Cost-per-Print Comparative Benchmarking User-Representative Test Target

HP LaserJet 1320, Dell 1710, Lexmark E340, and Samsung ML-2250 Laser Printers

Final Report Presentation

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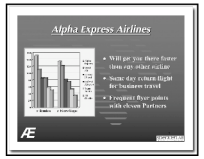
Executive Summary — Research Objectives

Determine Cost-per-Print of a Higher Coverage, User Document

- The ISO 19752 standard measure of Monochrome Toner Cartridge Yield uses a simple text document
- When users print a higher coverage mix of text and graphics, do all printers have the same yield?
- Since Cost-per-Print varies directly with Cartridge Yield, this is a real cost users will experience



Conduct Two Cartridge Yield Tests

- Perform fully compliant ISO/IEC 19752 Cartridge Yield testing to verify manufacturers' Stated Yield
  - *Use of ISO/IEC 19752 Standard Test Page*
- Adapt ISO/IEC 19752 methodology to test Cartridge Yield utilizing a higher coverage, user-representative test file
  - *Use high-coverage, monochrome presentation slide as test target*
    - An office-type document of mixed text and graphics from the *SpencerLab* Printer Test Suite*
  - *Test under identical controls of ISO/IEC 19752 Standard, only changing the test file*

*The *SpencerLab* Printer Test Suite, now in βeta, is an extension of Spencer& Associates' Color Hardcopy Quality Factors test suite, a de facto industry standard since 1990.

Test Results — Overview

All manufacturers met their stated yields per ISO 19752

- *Standardized file important in comparison of manufacturer's stated toner yield*

Two out of nine Dell “Use & Return” cartridges (22.2%) failed during testing

- *Two replacement cartridges were used to complete testing*

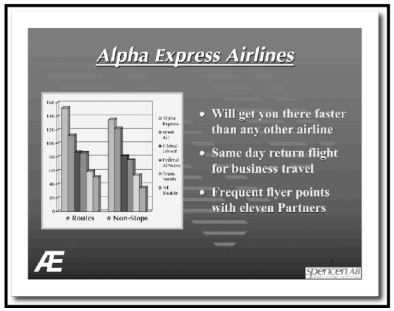
Higher Coverage Toner Cartridge Yield and Cost-per-Print

HP's Declared Page Yield* was greater than other tested printers' yields

- *HP had 103% greater yield than the Dell 1710*
- *HP had 79% greater yield than the Lexmark E340*
- *HP had 35% greater yield than the Samsung ML-2250*

HP had the lowest Cost-per-Print

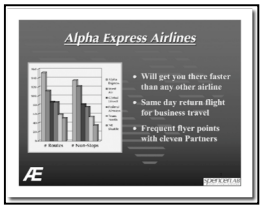
- *Dell 1710's Cost-per-Print was 40% higher than HP*
- *Lexmark E340’s Cost-per-Print was 64% higher than HP*
- *Samsung ML-2250’s Cost-per-Print was 16% higher than HP*
- *Dell and Lexmark Customers not opting for "Use and Return" cartridges will incur still higher costs*
  - Dell "Regular" cartridge Cost-per-Print was 102% higher than HP
  - Lexmark "Regular" cartridge Cost-per-Print was 92% higher than HP



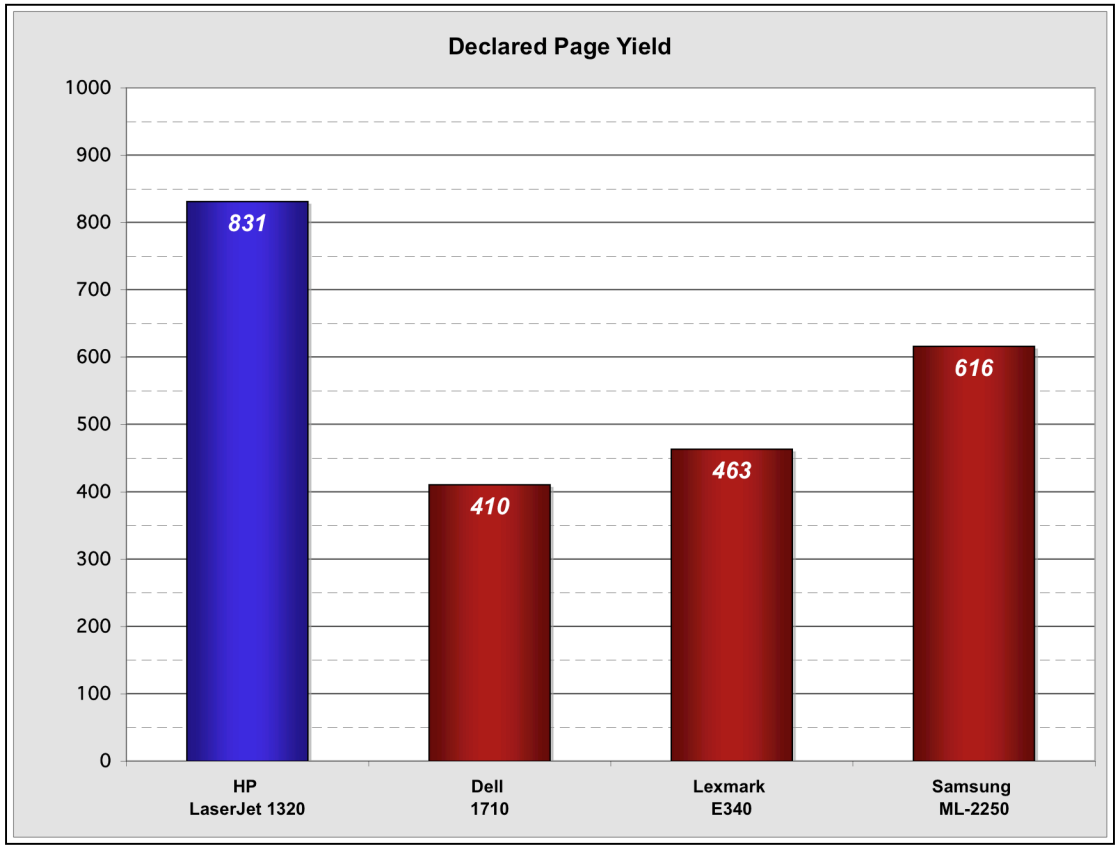
Higher Coverage User-Representative Test File

*Declared Page Yield derived from tested Average Yield calculated with 90% confidence bound, in accordance with ISO/IEC:19752

Test Results — Page Yield Analysis



Higher Coverage User-Representative Test File



HP's Declared Page Yield* was *greater* than all tested competitors'

- *103% higher yield than Dell 1710*
- *79% higher yield than Lexmark E340*
- *35% higher yield than Samsung ML-2250*

*Declared Page Yield derived from tested Average Yield calculated with 90% confidence bound, in accordance with ISO/IEC:19752

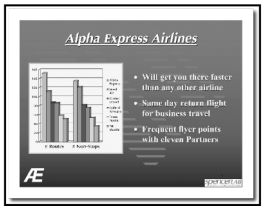
Test Results — Cost-per-Print Analysis

Cost-per-Print

Toner Cartridge Cost divided by Declared Page Yield*, plus Drum pro-rata Cost

Printer	HP LaserJet 1320	Dell 1710		Lexmark E340		Samsung ML-2250
Toner Cartridge Part Number	Q5949X	K3756 "Use & Return"	H3730 "Regular"	34015HA "Use & Return"	34035HA "Regular"	ML-2250D5
Toner Cost per Cartridge	$130.99	$89.99	$129.99	$119.00	$139.00	$112.50
Pages per Cartridge	831	410	410	463	463	616
Toner Cost per Print	15.76 ¢	21.95 ¢	31.70 ¢	25.70 ¢	30.02 ¢	18.26 ¢
Drum Cartridge Cost	N/A	$49.99		$62.50		N/A
Pages per Drum		30,000		30,000		
Drum Cost per Print		0.17 ¢		0.21 ¢		
Total	15.76 ¢	22.12 ¢	31.87 ¢	25.91 ¢	30.23 ¢	18.26 ¢

Results based on tests conducted by *SpencerLAB* Digital Color Laboratory.
Pricing per respective manufacturers' web sites as of 01/15/2006.



Test File

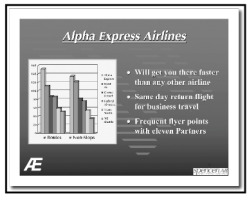
Toner Cartridge & Drum Costs

Obtained from respective manufacturers' web sites

- *Dell and Lexmark offer optional "Use and Return" toner cartridges at a lower cost with the understanding that they will be used once and returned to the manufacturer*
- *Dell 1710 and Lexmark E340 contain user-replaceable imaging drum/photoconductor, therefore include these costs in total cost-per-print*

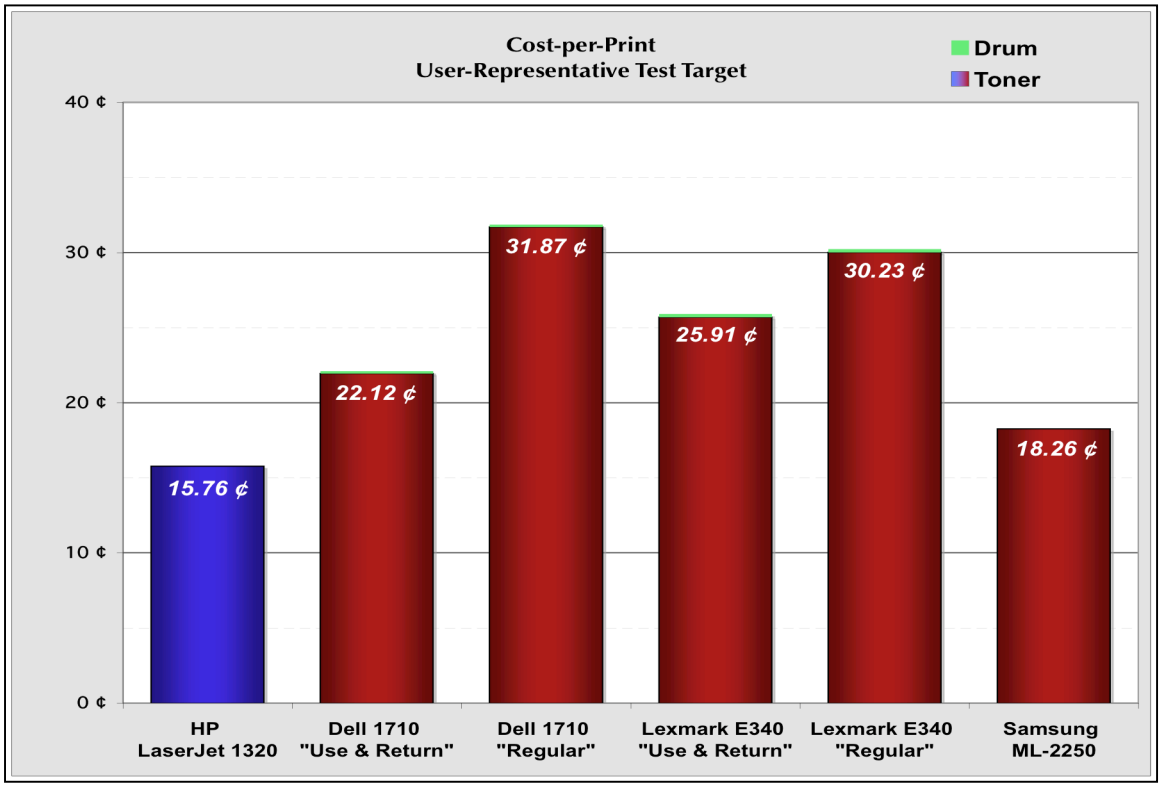
*Declared Page Yield derived from tested Average Yield calculated with 90% confidence bound, in accordance with ISO/IEC:19752

Test Results — Cost-per-Print Analysis (cont'd)



Test File

HP had the lowest Cost-per-Print



Dell's "Use and Return" Cost-per-Print was 40% more expensive than HP

- *Dell's "Regular" cartridge Cost-per-Print was 102% more expensive*

Lexmark's "Use and Return" Cost-per-Print was 64% more expensive than HP

- *Lexmark's "Regular" cartridge Cost-per-Print was 92% more expensive*

Samsung's Cost-per-Print was 16% more expensive than HP

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Methodology

Toner cartridge yield testing with adapted ISO/IEC 19752:2004 methodology

- *Higher-coverage, user-representative, monochrome presentation slide used as test target*
  - Test file, *SpencerLab HC MC Presentation,* from the *SpencerLab* Digital Color Laboratory Printer Test Suite
- *ISO/IEC 19752:2004 compliance on all methodology, other than test target*

Nine (9) OEM high-capacity cartridges, where available, were tested for each printer

- Three cartridges on each of three printers, procured from at least three sources on the open market
- "Use and Return" cartridges were tested for Dell and Lexmark
- Samsung does not produce a high-capacity cartridge for use with the ML-2250

- *Machines were run in semi-continuous mode (per ISO 19752)*
  - Automatic paper sensing was disabled to prevent possible error
  - Stops were for paper replenishment, jam clearance, and overnight
- *Testing was performed under ISO 19752 environmental controls*
  - 23° ± 2°C temperature; 50% ±10% relative humidity

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

- *End-of-Life and Fade determined per ISO 19752 definition*
  - None of the tested machines employed a TONER-OUT stop
- *The cartridge was first shaken at the first of either "Toner Low" signal on the printer control panel or visible fade; upon the next fade the cartridge was shaken again; the subsequent fade determined End-of-Life*
  - The Samsung ML-2250 did not have a "Toner-Low" signal; the cartridge was shaken at the first and second fades; the third fade determined End-of-Life

Declared Page Yield calculated per ISO/IEC 19752

- Declared Page Yield derived from tested Average Yield calculated with 90% confidence bound

Methodology (cont'd)

Cost-per-Print

- Calculate toner component cost-per-print
  - *Toner Cartridge Cost divided by the corresponding Declared Page Yield*

  PLUS
- Calculate other user-replaceable component pro-rata costs
  - *Dell 1710 and Lexmark E340 contain user-replaceable imaging drum/photoconductor, therefore include drum/photoconductor cost in total cost-per-print*
  - *Drum Cost divided by Manufacturer's Stated Yield*
  - *HP LaserJet 1320 and Samsung ML-2250 use all-in-one (integrated toner and drum) cartridges*
- Toner and Drum Cartridge Prices
  - *Pricing was obtained from manufacturers' web sites*
    - Dell and Lexmark "Use and Return" cartridges are offered at a lower price with the understanding of one-time use and return to the manufacturer. "Regular" cartridges are offered at regular prices without these terms
- Sum these component costs to obtain total Cost-per-Print for the test document