WHITE PAPER

spencerLAB
DIGITAL COLOR LABORATORY

Digital Presses Rise to a New Challenge — HP Indigo press 5500 leads in Photographic Print Quality

Digital cameras have become a disruptive technology – with increasing image quality, decreasing acquisition cost, nearly zero cost-per-click, and better ease-of-use, consumers are taking exponentially more and better photographs. Showing these photos on monitors and sharing them on the Internet are good, but having hardcopy prints to cherish still has its place.

Printing is becoming more and more affordable, accessible, and convenient – resulting in an explosion of applications. Whether celebrating recent travels, a party, or a major family event (births, confirmation and bar mitzvahs, graduations, weddings, special birthdays and anniversaries, etc.), there is significantly increasing demand for high quality, low cost photographic albums. Technology also makes personalized calendars, greeting cards, postcards, birthday cards, invitations, et. al., accessible to the consumer.

Photographic print quality has become the latest challenge for digital presses...

Executive Summary

Methodology

The *SpencerLab* Digital Color Laboratory was commissioned by Hewlett-Packard Company to perform an independent comparative analysis of Photographic Print Quality. We researched, contacted vendors, and spent considerable effort to identify high-level commercial/retail printers offering current versions of the competitive digital presses; comparable media and gloss were specified. About three dozen sets of test documents that incorporate a representative suite of images were then printed, sometimes additionally and even at alternate printers, until deemed representative. A comparative photographic Print Quality analysis was performed by a team of experienced *SpencerLab* staff, focussing on the areas of Richness, Realism, Sharpness, Smoothness, and Overall preference.

A Range of Consumer Photographs

Selected from the *SpencerLab* Printer Test Suite

Key Findings

We found that the HP Indigo press 5500 prints were preferred Overall, and they were preferred over the competitive digital presses in every category.

Indigo press 5500 prints were even preferred Overall to conventional film, the continuous-tone benchmark process.

Our summary finding is that **the HP Indigo press 5500 prints had the best photo quality, better than the other tested digital solutions and even conventional film.**

Detailed Results

Procedure

• We prepared a suite of test files (some of which are shown on the prior page) representing a broad range of consumer photographs, augmented by test files from the *SpencerLab* Printer Test Suite, which has been used extensively in our testing as well as by many major printer manufacturers under license.

• These files were printed on an HP Indigo press 5500, Kodak NexPress 2500 and Xerox iGen3 competitive digital presses, and a Fujifilm Frontier conventional photographic printer (silver halide, or AgX). Digital press prints were imaged on comparable media and coated so that all test prints were glossy.

• Consistency is an issue with many printing technologies. For example, even with digital enhancement, conventional film processing is a chemical process that changes with time and use, and needs frequent and accurate calibration. Xerography is sensitive to the physics of temperature, humidity, and atmospheric pressure changes, as well as changes in the toner and media; digital presses incorporate multiple feedback mechanisms to minimize these changes. In order to minimize the impact of these issues, prints were obtained from multiple commercial/retail printers and/or the manufacturers, and the best examples were selected for analysis.

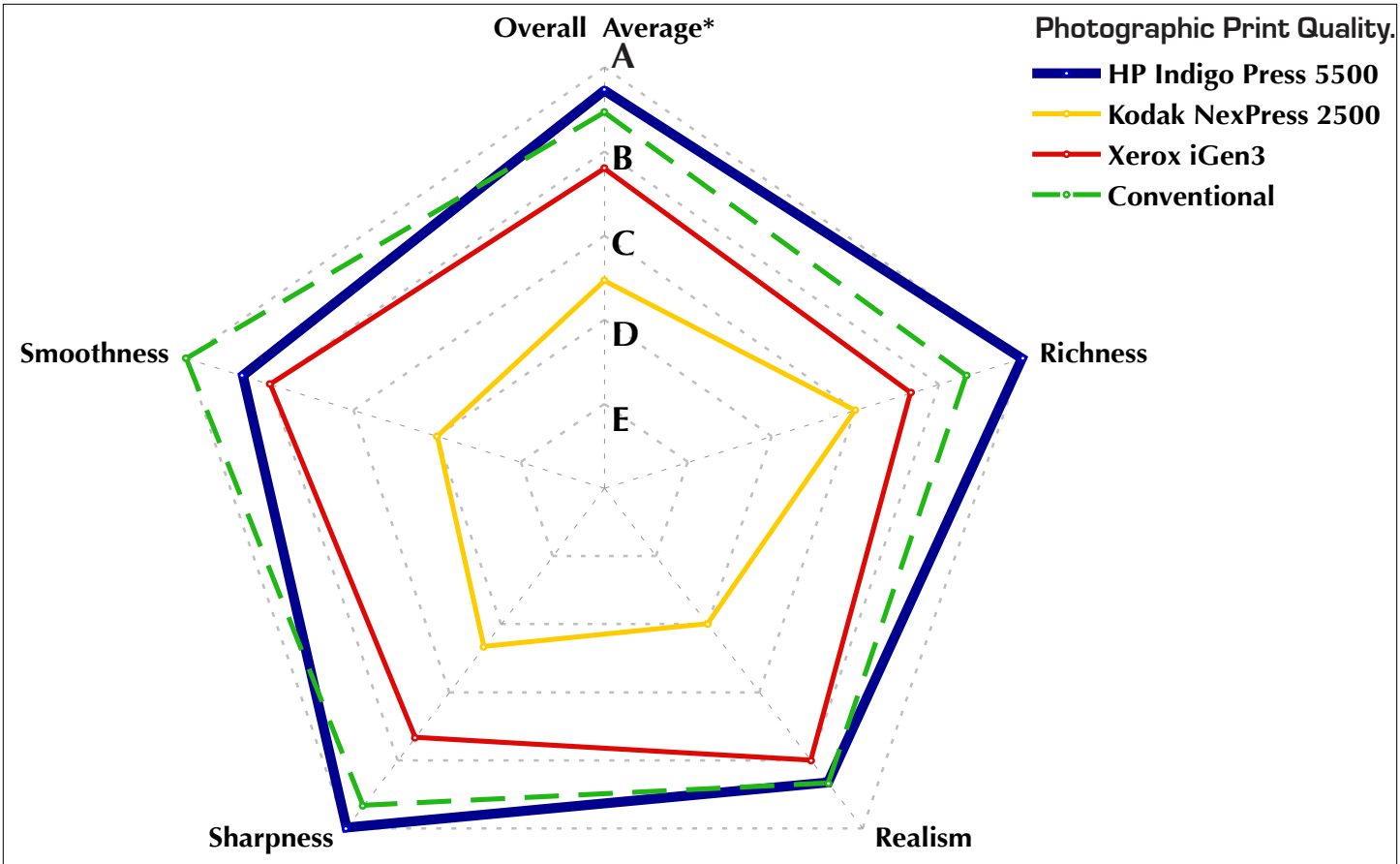
• Analysis was performed by an experienced team of *SpencerLab* staff.

• A summary of the analysis was compiled in five categories: Richness, Realism, Sharpness, Smoothness, and Overall. Each print set was then comparatively graded on an ABC... scale, whose results were summarized in an overall average, shown graphically below.

Richness

Richness is a way of describing the combination of vividness, contrast, and exposure (lightness). Vividness is the saturation or strength of the colors, while contrast and lightness are concerned with how well highlights, midtones, and shadows are balanced.

Richness, Realism, Sharpness, Smoothness, and Overall Preference Grades



Findings represent our best knowledge at time of publication based upon analysis of photographic test prints used in independent research conducted by the *SpencerLab* Digital Color Laboratory under commission by Hewlett-Packard Company.

*Weighted 40/30/20/10%

HP Indigo press 5500 prints displayed well saturated, vibrant color that did not overpower Realism. The optical density of black was the best of the competitive group at over 2.5 ODU (less than 3 CIE *L**). This earned a relative grade of "A". In comparison:

• The Kodak NexPress prints were produced with too much lightness overall and noticeable greenish-yellow color cast that detracted from overall vividness, imparting a haze to the printed images. Surprisingly, yellow flowers lost saturation to excessive highlights. Solid blacks had significantly the least density of the competitive group at under 1.6 (almost 18 *L**) and appeared muddy. Grade: C

• The Xerox iGen3 prints were fairly clean and bright but lacked depth and therefore richness. Lack of image depth and saturation was most noticeable in skin tones and deep reds. Solid black density was 2.0 (over 8 *L**). Grade: B-

• The conventional Fujifilm Frontier prints were vibrant but not very bright, and some colors, especially red, were rendered too dark and lost richness. Some shadow regions were plugged while highlights were blown out – a result of excessive contrast. Solid black density was 2.2 (less than 6 *L**). Grade: B+

Realism

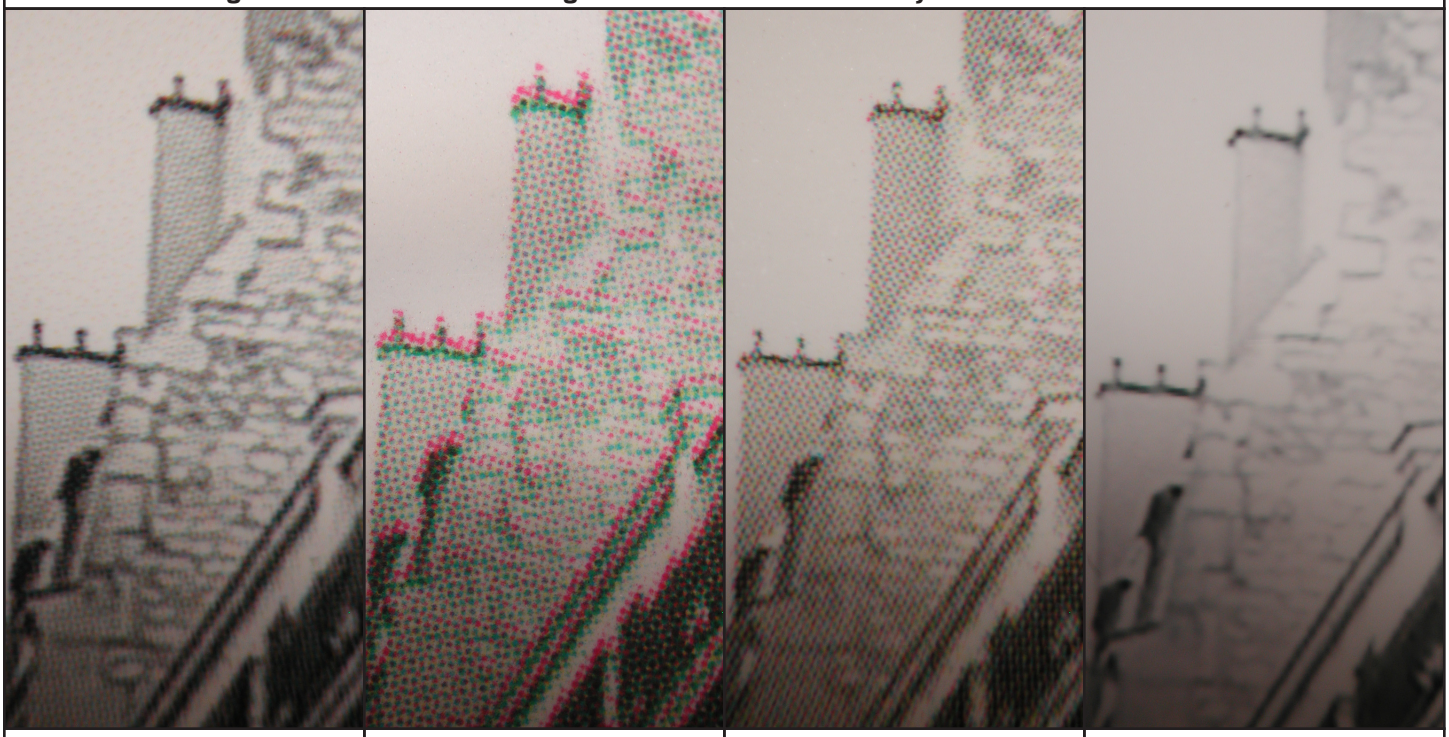
Realism includes true-to-life reproduction of memory colors – those with which users are heuristically familiar without requiring an original for comparison. Natural greens, sky blues, skintones, woods, fruits, and neutrals represent common memory colors that can tax a printer's color rendering ability.

HP Indigo press 5500 skintones were true-to-life with good tone reproduction, but a slightly warm color balance; vegetation and sky renditions were pleasingly realistic. Neutral gray Chroma under 10 ∂E was the lowest of the group. Grade: B+ In comparison:

• The greenish-yellow color cast in the Kodak NexPress prints, as noted above, imparted a haze to the printed images – skintones especially were rendered dull and lifeless. Night images had light skies and lacked depth. Neutral gray showed a Chroma over 21 ∂E (at an expected 100° Hue), by far the highest deviation of the group. Sky tones tended toward purple, while vegetation had a yellow cast and lacked depth. Grade: D

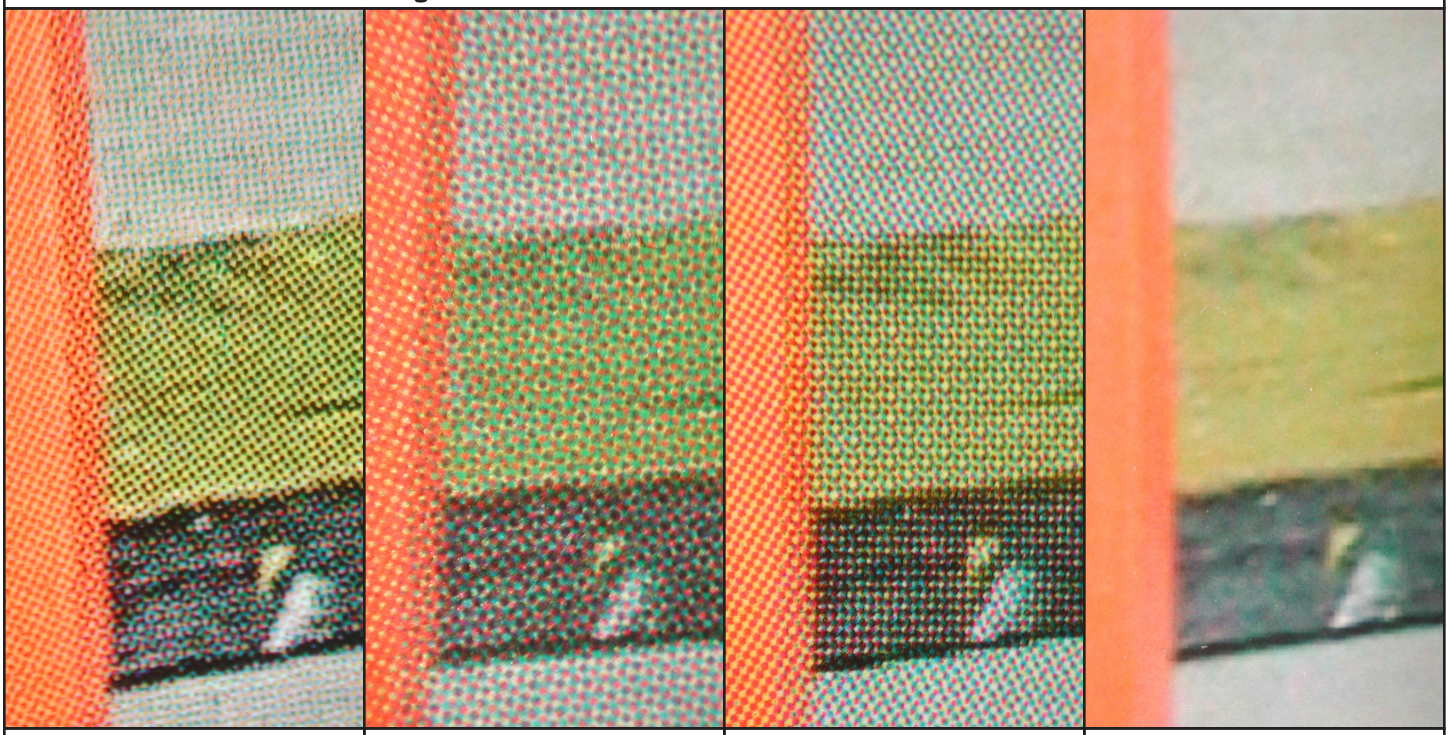
• The Xerox iGen3 prints showed good realism, except for the lack of image depth noted above; night photos had excessive highlights. Otherwise, skintones, sky

Magnified Section of Building from Black & White 'City Street: Paris Rue Littre'



HP Indigo press 5500	Kodak NexPress 2500	Xerox iGen3 110	Fujifilm Frontier 570

Magnified Section of Wood Plank from 'Gas Station'



HP Indigo press 5500	Kodak NexPress 2500	Xerox iGen3 110	Fujifilm Frontier 570

renditions, and vegetation were all realistic. Neutral grays were good but some showed a magenta cast. Grade: B

• The conventional Fujifilm Frontier prints had excellent color balance with extremely realistic skintones, water color, and shrubbery rendition; however, the apparent lack of brightness noted above caused noticeable loss of shadow detail and color saturation in hair, outdoor shadows, etc. Our Fruits test image showed blown out highlights of honeydew and pineapple, while strawberries appeared overly ripe (dark). Neutral grays were close to those of the HP Indigo press 5500. Grade: B+

Sharpness

Sharpness is the combination of image definition, highlight and shadow detail, and image clarity. It is affected by contrast, which may make midtones appear sharper at the expense of highlights and/or shadows, by the screening algorithm, and it can be subjectively enhanced by local contrast enhancement techniques such as the counter-intuitively named 'unsharp masking'.

HP Indigo press 5500 had excellent sharpness, perhaps the best of the competitive group. The image processing in the Photo Enhancement Server is providing excellent local contrast, while the screening algorithm is retaining the image definition with low noise; perhaps the smaller particles in ElectroInk facilitate such high quality screening. This can be seen in the magnified 'City Street' and 'Gas Station' sections above. Grade: A In comparison:

• Our Kodak NexPress test prints were soft, almost blurry or defocussed. This was particularly noteworthy on grass and on a monochrome building as shown in the sections above (see observations about Smoothness, below). Apparent noise associated with the screening algorithm sometimes also impacted sharpness quite negatively. Image enhancement is insufficient. Grade: D+

• The Xerox iGen3 prints were also noticeably less sharp than those of the HP Indigo press 5500. There was a little more shadow detail, but at the significant expense of the midrange and the overall effect. Note the lack of sharpness at the top of the yellow wood plank and the stepping at the bottom of the plank side in the 'Gas Station' section above. Grade: B-

• Within the conventional Fujifilm Frontier prints, as in the Fruit image (above) highlight details suffered on the high-contrast LaBoca photo. Otherwise, image processing is providing excellent local contrast, such that sharpness of the conventional film rivaled that of the HP Indigo press 5500. Grade: A-

Smoothness

Smoothness may be thought of as a lack of artifacts, such as grain, screening, color registration, process noise, streaking or banding, gloss differentials, etc. In areas of little image content variation (low spatial frequency) and/or on sharp transitions (high spatial frequency), screening artifacts (except in continuous-tone printing) and process noise can be readily apparent.

HP Indigo press 5500 provided the smoothest digital press images – coming closest to the continuous-tone conventional film. The additional 5th and 6th colors, Light Cyan and Light Magenta, are expertly integrated to provide smoothness in pastels, skintones, highlight, etc. This may be seen in the comparison example sections above. Grade: B+ In comparison:

• The Kodak NexPress prints exhibited the highest level of screening grain and had significant registration issues. Grain was apparent in sky and skintones. Misregistration between cyan and magenta (measured at 5 to 20 mils in different parts of our test prints) created a blurry, color-fringed monochrome edge and apparent defocussing of color images, as shown in the 'City Street' section above. Grade: D

• The Xerox iGen3 prints showed some apparent noise in a smooth, light blue sky. Screening noise is more apparent than in the HP Indigo press 5500 prints, as can be seen in the sections above. We noted in Sharpness some screening-induced stepping in high-contrast near-horizontal edges. Otherwise, the prints were fairly smooth. Grade: B

• The conventional Fujifilm Frontier prints are the benchmark of smoothness. Their continuous-tone process completely avoids the need for screening. No other significant artifacts were noted. Grade: A

Overall Preference

Overall Preference is both a gestalt subjective judgement and the weighted combination of the Richness, Realism, Sharpness, and Smoothness of the photographic prints. Weighting may reflect the lack of one or more of these characteristics rather than their presence. For this evaluation we found weights of 40%, 30%, 20%, and 10%, respectively, reasonably reflected our gestalt judgements; however, the overall result is relatively insensitive to the specific weights.

HP Indigo press 5500, with good Richness, Sharpness, and Realism, and with Smoothness approaching that of conventional film, garnered our overall preference. It offers 'True Photo Quality' and our staff members would be pleased to have its prints. Overall Grade: A-
In comparison:

• The Kodak NexPress prints took last place with issues in every area. Richness lacked depth, Realism suffered from a color cast, Sharpness was poor (possibly due to misregistration on our test prints), and Smoothness was hampered by screening artifacts. Overall Grade: D+

• The Xerox iGen3 prints were our second preference among the digital presses. Images have very good Realism and Richness except for a lack of apparent depth that affected our preference, as did a lack of Sharpness. Overall Grade: B-

• The conventional Fujifilm Frontier prints – the benchmark – were rated below the HP Indigo press 5500. Richness, Realism, and Sharpness all suffered from dark reds and excessive contrast, but were otherwise good. Smoothness, as expected, was exceptional. Overall Grade: B+

The *spencerLAB* Digital Color Laboratory

The *SpencerLab* Digital Color Laboratory is an independent printer evaluation laboratory 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 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, 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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