

Cartridge Yield and Cost-per-Print

HP psc 1350, Dell 922, and Lexmark X5270

Color InkJet MFPs: Black & Color Docs

Final Report Presentation

August 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

Independent test of high-yield ink cartridge yield

- Sponsored by Hewlett-Packard

Incorporate sound, unbiased testing methodologies

° *Adapt ISO monochrome toner test methodology for color inkjet printers*

- Test at least three cartridges on each of three printers from each manufacturer
- Procure printers and cartridges from multiple distribution channels where possible
- Use “Declared” Page Yield statistical calculations

Calculate and compare Cost-per-Print

° *Combine test results with manufacturer’s published cartridge prices*

Help understand the differences among the color inkjet MFPs

° *HP 1350, Lexmark 5270, and Dell 922*

This report includes results of the Black and Color Document tests



Significant Findings

Ink Cartridge Yield

Test Results vs. Manufacturer's Ratings (Black and Color)

- ° *Dell tested below its Rated Yield, especially Black*
- ° *Dell yield tested comparable to Lexmark*
 - Lexmark's rated yield is within its tested result
- ° *HP yield tested higher than either Dell or Lexmark, although rated* more conservatively*
 - Lexmark ratings per *The Hard Copy Observer*, June 2004, p45

Ink Usage

Average Starting and Ending Cartridge Weights – Usable Ink Content

- ° *Dell ink content tested comparable to Lexmark*

Ink Cost-per-Print...



Significant Findings (cont'd)

Ink Cost-per-Print

Tested InkJet MFPs: HP psc 1350, Dell 922, and Lexmark X5270

- Overall, HP's tested Cost-per-Print was comparable or lower than Dell's
- HP's tested black Cost-per-Print was lower than Dell's and Lexmark's

SpencerLab Tested Yield with Individual Cartridge Prices (Manufacturer's Web Site)

◦ Black Usage

- HP Lowest Cost at 4.38¢, 12% less than Dell at 4.99¢, 16% less than Lexmark Highest at 5.21¢

◦ Color Usage

- HP Highest Cost at 6.20¢, 5% more than Dell and Lexmark at 5.88¢ and 5.87¢

◦ Mixed Black and Color Usage

- HP Lowest Cost at 5.29¢, 3% less than Dell at 5.44¢, 5% less than Lexmark at 5.54¢

SpencerLab Tested Yield with Multi-Pack Cartridge Prices (Manufacturer's Web Site)

◦ Black Usage

- HP Lowest Cost at 3.94¢, 18% less than Dell at 4.80¢, 24% less than Lexmark at 5.21¢

◦ Color Usage

- HP Cost at 5.58¢, 1% more than Dell at 5.51¢, 5% less than Lexmark at 5.87¢

◦ Mixed Black and Color Usage

- HP Lowest Cost at 4.76¢, 8% less than Dell at 5.15¢, 14% less than Lexmark at 5.54¢



Methodology

Test Methodology

HP and Lexmark MFPs and ink cartridges were procured from multiple distribution channels, both e-commerce and retail; Dell is sole-source

Ink Cartridge Prices were obtained from manufacturer's web sites

- *Both Individual and Multi-Pack pricing were used and presented*

Machines and Drivers were tested with default settings

- *Automatic paper sensing was disabled to prevent possible error*
- *Machines were run in nominally continuous mode*
 - Stops were for paper replenishment, jam clearance, and overnight

Testing was performed in an environmentally controlled office environment

- *One machine from each vendor was tested essentially simultaneously from a single computer*

Cartridge Yield was the number of pages printed until End-of-Life, determined by Fade

- *None of the tested machines employed an INK-OUT stop*
 - INK-LOW warnings were ignored (and highly variable)
- *Cost-per-Print included the pro-rata cost of ancillary ink*
 - Some color is used when printing the black document, and black on the color document
 - Ink usage was determined by the ratio of the begin-end weight change: partially-used cartridge to fully-used average

The ISO confidence factor was employed in reporting page yield and resultant cost

Issues noted during testing include differences in Print Quality, Paper Feed Reliability, Auto Continue functionality, and Driver Robustness



Methodology (cont'd)

Test Files

The Black Test document was modeled after a business letter

- *It included a small graph without grayscale*
- *Digital coverage was below 5%*
 - Allowed for nominal dot gain of about 20%



The Color Test document was modeled after a simple presentation slide

- *It included simple graphics and bullet text*
- *It was created in RGB color space with only primary and secondary colors*
- *Digital coverage was below 5% per color*
 - Allowed for nominal dot gain of about 20%
 - Red, Green, and Blue components are nominally equal
 - Secondary color balance was not controlled



Test Results

The following tables and charts present the test results

Ink Cartridge Yield (Pages-per-Cartridge)

° *Test results (chart)*

° *Comparison with Manufacturer's rating*

- Black Cartridge
- Color Cartridge

Usable Ink Content

- Black Cartridge
- Color Cartridge

Cost-per-Print (Individual)

- Black & White Document
- Color Document
- Average of Black and Color Documents

Cost-per-Print (Multi-Cartridge)

- Black & White Document
- Color Document
- Average of Black and Color Documents



Ink Cartridge Yield

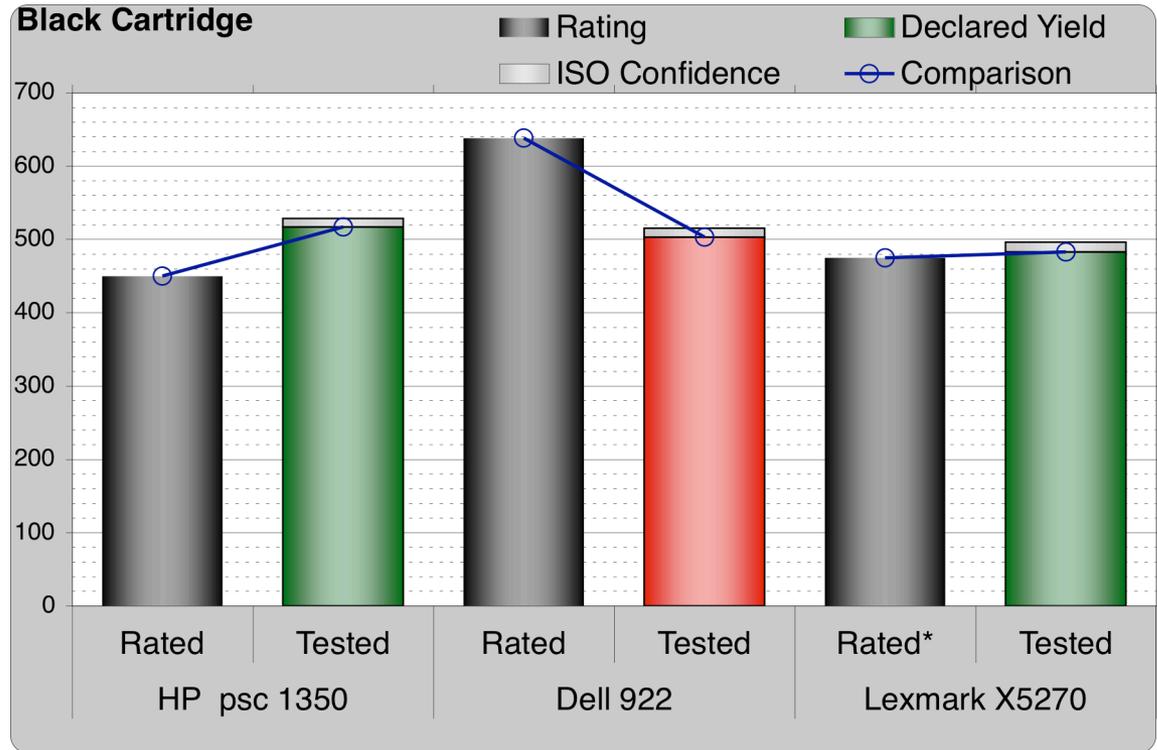
Ink Yield	Printer	Run	HP				Dell				Lexmark			
			Black		Color		Black		Color		Black		Color	
			grams	pages	grams	pages	grams	pages	grams	pages	grams	pages	grams	pages
Mono	1	1	20.2	521	1.6		18.9	513	0.0		17.2	478	0.0	
		2	20.2	529	1.5		18.4	508	0.1		18.0	510	0.2	
		3	20.0	547	1.4		18.9	546	0.1		18.1	488	0.0	
	2	1	19.8	509	1.6		18.5	519	0.1		17.7	521	0.0	
		2	20.0	530	1.6		18.5	478	0.0		19.2	511	0.2	
		3	20.3	560	1.6		18.8	531	0.1		18.5	495	0.0	
	3	1	20.3	519	1.6		18.6	516	0.0		18.3	518	0.1	
		2	19.8	529	1.4		18.8	515	0.1		17.8	465	0.1	
		3	20.2	510	1.4		18.6	509	0.1		17.9	480	0.1	
	Average		20.09	528.2	1.52		18.67	515.0	0.07		18.08	496.2	0.08	
	Std Dev		0.20	16.6	0.10		0.19	18.3	0.05		0.56	19.8	0.08	
	90% L Bound			517	8.52%		503	0.52%			483	0.62%		
	Color	1	1	1.2		18.4	593	1.3		13.2	569	1.2		13.8
2			1.5		18.0	603	1.6		12.8	567	1.8		11.2	500
3			1.5		17.4	616	1.0		12.2	548	1.1		12.2	550
2		1	0.6		16.8	619	1.4		12.8	600	1.3		11.9	633
		2	0.4		17.7	561	1.4		12.5	536	1.4		13.4	610
		3	0.2		18.1	605	1.2		13.0	607	1.2		12.4	554
3		1	1.0		18.0	572	1.3		13.2	518	1.3		13.5	567
		2	1.3		18.0	578	1.3		12.8	568	1.3		12.8	540
		3	0.8		18.4	597	1.2		12.4	531	1.3		12.5	590
Average		0.94		17.87	593.8	1.30		12.77	560.4	1.32		12.63	572.7	
Std Dev		0.47		0.51	19.8	0.17		0.35	30.3	0.20		0.84	41.8	
90% L Bound		4.70%		581	6.96%			541	7.31%			546		



Ink Cartridge Yield (cont'd)



Black Coverage < 5%



° Dell tested below its Rated Yield

° Dell yield tested comparable to Lexmark

- Lexmark's rated yield is within its tested yield

° HP yield tested higher than either Dell or Lexmark

- HP tested yield far exceeded their rated yield

Monochrome	HP psc 1350		Dell 922		Lexmark X5270	
	Rated	Tested	Rated	Tested	Rated*	Tested
Rating	450		638		475	
Tested Average		528		515		496
ISO Confidence		11.2		12.0		13.2
Declared Yield		517		503		483

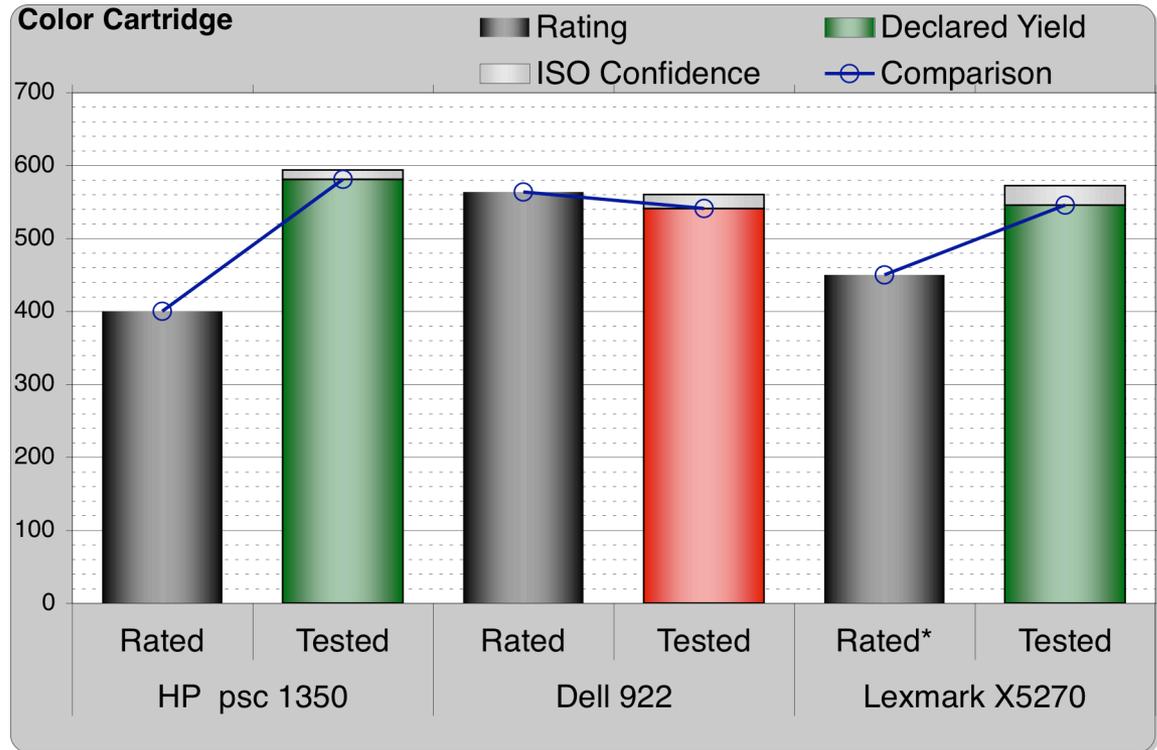
*The Hard Copy Observer, June 2004, p45



Ink Cartridge Yield (cont'd)



Red=Green=Blue
Coverage < 5% each



°Dell tested slightly below its Rated Yield

°Dell yield tested comparable to Lexmark

- Lexmark's rated yield is well within its tested yield

°HP yield tested higher than either Dell or Lexmark

- HP tested yield far exceeded their rated yield

Color	HP psc 1350		Dell 922		Lexmark X5270	
	Rated	Tested	Rated	Tested	Rated*	Tested
Rating	400		564		450	
Tested Average		594		560		573
ISO Confidence		12.8		19.4		26.7
Declared Yield		581		541		546

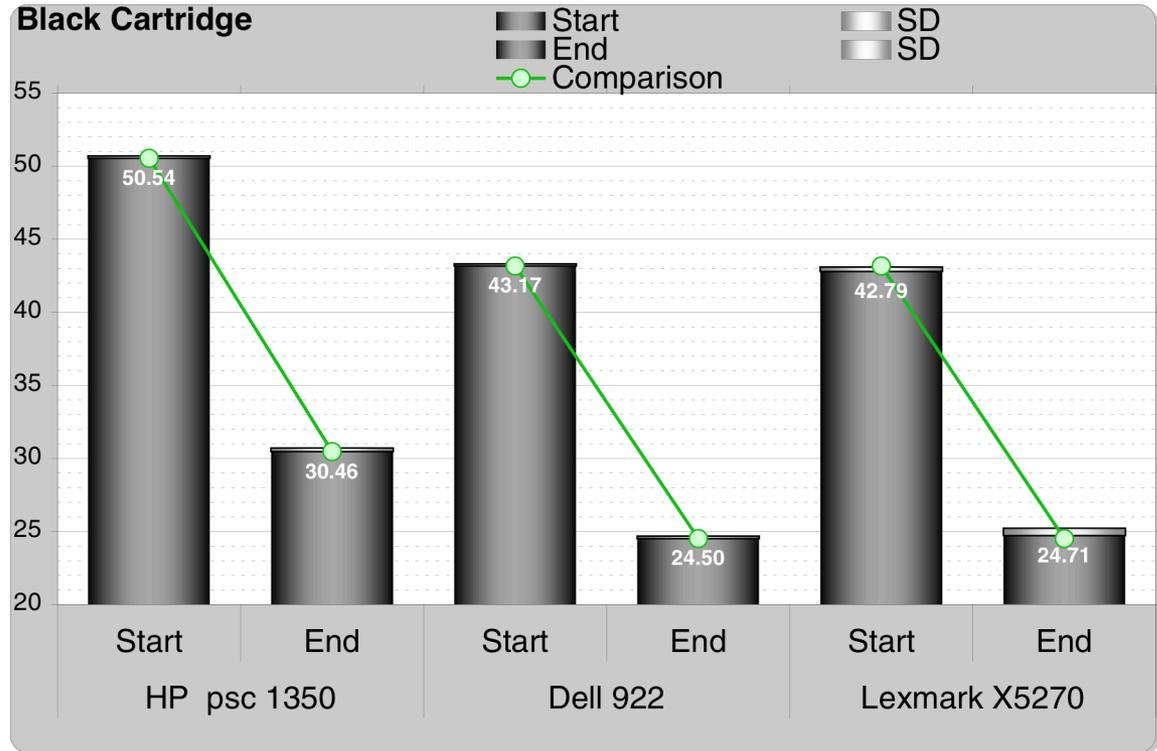
*The Hard Copy Observer, June 2004, p45



Ink Usage (by Weight)



Black Coverage < 5%



Monochrome	HP psc 1350		Dell 922		Lexmark X5270	
	Start	End	Start	End	Start	End
Start	50.54		43.17		42.79	
End		30.46		24.50		24.71
SD	0.15		0.14		0.30	
SD		0.25		0.17		0.50
TOTAL	50.70	30.70	43.31	24.67	43.09	25.21

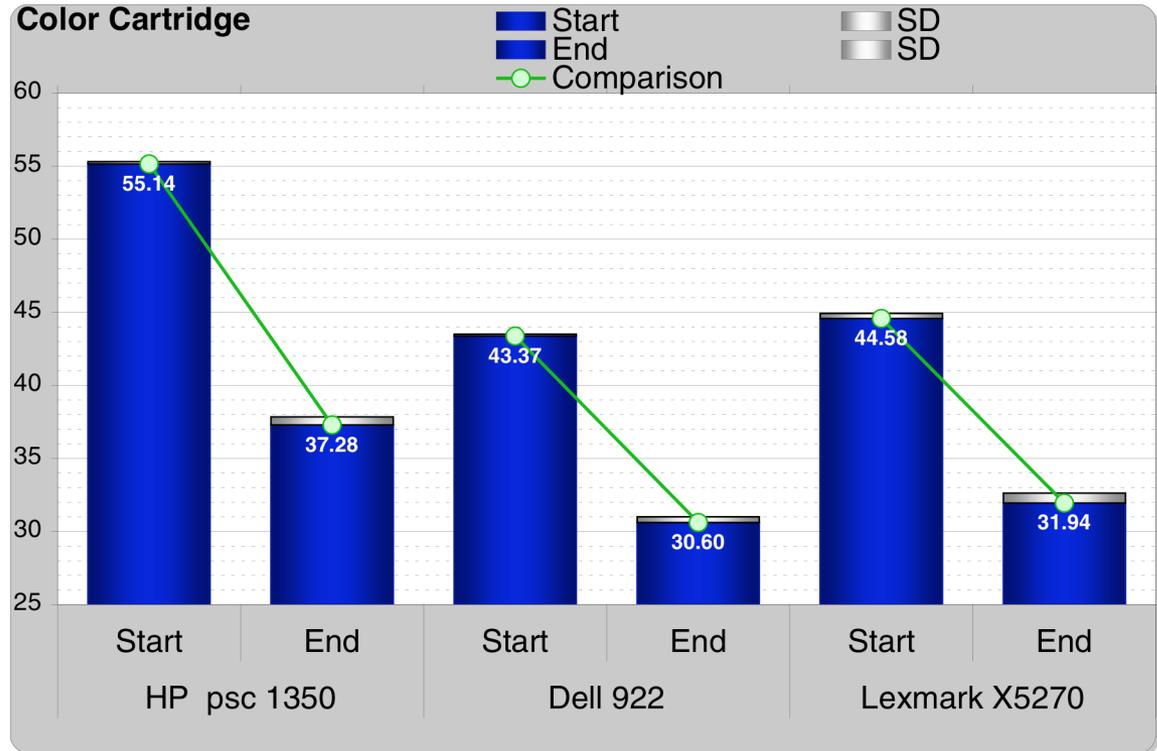
°The amount of usable ink in the Dell black cartridge tested comparable to Lexmark



Ink Usage (by Weight) (cont'd)



Red=Green=Blue
Coverage < 5% each

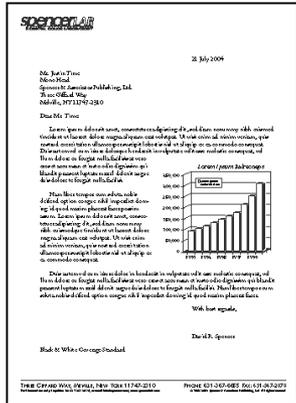


°The amount of usable ink in the Dell color cartridge tested comparable to Lexmark

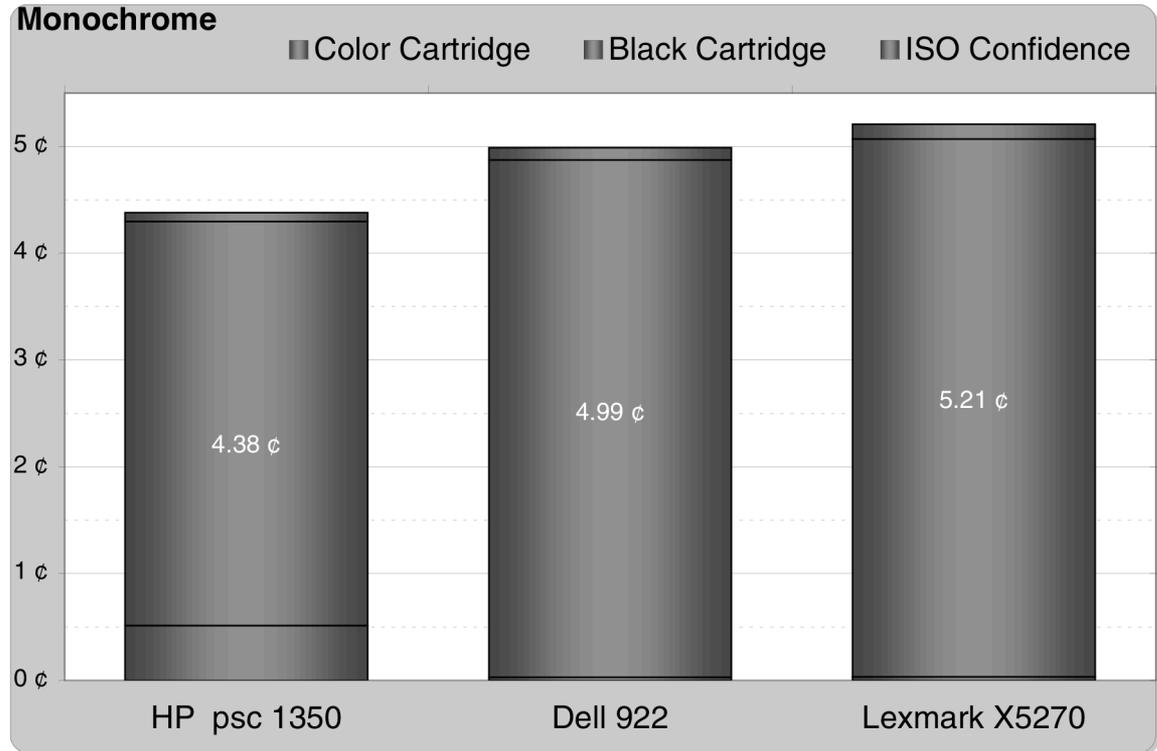
Color	HP psc 1350		Dell 922		Lexmark X5270	
	Start	End	Start	End	Start	End
Start	55.14		43.37		44.58	
End		37.28		30.60		31.94
SD	0.17		0.13		0.34	
SD		0.55		0.40		0.67
TOTAL	55.31	37.83	43.50	31.00	44.92	32.61



Cost-per-Print (Individual) — Black Document



Black Coverage < 5%



Combining test results for the Black Test Page with manufacturer's web site prices for individual cartridges, HP had the lowest Ink Cost-per-Print at 4.38¢, 12% less than Dell, 16% less than Lexmark

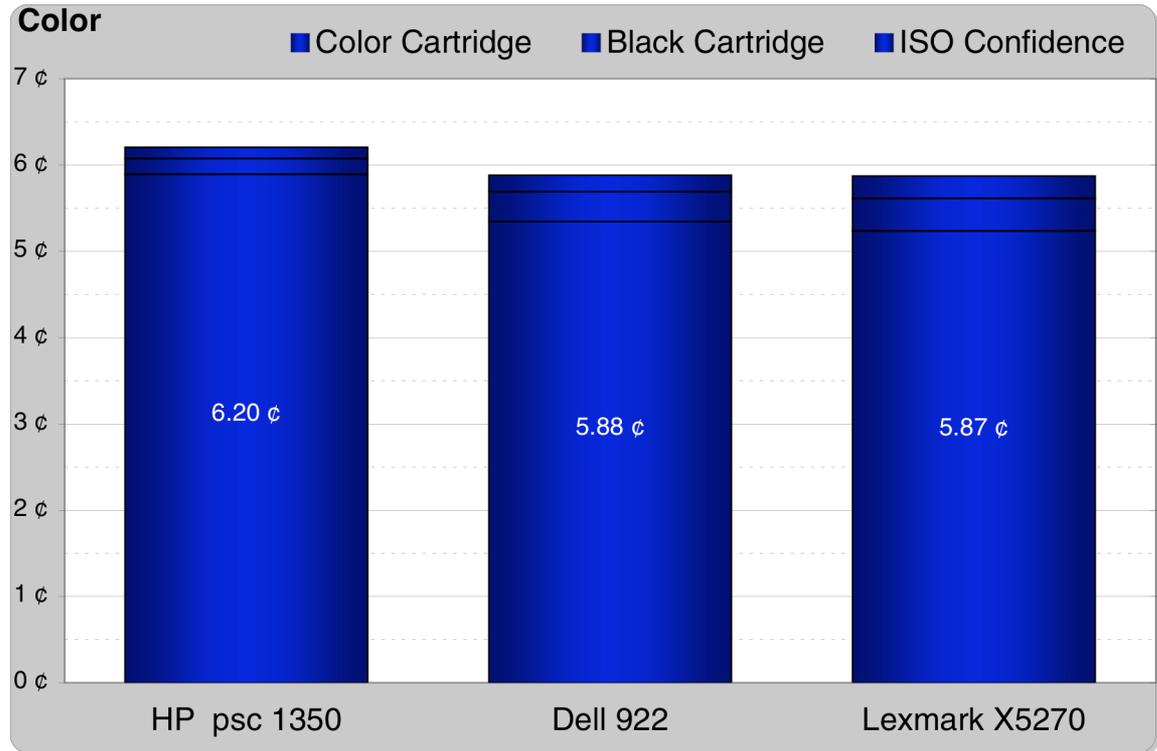
Monochrome	HP psc 1350	Dell 922	Lexmark X5270
Color Cartridge	0.513	0.029	0.034
Black Cartridge	3.784	4.845	5.036
ISO Confidence	0.082	0.116	0.138
TOTAL	4.38 ¢	4.99 ¢	5.21 ¢



Cost-per-Print (Individual) — Color Document



Red=Green=Blue
Coverage < 5% each



Combining test results for the Color Test Page with manufacturer's web site prices for individual cartridges, HP had the highest Ink Cost-per-Print at 6.20¢, 5% more than Dell; Lexmark was slightly lower

Color	HP psc 1350	Dell 922	Lexmark X5270
Color Cartridge	5.893	5.344	5.237
Black Cartridge	0.182	0.345	0.378
ISO Confidence	0.130	0.192	0.256
TOTAL	6.20 ¢	5.88 ¢	5.87 ¢



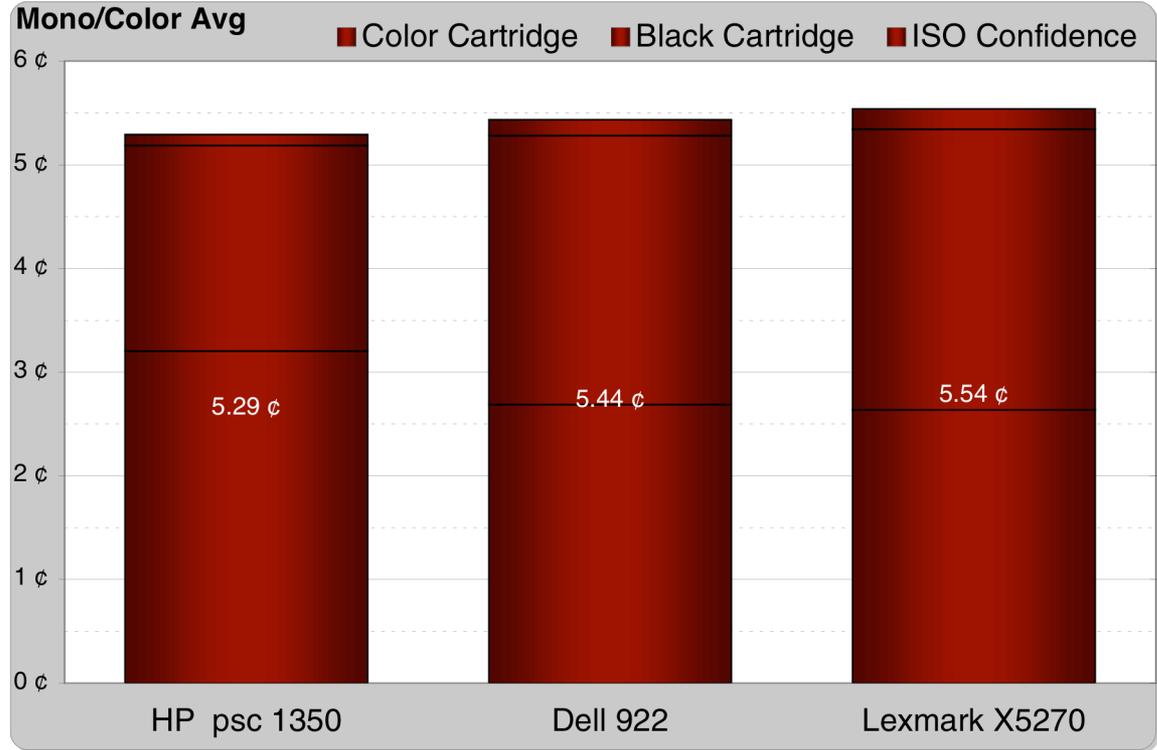
Cost-per-Print (Individual) — Black/Color Document Average



Black Coverage < 5%



Red=Green=Blue Coverage < 5% each



Combining average test results for Black and Color Test Pages with manufacturer's web site prices for individual cartridges, HP had the lowest Ink Cost-per-Print at 5.29¢, 3% less than Dell, 5% less than Lexmark

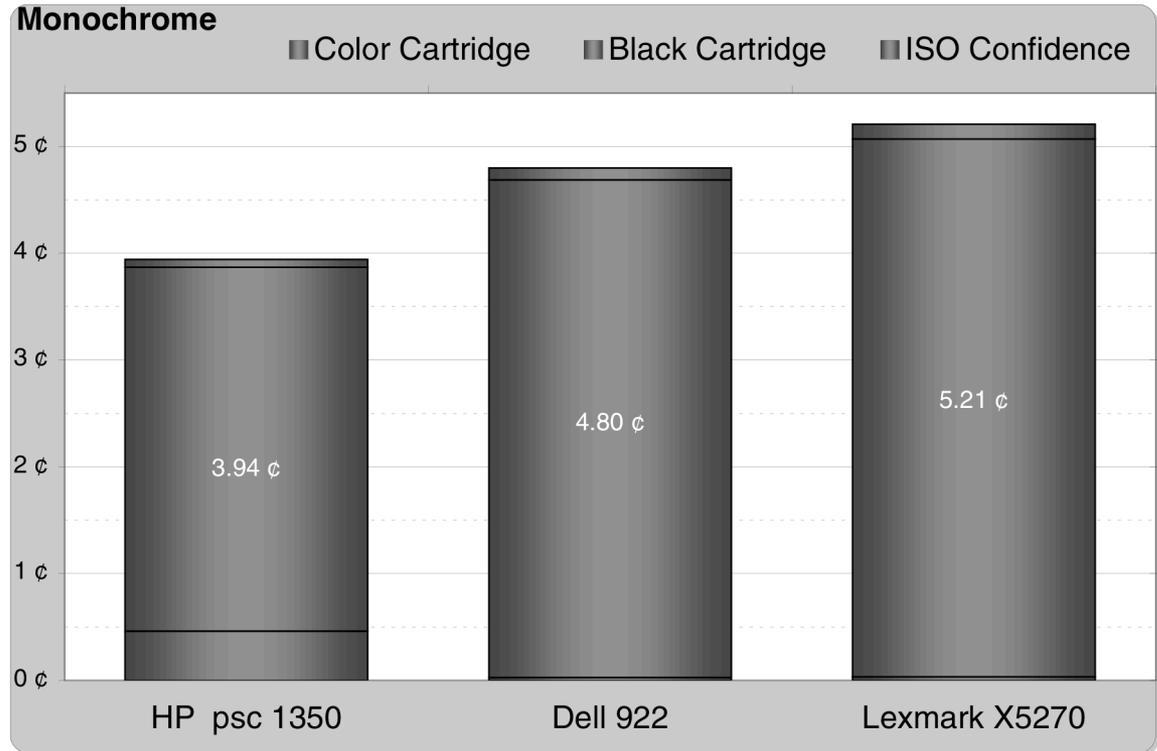
Color	HP psc 1350	Dell 922	Lexmark X5270
Color Cartridge	3.203	2.686	2.635
Black Cartridge	1.983	2.595	2.707
ISO Confidence	0.106	0.154	0.197
TOTAL	5.29 ¢	5.44 ¢	5.54 ¢



Cost-per-Print (Multi-Pack) — Black Document



Black Coverage < 5%



Combining test results for the Black Test Page with manufacturer's web site prices for multiple-pack cartridges, HP had the lowest Ink Cost-per-Print at 3.94¢, 18% less than Dell, 24% less than Lexmark

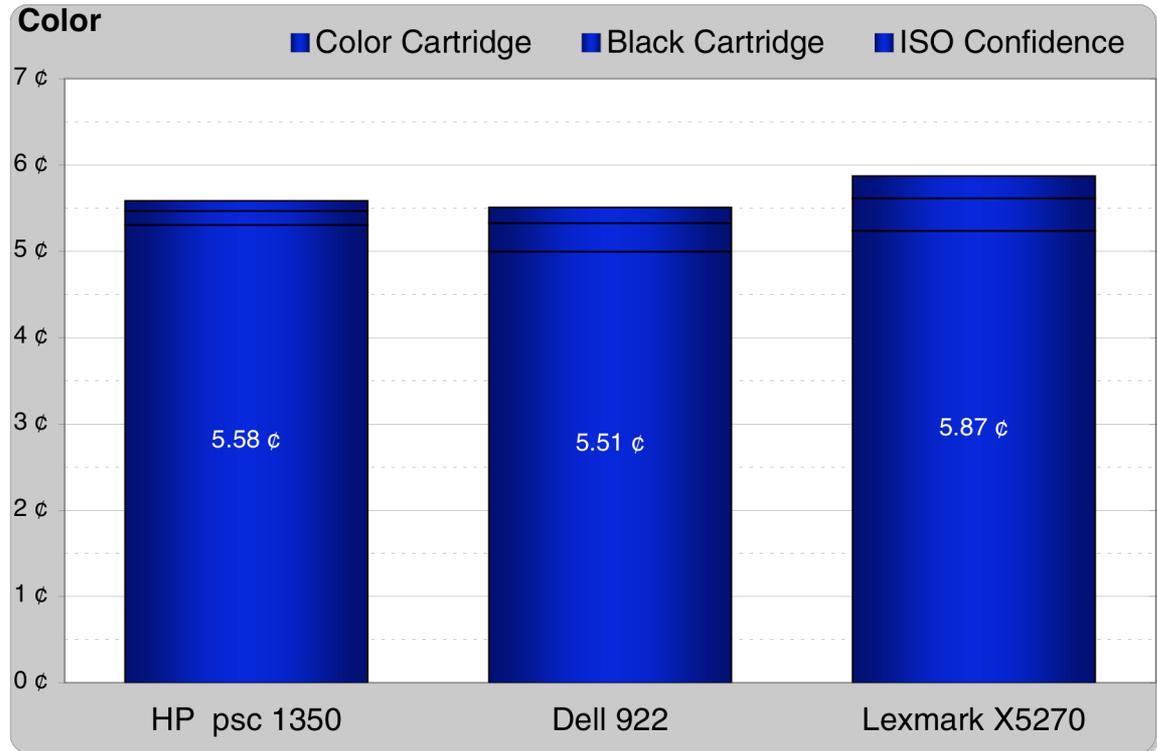
Monochrome	HP psc 1350	Dell 922	Lexmark X5270
Color Cartridge	0.462	0.027	0.034
Black Cartridge	3.407	4.660	5.036
ISO Confidence	0.074	0.111	0.138
TOTAL	3.94 ¢	4.80 ¢	5.21 ¢



Cost-per-Print (Multi-Pack) — Color Document



Red=Green=Blue
Coverage < 5% each



Combining test results for the Color Test Page with manufacturer's web site prices for multiple-pack cartridges, HP's Ink Cost-per-Print of 5.58¢ was 1% more than Dell, 5% less than Lexmark

Color	HP psc 1350	Dell 922	Lexmark X5270
Color Cartridge	5.304	4.996	5.237
Black Cartridge	0.164	0.332	0.378
ISO Confidence	0.117	0.180	0.256
TOTAL	5.58 ¢	5.51 ¢	5.87 ¢



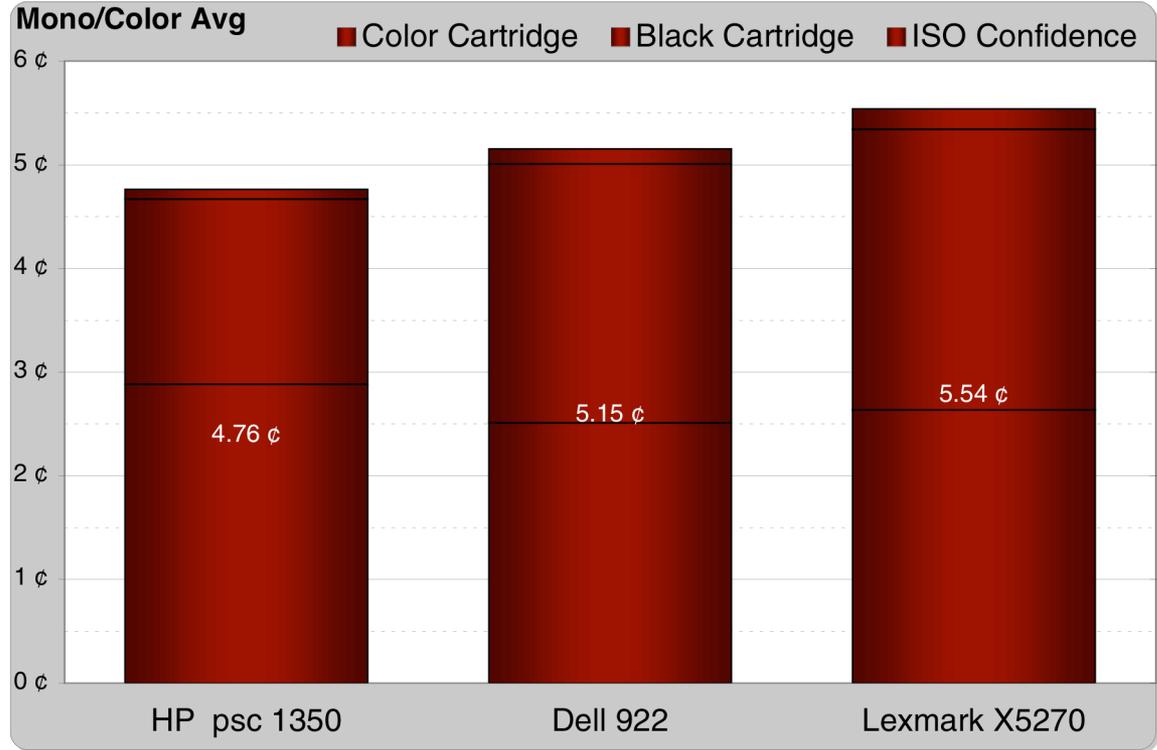
Cost-per-Print (Multi-Pack) — Black/Color Document Average



Black Coverage < 5%



Red=Green=Blue Coverage < 5% each



Combining average test results for Black and Color Test Pages with manufacturer's web site prices for multiple-pack cartridges, HP had the lowest Ink Cost-per-Print at 4.76¢, 8% less than Dell, 14% less than Lexmark

Color	HP psc 1350	Dell 922	Lexmark X5270
Color Cartridge	2.883	2.512	2.635
Black Cartridge	1.785	2.496	2.707
ISO Confidence	0.095	0.145	0.197
TOTAL	4.76 ¢	5.15 ¢	5.54 ¢



Thank You — SpencerLab Project Team

Project Leader

David R Spencer, president

Associate Project Leader

Catherine Fiasconaro, director of SpencerLab

Project Administrator

Jennifer Piano, manager

Project Analysis

Vikaas Gupta, color engineer

Vishal Sahay, laboratory engineer

Support

Richard Sinn, intern

Samantha Bennett, intern

Maureen Minitier, purchasing

info@spencer.com

041013

