

Cartridge Yield and Cost-per-Print for Photo Images HP PSC 2355 and Dell 942 Color InkJet All-in-Ones

Final Report Presentation

December 2004

spencerLAB DIGITAL COLOR LABORATORY

Catherine Fiasconaro, Director

Spencer & Associates Publishing, Ltd.

David R Spencer, President

Melville, New York

1.631.367.6655



Project Overview

Objective

Help understand 4-color photo Cost-per-Print of two color inkjet All-in-Ones

- *HP PSC 2355 and Dell 942*
- *Verify HP published Cost-per-Print claims for “bundled” ink and media value pack*

Incorporate sound, unbiased test and analysis methodologies

- *Independent comparative test, sponsored by Hewlett-Packard*
 - Our methodology and procedures maintain *spencerLAB*’s reputation for unbiased integrity
- *Utilize nine-image spencerLAB Photo Test Suite*
 - Intended to represent typical consumer usage

Independent test of 4-color ink cartridge yield

- *Adapt ISO monochrome toner test methodology to color inkjet printing*
 - Test at least three color cartridges on each of three All-in-Ones from each manufacturer
 - Procure All-in-Ones and cartridges from multiple distribution channels where possible
 - Use “Declared” Page Yield statistical calculations where possible

Calculate and compare Cost-per-Print

- *Combine test results with manufacturer’s published cartridge and photo paper prices*



Significant Findings

HP PSC 2355, Dell 942 color inkjet All-in-Ones tested with *spencerLAB Photo Test Suite*

Ink Cartridge Yield

HP tri-color ink cartridge average photo yield exceeds its *97/97 280-Sheet Photo Value Pack* bundle published marketing claims

HP tri-color ink cartridge photo yield tested higher than Dell's

Cost-per-Print

Tested photo yield combined with Ink and Media cost

- *Tri-color ink, black ink, and media usage per 4"x6" photo image*
- *Pricing based upon "bundles" where available; otherwise, individual ink cartridges and media*
- *Prices per Manufacturer's Web Sites*

HP's tested photo Cost-per-Print was lower than Dell's

- *Dell's cost-per-print 44 to 52% more than HP's*
- *HP at 27.67 to 29.06¢; Dell at 41.95¢*

Confirmed HP *97/97 280-Sheet Photo Value Pack* marketing claim: 29¢-per-Print

Consistent Color Reproduction

Dell cartridges displayed significant cartridge-to-cartridge color variation

HP cartridges produced more uniform color prints



Methodology

Yield Test Methodology

HP ink cartridges were procured from multiple distribution channels; Dell is sole-source

◦ *At least nine tri-color cartridges were tested for each All-in-One*

- Three cartridges were tested in each of three machines for each All-in-One

Manufacturer-recommended media was used for testing

- HP PSC 2355: HP Premium Photo Paper, glossy
- Dell 942: Dell Premium Photo Paper

The All-in-Ones were tested with comparable photo driver settings

◦ *Chosen modes were based upon establishment of comparable output print quality levels*

- HP PSC 2355 Paper Type: hp premium photo paper, glossy; Print Quality: Best
- Dell 942 Paper Type: Photo/Glossy; Quality/Speed: Photo, 4800 dpi
- Automatic paper sensing was disabled in the drivers to prevent possible error

◦ *Machines were run in nominally continuous mode*

- Pauses were only for paper replenishment, jam clearance, and overnight
- Each copy of Photo Test Suite was printed as a separate print job in order to allow for possible intra-job calibration

◦ *Windows Photo Printing software was used with a spencerLAB Photo Test Suite*

Testing was performed in an environmentally controlled office environment

◦ *Machines/cartridges from each vendor were tested from a single computer at the same time*

Declared Color Cartridge Page Yield was calculated in accordance with ISO 19752

◦ *Individual page yield of each cartridge was the number of 4x6" pages printed until End-of-Life*

◦ *End-of-Life was determined by Fade, since neither tested machine employed an INK-OUT stop*

◦ *The prescribed statistical confidence factor was used in calculating Declared Page Yield*

- and resultant cost-per-print



Methodology (cont'd)

spencerLAB Photo Test Suite

Intended to represent typical consumer photographic content

° *Nine photographs*

- Portraits, family photos, landscapes, scenery, vacation photos, etc.

° *Source images color corrected and retouched in sRGB*

- Optimized, maintaining representative photographic quality
- High quality JPEG compression representative of 3-5 MegaPixel digital cameras

° *Red, Green, and Blue components are nominally balanced*



Methodology (cont'd)

Cost-per-Print Analysis Methodology

Ink Cartridge and Media Prices were obtained from manufacturer's current web sites

◦ *Ink and media "bundle" pricing used, where available*

- HP offers a bundle of two tri-color ink cartridges and 280 sheets of 4x6" media (Q6636AN#140) and an *instant rebate* on two 100-sheet packs of 4x6" media (901211)
- Dell does not offer an ink and media bundle; however, a *Get 4 Packs for The Price of 3* for 4x6" media was used (44X6PHO)

Cost-per-Print included the pro-rata cost of ancillary Black ink usage

◦ *Some Black as well as Tri-Color cartridge ink is used when printing photographs*

◦ *Black ink usage determination used pro-rata, average begin-end cartridge weight change*

- Data taken over the lives of three tri-color ink cartridges per machine was averaged

Analysis reflects alternate HP user Usage Scenarios:

◦ *Scenario I – Consumer prints 280 photos, the number of sheets of media supplied in a Value Pack, and discards the ink cartridges upon using up the media*

- Cost-per-Print includes cost of Value Pack plus ancillary Black ink
- Consumer will print 280 photos and may have ink left over in a discarded tri-color cartridge

◦ *Scenario II – Consumer prints additional photos by purchasing additional 4x6" media until all ink from both Value Pack cartridges is used*

- Since 280 sheets are included with Value Pack, user would purchase additional media to use remaining tri-color ink
- Cost of additional media based upon prorated usage of 100-sheet package
- Cost-per-Print includes cost of additional media as well as cost of Value Pack plus ancillary Black ink
- Consumer will have printed more than 280 prints



Test Results

The following tables and charts present the test results

Ink Cartridge Yield (Prints-per-Cartridge)

- *Test results (chart)*
- *Usable Color Ink Content (graph)*

Cost-per-Print

- *Ink and Media*
 - Scenario I
 - Scenario II
- *HP Value Pack Verification*

Appendix

- *Cartridge Reliability*
- *Photographic Image Print Quality*



Ink Cartridge Photo Yield

Individual Page Yields

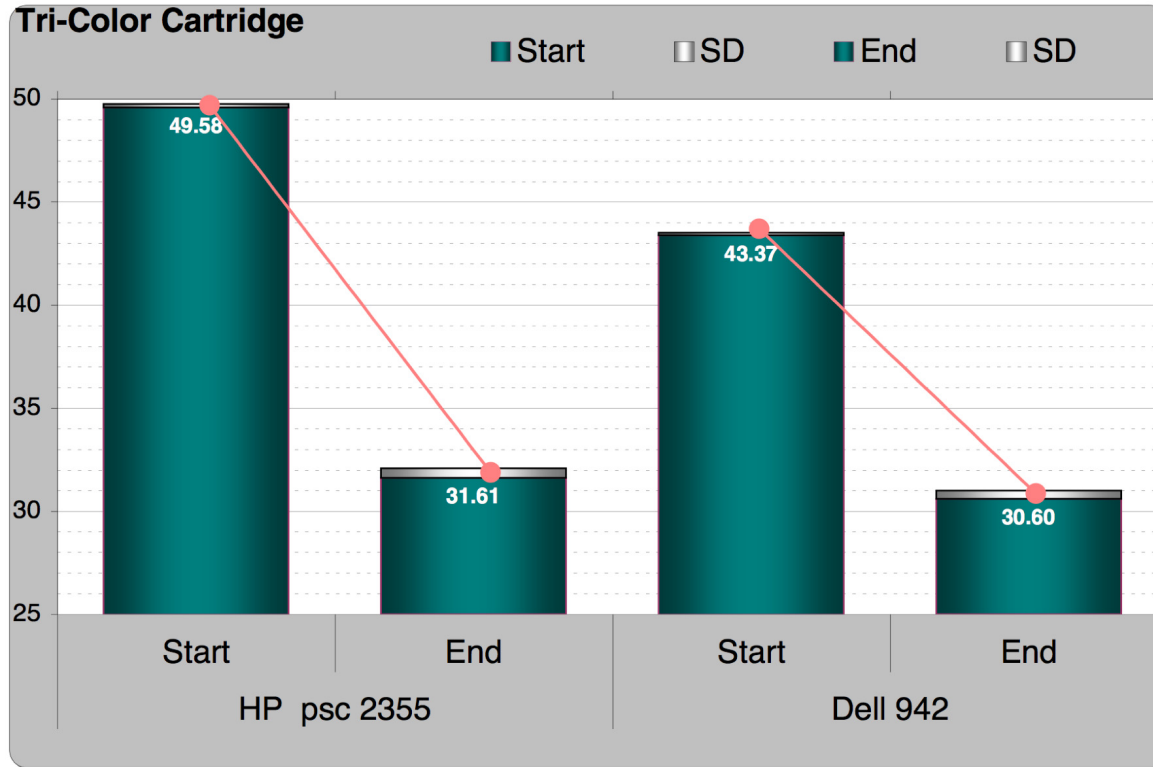
Printer	Run	HP				Dell			
		Color		Black		Color		Black	
		grams	pages	grams	pages	grams	pages	grams	pages
1	1	17.8	165	0.6		14.2	126	0.1	
	2	17.7	147	0.4		14.3	123	0.2	
	3	18.4	168	0.4		14.1	117	0.3	
2	1	17.9	165	0.6		13.8	108	0.1	
	2	17.1	159	0.3		13.0	108	0.2	
	3	18.2	165	0.4		14.2	117	0.4	
3	1	18.8	162	0.5		15.1	126	0.1	
	2	17.5	150	0.4		13.3	108	0.2	
	3	18.3	165	0.4		12.8	117	0.1	
Average		17.97	160.7	0.44		13.87	116.7	0.19	
Std Dev		0.51	7.37	0.10		0.72	7.42	0.11	
90% L Bound			156	4.04%			112	1.01%	

Declared Yield

The declared photo yield value for the HP 97 tri-color cartridge was 156 prints
 The twin-pack cartridge “bundle” yield of 312 prints (156 x 2 cartridges)
 exceeds HP’s advertised yield of 280 images



Color Ink Usage (by Weight)



Tested HP tri-color cartridges contained 41% more usable ink than tested Dell tri-color cartridges

Color	HP psc 2355		Dell 942	
	Start	End	Start	End
Start	49.58		43.37	
End		31.61		30.60
SD	0.17		0.13	
SD		0.48		0.40
TOTAL	49.75	32.09	43.50	31.00



Cost-per-Print (4x6") — Scenario I

Combining declared photo yield test results with manufacturer's web site prices for cartridges and 4x6" media:

Dell's Photo Cost-per-Print of 42¢ was 44% higher than HP's Photo Cost-per-Print of 29¢

		HP psc 2355		Dell 942	
Price per Item	Black #94	\$ 19.99	HiCap Black	\$ 24.99	
	Tricolor #97 Bundle	\$ 79.99	Hi Cap Color 4x6" Media	\$ 59.85	
Pages per Item	Monochrome	4,051	Monochrome	11,748	
	Color/Media Bundle	312	Color	112	
		280	Media	400	
Cost per Print	Monochrome	0.49 ¢	Monochrome	0.21 ¢	
	Color/Media Bundle	28.57 ¢	Color	26.78 ¢	
			Media	14.96 ¢	
	Total	29.06 ¢	Total	41.95 ¢	

Results based on *spencerLAB* Digital Color Laboratory cartridge yield tests, November 2004; Hewlett-Packard and Dell pricing per their respective web sites, December 2004

Assumes HP user prints 280 photos

(Value Pack media sheet limit; user will have enough color ink left to print 32 additional photos, per Declared Photo Yield)



Cost-per-Print (4x6") — Scenario II

Combining declared photo yield test results with manufacturer's web site prices for cartridges and 4x6" media:

Dell's Photo Cost-per-Print of 42¢ was 52% higher than HP's Photo Cost-per-Print of 28¢

		HP psc 2355				Dell 942	
		Black #94	\$ 19.99	Black #94	\$ 19.99	HiCap Black	\$ 24.99
Price per Item	Tricolor #97 Bundle	\$ 79.99				Hi Cap Color	\$ 29.99
			4x6" Media	\$ 29.99		4x6" Media	\$ 59.85
Pages per Item	Monochrome	4,051	Monochrome	4,051	Monochrome	11,748	
	Color/Media Bundle	312 280	Media	32 200	Color	112	
Cost per Print	Monochrome	0.49 ¢	Monochrome	0.49 ¢	Monochrome	0.21 ¢	
	Color/Media Bundle	28.57 ¢	Color/Media Bundle	15.00 ¢	Color	26.78 ¢	
					Media	14.96 ¢	
	Total	29.06 ¢	Total	15.49 ¢	Total	41.95 ¢	
		27.67 ¢	Weighted Average				
Results based on <i>spencerLAB</i> Digital Color Laboratory cartridge yield tests, November 2004; Hewlett-Packard and Dell pricing per their respective web sites, December 2004							

Assumes HP user prints 312 photos per Declared Photo Yield (using the tri-color ink in the Value Pack cartridges, 280 media sheets from the Value Pack plus 32 sheets from a twin 100-sheet pack of *HP Premium Photo Paper, glossy*)



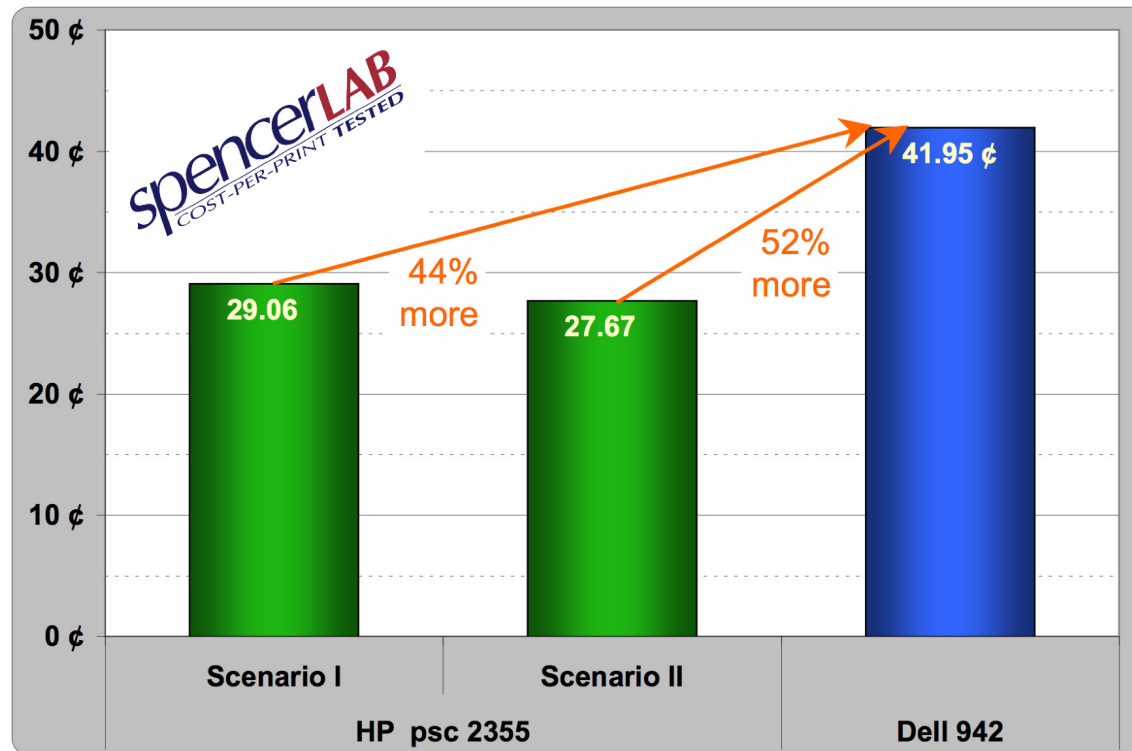
Cost-per-Print — HP Value Pack Verification

spencerLAB testing confirms HP claim:

29¢ per print with “97/97 280-Sheet Photo Value Pack with Vivera Inks”

° 280 photos printed at a cost of 29¢ each (Scenario I)

° 312 photos printed at a cost of 28¢ each (Scenario II)



Appendix

Cartridge Reliability

Two of nine Dell color ink cartridges failed during testing

- ° *One cartridge applied Yellow ink outline (that was not present in image files) to prints*
- ° *One cartridge incorrectly produced desaturated color images, with excessive banding*

Both cartridges were replaced with properly functioning cartridges

- ° *Defective cartridges were not used in the testing or analysis*

Photographic Image Print Quality

HP prints displayed exceptional richness and were well saturated

Dell prints appeared light and washed out in comparison

Dell prints exhibited noticeable banding

HP prints were very smooth and uniform

Dell output displayed significant cartridge-to-cartridge color inconsistencies

HP prints remained consistent, with accurate and predictable color



Thank You — The *spencerLAB* Project Team

Project Management

David R Spencer, president

Catherine Fiasconaro, director of *spencerLAB*

<fiasconaro@spencer.com>

Project Administrator

Jennifer Piano, manager

Project Analysis

Vikaas Gupta, color engineer

Vishal Sahay, laboratory engineer

Support

Maureen Minter, purchasing

