

## Print Quality Analyses – ColorLok Media Evaluation

**AiO Printers: Brother MFC-5490CN, Canon PIXMA MX860 & MX7600, Epson WorkForce 600, HP Officejet 6500 & Officejet Pro 8500**

The *spencerLAB* DIGITAL COLOR LABORATORY has conducted independent testing and evaluation of the print quality attributes of COLORLOK and NON-COLORLOK media on color inkjet All-in-One (AiO) printers in order to ascertain benefits and/or limitations of the COLORLOK technology.

The analysis comparatively evaluated the print quality of the various elements that comprise documents, including BLACK and COLOR TEXT & LINES, TINTS & BLENDS, and IMAGES. In addition, Black Density and Color Gamut Volume were measured.

### KEY FINDINGS

The primary benefit of COLORLOK media was higher saturation and higher sharpness. This increased sharpness has an associated limitation: increased appearance of graininess in pastel tints. Both effects stem from the smaller ink spread on COLORLOK media that minimizes the wicking noticeable on NON-COLORLOK media.

Both color GAMUT VOLUME and BLACK DENSITY were greater on COLORLOK media than on NON-COLORLOK media, for all tested AiO printers. This corresponded to higher color saturation and richer blacks on COLORLOK media.

In general, differences with the COLORLOK media were more apparent in black than in color output. In addition, the differences were generally more significant on pigment-based inks.

In summary, there is a noticeable improvement in print quality when using media with COLORLOK technology – bolder blacks and more vivid colors, especially on pigment-based inkjet printers.

### GENERAL METHODOLOGY

Key elements of the *spencerLAB* test methodology included:

- Selection of appropriate test files from the *spencerLAB* PRINTER TEST SUITE
- Determination of COLORLOK and NON-COLORLOK test media
- Print Quality analysis between COLORLOK and NON-COLORLOK media on each tested AiO printer's output

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The *spencerLAB* DIGITAL COLOR LABORATORY, a division of Spencer & Associates Publishing, Ltd., is an independent test laboratory with a broad base of industry clients. Although this independent 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.

**TEST PARAMETERS**

Test files selected from the *spencerLAB* PRINTER TEST SUITE included *Color Spectrum RGB*, *Enhanced Black*, and *Graphic RGB* PDF files. PDF files were printed under Windows XP (SP3) operating system, using Acrobat Reader 9.1.2 with the ‘LET PRINTER DETERMINE COLORS’ option selected in Reader’s Advanced print dialog box. Test files were printed in Default and Draft modes for Plain paper, using the latest print driver available from the respective manufacturer’s web site. The *Enhanced Black* test file was printed using Grayscale/Black default settings. All test prints were printed by *spencerLAB* personnel for analysis.

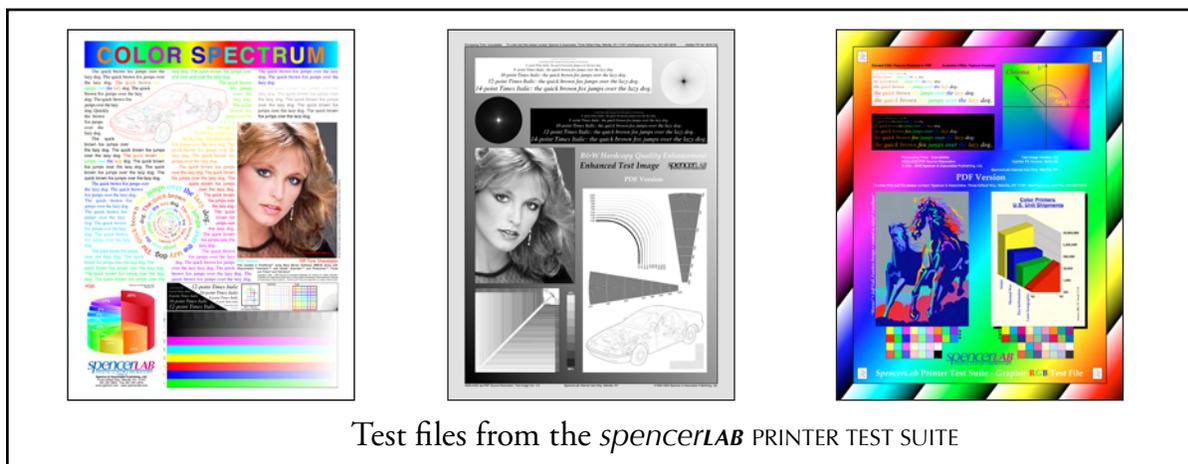
Both selected test media were 20# bond, 96 Brightness office papers. For a COLORLOK media, Domtar Multi-System Ultra with COLORLOK Technology was chosen; Boise X-9 Hi-Brite was chosen for a comparable NON-COLORLOK media.

The six color All-in-One inkjet printers, in alphanumeric order, are:

- Brother MFC-5490CN
- Canon PIXMA MX860
- Canon PIXMA MX7600
- Epson WorkForce 600
- HP Officejet 6500
- HP Officejet Pro 8500

One unit for each competitive printer was used in testing, and it was assumed to be representative for analysis. Printer maintenance (print head cleaning, alignment, etc.) was performed on all devices prior to testing. All printers are referenced herein with randomly assigned letters.

Comparative print quality of BLACK and COLOR TEXT & LINES, TINTS & BLENDS, and IMAGES was comparatively analyzed between COLORLOK and NON-COLORLOK media, in each tested AiO printer’s respective Default and Draft print driver modes for Plain paper, by a team of experienced *spencerLAB* analysts (*spencerLAB* has been performing Print Quality analyses for over 20 years, and has benefited from the management of focus groups in 11 cities on three continents) – within the expected range appropriate to the intended applications in the office printing marketplace.



In addition, BLACK DENSITY and color GAMUT VOLUME and AREA were measured and analyzed. All Density (Status T) and Color -  $L^*a^*b^*$  (D50/2°) measurements were taken with a calibrated X-Rite 939 spectrodensitometer.

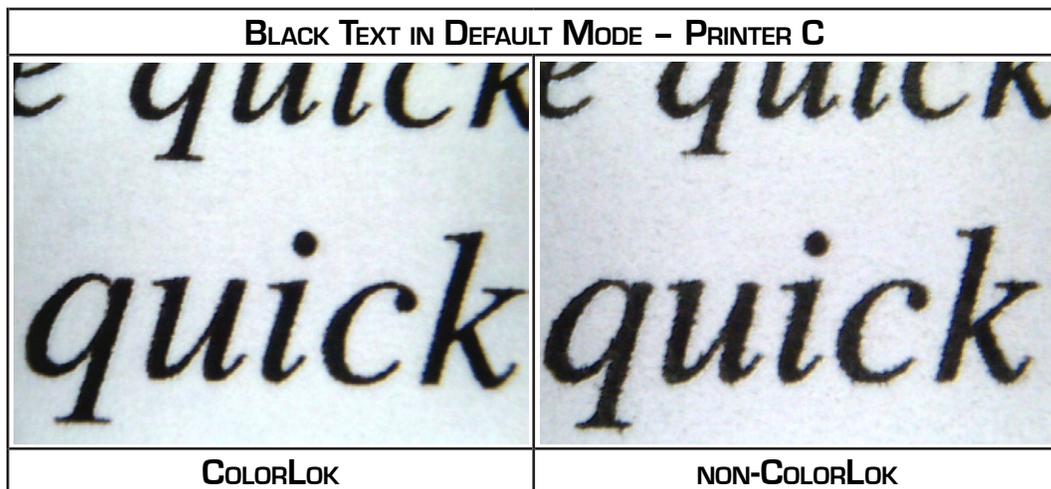
## PRINT QUALITY TEST ANALYSIS AND FINDINGS

Results of the comparative analysis between the COLORLOK and NON-COLORLOK media on tested AiO printers are noted in the areas of BLACK and COLOR TEXT & LINES, TINTS & BLENDS, and IMAGES.

### BLACK TEXT & LINES

#### Default Mode

BLACK TEXT & LINES on COLORLOK media, printed in Default mode, were rendered slightly sharper and cleaner with less edge noise than on NON-COLORLOK media, due to comparatively less wicking and spreading of ink on dye- as well as pigment-based output. Output on NON-COLORLOK media appeared softer and less dense in comparison. On PRINTER E output, apparent noise was slightly increased by the additional sharpness and density of COLORLOK media. REVERSE BLACK TEXT exhibited more fill-ins on NON-COLORLOK than on COLORLOK media output due to ink spread, although legibility of regular BLACK TEXT was maintained equally.



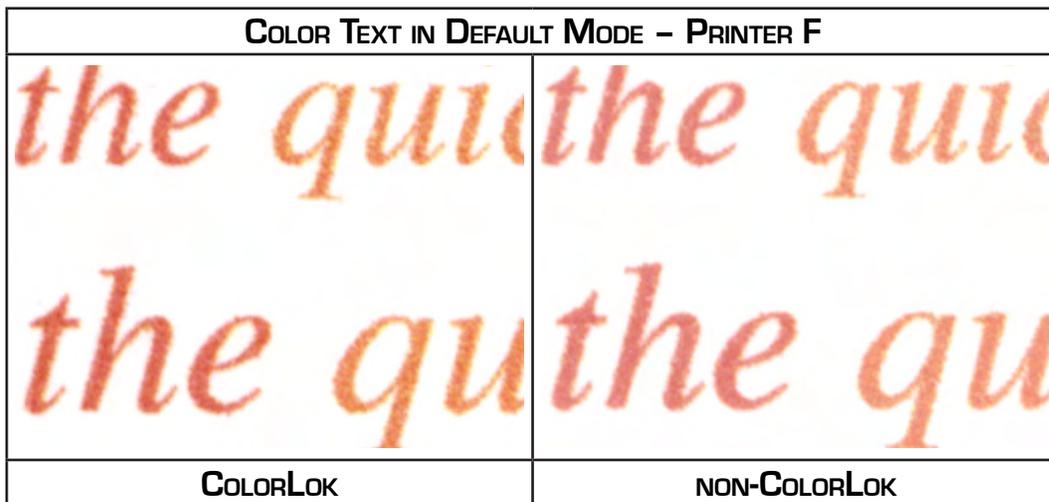
#### Draft Mode

In Draft mode, BLACK TEXT & LINES on COLORLOK media had only slightly sharper and darker BLACK TEXT & LINE rendition compared to NON-COLORLOK output. However, PRINTER D Draft output was extremely washed out and broken, causing any difference in quality between the two media to be insignificant. The PRINTER B Draft output on COLORLOK media had slightly higher density; however, overall Draft print quality was still poor.

**COLOR TEXT & LINES**

**Default Mode**

COLOR TEXT & LINES in Default mode were sharper and more saturated on COLORLOK output for PRINTER B and PRINTER F pigment-ink based machines. NON-COLORLOK color TEXT on these AiO printers appeared soft in comparison. However, on PRINTER E’s pigment-ink output, the difference was comparatively less noticeable, and COLOR TEXT & LINES were only slightly more saturated on COLORLOK media, and improved sharpness was more visible on horizontal lines (in general, vertical lines are not rendered as sharply by the printers). On the PRINTER A, PRINTER C, and PRINTER D dye-based ink output, COLOR TEXT & LINES on COLORLOK and NON-COLORLOK media showed negligible differences. On all tested AiO printers, reverse COLOR TEXT with Black surround showed more fill-ins on NON-COLORLOK media than COLORLOK media, due to the greater ink spread.



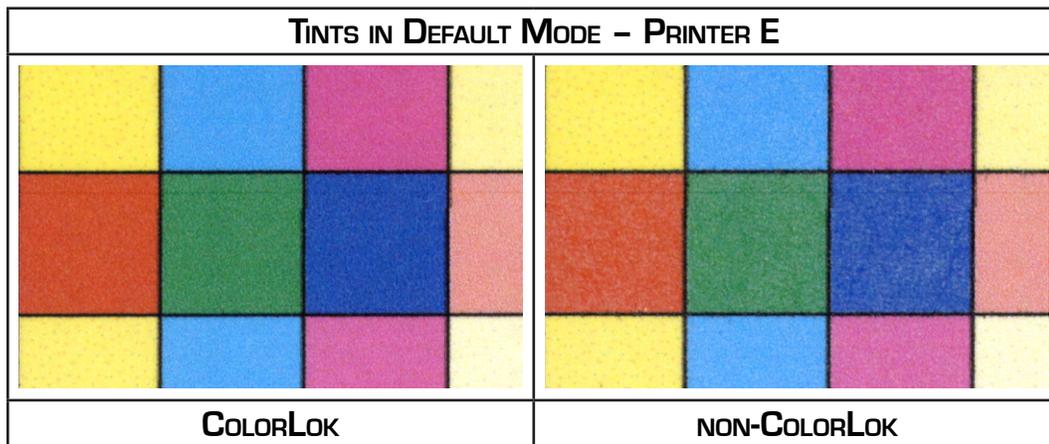
**Draft Mode**

In Draft mode, noticeable differences in COLOR TEXT & LINES on COLORLOK and NON-COLORLOK media were negligible due to comparably lower saturation and overall lower quality. However, COLOR TEXT & LINE saturation was slightly higher on PRINTER E and PRINTER F COLORLOK output. PRINTER F output was also marginally sharper on COLORLOK media. PRINTER B and PRINTER D Draft COLOR TEXT & LINES were rendered with poor quality, being extremely washed out and broken, causing any difference in quality between the two media to be insignificant.

**TINTS & BLENDS**

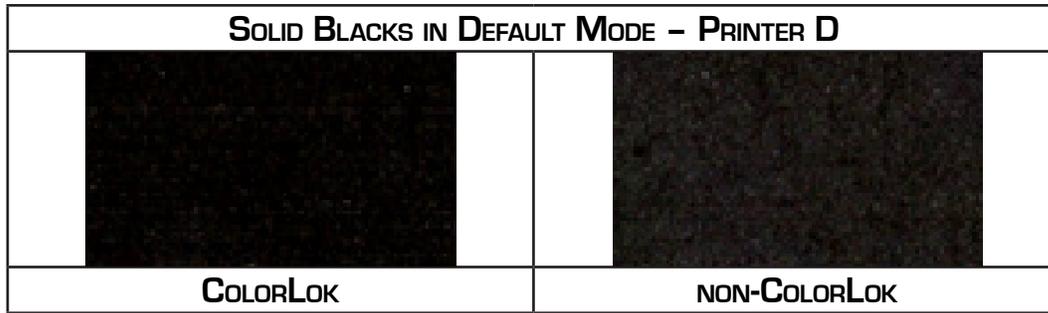
**Default Mode**

As with COLOR TEXT & LINES, similar differences were noticed between pigment and dye-ink based machine output on TINTS & BLENDS in Default mode. The PRINTER B, PRINTER E, and PRINTER F TINTS & BLENDS had noticeably higher saturation on COLORLOK output than on NON-COLORLOK output, which appeared muted in comparison. PRINTER A, PRINTER C, and PRINTER D TINTS & BLENDS were comparable in saturation on both media. On all tested AiO printer output except the PRINTER E, TINTS & BLENDS were slightly smoother overall on NON-COLORLOK, appearing less grainy, perhaps due to greater ink spread. Blacks were rendered richer (higher density) on COLORLOK media on all tested AiO printers, resulting in better depth on graphics. All tested NON-COLORLOK output exhibited some mottling on solid Blacks as well as saturated colors, most severe on PRINTER E output.



**Draft Mode**

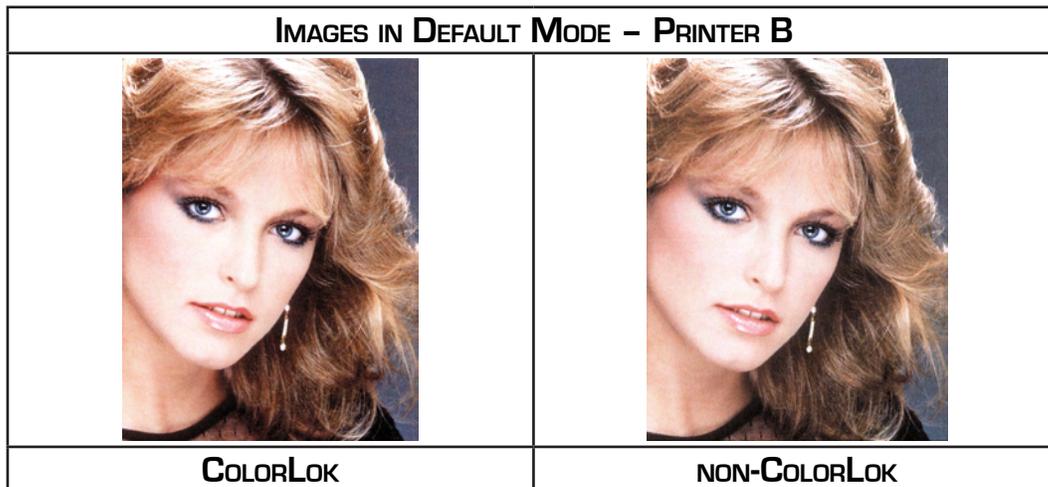
In Draft mode, TINTS & BLENDS were rendered with comparatively lower saturation and appeared more grainy than on Default mode output, making saturation and smoothness differences marginal between COLORLOK and NON-COLORLOK Draft output. However, slightly higher saturation was noticed on PRINTER E and PRINTER F COLORLOK output. PRINTER A and PRINTER C output did not show any noticeable difference between the media types on COLOR TINTS & BLENDS. Again, the lower quality of PRINTER B and PRINTER D output made differences between media types indistinguishable. Mottling was noticed in solid black areas on all tested AiO printers’ NON-COLORLOK output.



## IMAGES

### Default Mode

COLORLOK media IMAGES in Default mode were rendered sharper and with higher contrast and richer Blacks on all tested AiO printers. NON-COLORLOK output appeared muted overall in comparison. IMAGES from the PRINTER B, PRINTER E, and PRINTER F (THE THREE PIGMENT-BASED INKJET AiO PRINTERS) exhibited more vibrant colors on COLORLOK media, along with increased color casts. While PRINTER A, PRINTER C, and PRINTER D IMAGES had comparable color rendition on both media, Blacks were darker on their output on COLORLOK media.

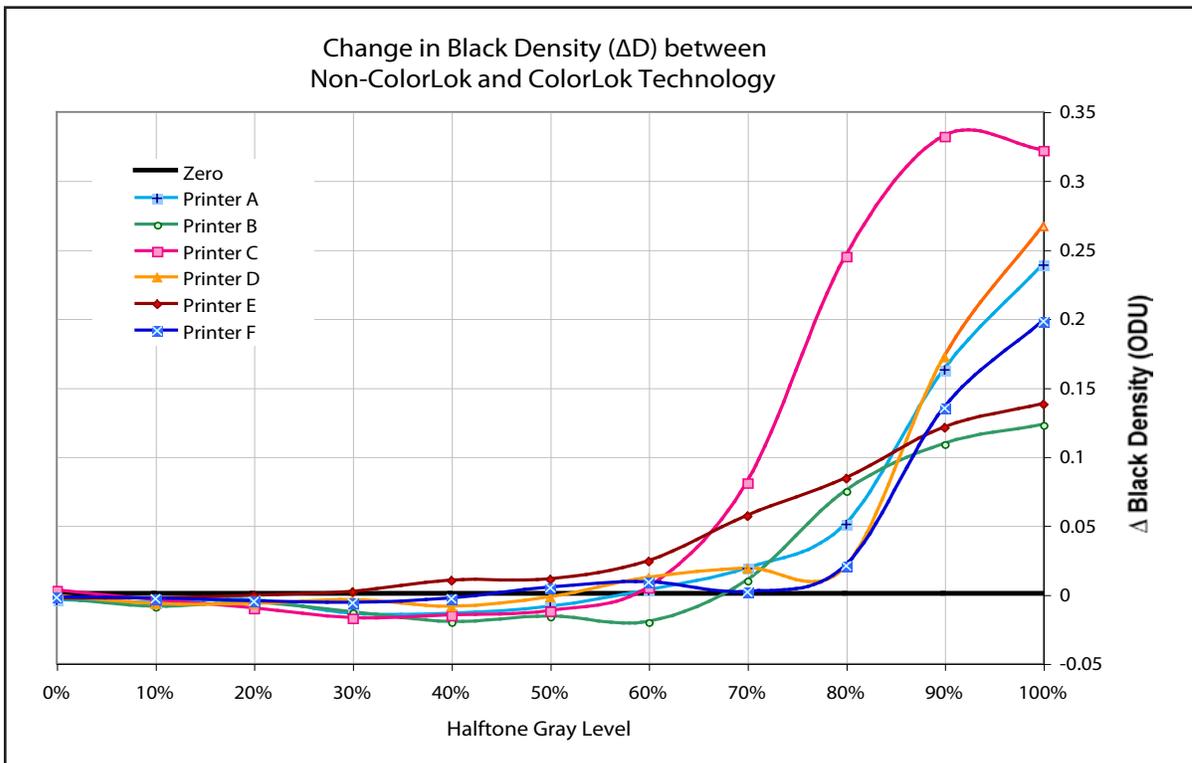
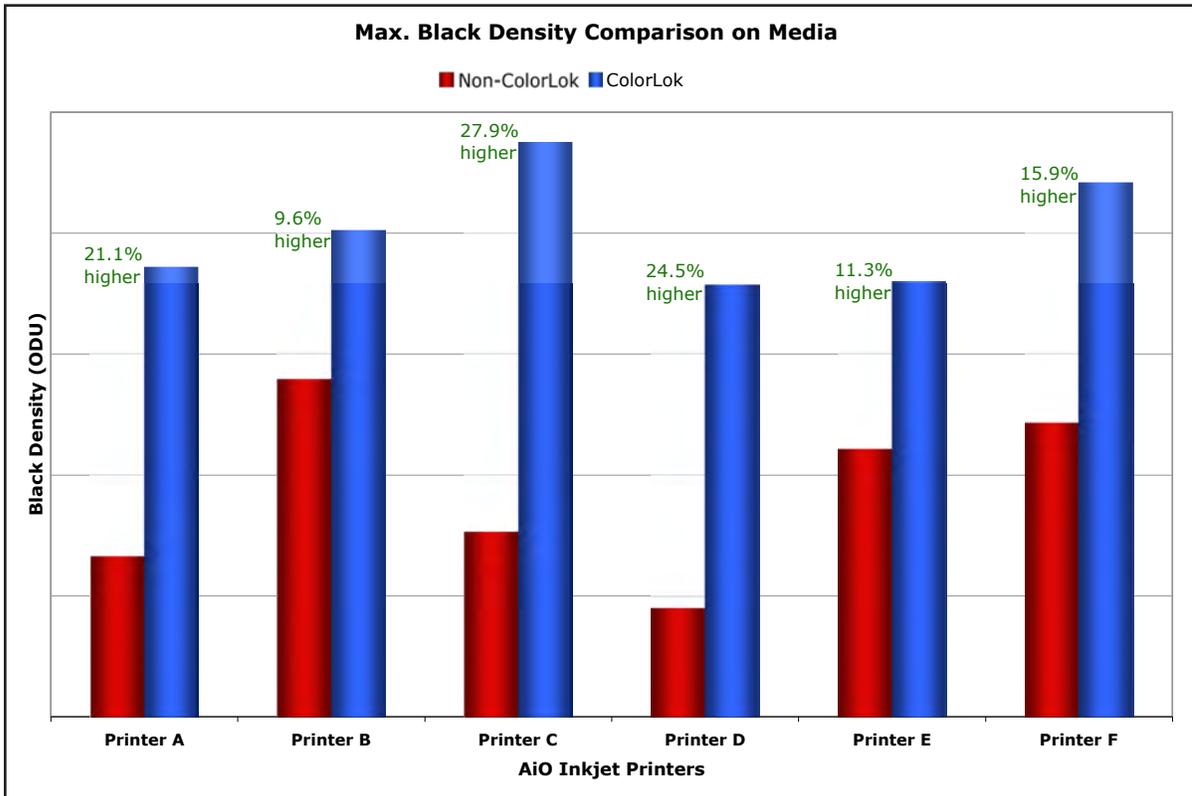


### Draft Mode

IMAGES in Draft mode on COLORLOK media, on PRINTER A, PRINTER C, PRINTER E, and PRINTER F, were only marginally sharper than on NON-COLORLOK media. PRINTER B and PRINTER D's poor image quality on Draft mode output made any noticeable differences between the two media types insignificant.

## BLACK DENSITY

One of the most noticeable benefits of using COLORLOK media was the greater BLACK DENSITY achieved. All tested AiO printers recorded higher 100% BLACK DENSITY on the COLORLOK media, providing richer and bolder TEXT & LINES and better depth on graphics



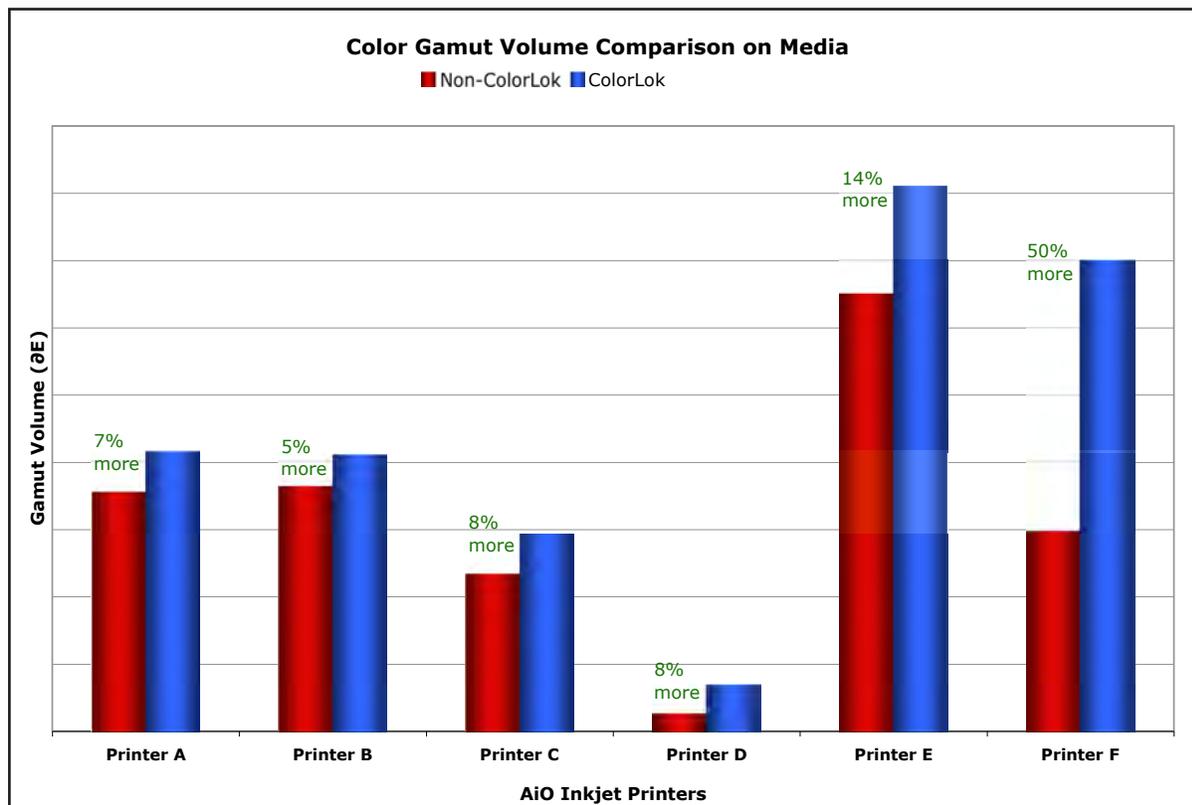
and IMAGES. Lower BLACK DENSITY on NON-COLORLOK media corresponded to the mottling on solid Black areas.

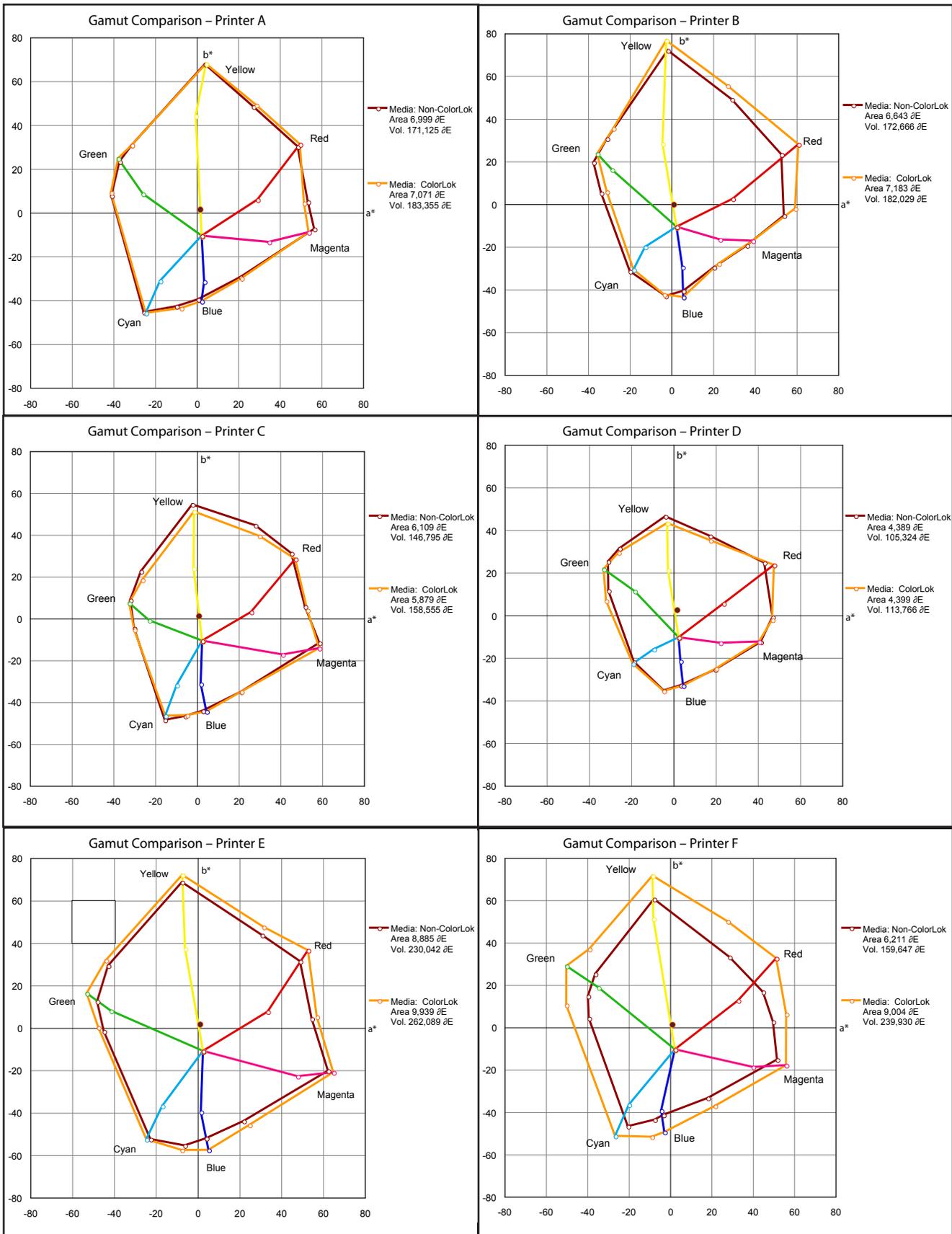
The PRINTER C provided the highest BLACK DENSITY of 1.47 ODU (Optical Density Units) on COLORLOK media, and the largest increase, 0.32 ODU, over NON-COLORLOK media. Note that the PRINTER C has a pigment-based Black cartridge, used nominally for text, as well as a dye-based ink cartridge. The PRINTER F was close behind with the second highest 1.44 ODU on COLORLOK media, with an increase of 0.20 ODU over NON-COLORLOK. Perhaps the major beneficiary of using COLORLOK media would be the PRINTER D, whose 0.27 ODU increase brought it up from the lowest BLACK DENSITY on NON-COLORLOK media to be nearly tied with the PRINTER E, which only increased 0.14 ODU. The smallest increase in BLACK DENSITY was noted for the PRINTER B. The PRINTER A had a mid-range BLACK DENSITY of 1.37 ODU on COLORLOK, that had increased 0.24 ODU, also a mid-range change.

In general, we noted little increase in the BLACK DENSITIES below 75%. On both media types, PRINTER F output showed a lower-than-trend density at 80% gray, resulting in a noticeable jump in density between 80% and 90%.

### GAMUT VOLUME

On all tested AiO printers, the color GAMUT VOLUMES on the COLORLOK prints were larger than on NON-COLORLOK output. This contributed to higher saturation and vibrance of colors on COLORLOK media output compared to NON-COLORLOK media. Two-dimensional projections ( $a^*b^*$  plot) of the 3-dimensional GAMUT VOLUMES are shown for





each tested AiO. Along with the 3-dimensional GAMUT VOLUMES, the 2-dimensional GAMUT AREA was calculated.

The PRINTER F recorded the largest increase by far in GAMUT VOLUME among all tested AiO printers – over 50% (45% larger in AREA) – when changed to printing on media with COLORLOK technology. The PRINTER E had the largest GAMUT VOLUME on COLORLOK media, having increased 14% with the technology. The PRINTER A and the PRINTER B showed essentially equal and large 3-dimensional GAMUT VOLUMES. Their increases were only in the 5-8% range, as were those of the PRINTER C and PRINTER D. Even on COLORLOK media, the PRINTER D's GAMUT VOLUME was less than half that of the PRINTER E and PRINTER F.

GAMUT AREA changes in conjunction with GAMUT VOLUMES can indicate hue shifts and saturation changes. As with its GAMUT VOLUME, the gamut area of the PRINTER F increased a whopping 45%, indicating a very significant increase in saturation; this increase was accompanied by a hue shift towards Yellow. The PRINTER E, which on COLORLOK media had a GAMUT AREA 10% larger than the PRINTER F, increased only 12%; although there was no hue shift, the Magenta cast unfortunately remained. As with its GAMUT VOLUME, the PRINTER D had the smallest GAMUT AREA with negligible help from the ColorLok technology; however, it experienced minor Red and Green hue shifts away from Yellow (Red less Orange, green less Lime) with the COLORLOK media (apparent more on the TINT test than on the IMAGE test illustrations). The PRINTER C experienced a 4% decrease in GAMUT AREA, primarily in Cyan and Yellow. The PRINTER A and PRINTER B had similar mid-range GAMUT AREAS on the COLORLOK media; the PRINTER B acquiring an Orange cast while the PRINTER A secondaries benefitted at the expense of the primaries, especially Magenta.

## THE *spencerLAB* DIGITAL COLOR LABORATORY

The *spencerLAB* DIGITAL COLOR LABORATORY is an independent printing device evaluation firm that provides services to vendors and corporations for whom digital color printing is mission-critical. The Laboratory follows strict guidelines in the integrity of both its methodology and reporting; vendor-sponsored studies do not guarantee favorable results. *spencerLAB* has developed industry-standard test software, and performs print quality, cost-per-page/yield, throughput speed, and ease-of-use analyses in all technology classes, from desktop printers to digital color presses.

*spencerLAB* is operated by Spencer & Associates Publishing, Ltd., a premier IT consulting boutique specializing in Digital Color Imaging. Since 1989 Spencer & Associates has provided strategic support in product planning, development, and launch to manufacturers, and workflow analysis, usage optimization and print system selection to corporate users.

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