Inkjet Architecture - Printheads

As superwide format printer manufacturers continue to increase speed and resolution, printer designs become more complex. Current printers can have more than eight thousand nozzles with each being capable of firing more than forty thousand drops per second. While sophisticated electronic and mechanical systems are required to drive these printers, the printhead itself is a fundamental system building block. This brief discusses the key features of inkjet printhead design and architecture that influence not only image quality but also system reliability, serviceability and cost of ownership.

The printhead is the heart of the inkjet printer. The combination of the number of nozzles in the printhead and the firing frequency drives the ultimate speed of the printer. In general more nozzles equates to more speed. Manufacturers can increase speed in two ways: add printheads or increase nozzle density per printhead. Understanding nozzle density is important when analyzing printer architecture because it impacts reliability, cost and print quality and selection of a printhead with more nozzles results in a simplified design with fewer printheads.

Fewer Printheads Improves Reliability

Printheads are complex subsystems containing circuit boards, piezo technology, cables, vacuum lines and ink lines. Fewer total printheads simplifies the design and results in fewer failure points in terms of component counts and fewer connection points that may leak. For all vendors, each new generation of printhead design has generally increased nozzles density in order to drive more simple and reliable architecture.

Fewer Printheads Reduces Printer Cost

Printheads are mounted in a carriage that travels back and forth on rails thousands of times per day. Designs with fewer printheads fit into a smaller and more compact carriage that exerts less stress on the entire system. This allows lighter weight frames with simple and reliable drive systems to be used, reducing cost. Conversely, printers with many printheads are typically larger and more complex designs that require massive rail beams, linear magnetic drives and extra large frames which add unnecessary cost and complexity.

More Nozzles per Printhead Improves Print Quality

All nozzles in the printer must be aligned to achieve proper print quality. This is a two step process. First, nozzles are laser cut into the printhead, and then the printheads are assembled into the printer carriage. The laser cutting process is very precise but printheads still require mechanical alignments which have variance. High nozzle density results in fewer printheads with less alignment points and variance, which optimizes print quality. Although alignment variance and print quality is not likely to be a problem on a new printer with printheads installed in the factory, field replaced printheads may not be as precise and print quality may drift over time. Using fewer high nozzle density printheads reduces alignment points and variation resulting in better print quality over the life of the printer.

VUTEk printhead with 508 nozzles

High Nozzle Density Means Lower Cost per Nozzle

Printhead prices can vary widely based on performance and features. When evaluating a price to performance ratio, comparisons should be made on a price per nozzle basis. The cost per nozzle of a printhead with 508 nozzles is typically lower than a printhead with only 128 nozzles due to material and production efficiency.

Some vendors address lower nozzle count printheads by arranging them into arrays. While this is a creative way to overcome the lower nozzle density, it adds steps to the assembly process and associated complexity and cost. It is also very important to understand if one of the printheads in the array design fails, the entire array may need to be replaced driving higher field service costs.

Competitive printhead array with 4 x 128 nozzles

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Printhead Serviceability

Printheads rarely fail for mechanical reasons because they have virtually no moving parts. Failures are more often caused by dust or debris getting lodged into the nozzles. The ability to easily remove debris without calling field service will keep the printer up and running. Removing the obstruction starts with a simple ink purge. If this is not successful some printers have a solvent flush system that is more aggressive.

Printhead Replacement

If the nozzles are still not working, replacement will be necessary. This could mean days of downtime if a field service engineer is required, unless the printhead carriage has a field replaceable design that allows customers to easily maintain heads with minimal alignment required. The alignment system is a precision fit between the carriage and the printhead that allows the user to quickly remove and mount the head in the carriage. This type of system will have the printer up and running within an hour. The clogged printhead can then be brought to an off-line flush system that pumps solvent in the reverse direction to dislodge debris. If successful the printhead can simply be returned to stock with no replacement cost incurred. User replaceable printheads and aggressive head flush options are important components of inkjet architecture that will minimize downtime and reduce the total cost of ownership.

Conclusion

Printheads are a vital component which impacts the entire mechanical and electrical design and performance of the printer. The best printhead will be reliable and serviceable while delivering accurate and high quality dot placement over the life of the printer. Higher nozzle density is a key attribute resulting in fewer printheads, overall simplicity in design, and a lower cost of ownership.