-very-best/

Unlike thermal inkjet components, the piezoelectric material lasts for billions of operations, corresponding to many years of life. The usual causes of printhead failure are (a) clogged nozzles, and (b) damage to the nozzle plate. Both of these typically result from poor maintenance or incorrect fluid use, so it is important that the manufacturer's instructions are followed to get the most life from your inkjet system.

Another frequent cause of problems with industrial inkjet systems – especially ones that are used to decorate products or packaging – is nothing to do with the printheads or system design: it is the interaction of the fluid with the substrate. If the surface tension of the fluid is not compatible with the surface energy of the substrate, the fluid may not adhere properly, or it may cause a variety of unpleasant print artefacts because of the way the fluid drops behave when they strike the moving substrate. These effects can be mitigated by optimising the fluid formulation, and by techniques such as corona-treatment or flame-treatment of the substrate.

Summary

We've had 30 years of experience in developing with inkjet and hope that this guide has distilled down some of the key information needed to get started on your inkjet development journey and highlighted a number of considerations to think about.

Developing with inkjet is not an easy task but with support, a clear structure and the correct products, it is a viable, cost-effective manufacturing method with many benefits. Only by understanding some of the challenges earlier in the process, can they be more easily and cheaply resolved, reducing time to market and return on investment.

If you're still unsure or you'd like to discuss your project with us, we'd be happy to help. We want to help take the unknown out of inkjet by providing the latest printheads, technologies and infrastructure all under one roof.

Get in touch today and speak to one of our experts.

Extracts of this guide have been sourced from **Xaar – A Guide to Industial Inkjet**.

Xaar is a world leader in the development of inkjet technology and manufacturer of piezoelectric drop-on-demand industrial inkjet printheads. Our technology is used all over the world in a wide range of print applications including wide-format graphics, labels, packaging, ceramic tile decoration and outer case coding, as well as printing with specialist fluids for advanced manufacturing and 3D printing applications.

We design and manufacture our printheads in the UK and Sweden, exporting over 85% of our production to customers around the world. We also develop and sell inks and ink systems, electronics and offer a fluid optimisation service to accelerate inkjet system development and adoption.

With 30 years of experience, world class products and talented people our mission is to push technical boundaries as a leading driver of innovation and for driving production.

XAAR

Xaar plc

T +44 (0) 1223 423663

E info@xaar.com

www.xaar.com

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