Technology Backgrounder: HP Inkjet Web Press

The HP Inkjet Web Press is a new industrial inkjet printing solution built on HP Scalable Printing Technology. This document explores design features of the HP Inkjet Web Press and illustrates the underlying capability of Scalable Printing Technology to deliver high-speed web printing solutions scalable in features and performance to meet a variety of applications and requirements.

The HP Inkjet Web Press offers four-color, 1200 X 600 dpi duplex printing over a 30-inch (76 cm) web at speeds up to 400 feet (120 meters) per minute. Using HP pigment Inks with a colorless bonding agent, the HP Inkjet Web Press produces high-quality print with excellent color saturation on uncoated stock. Papers treated with HP Paper Enhancement technology offer offset-comparable quality on uncoated stock, and HP coated media deliver outstanding quality at full press speed.

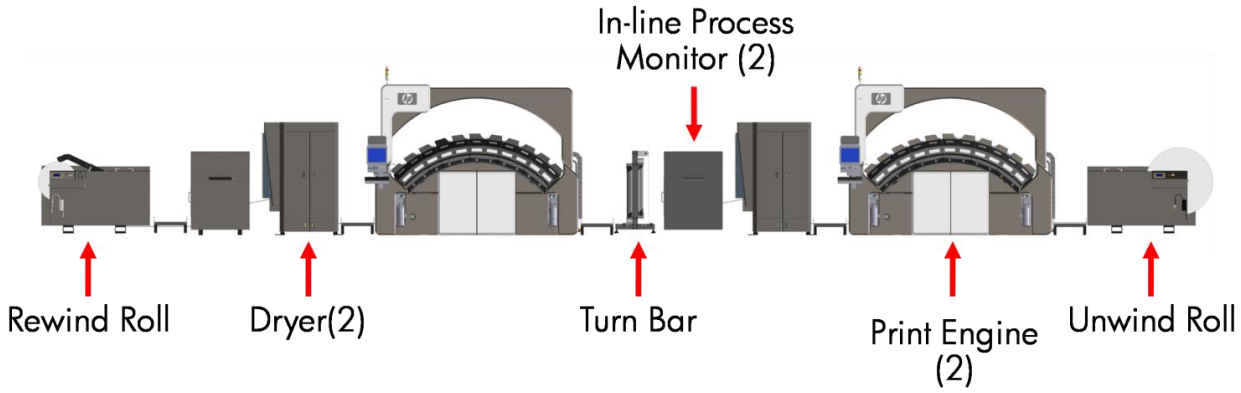
The HP Inkjet Web Press is built on HP's core competencies in printing and information processing technologies. Modular designs in both the inkjet print engines and image processing pipelines provide scalability in features and performance as well as high reliability and ease of maintenance.

HP Inkjet Web Press

A schematic view of an HP Inkjet Web Press is shown in Figure 1. Moving right-to-left in this view, paper is supplied by the *Unwind Roll* and the printed web is taken up on the *Rewind Roll*.

The HP Inkjet Web Press has a modular design: for duplex printing, two identical sets of writing systems are used. Each writing system consists of a *Print Engine*, *Dryer,* and *In-Line Process Monitor*. Print Engines apply ink to the moving web. Dryers use warm forced air to dry the web as it passes over a series of rollers. The number of heaters active at any time within each Dryer depends on the paper and the print density. Water vapor is removed by ductwork (not shown). In-line Process Monitors are machine vision systems that evaluate printing performance in real-time. A *Turn Bar* flips the web over between writing systems for duplex printing. A Press Controller (not shown) provides a touch screen user interface for the press operator and controls and coordinates operation of press subsystems.

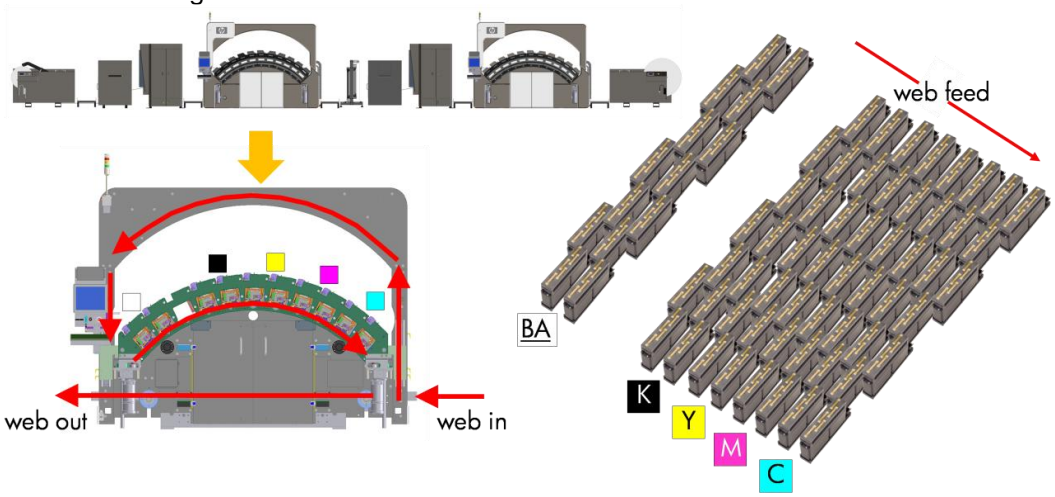
Figure 1. HP Inkjet Web Press: Layout



Print Engine

The HP Inkjet Web Press configured for double-sided printing uses two identical 1200 X 600 dpi Print Engines, shown schematically in Figure 2. As seen here, the web moves right-to-left passing across rollers at the top of the module (printed side up for the second in-line Print Engine) and is then fed down and left-to-right over an arched paper path under the printhead array. This arrangement maximizes the time before rollers touch the inked surface, and tension over an arched paper path positions the paper and holds it a controlled distance from the printheads.

Figure 2. Detail of a Print Engine Module



1200 X 600 dpi printing allows the Print Engine to produce 3-level halftone pixels at 600 dpi. Each Print Engine prints four colors of ink (CMYK) and can print bonding agent (BA) on uncoated stock. The print order is BA, K, Y, M, and C. Bonding agent is applied first and separate from the color printheads to give it time to penetrate and prepare the paper surface before colored inks are applied.

Notice that this configuration employs two printbars in tandem for each ink (and bonding agent). This arrangement provides additional fault-tolerance compared to a single printbar because any one of eight (8) nozzles can print a dot in a 600 dpi dot-row. This is called *nozzle redundancy*.

In the configuration shown for a 30-inch web, there are 14 printheads per color giving 70 printheads in each engine and a total of 140 in the web press. Each Print Engine has more than 140,000 nozzles per color.

Each set of tandem printheads is maintained by an automatic Printhead Service Station, which performs wiping and other functions while the press is stopped for maintenance or changing the paper rolls.

Real-time process monitoring and diagnostics in the HP Inkjet Web Press support a fault-tolerant design by transferring printing from nozzles that are not operating within specifications to their redundant good nozzles, and the operator is informed when an individual printhead should be replaced.

Each printhead is individually replaceable. The snap-out/snap-in design eliminates the need for tools and mechanical adjustments whenever a printhead is inserted into its pocket on the printbar. Alignment across the web (within a printbar) and along the web (printbar-to-printbar) is performed automatically by printing a test pattern and processing it with the In-line Process Monitor that scans the output of each Print Engine.

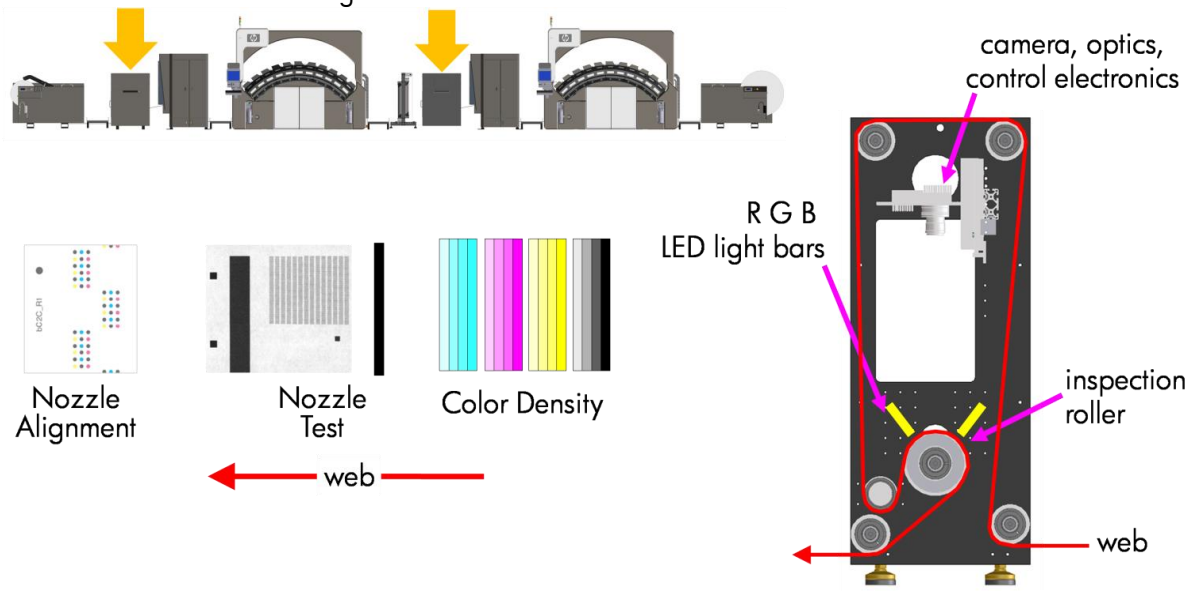
Automatic Process Monitoring

Automatic real-time process monitoring is provided by custom digital machine vision systems developed by HP. These modules are installed in-line after the Print Engine and Dryer as shown by the arrows in Figure 3. Image data captured by the modules is processed by the Press Controller in real-time.

Operation of the In-line Process Monitor is synchronized by the Press Controller to test pattern type and location on the moving web. As the web moves over the inspection roller, illumination from a red, green, or blue light-emitting diode (LED) light bar is coordinated with the color of the test pattern to give maximum contrast for measurement by the monochrome digital image sensor.

During operation of the HP Inkjet Web Press, the In-line Process Monitor scans test patterns printed across the web in the chip-out region between printed frames. This provides real-time monitoring of fitness-to-print by looking for low-density streaks (banding) in each color and bonding agent. Web width and position can also be measured with this system.

Figure 3. In-line Process Monitoring

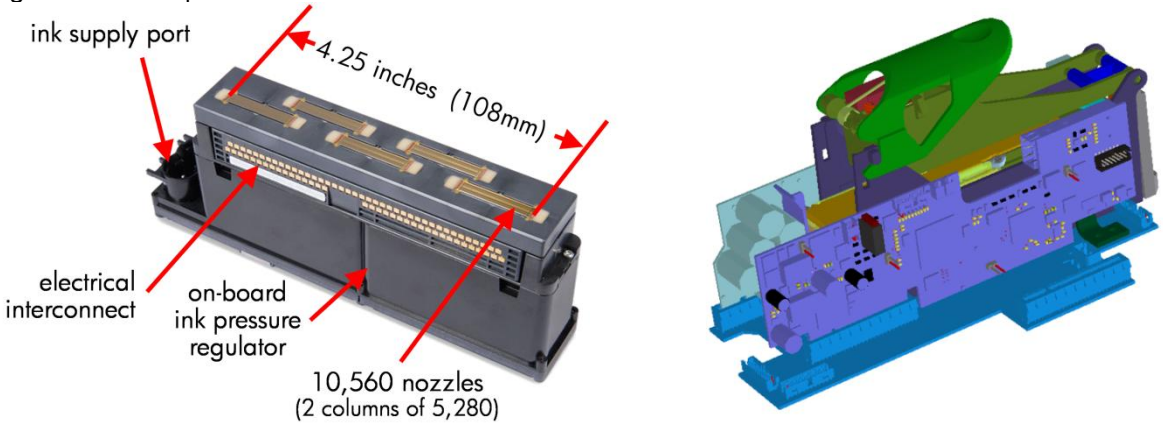


During start-up and periodically during operation, full test patterns are printed on the web. These patterns are shown schematically in Figure 3. They are scanned to provide color calibration, to make adjustments to give uniform print density across the web, to evaluate individual nozzles for dot presence and placement, and to electronically align nozzles whenever a printhead is replaced. The automatic alignment process allows dots from all nozzles to be placed within 1/1200-inch of their ideal position both across and along the web.

Scalable Printing Technology

The HP Inkjet Web Press uses 4.25-inch (108mm) thermal inkjet printheads built with HP Scalable Printing Technology. Scalable Printing Technology ("SPT") is the result of HP's investment of $1.4 billion and 4 years of R&D in thermal inkjet printing technology. SPT supports continued HP innovation and performance advancements in inkjet printing, and allows HP to expand into new markets with solutions based on proven technologies. By leveraging ink and printhead designs across all of HP's printing markets, SPT also brings HP's customers the benefits of manufacturing economies of scale.

Figure 4. HP Inkjet Web Press Printhead and Printhead Pocket



The HP Inkjet Web Press printhead is shown in Figure 4. Also shown is a CAD rendering of a *Printhead Pocket*. The printhead pocket mechanically locates the printhead and supplies ink and electrical signals. The lock-down latch for the printhead is shown in green and light green in this figure. The latch allows the printhead to be easily and quickly snapped out and snapped in. No tools, no handling of ink tubes, or mechanical adjustments are required. Printheads are automatically aligned in the HP Inkjet Web Press by printing and scanning a nozzle alignment test pattern. This feature significantly reduces maintenance expense and printer down-time.

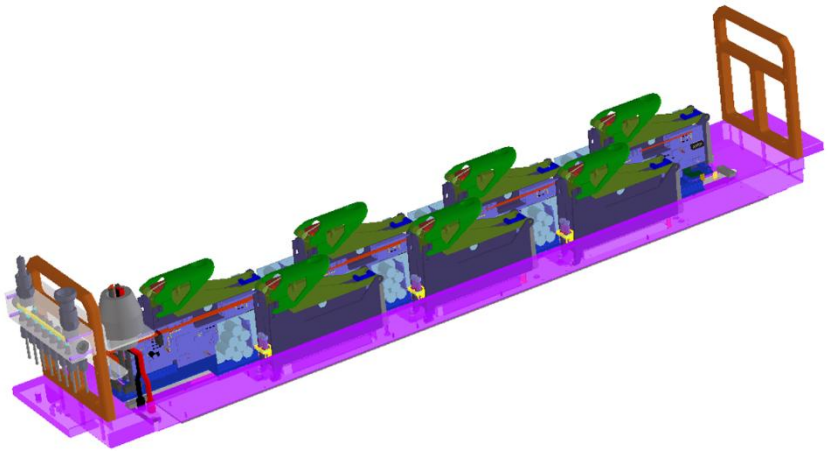
The printhead consists of five (5) thermal inkjet printhead chips (called "die") placed on a ceramic substrate and a backend assembly that provides mechanical alignment, ink pressure regulation, and electrical interconnections. The printhead has two (2) columns of 5,280 nozzles, each producing a 4.25-inch swath with 1,200 nozzles per inch. This gives the HP Inkjet Web Press a printing resolution of 1200 dpi across the web.

The Print Engine produces 3-level halftone pixels for each primary color (CMYK) at 600 dpi by printing 0, 1, or 2 drops of ink per primary into a 1200 X 600 dpi matrix. CMY inks and HP bonding agent are printed with 6 picoliter (pl) drops; black ink is printed with 9pl drops.

This printhead assembly has an independent ink supply and pressure regulator for each column of nozzles. In some applications, such as the HP Designjet L65500 with HP Latex Inks, the printhead prints two colors of ink. In the HP Inkjet Web Press, both nozzle columns print the same color of ink providing *nozzle redundancy*: two (2) nozzles can print a dot at the same point in a 1,200 dpi dot-row on the moving web. Four (4) nozzles addressing a 3-level, 600 dpi pixel permits load-sharing for longer printhead life and nozzle replacement for fault-tolerant operation.

The HP Inkjet Web Press has printheads arranged in a fixed printbar for each ink and bonding agent that spans the moving web. This fully-modular design is shown in Figure 5. Note the seven (7) printhead lock-down latches (green and light green) in this CAD rendering.

Figure 5. HP Inkjet Web Press Printbar (7 Printheads)



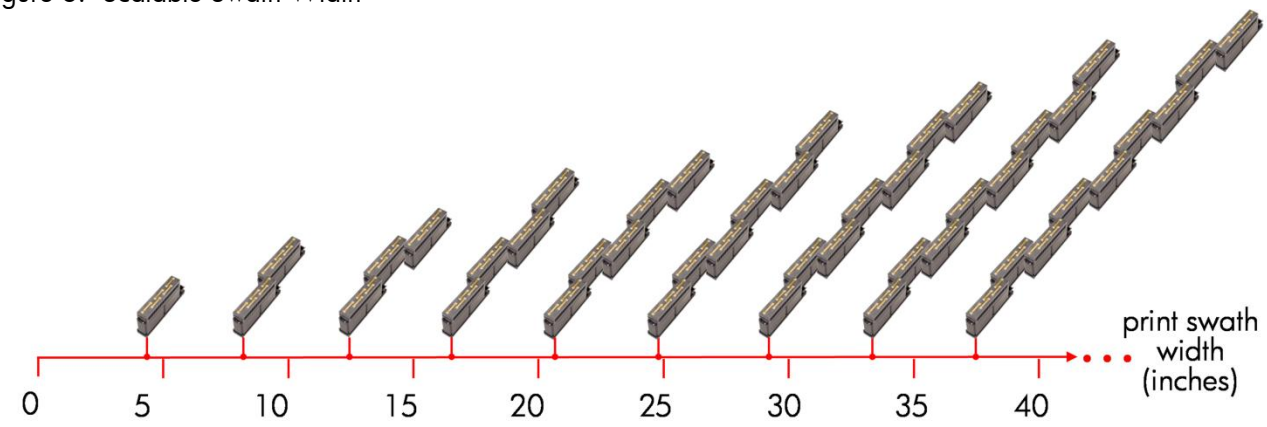
Scalable Printing Architecture

The HP Inkjet Web Press employs a scalable printing architecture based on a modular design consisting of an HP 4.25-inch thermal inkjet printheads installed in printhead pockets.

Figure 6 shows schematically how various print swaths can be produced by stacking individually-replaceable printheads in printbars across the web.[1] For example, a 30-inch web with a 29-inch print swath uses seven (7) HP 4.25-inch thermal inkjet printheads in each printbar.

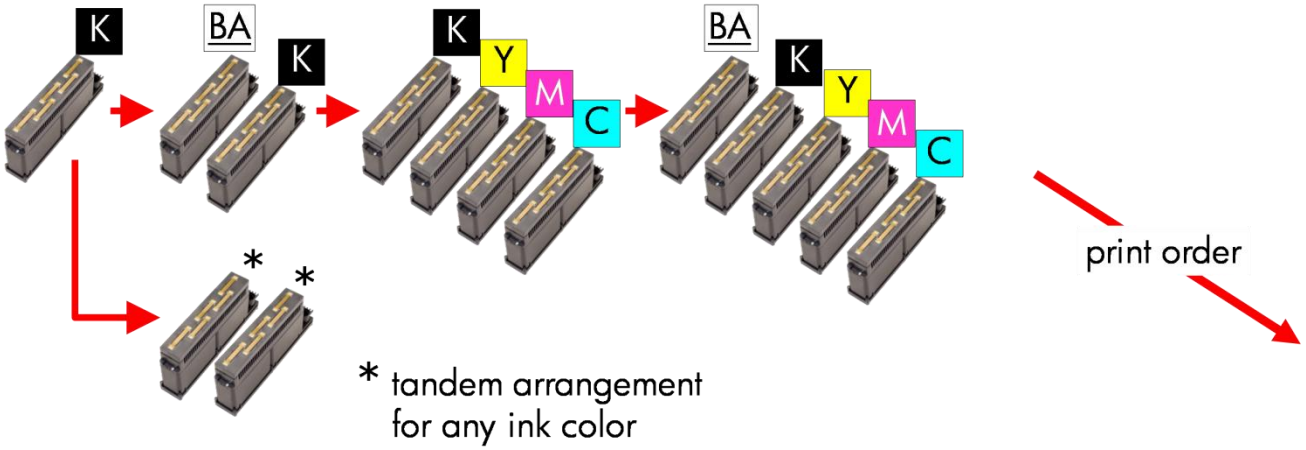
[1] A small overlap between neighboring printheads reduces the visibility of any printhead-to-printhead variations.

Figure 6. Scalable Swath Width



Printbars can be added along the web to build different writing system configurations, as shown in Figure 7 and described below. For illustrative purposes, a single printhead represents a web-wide printbar.

Figure 7. Scalable in Features and Performance



- **K**: Single black ink for monochrome printing on coated paper
- **BA + K**: Flexible system allowing black-only printing on uncoated paper with bonding agent (BA) or black-only on coated papers
- **K + Y + M + C**: 4-color printing on coated paper
- **BA + K + Y + M + C**: 4-color printing with bonding agent for uncoated paper
- *** + *** : tandem arrangement for printing any ink color, for example black + black

Increased fault tolerance and load sharing is achieved by adding a second printbar for a given color, as shown by the tandem configuration: * + *. For example, two black printbars in tandem allow a 600 dpi pixel in a given dot-row to be printed by any one of eight (8) nozzles. Tandem printbars for each color provide benefits of multiple-pass printing in a single pass, and load-sharing reduces the frequency of printhead replacement.

Robust Pixel Printing

A significant challenge for printing with stationary, pagewide printheads on a moving web is to suppress print quality artifacts from "nozzle errors". These errors, which include low and high drop weights, misdirected or missing drops, or a nozzle "stuck on"[2], can be caused by a variety of factors including paper dust on the printhead nozzle plate, particles in the ink supply that clog the nozzle or affect drop ejection, printhead wear-out, or manufacturing defects. Each nozzle produces a row of dots, and the effect of a nozzle error is a dot-row that is missing (a white streak through text or an area fill), the wrong color, or the wrong density.

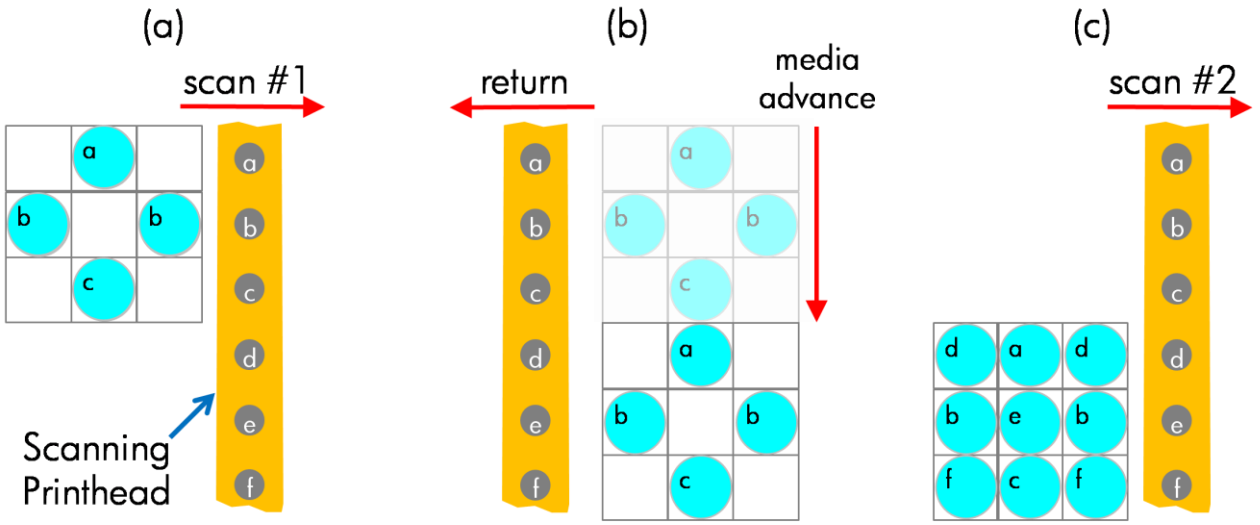
Nozzle errors are common to all inkjet technologies, and practical solutions have evolved for high-quality inkjet printing where visible print quality defects from nozzle errors can be suppressed or even completely eliminated. These solutions generally involve some form of "nozzle substitution" implemented through multiple-pass printing or by nozzle redundancy.

In printers that can automatically measure nozzle health, bad nozzles are identified, taken out of service, and good nozzles are substituted to print pixels in their dot-rows. Another solution involves printing neighboring pixels on the paper by nozzles which are located in different parts of the printhead. The expectation is that a pixel affected by a bad nozzle will be surrounded by good pixels and will therefore be less visible. This is the principle of multiple-pass printing with scanning printheads shown schematically in Figure 8.

Multi-Pass Printing

Figure 8 shows a schematic of two-pass printing with a simple printhead having only 6 nozzles, labeled "a" through "f". The objective is put a dot in every pixel in a 3 X 3 array as shown, and to reduce the visibility of nozzle errors by having each dot-row printed by more than one nozzle.

Figure 8. Schematic of Multiple-Pass Scanning Printhead
(a) Dots Printed by Nozzles "a", "b", and "c" on Scan #1
(b) Printhead Return and Media Advance
(c) Dots Printed by Nozzles "d", "e", and "f" on Scan #2



In Figure 8a, the printhead has just finished scan #1 from left-to-right and printed dots coming from nozzles "a", "b", and "c". Notice that each dot is surrounded by an empty pixel: for example, nozzle "b" doesn't print two dots next to each other in its dot-row.

[2] Nozzles stuck "on" are a problem for continuous inkjet printing systems, when unwanted drops are not properly deflected and reach the paper. This produces a colored line or "streak" down the web. Drop-on-demand inkjet printers do not have this problem.

In Figure 8b, the printhead returns by moving from right-to-left, and the media is advanced down the array of nozzles so that dot-rows printed on scan #1 by nozzles "a"-"c" are now under nozzles "d"-"f".

In Figure 8c, scan #2 again moves the printhead from left-to-right printing dots with nozzles "d", "e", and "f" to fill every pixel with a dot. Note that the nearest neighbor dots to "e" were printed by nozzles "a", "b", and "c".

If, for example, nozzle "b" failed to print a dot, the result with multiple-pass printing would not be an empty dot-row, but a row with every other dot missing. This makes the effect of a nozzle error less visible.

If the printer could detect that nozzle "b" had failed, then nozzle "e" could be substituted for nozzle "b" and print every dot in the row to completely hide the nozzle error. In this case, nozzle "e" is said to be *redundant* to nozzle "b" because it can take over pointing of dots from nozzle "b".

The essential principle of multiple-pass printing is to provide *nozzle redundancy* with multiple nozzles printing in each dot-row. On systems with scanning printheads, this is accomplished by nozzles located in different positions on the printhead.[3]

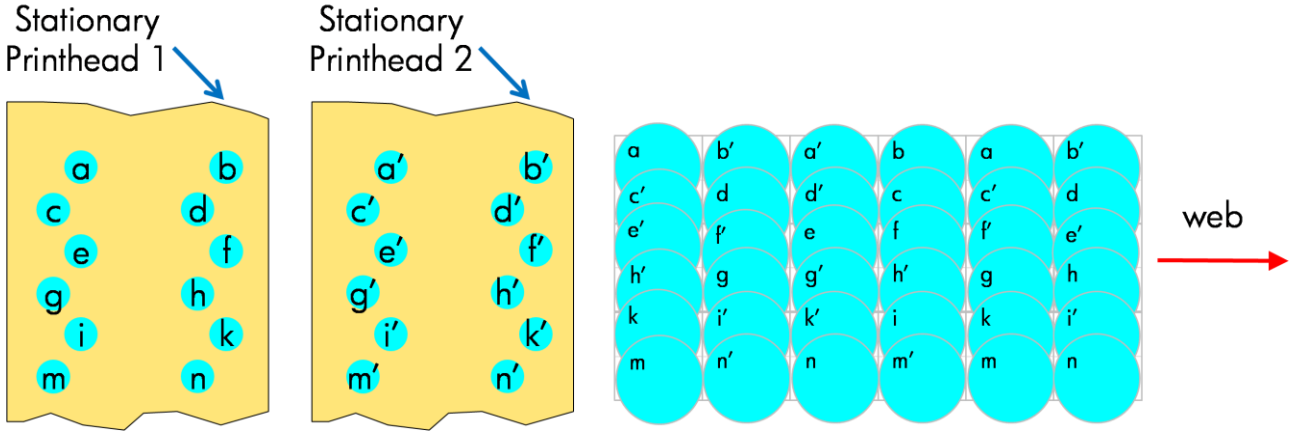
This is a highly simplified example of multiple-pass printing. In practice, a 2-pass mode has a limited ability to hide or compensate for nozzle errors, and scanning printhead printers use 4-, 6-, 8- or more passes in the highest-quality print modes.

Single-Pass Printing on a Web

In an inkjet web press, the moving paper passes only once under each stationary printhead. Without nozzle redundancy, a nozzle error will produce an empty dot-row or a missing halftone level at that nozzle location. Nozzle redundancy in stationary printheads comes from having more than one nozzle available to print in each dot-row.

Figure 9 is a schematic representation of the tandem printhead arrangement (for each color) used in the HP Inkjet Web Press. Printheads 1 and 2 are stationary and the web moves under them. Nozzles in each column (e.g., "a", "c", "e", etc.) are spaced 1/1200-inch apart to print at 1200 dpi across the web.

Figure 9. Nozzle Cycling with Tandem Printheads in the HP Inkjet Web Press.



Nozzles "a" and "b" on Printhead 1 print in the same dot-row[4]. Aligning nozzles "a'" and "b'" on Printhead 2 with "a" and "b" on Printhead 1 gives four (4) redundant nozzles (e.g., "a", "b", "a'", and "b'") that can print a dot in any given 1200-inch dot-row.

In Figure 9, the neighbors to any dot are seen coming from different nozzle columns and different printheads.

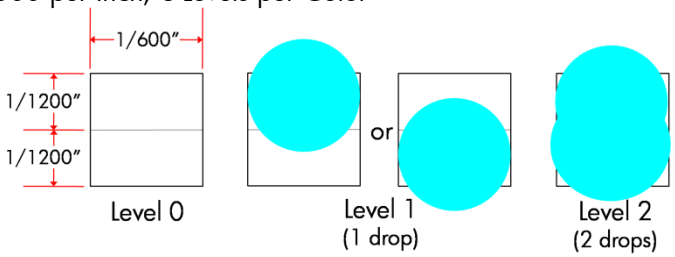
[3] Multiple-pass printing has other benefits, such as allowing time between drops into the same or neighboring pixel for the ink to penetrate or the colorant to immobilize. This reduces wet interactions between ink drops on the surface.
[4] Nozzles "c" and "d" print in the same dot-row, and so on.

This arrangement of dots can be continuously randomized during printing to further reduce any periodic patterns resulting from particular combination of nozzles. This process is called *nozzle cycling*, and it provides suppression of nozzle errors comparable to multiple-pass printing in a single pass of the paper under the printheads. Nozzle cycling is used in the HP Inkjet Web Press.

To demonstrate nozzle redundancy, refer to the first row of dots in Figure 9 and consider a situation where nozzle 'b' has failed. Nozzles "a", "b'", and "c'" are redundant to nozzle "b" and can share printing its dots to eliminate the print quality defect from a nozzle failure.[5]

The HP Inkjet Web Press prints 600 halftone pixels per inch with 3-levels per color. With dots printed at 600 dpi along the web and 1200 dpi across the web, the method for printing 3-level halftone pixels for each color (CMYK) is shown schematically in Figure 10.

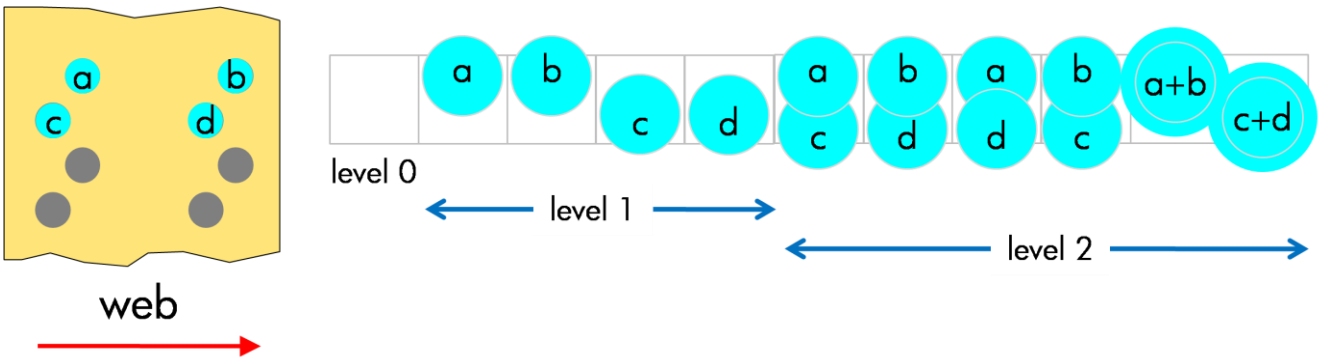
Figure 10. Halftone Pixels: 600 per Inch, 3-Levels per Color



The halftone pixel is formed from two subpixels, each 1/1200" across the web and 1/600" along the web. Printheads in the HP Inkjet Web Press can place a dot in either or both subpixels.

Level 0 is an empty pixel. Level 1 uses one drop of ink by printing a dot in either subpixel. Level 2 uses two drops of ink, one in each subpixel.

Figure 11. Nozzle Redundancy: Many Ways to Print 3-Level Pixels



Nozzle redundancy in 1200dpi dot-rows and nozzle cycling provides robust pixel printing in the HP Inkjet Web Press. Figure 11 shows how different nozzles can be used to print Level 1 and Level 2 pixels in single 600 dpi dot-row. To make the illustration simple, only a single printhead is shown. Considering all the possible combinations of using nozzles "a", "b", "c". and "d", this figure shows how a single printhead offers four (4) ways to print a Level 1 pixel and six (6) ways to print a Level 2 pixel. In the tandem arrangement of printheads in the HP Inkjet Web Press, there are eight (8) ways of printing a Level 1 pixel and twenty-eight (28) ways of printing a Level 2 pixel.

[5] In practice, the failure of nozzle "b" would be detected by scanning a nozzle test pattern and new nozzle control instructions (called "nozzle masks") would be generated automatically to replace nozzle "b" with nozzles "a", "a'", and "b''.

Cycling through the available nozzles to print any given pixel means that nozzle errors are suppressed. This allows the HP Inkjet Web Press to produce print quality in a single-pass that is comparable to multi-pass printing.

Figure 12. 600 dpi Printing without Nozzle Redundancy

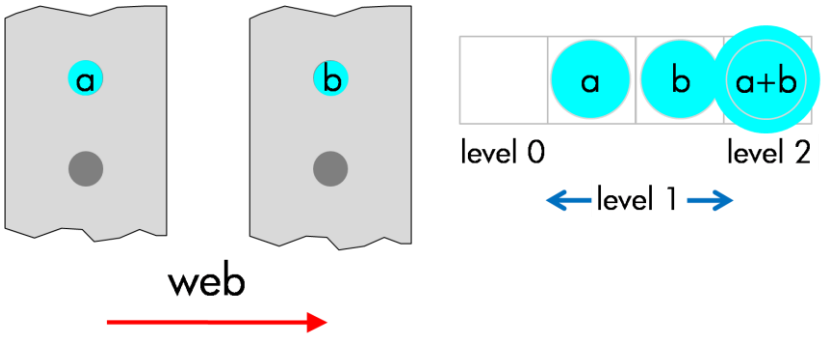


Figure 12 is a schematic representation of how two 600 dpi printheads can be arranged to print 3-level pixels at 600 pixels per inch. This configuration is used in some web printers employing piezoelectric (PZT) inkjet printheads. Each printhead is shown schematically with a single column of nozzles, 600 per inch across the web.[6]

One drop of ink is required to print Level 1 pixels, and this pixel can be printed by either nozzle "a" or "b". This gives nozzle redundancy with two (2) ways to print a Level 1 pixel.

Two drops are required for Level 2 pixels, and each printhead must print a drop in the pixel. This means there is only one (1) way to print a Level 2 pixel. If either nozzle fails, a print quality defect from a missing level in a dot-row will occur.

HP uses thermal inkjet printheads and piezo inkjet printheads in its commercial and industrial printing systems. The choice of which technology to use depends on many factors including ink type, ink physical properties (e.g., viscosity and surface tension), printing resolution, nozzle packing density (nozzles/inch), drop volume range, print speed, and nozzle redundancy. HP chose thermal inkjet for web press applications because aqueous pigment inks, scalability and reliability using 4.25-inch printheads, and the need for a high level of nozzle redundancy at a printing resolution of 1200 X 600 dpi were key requirements best met by thermal inkjet technologies.

Scalable Processing Architecture

The design philosophy behind scalable printing architecture in the HP Inkjet Web Press extends to scalable image processing hardware. Modular electronic elements are replicated across and along the web for design flexibility and to provide simplicity, reliability, and ease of maintainability. Parallel processing in RIPs and writing system hardware allow the HP Inkjet Web Press to run at full-speed with 100% variable page content. On the front-end, HP's scalable RIP architecture matches the number of RIPs to the complexity of the print job: the fewest number of RIPs is needed for monochrome text printing, more RIPs are required for printing pages in full-color and 100% variable content.

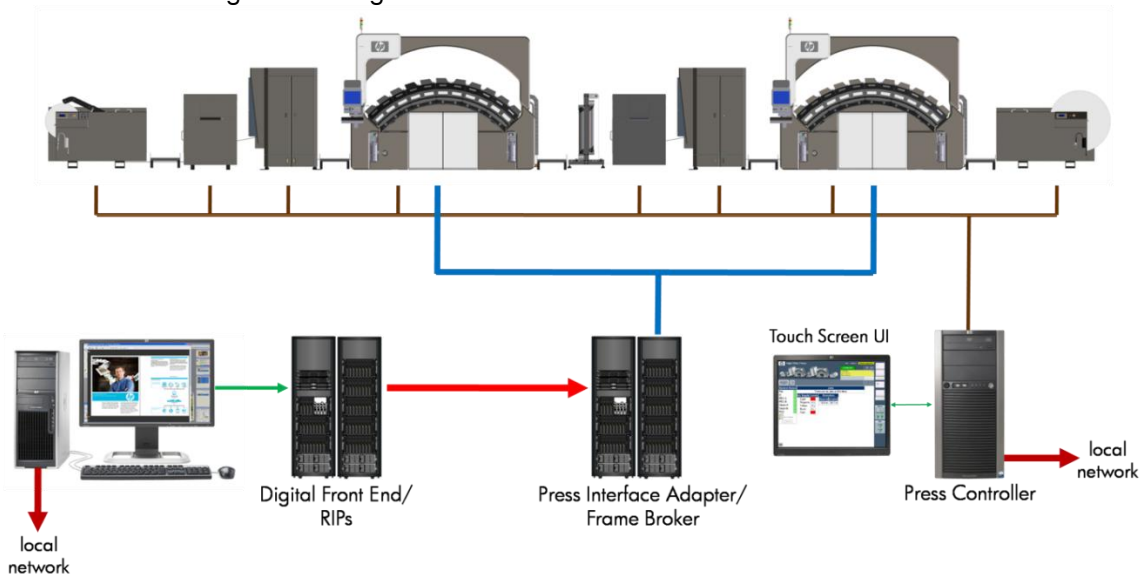
The image processing and control architecture for a complete press with two Print Engines is shown schematically in Figure 13. This figure shows the data pathway from the user's workstation through the Digital Front End, RIPs, Press Interface Adapter, and Frame Broker to the Print Engines.

The *Digital Front End* provides the user interface to the press, processes job ticketing, and controls the raster image processors (RIPs).

[6] The actual arrangement of nozzles is not important as the effective printing resolution is 600 dpi across the web.

HP's scalable RIP architecture is a grid computing application, managed by the Digital Front End, and is built on HP's high-performance C-class Blade Servers. PDF files that can be a single image frame or span the entire roll of paper are decomposed into smaller jobs that are concurrently processed by the RIPs. This solution allows RIPs to be tailored to meet any demand required by a customer's print job: monochrome presses use fewer RIPs, presses running full-color and 100% variable content use more RIPs.

Figure 13. Schematic: Image Processing and Control Architecture



The *Press Interface Adapter* and *Frame Broker* interface the Digital Front End and RIPs to the Print Engine by buffering frames from the RIPs, controlling the sequence of printing frames, and delivering frames to the Print Engines. The *Press Controller* provides a (touchscreen) user interface to the press operator and controls and coordinates the press subsystems including paper supply and rewind systems, print engines, ink delivery systems, service stations, web dryers, and in-line process monitoring.

Modular electronics underlies a reliable, simple, and maintainable scalable processing architecture that controls almost 1.5 million nozzles in the HP Inkjet Web Press.[7]

The image processing hardware in the HP Inkjet Web Press is based on the scheme of spanning the web with overlapping printheads (Figure 6). An image wider than a single printhead is partitioned into overlapping print swaths, called *slices*. Printed with tandem printbars for each color (and bonding agent), each slice is 5½ die wide (4.7 inches) to allow overlap between the printbars. Neighboring printheads spanning the web, for example those printing slices 0 and 1 in Figure 14, print in the overlap zone for seamless stitching.

Figure 14. Slicing an Image

[7] 29-inch print swath, two-sided printing with 140 HP 4.25-inch thermal inkjet printheads.

Figure 15 shows the image frame on the web sliced into "N" overlapping slices, where each slice is 4.7-inches wide. Notice the overlap zone between slices that is shown circled in this figure. The print order down the web is bonding agent followed by black, yellow, magenta, and cyan inks. Image processing hardware runs in parallel for each slice.

Figure 15. Slicing the Image Frame (Slices 0…N)

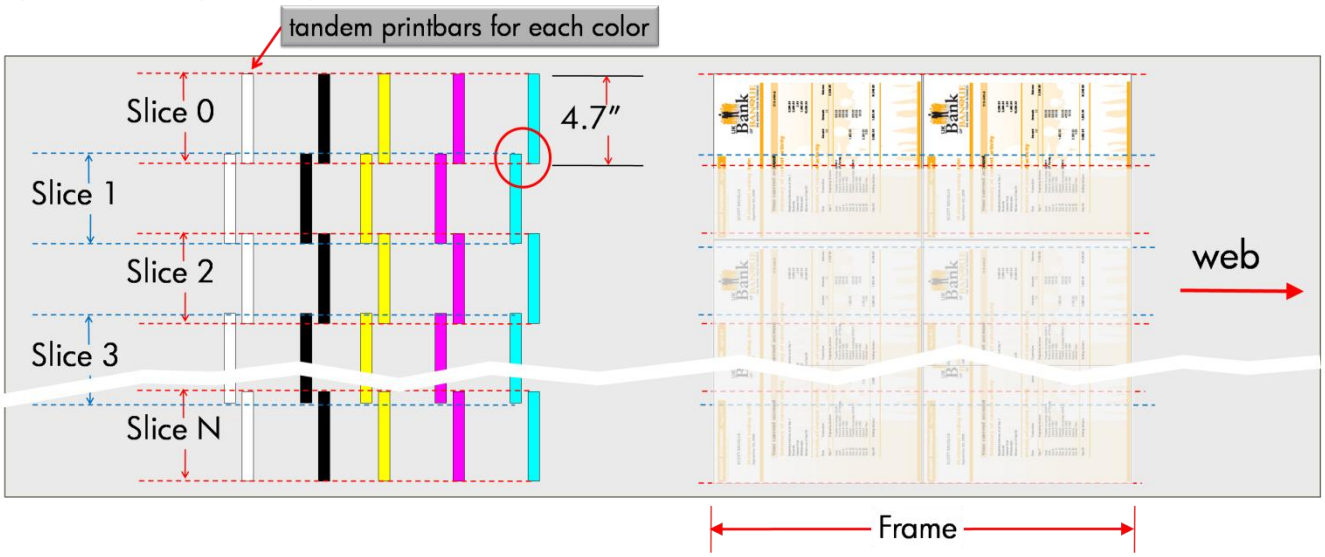
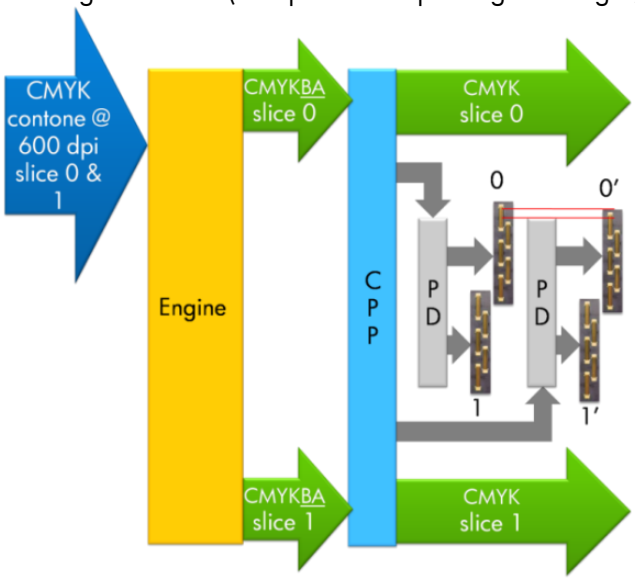


Figure 16 introduces HP's modular image processing hardware. It consists of printed circuit assemblies, called "PCAs", for the imaging Engine, Color Plane Processor ("CPP"), and Printhead Driver ("PD"). A module consisting of a Color Plane Processor and two Printhead Drivers controls four printheads on two tandem printbars printing two slices, for example slice 0 and slice 1. Printheads 0 and 1 are on one printbar, 0' and 1' are on another.

Tandem printheads 0 and 0' overlap as shown by ½ die and print slice 0; printheads 1 and 1' overlap and print slice 1. The CPP-PD modules as shown in Figure 16 print bonding agent.

Figure 16. Modular Image Processing Hardware (Ex.: printheads printing bonding agent)



The image in the print frame is sliced as shown schematically in Figures 14 and 15, and 600 dpi CMYK contone image data for slices 0 and 1 are sent to the Engine PCA (blue arrow).

The Engine converts contone data into 600 dpi, 3-level CMYK halftone data and generates the CMYK planes for each slice. The CMYK planes are processed to generate the bonding agent plane, if bonding agent is used.[8] The output from each Engine, shown by the green arrows, is five (5) halftone planes (CMYK+BA) for each slice and this is the input to the Color Plane Processor PCA for the first set of printbars. For the print order BA-K-Y-M-C, the first set of tandem printbars print bonding agent (BA).

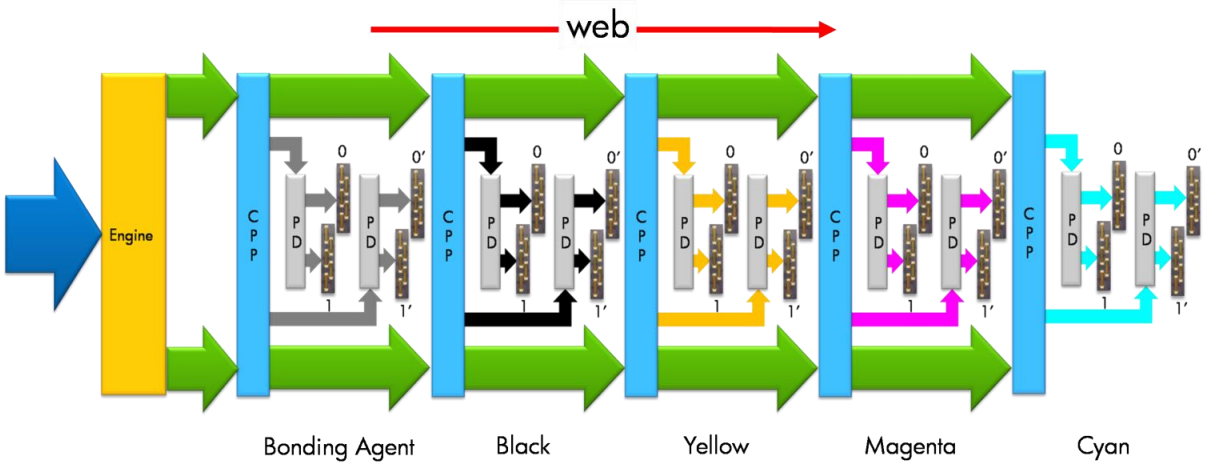
Figure 16 shows schematically how the Color Plane Processor (CPP) takes one color plane, for example BA, processes it into nozzle instructions for tandem printheads in two slices, and transfers the remaining color planes downstream (green arrows on the output side of CPP).

A Printhead Driver (PD) on each printbar provides data, control signals, and power to two printheads. As shown, one Printhead Driver PCA operates printheads 0 and 1 on the first of two tandem printbars; another Printhead Driver PCA operating printheads 0′ and 1′ is on the second printbar.

At full press speed of 400 feet per minute, each printhead receives 0.5 gigabits/sec of nozzle control data from its Printhead Driver. Data channels that return printhead operational data[9] to the press controller are not shown for clarity.

The CPP and PD hardware shown in Figure 16 is replicated for each color plane along the web to operate tandem printbars. This configuration is shown schematically in Figure 17. This is a 2-slice, CMYKBA writing system producing a print swath about 8.5 inches wide.

Figure 17. 5-Ink Writing System based on Replicating CPP and PD Printed Circuit Assemblies, Slices 0 and 1

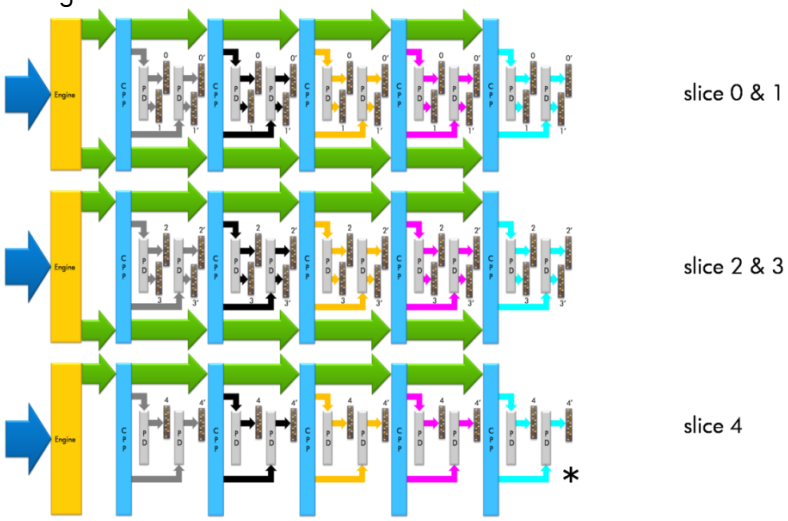


Each CPP processes one color plane and sends the remaining ones to the next CPP. The same CPP and PD printed circuit assemblies are used for each color plane and set of tandem printbars. This significantly simplifies the design of electronic hardware for the HP Inkjet Web Press and contributes to high reliability, ease of maintenance, and reducing system complexity.

The 5-ink writing system of Figure 17 is a scalable image processing architecture that can build wider presses in 2-slice increments. For example, a 5-slice CMYKBA writing system for a 21-inch web is shown in Figure 18 to illustrate two points: the hardware is replicated across the web for each pair of slices, and that for an odd-number of slices some hardware is not used (shown by *). This scheme has a negligible impact on the cost of the web press and offers the benefit of using common electronic hardware for presses having an even or odd number of slices.

[8] When used, bonding agent is applied wherever a pixel will receive ink and in certain boundary pixels to control ink bleed.
[9] Printhead operating temperature, for example, can be monitored.

Figure 18. 5-Ink, 5-Slice Engine



Inks and Media for the HP Inkjet Web Press

HP Pigment Inks

The HP Inkjet Web Press uses water-based, HP pigment inks that were developed for high print quality and high reliability in HP's 4.25-inch thermal inkjet printheads. These inks produce very low VOC (Volatile Organic Compound) emissions, [10] no ozone, and contain no HAPs (Hazardous Air Pollutants).[11] The inks and bonding agent used in the HP Inkjet Web Press are non-flammable and non-combustible.

HP Bonding Agent

Achieving high print quality requires precise control of the spread and penetration of ink on paper. The surface chemistry and physical properties of uncoated papers can be highly variable, and this can produce unpredictable results. Calibrating the printer by printing and scanning test patterns for each ink color can achieve the best-possible results for a particular combination of ink and paper, but at a level that may not be satisfactory for a particular application. Low optical density, feathering, and strike-through are common issues with inkjet printing on uncoated papers, particularly on porous, low grammage (gm/m^2) stock such as newsprint.

The HP Inkjet Web Press delivers high print quality and durability on uncoated stock by pre-printing a colorless liquid, called bonding agent, into those pixels that will receive ink.[12] Bonding agent is applied by inkjet printbars before colored inks are printed (recall Figure 2). HP bonding agent chemically reacts with HP pigment inks to rapidly immobilize pigments at or near the paper surface to control ink spread and penetration.

Bonding agent also improves pigment adhesion to the paper fibers for better print durability. Used with bonding agent, HP pigment inks produce high quality results on uncoated papers with print durability suitable for applications such as direct mail, newspaper, and book production.

[10] Dryer and print zone exhaust systems, along with very low levels of VOC emissions enable an improved print shop work environment. Typically, no air discharge permitting is required for the HP Inkjet Web Press. Customers should consult state and local requirements and regulations..

[11] No ozone products expected based on ink composition and printing technology. No detectable Hazardous Air Pollutants per U.S. Environmental Protection Agency Method 311 (testing conducted in 2008). HAPs are air pollutants which are not covered by ambient air quality standards but which, as defined in the Clean Air Act, may present a threat of adverse human health effects or adverse environmental effects.

[12] In practice, bonding agent is printed only where ink is applied and in a 1-2 pixel boundary around the edges of characters and graphical elements to ensure consistent color and edge sharpness.

Figure 19. Microscopic Cross-sectional Views of Uncoated Paper

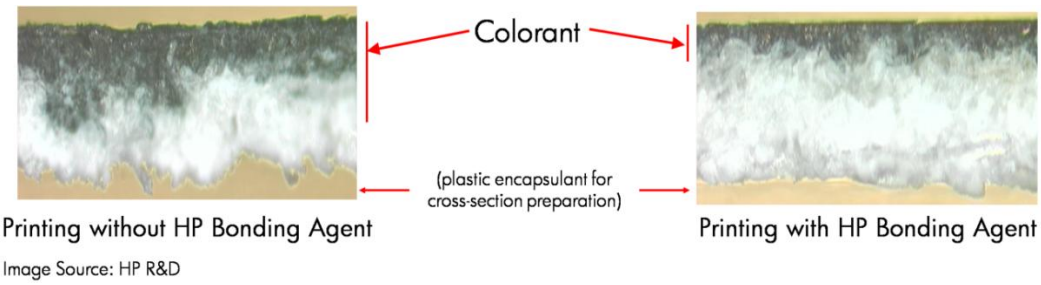


Figure 19 shows microscopic cross-sectional views of uncoated paper printed with black HP pigment ink. The sample on the left was printed without bonding agent, and pigment is seen to penetrate deeply into the paper. This reduces print optical density and can create strike-through in low grammage, highly porous, or translucent stock. In the sample on the right, bonding agent was printed into pixels receiving ink, and the pigments are clearly seen to remain near the paper's surface.

HP Paper Enhancement technology

HP Paper Enhancement technology is a surface treatment for web press papers. It immobilizes pigments in HP pigment inks near the surface to reduce strikethrough and provide offset comparable quality on uncoated papers.[13] HP Paper Enhancement technology and HP pigment inks provide high black optical density, high line and text quality, and a large color gamut. And, HP Paper Enhancement technology delivers superior performance on lighter weight papers to reduce costs of printing and distribution.

HP Coated Media

HP has developed a new coating technology designed for high-quality in high-speed web printing applications. HP-engineered coatings take the trial and error out of getting optimum quality and consistent results. Working together, Original HP paper, HP pigment inks, and the HP Inkjet Web Press produce outstanding quality at full press speed (400 fpm).

Summary

HP's core competencies in inkjet printing and information technology combined with manufacturing economies of scale place HP in a unique position to deliver an end-to-end, high-speed web printing solution. Users of the HP Inkjet Web Press benefit from reliable, proven thermal inkjet printheads and HP Blade Servers.

With CMYK HP pigment inks and a printing resolution of 1200 X 600 dpi from HP's 4.25-inch thermal inkjet printheads, the HP Inkjet Web Press produces high quality text, images, graphics, and uniform area fills with 100% variable content at full press speed of 400 feet per minute. Snap-out/snap-in printhead maintenance provides easy and quick user-serviceability that reduces press down-time. Aqueous HP pigment inks deliver high quality, durable prints on uncoated and coated papers.

To meet the demands of industrial printing environments, the HP Inkjet Web Press uses real-time, in-line process monitoring and control to deliver consistent image quality and fault-tolerant operation.

Nozzle redundancy and nozzle cycling in the HP Inkjet Web Press provide robust pixel printing to deliver print quality in a single pass that is comparable to multiple-pass inkjet printing technologies.

HP based the design of the HP Inkjet Web Press on fully-scalable printing and information processing architectures. Modular inkjet and electronic elements reduce development time and leverage proven performance and design rules into presses that can meet different customer requirements for web width and features.

[13] Offset offers higher highlighter smear resistance and lower strikethrough.

For more information

To learn more about the HP Inkjet Web Press, visit www.hp.com/go/inkjetwebpress

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