spencerLAB
DIGITAL COLOR LABORATORY

# Final Report

## Comparative Study: *Hewlett-Packard Designjet Z6100*

**vs. Canon imagePROGRAF 9000**

The *SpencerLab* Digital Color Laboratory, a division of Spencer & Associates Publishing, Ltd, has conducted independent testing and comparative evaluation of ***Photographic Image Print Quality and Throughput Speed vs. Image Quality Modes,*** of the HEWLETT-PACKARD DESIGNJET Z6100 (Z6100) and the CANON IPF9000 (iPF9000) 60-inch large-format printers. These elements of Quality and Productivity are key essentials of customer value.

The *SpencerLab* Digital Color Laboratory is an independent test laboratory with a broad base of industry clients. Although this comparative study was commissioned by Hewlett-Packard Company, *SpencerLab* believes these results maintain its reputation for the integrity of its procedures and analyses. Results stated herein are based upon direct testing by *SpencerLab* of actual products believed to be representative.

## Executive Summary

Overall, Photographic Print Quality of the HP Z6100 on HP Premium Instant-Dry Photo Gloss Paper is excellent with exceptional smoothness and sharpness. Images are produced with good richness, are extremely true-to-life, have extremely low grain, and print artifacts are limited to minor gloss banding in solid dark areas in FAST and NORMAL-FAST modes. The Z6100 renders high quality images in all print modes. Since large-format images do not require rendering resolutions over 300 dpi, the only significant photographic image print quality improvements beyond the FAST print mode is a reduction in gloss banding visibility with some improvement in sharpness.

The Z6100 Image Print Quality was comparable to and, in some cases, better than iPF9000 despite having a slightly smaller RGB color gamut than its twelve-ink competitor. Our testing did not show any significant color fidelity or photographic print quality differences relating to gamut. In fact, the Z6100's Black Density was better than that of the iPF9000, with a CIE $L^*$ value less than half that of the iPF9000 in their fastest modes. Deep Blacks allow for crisp and sharp printing, and more visible detail in image shadow areas.

In tests of Throughput Speed Performance at similar printer modes, the Z6100 produced comparable quality prints at speeds of up to twice as fast as the iPF9000. **Our tests showed that the Z6100 prints up to twice as fast at comparable print quality – a highly productive machine.**

*(The full report may be downloaded at* http://www.spencerlab.com*)* *May 2007*


www.spencerlab.com
631-367-6655 Fax: 631-367-2878
Division of SPENCER & ASSOCIATES PUBLISHING, LTD.
Three Giffard Way, Melville, NY. 11747-2310

# Detailed Test and Analysis Results

## *Test Printers*

### HP Designjet Z6100

The Z6100 offers great functionality and a feature-rich interface, on both the control panel and the printer driver and utility software. Printer functions, both basic and advanced, can be accessed directly from a computer workstation through a web browser.

HP DreamColor Technologies provide color accuracy and consistency – eight Vivera pigmented inks (Cyan, Magenta, Yellow, Light-Cyan, Light-Magenta, Light-Gray, Matte-Black, and Photo-Black) provide a wide color gamut and true neutral grays, while the built-in spectrophotometer used in conjunction with HP Color Center software utility helps the user to precisely calibrate the Z6100 and easily create and manage ICC profiles. The HP Color Center utility is available through an icon on the workstation desktop or can be accessed through the HP Easy Printer Care Tool that allows users to navigate through color management, printing, and job management workflows. The Z6100 also incorporates an HP Optical Media Advance Sensor that allows printing at high speeds with extremely accurate media advance.

A broad range of original HP media (including bond, coated, photo and proofing papers; technical and graphic papers and film; specialty banner and signage, fabric/textile; and fine arts printing materials) are readily available through the HP website and/or online resellers and retail stores, along with additional third-party options.

The alternate Z6100ps model offers an Embedded Adobe® PostScript 3 RIP that enables direct printing of PostScript, EPS and PDF files – a most useful feature for Graphic Arts users and those who desire a larger CMYK gamut.

### Canon iPF9000

The iPF9000 has a user-friendly interface and the printer itself is easy to operate. Most functions like monitoring printer status, retrieving job logs, and performing printer maintenance etc. can be performed from the workstation using the GARO Status Monitor. Software like Digital Photo Print Pro, PosterArtist, and a Print Plug-in for Photoshop are included with the printer software.

The iPF9000 features a twelve pigment ink system (Cyan, Magenta, Yellow, Photo-Cyan, Photo-Magenta, Gray, Photo-Gray, [Photo] Black, Matte-Black, Red, Green, and Blue). The twelve-color combination includes two levels of gray for neutral monotone output and features automatic switching between regular black and matte black eliminating the need to manually swap ink tanks resulting in greater efficiency.

Only the GARO (Canon proprietary) printer language is supported by the iPF9000; Adobe® PostScript is not offered, even as an option. At the time of publication, no Canon proofing or Sign/Banner media compatible with the iPF9000 was available in 60-inch rolls, which can be an area of concern limiting the range of printable jobs for Graphic Arts and professional users. The choices available on Canon Photographic, Bond/CAD, and Fine Art paper are also limited.

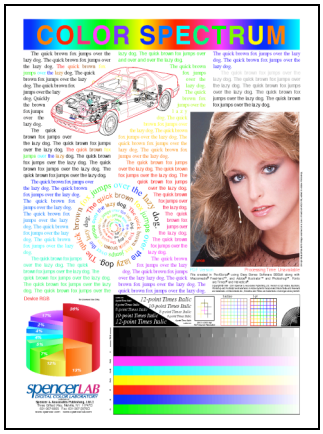
## Photographic Print Quality

### Test Methodology

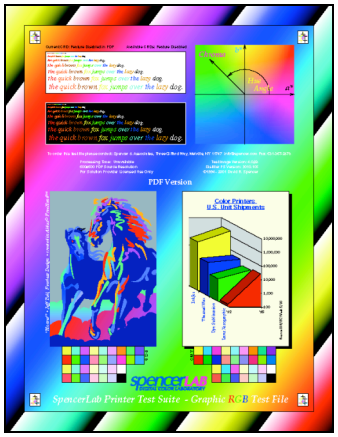
A variety of test documents selected from the *SpencerLab* Printer Test Suite were printed on each of the printers in a range of print modes, after printer setup and alignment. These test documents included current versions of the *Color Spectrum RGB* and *Graphic RGB* files (originally developed as part of the *Color Hardcopy Quality Factors* study series). Also included was the *Enhanced Graphic* file (originally developed as part of the *Hardcopy Quality Enhancement* study) and a variety of image test documents from the *SpencerLab* Photographic Printer Test Suite, covering a range of photographic printing requirements for this class of printers.

Print modes comparison included FAST, NORMAL-FAST, NORMAL, BEST (MAX RES FOR PHOTO PAPER: OFF), and BEST (MAX RES FOR PHOTO PAPER: ON) of the Z6100 and STANDARD, HIGH, and HIGHEST modes of the iPF9000 printer. Media used was OEM comparable Glossy photo paper. Additional analysis encompassed Gamut Comparison and Black Density. A single printer of each manufacturer used in the analysis was assumed to be representative.

Enhanced Graphic



Color Spectrum RGB



Graphic RGB

### Test Parameters

Testing of the HP DesignJet Z6100 and Canon iPF9000 printers were via 100Mb Ethernet connectivity, one-at-a-time. A 2.26 GHZ DELL Pentium 4 workstation with a 20 GB hard drive and 512 MB RAM running Windows XP (SP2) was used. Driver and firmware versions of each printer were as listed in the following table:

| | HP Z6100 | Canon iPF9000 |
|---|---|---|
| ***Driver*** | 60.071.341.00 (GM1.2) | 3.21 |
| ***Firmware*** | GG-GG_3.0.0.1 | 1.05 |

## Test Results and Analysis

Both the HP Designjet Z6100 and the Canon iPF9000 produce beautiful prints of high-quality photographic images. The Z6100 photographic print quality is somewhat better than that of the iPF9000 in the areas of Image Sharpness, Smoothness, and Realism at higher print modes, while the Z6100 shows minor gloss banding in large high-density areas in faster print modes; frequently applied to these prints, lamination eliminates this issue. The Z6100 also provides superior black density.

Unlike computer-generated graphics, images are the result of sampled raster data and seamlessly combine the quality elements of graphics, tints, and blends. Because of the wide range of potential subject matter in an image, a printer's ability to produce realistic, high-quality images is extremely difficult, but critical to user's quality perception.

The use of photographic data sources for images leads to a high demand for color fidelity. This includes accurate reproduction of memory colors – those with which users are heuristically familiar – without requiring an original for comparison. Natural greens, sky blues, wood browns, and skin tones represent common memory colors that can tax a printer's color rendering ability due to color gamut restrictions, imprecise color balance, or sub-optimal colorants. Another demand for image color fidelity is matching a color-corrected photograph such as a calibrated image file with an associated profile or in a standardized color space such as sRGB or SWOP. Although sometimes causing conflict, both objectives are important.

High spatial frequency, high-contrast detail within an image reflects a printer's ability to provide high quality text and graphics. The device resolution is used to carry the high level of fine detail. In areas of little variation (low spatial frequency), process noise and screen artifacts (in the case of non-continuous-tone printers) can be readily apparent. Finally, smoothly varying regions require blend linearity in order to accurately capture the realistic appearance and visual depth of the original.

Range of photographic images
*SpencerLab* Printer Test Suite

The Z6100 produces images that are very smooth, sharp and realistic. On glossy media and in higher print modes, the Z6100 renders images that are extremely sharp as seen, for example, on the *Basilica* image of the Photo Suite. Color Consistency is impressive across different Print Modes on glossy media. Images are vivid and realistic resulting in extremely pleasing skin tones when compared to the iPF9000. Although a slight bluish colorcast was perceptible, the images rendered on the Z6100 are of overall

superior quality and should exceed the expectations of commercial graphic arts customers as well as professional photographers.

Gloss bands were visible on HP Premium Instant-Dry Photo Gloss Paper in solid black regions in FAST print mode, less visible in NORMAL-FAST, and barely noticeable in NORMAL; however, solid black regions were smooth and free from gloss bands in BEST (MAX RES FOR PHOTO PAPER: OFF), and BEST (MAX RES FOR PHOTO PAPER: ON) print modes of the Z6100. Lamination is further expected to reduce visible gloss banding.

On the iPF9000, photographic images are clear and crisp with excellent contrast, resulting in faithful reproduction of fine details as seen, for example, in the *Museum* image. Images are fairly smooth, free from grain, banding and other print artifacts. Some minor roller streaking was noticed on the *Castle* (60-inch) image. Images are produced without any disturbing colorcasts; however, skin tones as seen on the *Pensive Man* and *Generations* images are rendered a bit yellow imparting an unhealthy (and therefore unpleasing) hue. Green grass also has a yellowish cast, making foliage appear artificial, though not unpleasing. Based on lighting conditions and consumer preference variations, minor quality differences were noted, with Z6100 print quality slightly better than that of Canon iPF9000.


Range of photographic images *SpencerLab* Printer Test Suite

## *Printer Color Gamut Analysis*

A printer's gamut refers to the range of colors the device can produce. The gamut of a printer is one of the limitations of the device it describes – number of inks, type of media (glossy, semi-glossy, matte), etc. A larger gamut typically, but not in all cases, means more producible colors and often enters into the customer's buying decision for printing and proofing systems.

### Methodology

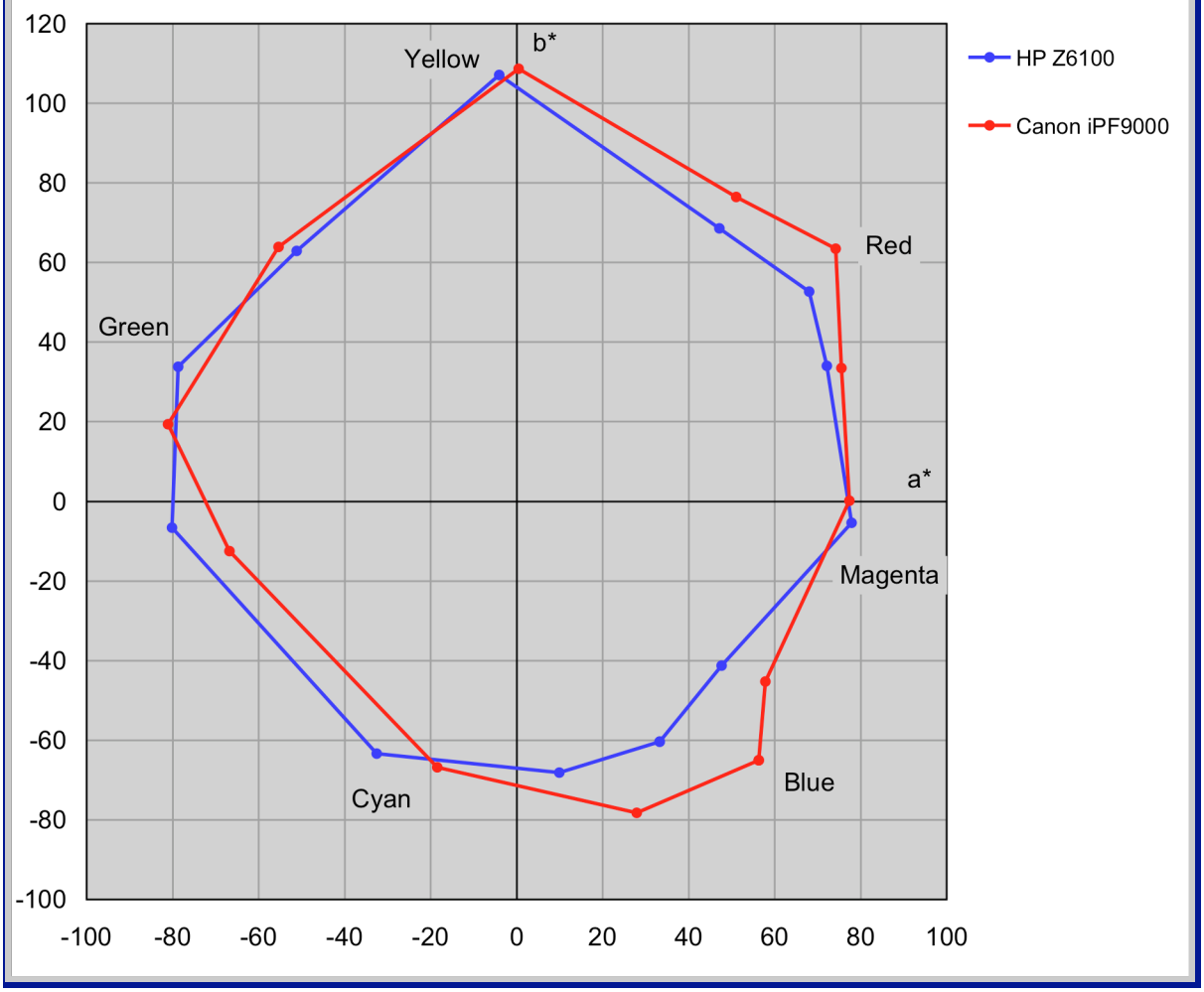
The Z6100 and iPF9000 printers were warmed up and in ready mode, with print engine maintenance (including but not limited to color calibration, nozzle check, cleaning and printhead alignment) performed as per manufacturer's recommendations/ user manual. The *Graphic* File from *SpencerLab* Printer Test Suite *(RGB version, PDF)* was printed on comparable 60-inch glossy roll media selected from each manufacturer's approved list of paper types. The test file incorporates RGB color patches appropriate for spectrodensitometric measurement. BEST (MAX RES FOR PHOTO PAPER ON)/HIGHEST print mode for each competitive test printer was used.

| | HP Z6100 | Canon iPF9000 |
|---|---|---|
| *Media* | HP Premium Instant-Dry Photo Gloss | Canon Glossy Photographic Paper (240 gsm) |
| *Printer Mode* | Best (Max res for photo paper: on) | Highest |
| *Driver* | Windows GL/2 Driver 60.071.341.00 (GM1.2) | 3.21 |
| *Firmware* | GG-GG_3.0.0.1 | 1.05 |

RGB gamut plots were made using primary colors of Cyan, Magenta, Yellow, Red, Green, and Blue and secondary colors of Blue-Cyan, Cyan-Green, Green-Yellow, Yellow-Red, Red-Magenta, and Magenta-Blue; these are shown in the graph below.

## Results and Analysis

### 2D Gamut Comparison – RGB




Canon iPF9000, with its twelve-ink system (Cyan, Magenta, Yellow, Photo-Cyan, Photo-Magenta, Gray, Photo-Gray, [Photo] Black, Matte-Black, Red, Green, and Blue) has a slightly larger gamut compared to the eight-ink system of HP Z6100 (Cyan, Ma-

genta, Yellow, Light-Cyan, Light-Magenta, Light-Gray, Matte-Black, and Photo-Black). The addition of Red and Blue inks contribute to a larger gamut in the Red and Blue areas; however that is not the case in the Green region – the HP Z6100 printer gamut is larger in Cyan and Cyan-Green regions. Gamuts in the Yellow-Green area are comparable.

Overall, the eight-ink Z6100 printer had a slightly smaller RGB color gamut than the twelve-ink iPF9000; however, the Z6100 Print Quality, color definition and color fidelity were comparable. No significant photographic print quality advantages were noted on image-intensive prints for the Canon iPF9000 when compared to HP Designjet Z6100.

## *Black Density/L**

High density blacks offer the user more intense photographic image detail, especially in the high contrast and shadow areas, as well as providing crisp, sharp black text and graphics printing.

### Methodology

Prior to testing, complete print engine maintenance (including but not limited to color calibration, nozzle check, cleaning and printhead alignment) was performed per manufacturer's recommendations/users manual. Printer engines were warmed and in ready mode.

A 10x60 inch, solid 100% black RGB test file was created in Adobe Photoshop and printed utilizing all print modes available for glossy media on the Z6100 and iPF9000. The black density of the print was measured in four corners plus two midpoints: top-left-corner (TLC), center-top (CT), top-right-corner (TRC), bottom-left-corner (BLC), bottom-center (BC), and bottom-right-corner (BRC).

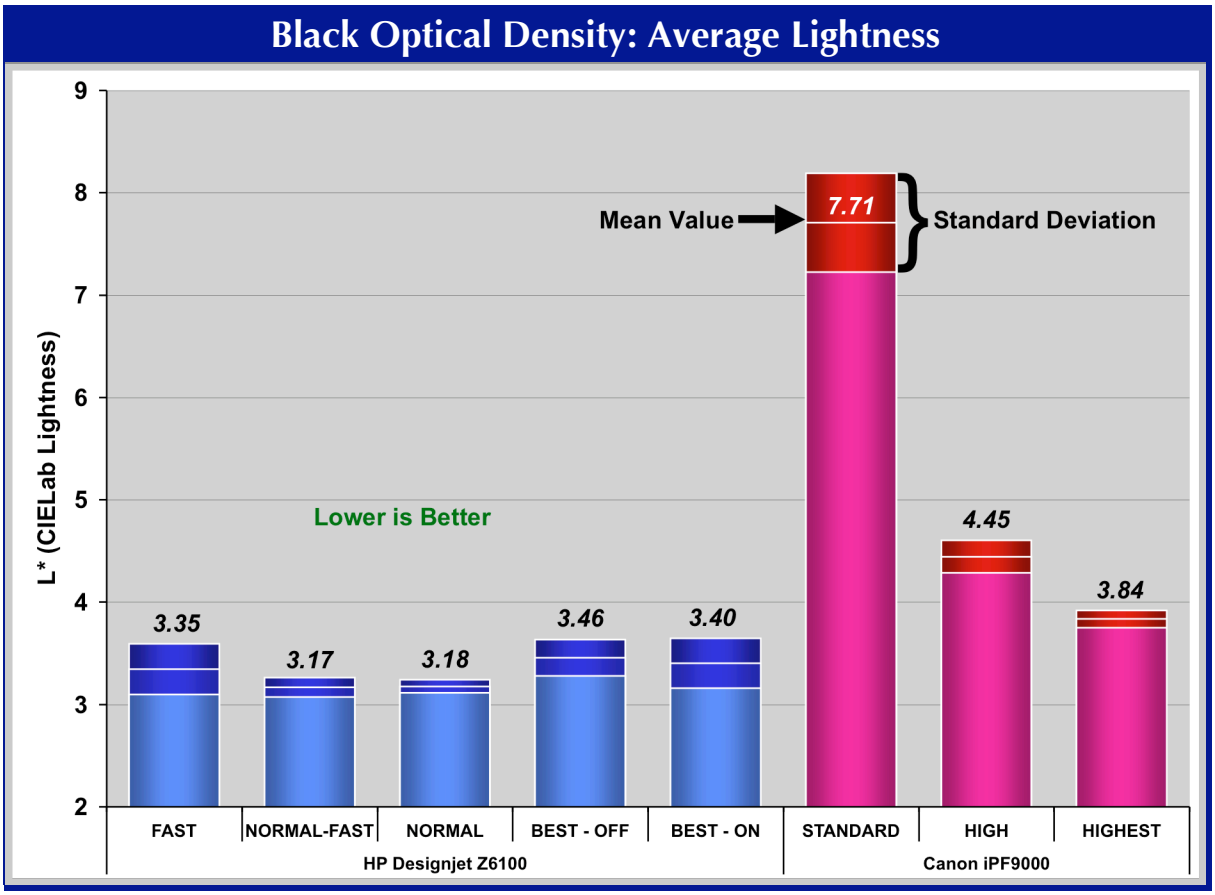
On the Z6100, the file was printed on HP Premium Instant-Dry Gloss Photo Paper with Print Modes: FAST, NORMAL-FAST, NORMAL, BEST (MAX RES ON PHOTO PAPER OFF) and BEST (MAX RES FOR PHOTO PAPER ON). On the iPF9000, the test file was printed on Canon Glossy Photographic Paper (240gsm) with Print Modes: STANDARD, HIGH, and HIGHEST.

CIE *L*a*b** Lightness and Density measurements were taken using a calibrated X-Rite 938 Spectrodensitometer with CIE (1931) 2-degree observer and D50 illuminant (D50-2). Average (mean) and standard deviation of the six Lightness (*L**) measurements was calculated for each of the available print modes on each printer.

### Results and Analysis

On glossy media, the *L** value of the Black produced by the Z6100 was less (less is better) than that of Canon iPF9000 on all available Print Modes, as is graphically illustrated on the following graph. Deeper Blacks allow for increased detail within shadow (dark) areas of images.

As seen in the graph, the Z6100 measured substantially greater Overall Average Black Density (lower Average *L**) than Canon iPF9000 on glossy media. Black densities of the Z6100 were darker than those on the iPF9000 in all modes. Comparing the fastest modes, the Z6100 Blacks were more than twice as dark.




The Z6100 also showed less variation in black density among the half-dozen test locations than the iPF9000. Z6100 measured Black Density is more consistent – average Standard Deviation of 4% across all Print Modes on HP Premium Instant-Dry Gloss Photo Paper – than the iPF9000 – average Standard Deviation of 39% on Canon Glossy Photographic Paper (240 GSM).

In terms of Density (CIE Lightness), HP Blacks were Blacker.

## *Image Quality Modes vs. Throughput Speed Performance*

Throughput Speed Performance is generally slower in higher Print Quality modes and each of the tested printers has multiple Print Quality modes. Therefore, direct comparison of Throughput Speed Performance requires a better understanding and comparison of Image Quality Modes in order to normalize the differences among the printers.

### Methodology

An sRGB photographic image test file from the *SpencerLab* Printer Test Suite, the *Castle*, was selected to represent an appropriate large-format user's photographic application. The image was scaled to 60 by 45 inches at 114 dpi, to print on 60-inch gloss media.

Since different print modes are available on each printer, a focused image quality mode evaluation was performed on comparable Gloss media to rate output quality levels among the various modes.

All time measurements begin with the request-to-print and the Total Print Time measurement is taken when the printed page is ejected from the printer. All timings were recorded over several iterations to assure accurate results.

### Results and Analysis

On glossy media, the Z6100 has five print quality modes while the iPF9000 has only three. Based on user manual/guide and driver settings for each printer, comparable print modes were determined as shown in the preceding table. The Z6100 BEST modes were judged comparable to the iPF9000 HIGHEST mode; the Z6100 NORMAL mode was judged comparable to the iPF9000 HIGH mode and the FAST and NORMAL-FAST modes of the Z6100 were equated to the STANDARD mode on the iPF9000.

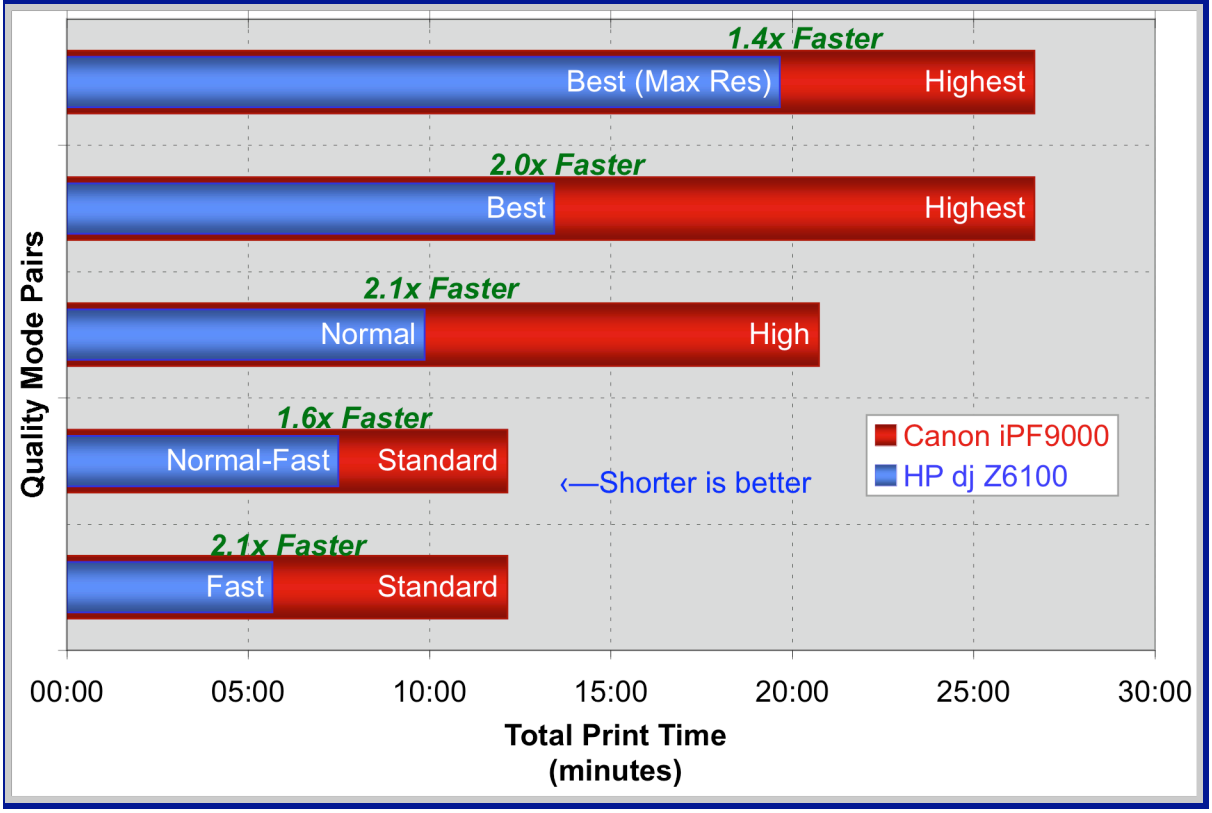
In the light of the throughput testing results, the Z6100 provides essentially similar image quality at significantly faster speeds, up to twice as fast.

On Glossy media, as illustrated above, the Z6100 BEST modes judged comparable to the iPF9000 HIGHEST mode were up to twice as fast. For comparable lower quality modes, the speed advantage is up to 2.1 times faster. Therefore, the Z6100 provides essentially similar high image quality at significantly faster speeds.

## Image Quality Mode Comparisons

| HP Designjet Z6100 | Canon iPF9000 |
|---|---|
| • HP Premium Instant-dry Photo Gloss (260gsm)<br>• HP-GL/2 driver | • Canon Glossy Photographic Paper (240 gsm) |
| BEST (Max Res)<br>° 1200 x 1200 dpi<br>° 2400 x 1200 output | HIGHEST<br>° 600 x 600 dpi<br>° 2400 x 1200, 16-pass output |
| BEST<br>° 600 x 600 dpi<br>° 1200 x 600 output | |
| NORMAL<br>° 600 x 600 dpi<br>° 1200 x 600 output | HIGH<br>° 600 x 600 dpi<br>° 2400 x 1200, 12-pass output |
| NORMAL-FAST<br>° 600 x 600 dpi<br>° 1200 x 600 output | |
| FAST<br>° 300 x 300 dpi<br>° 1200 x 600 output | STANDARD<br>° 600 x 600 dpi<br>° 1200 x 1200, 8-pass output |

## Image Quality Mode vs. Speed – *Glossy Media*



## About *spencerLAB*

The *SpencerLab* Digital Color Laboratory is an independent printer evaluation facility that provides services to vendors and corporations for whom color printing is mission-critical. The Laboratory follows strict guidelines in the integrity of both methodology and reporting; vendor-sponsored studies do not guarantee favorable results. *SpencerLab* has developed industry-standard test software, and performs print quality, throughput speed, ink and toner cartridge yield and cost-per-page/TCO, and ease-of-use analyses for color and monochrome printers in all technology classes, from inkjet and laser printers to digital color presses.

*SpencerLab* is operated by Spencer & Associates Publishing, Ltd., a premier IT consulting boutique specializing in the application of Digital Color Technology to all aspects of color imaging. For over a dozen years Spencer & Associates has been providing strategic support to manufacturers in product planning, development, and launch. Color printing workflow analysis, print system selection, and usage optimization services are provided to corporate users.

For more information, please see *SpencerLab* on the web at www.spencerlab.com, contact us by email at info@spencerlab.com, by telephone at 1-631-367-6655, or by fax at 1-631-367-2878.

May 2007