



QualityLogic Reliability/User Experience Test Report

- HP Color LaserJet 3600n Printer vs. Dell 3110cn -

QualityLogic Inc., an independent test firm, recently performed a reliability test comparing the HP Color LaserJet 3600n printer model with the Dell 3110cn. The test included three printers of each model and involved printing 100,000 images on each printer during the test. (Note: One of the Dell printers only completed half of the test before it failed and was pulled from the study.) During testing, QualityLogic monitored and documented all interactions and issues with the printers. After the test was completed, an analysis of the print quality consistency was implemented on a sample of the output from each printer. This document summarizes the results from the testing and issues that QualityLogic encountered during initial setup of the printers, the actual reliability test and the subsequent print quality evaluation. The information is divided into the following five sections:

1. Executive Summary (which provides an overview of the next four sections)
2. Planned Interventions
3. Failures
4. Print Quality Consistency
5. Customer Experience

Executive Summary

In the four areas evaluated during this testing, the HP printers performed better than the Dell printers as summarized in the table to the right. (A check mark in this table indicates that the model with the check did better than the other. If both models have a check mark it indicates that they had the same or very similar performance in that area.) The HP and Dell printers were easy to setup and had no initial problems. Print quality was more consistent for the HP printers. The overall customer experience was much better with HP. Orders for HP products were filled correctly and the two calls for technical support were handled promptly. Dell twice failed to ship all materials that they invoiced. In addition, Dell sent us the wrong parts multiple times and we encountered long delays in getting required parts.

	HP Color LaserJet 3600n	Dell 3110cn
Planned Interventions	✓ Only need to change toner cartridges	Need to change toner cartridges Requires fuser & belt replacement
Failures (including paper jams)	✓ No setup problems Paper jams rate – 1/37,500 One failed fuser replaced One failed toner cartridge replaced	No setup problems Paper jams rate – 1/16,667 Three paper tray failures Three toner cartridge failures resulting in a printer failure
Print Quality	✓ Much better consistency	Less consistent
Customer Experience	✓ Mostly positive response by HP on all issues 2 days of printer usage lost	Orders not filled Wrong parts sent 24.5 days of printer usage lost

Planned Interventions

Interventions are divided into two categories; those that occur frequently such as changing of paper and toner cartridges (referred to as Periodic), and those that are infrequent such as changing a drum assembly (referred to as Scheduled parts replacement).

	HP Color LaserJet 3600n	Dell 3110cn
Periodic (per 100,000 pages)	✓ Change toner cartridges	✓ Change toner cartridges
Scheduled parts replacement	✓ None	Change fuser & transfer belts at 100,000 pages

The HP and Dell printers had the same paper capacities in both of the paper drawers that were used for this test, thus the number of paper changes and the resulting time required to change paper was the same and is not included in this analysis. Note that interventions that resulted from failures during test are not covered in this section but in the next section.

Periodic – Both printers used toner cartridges that required periodic replacement. These are the only items that require periodic interventions on these two printers. The amount of time required between the models for actual replacement of the cartridges was similar. The number of cartridges used was not the same. The Dell high yield cartridge was used for this testing as opposed to the standard yield cartridge. The Dell printers required slightly fewer changes than the HP printers. Based on this study we estimate that the HP printers required 2.3 hours per 100,000 pages to change cartridges while Dell printers required only 1.9 hours.

Scheduled parts replacement – The Hewlett-Packard printer did not have any scheduled parts replacement during this test. The Dell printers have scheduled replacement of both transfer belts and fusers at 100,000 pages. The two Dell printers that finished the test did require transfer belt replacement although the fusers did not need replacement. We started receiving replacement messages about $\frac{3}{4}$ of the way through the testing that the fuser and belt was nearing end of life. The belts did need to be replaced near the end of testing. When we ordered these parts, they were not available and were on back order. They were delayed in shipping to us by five days and the printers were unusable during this period of time.

Failures

There are three areas that are covered under failures; initial issues encountered before testing began (initial set-up), failures during the actual test and paper jam rates for each model.

Initial Setup – During initial setup the HP and Dell printers encountered no issues. The purchase of both the Hewlett-Packard and Dell printers were straight forward and they arrived promptly.

	HP Color LaserJet 3600n	Dell 3110cn
Acquisition & Initial setup	✓ No issues	✓ No issues
Failures during test	✓ One fuser failed One toner cartridge failed	Three failures with paper trays Three toner cartridge failures resulting in a failed printer
Printer Jams	✓ 8 in 300,000 pages Jam rate 1/37,500	15 in 250,000 pages Jam rate 1/16,667

Failures during test – Both the HP and Dell printers encountered failures during testing although the Dell printers encountered more issues and more severe failures. One HP printer had a fuser fail half way through the test. HP was contacted and a replacement was received the next day. On another HP printer a cartridge failed and HP replaced the cartridge the next day although the cleaning supplies that they promised did not arrive until a month later. QualityLogic used other readily available supplies to clean the Hewlett-Packard printer rather than waiting. Two of the Dell printers encountered a total of three failures with the accessory paper feed trays. The first of these failures required Dell to send a replacement accessory drawer. It took three days for the package to arrive and it turned out to be the tray and not the drawer. Another call to Dell was required and the correct components arrived the next day. The second failure that was encountered was a bad sensor on the drawer. Dell was contacted and they sent us a replacement tray. It arrived the next working day but was for a Dell 3100 printer and could not be used with the Dell 3110. We returned the tray to Dell and resolved the problem by changing trays between printers which would not have been possible if we did not have multiple printers. A third paper feed problem was encountered. When Dell was contacted they sent the correct part which arrived the next business day. On Dell printer number three we encountered three toner spills that required cleaning and cartridge replacement. The third failure, which occurred at a page count of 50,180 pages, was severe and Dell replaced the printer. This study was designed to determine a printer's reliability over 100,000 pages. Since one printer failed half way through the test it was not replaced. The numerous calls to Dell required significantly more time than the two calls to HP. We spent 1.3 hours in total with HP on the phone as opposed to 5.6 hours with Dell.

Jam rates - When comparing the paper jam rates of the two printer models during testing the HP performed much better. The HP printers had 8 jams in 300,000 total images for an overall jam rate of 1 in 37,500 pages. The Dell had 15 jams in 250,000 images for a jam rate of 1 in 16,667 pages.

Print Quality Consistency

After all testing was completed, print quality consistency over the test period was evaluated.

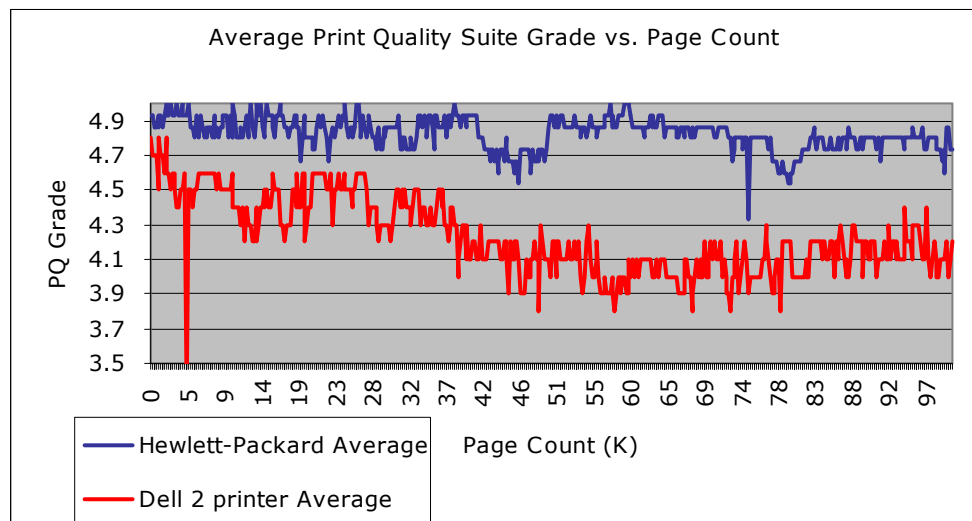
Consistency – We evaluated the consistency of the print quality over the test period. This test showed how much each individual printer’s output varied throughout the test. No comparison between models was done during this evaluation only for the given printer being graded.

	HP Color LaserJet 3600n	Dell 3110cn
Print Quality Consistency	✓ More consistent	Poor consistency with wider variation
Toner usage	✓ Much more consistent	Increased over time

In the consistency test the HP printers had significantly higher overall quality grades and printed higher quality pages more consistently. The Dell printers were less consistent with overall lower grades that were more spread out. All maintenance procedures were followed during this testing and printing did not exceed monthly recommended duty cycles. The following table compares the average grades on a scale of 1-5 for the three Hewlett-Packard and Dell printers. (Note that one of the Dell printers only completed half of the test.)

Quality Level	Print Quality Description	HP Color LaserJet 3600n	Dell 3110cn
High 5	Page has no apparent artifacts and a user would put this page in his or her resume.	82.8%	37.3%
Acceptable 4	Page may have a minor flaw such as one speck or uneven graphic rendering, but the average user would still use it in a typical business document.	17.1%	43.7%
Low 3	Page is sufficiently flawed that it would not be circulated to others as a business document and would only be acceptable as a draft page.	0.1%	17.8%
Flawed 2	Page has lost some legibility and/or has a definite shift in color and would need to be re-printed.	0%	1.2%
Very Flawed 1	Page has lost content and/or has a dramatic shift in color and would need to be re-printed. These pages are defined as “Low Quality” pages.	0%	0.1%

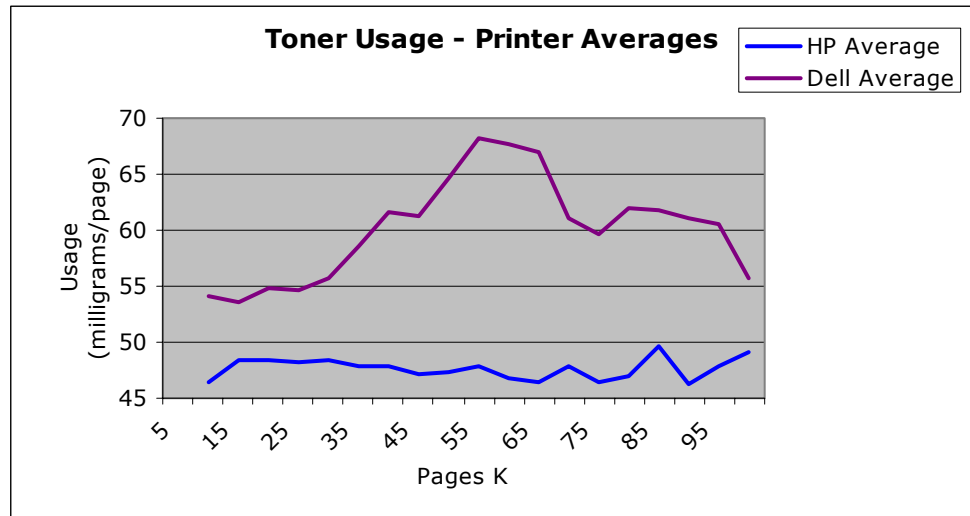
The adjacent graph compares the averages of the three HP and two Dell printers that completed the test over time. As the graph shows, initial print quality grades were approximately similar, with HP having an edge, among the products; however, the lower overall scores that the Dell printers received



over time in this evaluation are apparent. The Dell printers had a very clear downward trend in quality as evidenced in the graph. The third Dell printer that failed half way through the test had a slightly worse trend but is not included since it did not complete the test.

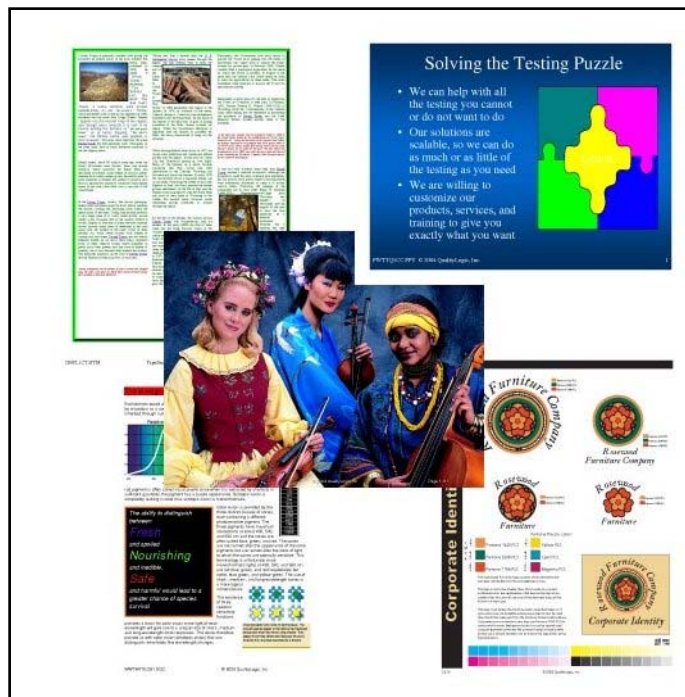
During the testing we noted that the Dell printers also used more toner as the testing proceeded. This resulted in fewer pages printed per cartridge as the testing progressed.

This test was not set up to be an ISO yield test so page yield counts will not be reported. The adjacent graph shows the average toner usage for the printers in the study for both the HP and Dell models.



As can be seen in this graph the HP printers are quite consistent in their usage while the Dell printers show a significant change and an increase in usage as the test proceeded. The averages, as above, are based on the printers that completed testing. If the third Dell printer were included the graph remains quite similar.

Summary - In summary, the HP printers showed much better consistency in both print quality and toner usage over the test period than the Dell printers.



Five Page Print Quality test suite

Customer Experience

There are three areas considered under customer experience; equipment acquisition, testing and downtime. We will cover interactions with the printer vendor or their support infrastructure and how effective those interactions were at resolving any issues that arose. In the first area under equipment acquisition we will cover the initial and subsequent acquisition of printers and consumables along with any initial setup problems. In the second area we will cover any interactions required during the test.

	HP Color LaserJet 3600n	Dell 3110cn
Equipment Acquisition	✓ No issues.	No invoice sent Two incomplete orders for toner required three calls to Dell
During test	✓ Replacement fuser arrived the next day Replacement toner cartridge arrived the next day Cleaning supplies not sent in a timely manner	Wrong parts sent twice for bad paper trays Transfer belt did not ship requiring two extra calls to Dell Next day shipping was not used for replacement parts
Downtime	✓ Printer downtime - 2 days lost during 300,000 pages	Printer downtime - 24.5 days lost during 250,000 pages

Equipment Acquisition – Both the HP and Dell printers were easy to order. Both models arrived promptly. No invoice was sent by Dell though for the purchase of the equipment. When Dell was contacted they could not find the order and thus could not issue an invoice. Several calls were made on this issue to Dell with no resolution.

Subsequent orders of consumables for the Hewlett-Packard printers also went smoothly. On both of the subsequent orders for toner from Dell insufficient quantities were sent although we were billed for the full invoice amount. On the first order we were three cartridges short while on the second we were short by two. Both instances required time on our part to clear up the shortages. One call to Dell was required on the first shortage while two were required the second time as they did not ship the missing cartridges after the first call.

During Test – During testing, the HP printer had two failures that required us to contact Hewlett-Packard. Replacement parts arrived the next day from HP in both instances. HP indicated cleaning supplies would be provided but they did not arrive for a month. We cleaned the printer and installed the cartridge, with other readily available cleaning supplies, as we assumed a typical customer would do. The Dell printers required significantly more time to resolve issues than the HP printers. The Dell printers had three issues with paper feed trays. Twice the wrong replacement parts were sent to us requiring us to contact Dell a second time for each instance. When we encountered the first toner cartridge failure on Dell printer #3 they told us they were sending us a replacement transfer belt and toner cartridge. The components did not arrive and we had to call Dell back twice before they arrived. There was a total of nine days of down time encountered on this issue alone.

Downtime – The HP printer had very limited downtime during testing compared to the Dell printers. The Hewlett-Packard printers encountered slightly less than two lost days waiting for replacement parts. The Dell printers experienced significantly more downtime due to waiting for replacement parts, shipment of the wrong parts or parts that were not available. The Dell printers experienced 24.5 days of lost usage for the 250,000 pages that were printed compared to 2 days of lost time for the HP printers which printed 300,000 pages.

Summary – During this test the HP printers had fewer problems and the subsequent interactions were mostly positive. The Dell printer had several issues that resulted in lost time on the phone along with lack of printer availability waiting for parts. Dell twice did not

ship everything that we ordered. In addition, twice when they were sending us replacement components the wrong parts were sent.

Conclusions

The HP Color LaserJet 3600n outperformed the Dell 3110cn in most of the tracked reliability metrics. Setup was similar between the two printers. During the test, the HP printer only required cartridge changes with no need for additional scheduled maintenance or parts replacement. In the print quality portion of the test, the HP Color LaserJet 3600n had much better consistency. Calls to HP revealed that HP support resolved issues quicker with less wasted time than calls to Dell. Orders to Dell for material were not completely filled or were filled with incorrect parts requiring extra time to resolve. Overall, Dell printer downtime was 24.5 days while printing 250,000 pages vs. HP downtime of 2 days printing 300,000 pages. In this reliability test, the HP Color LaserJet 3600n was the clear winner.

Test Approach

The objective of this reliability study was to identify any reliability and usage issues in a controlled and consistent test environment. The testing was done in a manner that attempted to simulate normal start stop printing usage in a high volume business environment. Another objective of the study was to understand and document the customer experience during the purchase, initial equipment setup and usage of the printers. The test length was set as 100,000 pages per printer with an initial burn in test that extended the test length to 102,000 pages for each printer.

Three printers of each model were purchased and tested in order to have a broad base to compare with and avoid having any single printer predominate. All equipment setup, maintenance (if required) and replacement of parts was done by trained QualityLogic test technicians unless local support was provided by the vendor. All procedures as recommended in supporting documentation provided by the manufacturer were adhered to during testing. The recommended maximum monthly duty cycle by the manufacturer was not exceeded during testing.

Print jobs were 10 pages in length and a pause was inserted between print jobs in order to simulate a work environment in a controlled manner. 90% of the pages were printed on standard 20 lb. laser paper while the remainder was divided between a 20 lb. recycled paper, a heavy 28 lb. laser grade paper and a 32 lb. glossy paper. 10% of the overall pages were in printed in duplex using the standard 20 lb laser grade paper. In each group of 100 pages, 95 were using a test suite available from ISO for yield testing while five pages were a print quality grading suite. This suite was developed for this test by QualityLogic from existing QualityLogic files. All printing was done on letter size paper.

All testing was done in an environmentally controlled environment with the average temperature controlled within the range of $23.0^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and humidity $50\% \pm 10\% \text{RH}$. All materials used in testing were acclimated in this environment for at least 8 hours prior to usage.

All printers were configured with similar options. A second bin was added for the standard 20 lb paper while the three special papers were fed from the standard tray. All printers were equipped with their duplex printing options and network connection option (which was used for delivering test files). All printers and consumables were purchased by QualityLogic on the open market. The majority of toner was purchased in one of three lots for each printer. The lots were disbursed over the test period in order to provide randomness in manufacturing lots used for the testing.

All print drivers were installed using the Plug-n-Play method and tested using the default settings. Files were initially printed and captured for later integration into the QualityLogic test environment. The captured files were then sent to the printers during testing. Logs were kept during testing regarding all issues encountered during the test.

After the test was completed, two print quality evaluations were conducted. The first comparison evaluated the consistency of output over the test period for each printer. A single grader was used for the evaluation in order to provide consistency in the process. All three printers from a single manufacturer were evaluated before proceeding to the next model. Every other print quality suite was graded and each page in the sampled suite was evaluated.

For the second portion of the study the grader removed representative samples of the suites from each model. These were graded on a one to ten scale by several evaluators.

This study was commissioned by HP.

About QualityLogic

QualityLogic is a leading Software Quality Services Company offering a variety of testing services and related tools focused on the conformance, performance, and interoperability testing needs, from low level firmware testing, to high level multi-tier application testing. QualityLogic has over 20 years' experience, both in developing specialized test tools and providing comprehensive testing services for top industry manufacturers.

Test results provided by QualityLogic. Tests were performed under laboratory conditions and your results may vary.

© 2007 QualityLogic Inc. All rights reserved.