spencerLAB DIGITAL COLOR LABORATORY

Final Report

Print Quality and Throughput Speed Comparisons:

Hewlett-Packard Designjet T610 *vs.* Canon imagePROGRAF iPF700

The *SpencerLab* Digital Color Laboratory, a division of Spencer & Associates Publishing, Ltd., has conducted independent testing and comparative evaluation of **Print Quality and Throughput Speed** of the 44-inch HEWLETT-PACKARD DESIGNJET T610 (T610) and the 36-inch CANON IPF700 (iPF700) 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, the Print Quality of the HP T610 is excellent; Text and Lines are rendered crisp and sharp, and color Tints, including pastels, are produced at appropriate saturation levels. The T610 renders high quality CAD/GIS images in all print modes.

The Black Density of the T610 is better than that of the iPF700 HDI driver, with lower CIE L^* values (lower is better) across all print modes. Deep Blacks allow for crisp and sharp rendition of monochrome Text and Lines.

The T610's color rendition and differentiation within the AutoCAD Color Index (ACI) palette is better than that of the Canon iPF700 HDI driver. Many adjacent color patches produced by the iPF700 HDI driver are visibly the same color, whereas those patches are easily differentiable on the T610 output. Blue Tints produced by the iPF700 HDI driver exhibit a visible magenta cast, making them appear purple; these Tints appear appropriately blue on the T610. Pastel tints are lighter on T610 output, and appear oversaturated when produced by the iPF700 HDI driver.

In tests of Throughput Speed Performance within AutoCAD 2007, the T610 produced output of better quality at faster speeds than the iPF700 HDI driver. Furthermore, the iPF700 HDI driver invariably crashed and was not able to complete the print job, consistently producing just eight pages out of the requested set of seventeen. Additionally, the iPF700 HDI driver produced output with missing or transposed Text, Line and Tint information, and was more demanding on system resources than the T610.

The T610 offers better compatibility with CAD/GIS environments.

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

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Detailed Test and Analysis Results

Test Printers

A single printer from each manufacturer was used in testing and analysis, and assumed to be representative.

HP Designjet T610

The T610 offers great functionality with feature-rich interfaces, on both the printer's control panel and within the printer driver and the utility software. Basic printer and network maintenance functions can be accessed directly from a computer workstation through a web browser.

The T610 features a six-ink, six-cartridge system of HP Vivera dye-based Cyan, Magenta, Yellow, Black, and Gray inks, and pigment-based Matte Black ink. The 44-inch width of the T610 can produce prints up to ANSI E-size (34” x 44") in landscape orientation; this affords the user flexibility in choosing media and allows for more efficient media usage when reproducing larger-scale CAD/GIS images.

The HP-GL/2 driver for the T610 is suitable for producing output from common Windows applications as well as from technical drawing applications such as AutoCAD, offering excellent compatibility with CAD/GIS environments.

Canon iPF700

The iPF700 drivers and control panel have user-friendly interfaces, and the printer itself is easy to operate. Most functions, such as monitoring printer status, retrieving job logs, and performing printer maintenance, can be performed from the workstation using the GARO Status Monitor.

The iPF700 features a five-ink, six-cartridge ink system of dye-based Cyan, Magenta, Yellow, Black, and two pigment-based Matte Black tanks.

The iPF700 can be accessed through the GARO driver for Windows and through HDI drivers developed for use with AutoCAD. The HDI driver supplied on the software CD shipped with the printer supports AutoCAD versions through AutoCAD 2007. However, at the time of testing, the latest HDI driver available on Canon’s USA website supported only AutoCAD versions through AutoCAD 2006.

Test Parameters

Testing of the HP Designjet T610 and Canon iPF700 printers was performed via 100Mb Ethernet connectivity, one printer at a time. An Acer Veriton VT6900 workstation with a 2.13GHz Intel Core 2 Duo processor, 250GB hard drive, 2GB of RAM, and a 256MB ATI Radeon X1650 graphics card, running Windows XP (SP2), Adobe Reader 8.1.0, and AutoCAD 2007, was used to send jobs to the printers under test.

Driver and firmware versions tested were as follows:

Driver and Firmware Versions			
Printer	**HP Designjet T610**	**Canon iPF700[1]**	
Driver	HP-GL/2 Driver	GARO Driver	HDI Driver for AutoCAD 2007
	61.71.343.0	3.42	1.22; CLIP DB VER. 2.2
Firmware	TJ6-TAJM_2.0.0.2	1.20	

Print Quality

Test Methodology

A variety of test documents, selected from the *SpencerLab* Printer Test Suite (Ver 4), was printed on each of the printers in a range of print modes after printer setup, calibration, and alignment. From the *SpencerLab* Print Test Suite, test documents include the *Color Spectrum RGB* and *Graphic RGB* PDF files (originally developed as part of the *Color Hardcopy Quality Factors* study series), as well as the *Enhanced Graphic* file (originally developed as part of the *Hardcopy Quality Enhancement* study). Additionally, *SpencerLab* selected and printed HP-supplied CAD/GIS documents, including the *PlantaPCI* AutoCAD DWG file and the *Gloppen Tourist and Hiking Map* PDF, covering the expected user requirements for this class of printers. Print Quality was analyzed by element type (*e.g.* Text, Lines, Tints, Blends, and Images) across these test documents.

Print modes included FAST, NORMAL, and BEST modes of the T610, STANDARD, HIGH, and HIGHEST modes of the iPF700 GARO driver, and DRAFT, STANDARD, and HIGH modes of the iPF700 HDI driver. Tested media included *HP Bright White Inkjet Bond Paper* and *HP Super Heavyweight Plus Matte Paper*, and *Canon Universal Bond Paper* and *Canon Premium Matte Paper*.

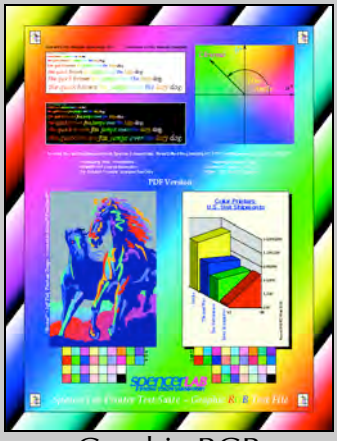
Additional analysis, encompassing Black Optical Density and Color Rendition of the ACI palette, was performed on the T610 HP-GL/2 and iPF700 HDI drivers. Prints included FAST, NORMAL, and BEST modes of the T610 HP-GL/2 and DRAFT, STANDARD, and HIGH modes of the iPF700. Tested media included *HP Bright White Inkjet Bond Paper* and *Canon Universal Bond Paper*.

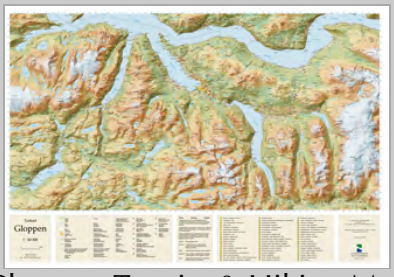
[1] The Canon iPF700 GARO driver was used to produce all PDF files; the Canon iPF700 HDI Driver for AutoCAD 2007 was used to produce all AutoCAD-specific output, including the *PlantaPCI* drawing and the AutoCAD color palette.

Print Quality Analysis Test Files


Enhanced Graphic

Color Spectrum RGB


Graphic RGB


Gloppen Tourist & Hiking Map


PlantaPCI AutoCAD Drawing

Print Quality Test Results and Analysis Summary

HP Designjet T610 overall print quality is generally better than that of the Canon iPF700[2], particularly in the areas of Text, Lines, Tints, and overall map quality. Text and Lines produced on AutoCAD drawings and GIS maps are sharp, crisp and precise in all print modes. Overall, Tints are produced with sufficient richness and appropriate saturation, resulting in high-quality GIS maps with excellent details. Areas for improvement include smoother transitions in Blends, better preservation of shadow details, and reduction/elimination of print artifacts (i.e. banding) in FAST and NORMAL print modes on Bond Paper.

Printing through the Canon HDI print driver resulted in errors in CAD file rendition, with missing or transposed Text, Line and Tint data. The Canon iPF700 GARO driver produces smooth and consistent multicolor Blends with smooth color transitions; however, when compared to the T610, Tints appeared somewhat dark and oversaturated, with nonlinearities in monotone Blends.

Although some limitations were noted on each, overall the Text, Line, Tint and map rendition of the HP Designjet T610 was judged better than that of the Canon iPF700 for CAD and GIS applications – the target market of these printers.

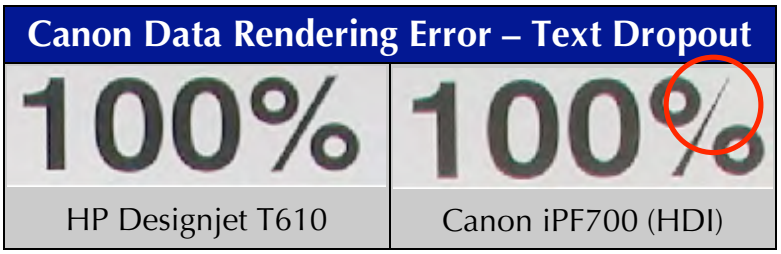
[2] Analysis of Canon iPF700 print quality refers to output produced by the GARO driver, unless otherwise specified.

Detailed Results

Text

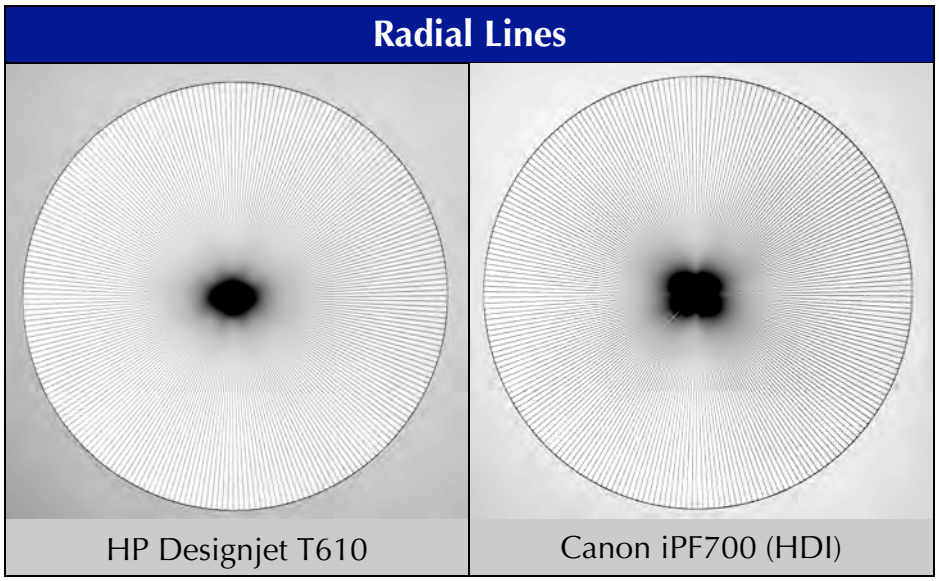
Both printers produced Black and Color Text that was clean and crisp when viewed from the typical viewing distance for large-format output. Upon closer inspection, output of both printers revealed jaggedness around character edges, which was especially noticeable on Text rendered in secondary and tertiary colors; however, the Text (both Black and Reverse Text) produced by the T610 was generally sharper and more legible at smaller point sizes than that of the iPF700, on output produced by both the GARO driver and the HDI driver.

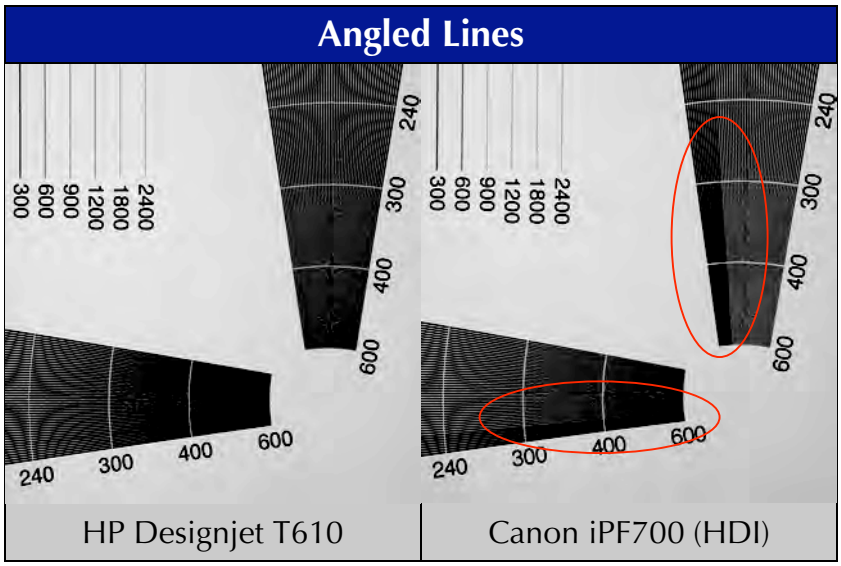
As noted earlier, the iPF700 HDI driver incorrectly rendered some text elements, while the T610 produced all requested text without errors or loss of details. As seen below, ACI palette output produced by the iPF700 HDI driver displayed data rendition errors, such as dropouts in the percent sign (%) in the heading.



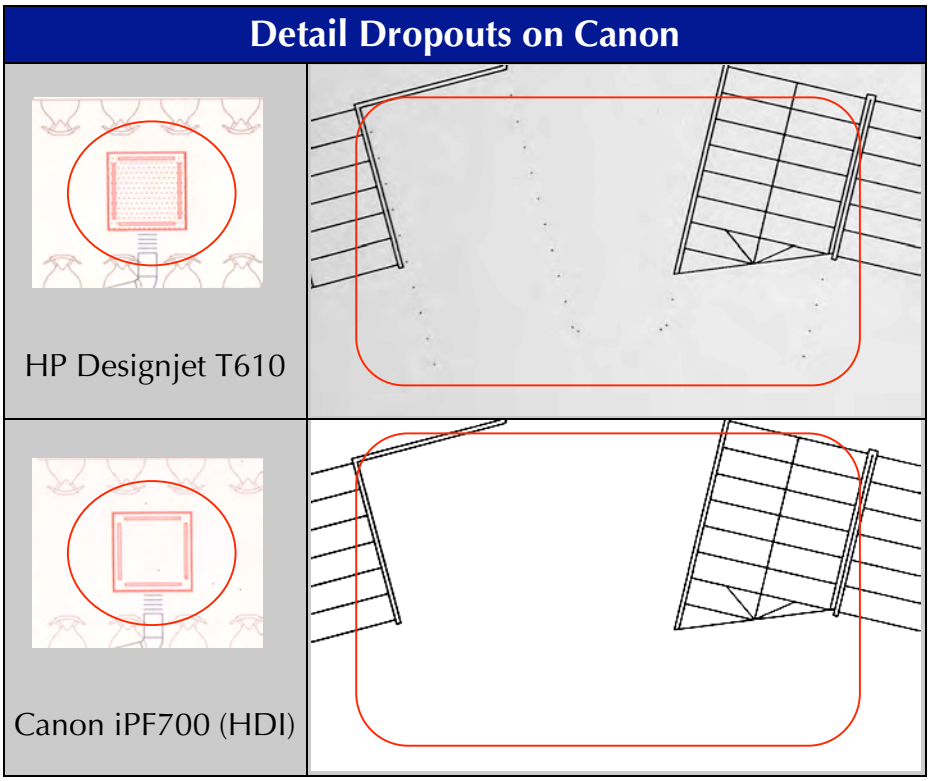
Lines

Black and Color Lines produced by the T610, especially curved and angled lines, exhibited better uniformity and less stepping than those produced by the iPF700 GARO driver. Additionally, minor inconsistencies were noticeable in Radial and Reverse Radial Lines and Angled Lines on the Enhanced Graphic file produced by the iPF700 GARO driver, with Radial Lines dropped out at 45° and 225°, Reverse Radial Lines filled in at the same angles, and Angled Lines from ~100° to ~190° rendered thicker than adjacent lines.



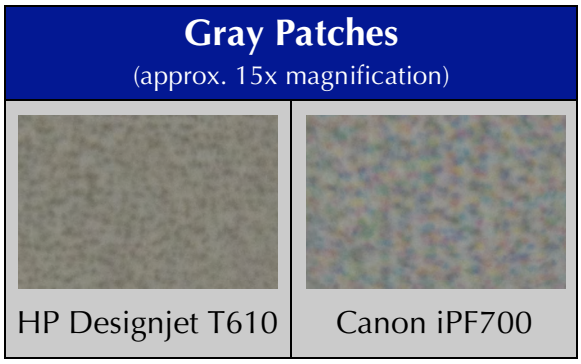


On the PlantaPCI AutoCAD drawing, Lines rendered by the T610 were sharp, well defined, and correctly placed. The iPF700 HDI driver provided line quality sufficient for the application, but was unable to render certain elements of the file properly – some fine Lines and dot patterns were either transposed to incorrect areas of the drawing or not rendered at all. Additionally, the iPF700 HDI driver failed to reproduce a solid, light gray fill (#255 on AutoCAD Color Index), leaving the area paper-white. The T610 rendered this light gray fill properly.



Tints & Blends

Monochrome Tints (Gray Patches) produced by the T610 were rendered using Black and Gray inks, while those produced by the iPF700 – through both the GARO and HDI drivers – were rendered as a composite of Color and Black inks. Such use of color in reproducing Gray, with its concomitant potential for metamerism, is usually incorporated when inadequate smoothness is otherwise available; as can be seen below, the T610 is quite smooth without resorting to multicolor highlights.



Color Tints produced by the T610 were excellent, with proper lightness; however, the Tints produced by the iPF700 GARO driver appeared somewhat oversaturated by comparison. Color differentiation, on the *Color Spectrum RGB* file, between Green and Yellow-Green Tints was higher on the iPF700 GARO driver than on the T610; although we noted that in this area, the color match to screen was overall closer on the T610 print than on the iPF700 GARO driver print.

On some graphic applications demanding extreme image quality, Color Blends on the T610 exhibited non-linearities and noticeable transitions between Yellow and Yellow-Green, and from Magenta into Purple. Transitions were also seen between the highlight and midtone regions within the Cyan and Green Blends. The T610 Yellow Blend transitioned sharply from midtone into shadow about halfway through the band on output. Fully saturated Color Blends produced by the iPF700 GARO driver were somewhat smoother and more consistent. While some non-linearities were present on Blends produced by the iPF700 GARO driver, stepping was generally less than that seen on the T610 output.

GIS Images

Differences in saturation across media types and all print modes were noticeable on the *Gloppen* map when reproduced on both printers. The iPF700 GARO driver output on *Canon Universal Bond Paper* was oversaturated in comparison to the T610's output on *HP Bright White Inkjet Bond Paper*. The reverse was true on heavier media; the T610 output on *HP Super Heavyweight Plus Matte Paper* was more saturated than the iPF700 output on *Canon Premium Matte Paper*. It appeared that the T610 appropriately adjusted the ink volume that was delivered based upon the loaded media, while the iPF700 rendered the image with the same volume of ink irrespective of the media that was loaded.

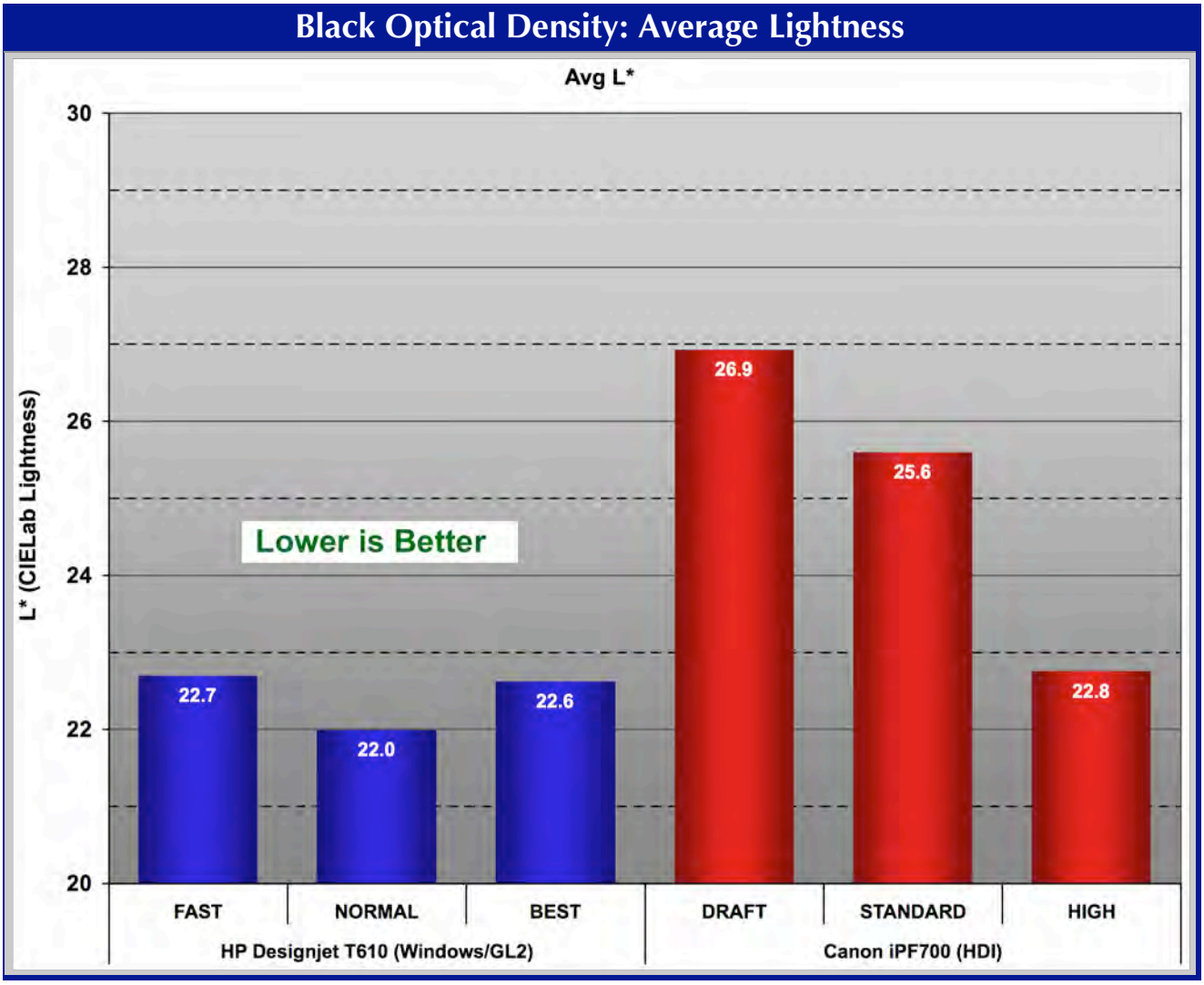
Highlight and midtone areas on the *Gloppen* map – meant to denote changes in elevation and terrain – were generally produced with better detail on the T610 than on the iPF700 GARO driver, but shadow regions were rendered darker, obscuring fine line detail and shade subtleties. The reverse was true on the iPF700, with shadow details more pronounced than on the T610, but highlight regions appearing somewhat blown-out.

GIS Image quality across all print quality modes varied just slightly on both HP and Canon; both the T610 and the iPF700 are capable of producing high-quality GIS images even in their lowest print modes.

Black Optical Density/L Analyses*

High-density blacks produce sharp, well-defined lines as well as crisp, sharp black text and graphics printing.

CIE *L*a*b** Lightness and Density measurements of the printed 100% Black patch were taken using a calibrated X-Rite 938 Spectrodensitometer with CIE (1931) 2-degree observer and D50 illuminant (D50-2). The mean of three Lightness (*L**) measurements was calculated for each of the available print modes on each printer.



The *L** value of the Black produced by the T610 was darker and better (lower) than that of the Canon iPF700 on all print modes, as is illustrated on the above graph.

As shown in the graph, the T610 output measured substantially greater Average Black Density (lower Average *L**) than the iPF700 HDI driver output. Black densities of the T610 were darker than those of the iPF700 HDI driver in all modes, allowing for crisp, sharp black text, lines and graphics printing.

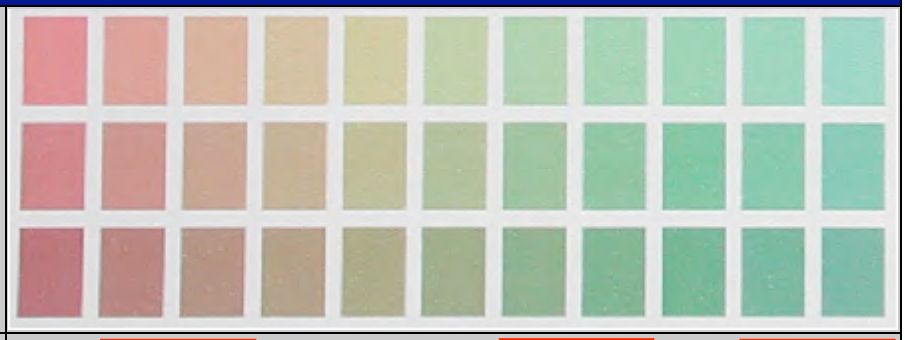
Color Rendition Analyses

Colors in CAD/GIS applications can assist in detail rendition within complex drawings by providing the ability to visually differentiate elements.

Color Differentiation

The ACI palette, as produced by the iPF700 HDI driver, exhibited poor color differentiation. Many adjacent patches appeared to have been rendered as the same visible color. The T610 output exhibited better color differentiation, maintaining visible color differences among the rendered color patches.

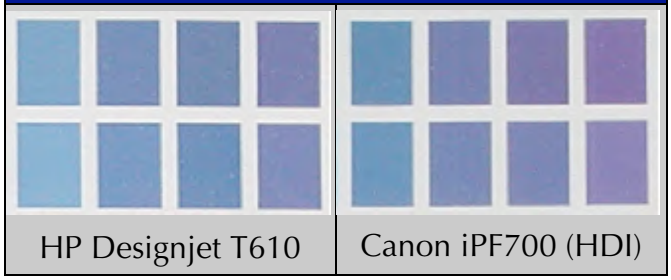
Color Differentiation

HP Designjet T610	
Canon iPF700 (HDI)	

Blues

Blues produced by the T610 appeared bluer than those of the iPF700 HDI driver. The iPF700 HDI driver blues had a magenta cast, giving them a purple appearance rather than blue.

Blue Patches



Pastels

The T610 produced better pastel tints than the iPF700 HDI driver. T610 pastels were rendered lighter and maintained visible hue differentiation among adjacent patches. The pastel tints produced by the iPF700 HDI driver appeared oversaturated in comparison to the T610, and many adjacent patches were visibly the same color.

Pastel Patches

Throughput Speed Performance

Complex jobs often illustrate spooling and printing issues, along with consumption of computer resources—all of which can impact user productivity.

Test Methodology

The *SpencerLab Project* file, consisting of a sheet set of seventeen complex AutoCAD 2007 drawings of a typical residential building plan, was selected from the *SpencerLab* Printer Test Suite to represent an appropriate example of a user application (proofing CAD drawings) for this group of large-format printers. The drawings were sized for Arch D paper (36" x 24"), landscape orientation, centered on the page, printed at 1:1 scale, and printed using each printer's default print mode.

Throughput Performance Test File

SpencerLab Project AutoCAD Drawing

Per each manufacturer's technical support, the default modes for each driver – FAST mode for the HP T610 GL/2 driver and STANDARD mode for the Canon iPF700 HDI Driver for AutoCAD 2007 – are suitable for reproducing CAD drawings for proofing purposes. Both units print bi-directionally in their respective default print modes.

All time measurements begin with the Request-to-Print. Timing events recorded during testing included the following:

- Application Release—the time elapsed until the application (AutoCAD 2007) has completed creating the print file and is freed to perform other tasks
- Workstation Release—the time elapsed until the workstation is released from the print task and can be productive at full processing power; the interval until the print file disappears from the printer's queue/spooling system
- Engine Start—the time elapsed until the print engine makes some sound indicating the activation of imaging or paper feed mechanisms
- Print Start—the time elapsed until the first carriage movement of the print engine, indicating that printing has started
- First Page Out—the time elapsed until the trailing edge of the first page of the test document has exited from the printing device and the page has dropped into the output bin of the printer, available to the user; in the case of roll-fed units, this is the time elapsed until the cutting procedure is complete
- Last Page Out—the time elapsed until the trailing edge of the last page of the test document has exited from the printing device and the page has dropped into the output bin of the printer, available to the user; in the case of roll-fed units, this is the time elapsed until the cutting procedure is complete

Additionally, due to anomalies in the print process of the Canon iPF700 (documented below), two additional timing events were recorded:

- Eighth Page Out—the time elapsed until the trailing edge of the eighth page of the test document has exited from the printing device and the page has dropped into the output bin of the printer, available to the user; in the case of roll-fed units, this is the time elapsed until the cutting procedure is complete
- Online State—the point at which the control panel on the iPF700 had indicated that the prior job had finished printing

Processor and spooler loads were also monitored on the workstation over the course of all timing iterations.

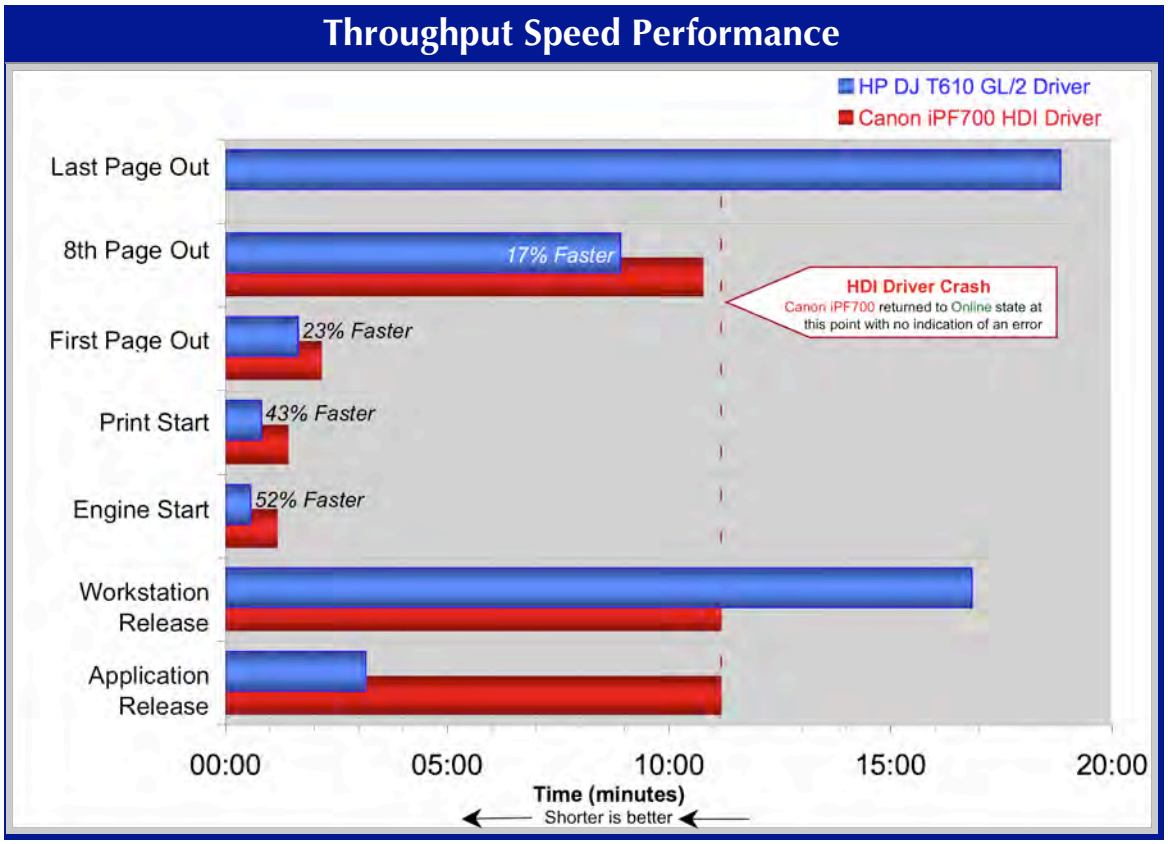
Results and Analysis

The iPF700 HDI driver was consistently unable to print the entire, seventeen-page sheet set. Invariably, the spooling process failed while processing the ninth page of the job; therefore, a timing event for the Eighth Page Out was recorded for both the iPF700 and the T610 for purposes of comparison to that point. The T610 produced all seventeen pages without errors or failures during all the iterations of the testing.

Multiple calls were placed to Canon technical support in an attempt to resolve the issue at hand; the response from Canon was that the issue was caused by a memory overflow within the printer, and as the printer's memory is not upgradeable, the suggested workaround was to print multiple, smaller sheet sets to ensure complete production of the print job – a significant impact to workflow.

Throughput Speed

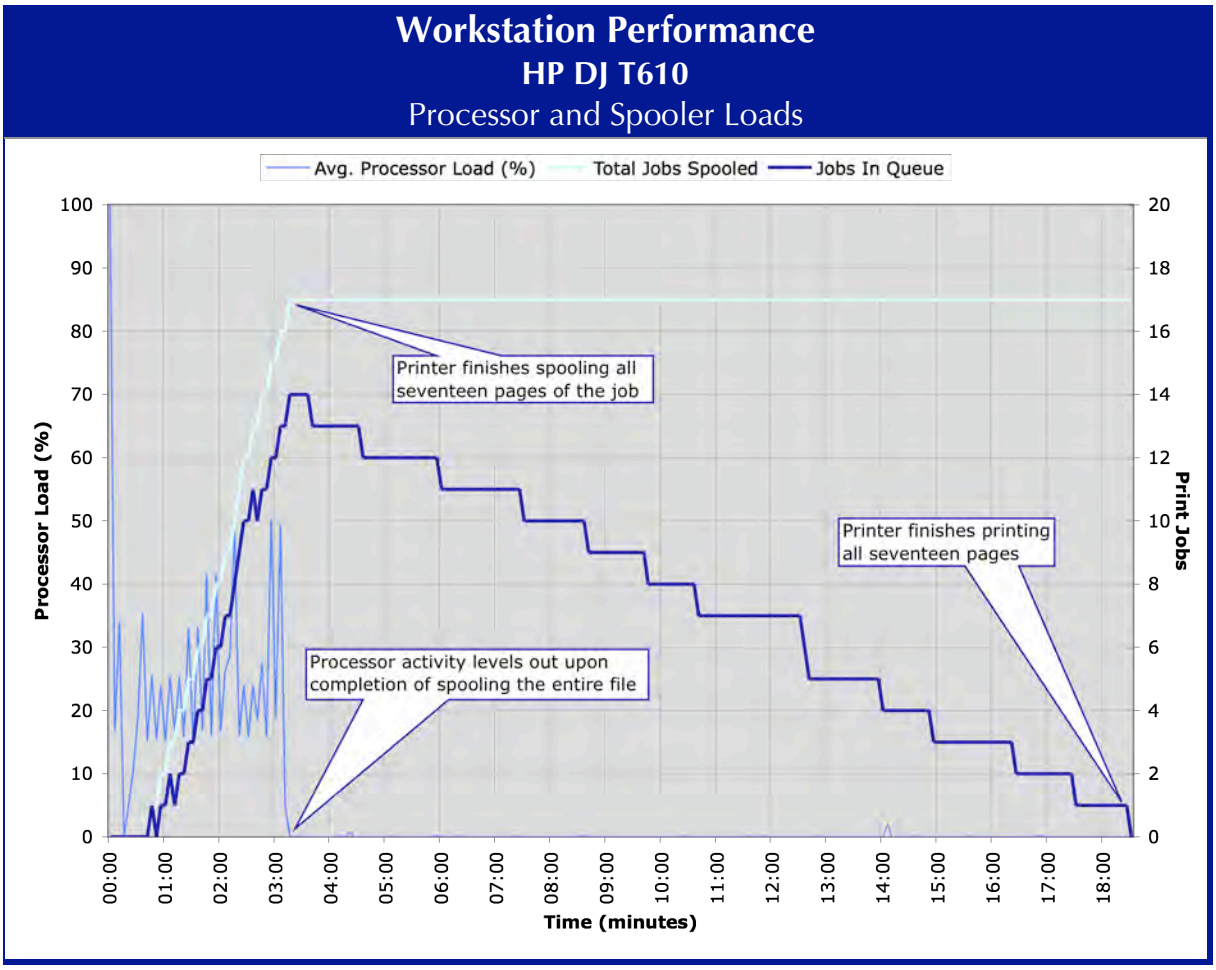
Across eight pages, the T610 consistently provided a speed advantage of nearly two minutes – 8:50 for Eighth Page Out on the T610 versus the 10:42 from the iPF700. Engine Start times were an average of 52% faster on the T610, Print Start times were 43% faster, and T610 First Page Out times were 23% faster than the iPF700.



Computer Workstation Performance Results

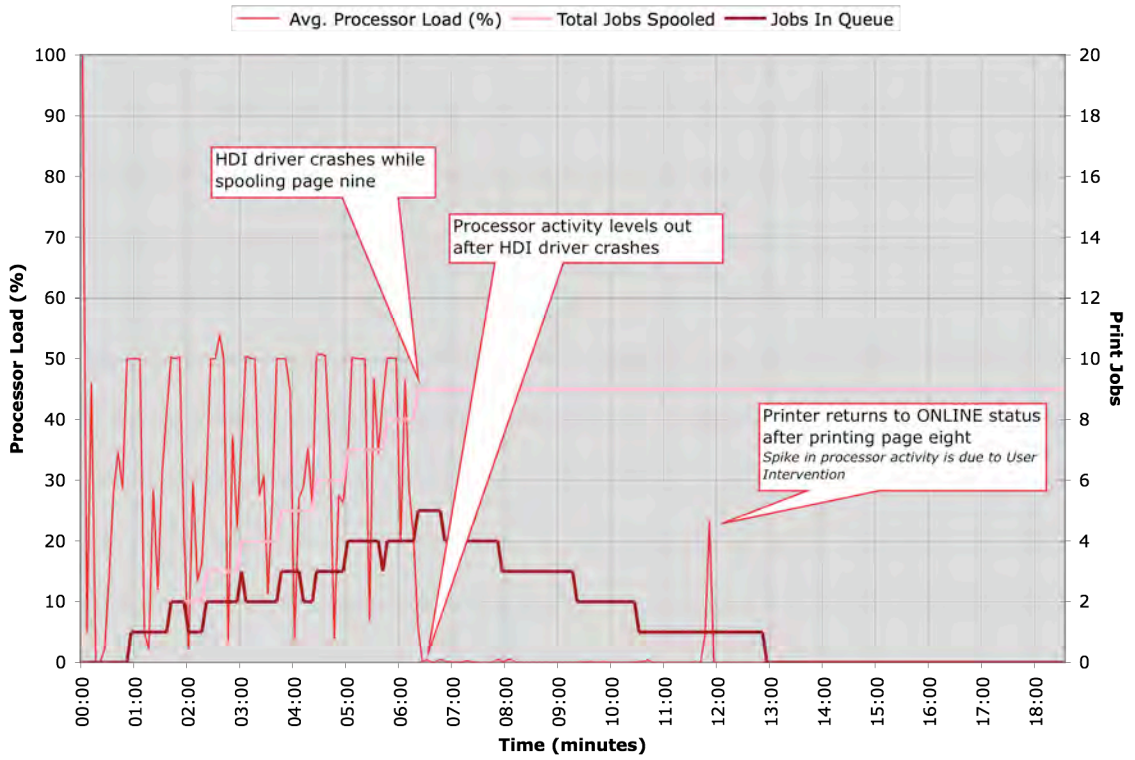
Both the T610 and the iPF700 demanded up to 50% of the workstation's processor load over the course of spooling the print job; however, the T610 HP-GL/2 driver was able to spool the seventeen page job and then release both the application and the proces-

sor in roughly half the time it took for the iPF700 HDI driver to spool nine pages and crash – which released the processor, but not the application.



The T610 HP-GL/2 driver demanded the processor's attention for just upwards of three minutes, at which point all seventeen pages had entered the printer's queue. From there, the user was able to make further use of the application while the T610 produced the entire set of requested output without further impact on the workstation's processor.

Workstation Performance
CANON iPF700
Processor and Spooler Loads



In sharp contrast to the HP T610 experience, the iPF700 HDI driver's spooling process demanded the processor's attention for upwards of six minutes, during which time it did not spool the entire set of seventeen pages.

While spooling the ninth page in the set, the application hung, and displayed a dialog box with a progress bar that never filled; this progress bar did not disappear until the user forcefully terminated the application. After printing the eighth page in the set, the iPF700 control panel returned to ONLINE status, ready to accept another print job. The printer showed no indication of an error, and the user was left with an incomplete set of output.

In their default print modes, the T610 was able to produce output of better quality than the iPF700 HDI driver, with the T610 exhibiting significant performance advantages in both speed and reliability when printing complex CAD files.

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.

August 2007