THE MCNAMARA REPORT
Insights into Imaging Products, Trends, & Techniques

Feb. 09, 2010

AIO OFFICE INKJET PRINTER SHOOTOUT:

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Section I: Introduction:

When it comes to versatility and the price you pay for features, few office products can top an All-in-One inkjet printer. These multipurpose devices can print, scan and copy documents, send faxes, and even transfer files from memory cards directly to your computer. The latest AIO models priced below $200 even include premium features such as WiFi connectivity, high speed fax, auto-document feeders, touch-screen LCD panels, and duplex (double-sided) printing.

Since AIO office printers include so many features, it's hard to figure out which one is the best value or overall top-performer. However, for most buyers printing speed and print quality (including font sharpness, contrast, and color accuracy) on plain paper top the list of valued performance features. Next in line are photo-print speed and quality and copy/scan speed and quality. Ease of use is certainly a factor, and models with fast memory card readers and color LCD monitors that let you preview, adjust, and crop photos from your memory cards earn bonus points. Other factors to consider are the design and size of the printer, connectivity options (WiFi, Ethernet, or USB), fax features, and the amount of power used in printing or sleep modes.

For business owners, waiting around for a slow printer adds up to a waste of time and money—even if that printer has all the other bells and whistles mentioned above. So how can you determine the real speed of a printer before you purchase it? And which one is not only fast but has the best balance of features and performance for the price? To find out, I ran the six models below through a gauntlet of tests to determine the best of the breed. A quick overview of the results for five of these (not the Kodak) can be found in the **All-in-One Printer Shootout Video**, while detailed test results for all six can be found in **Section III** and **Section IV** of this report (click on each device name below to jump straight to its overview page in Section IV):

1) **Brother MFP-790CW ($139)***
2) **Canon Pixma MX860 ($179)**
3) **Epson Workforce 610 ($129)**
4) **Hewlett Packard Officejet 6500 ($159)**
5) **Kodak ESP 7 ($149)**
6) **Lexmark X7675 Professional ($189)**

*all prices are street prices as of Feb. 5, 2010.

Click on the image above or the following link to view the movie [All-in-One Printer Shootout]

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SECTION II: TESTING PROCEDURES:

This section describes the procedures, technical definitions, and adjustments made for print speed, font sharpness, image quality, power usage, and ease-of-use analysis.

A) ISO/IEC Standard 24734: Leveling the playing field for print-speed ratings

Until recently there were so many variations in the procedures used by manufacturers to generate their print speed ratings that it was impossible to determine which printer was actually the fastest. For example, one manufacturer used a b&w or color text document with no graphics to determine speed, while another used a mix of text, graphics, and photos but set the print quality to the lowest (and fastest) draft mode. Since the office-printing category is so large and printing time and quality affects overall productivity in the work place, an international printing speed standard**, ISO/IEC 24734, Information Technology—Office equipment—Method for measuring digital printing productivity**, was adopted in April 2009 to help level the print-speed playing field.


INTERNATIONAL STANDARD

ISO/IEC 24734

First edition
2009-03-01

Information technology — Office equipment — Method for measuring digital printing productivity

Technologies de l'information — Équipements de bureau — Méthode de mesure de la productivité d'impression numérique

Reference number
ISO/IEC 24734:2009(E)

ISO IEC

© ISO/IEC 2009

I'll spare you some of the tedious details found in this 50-page document, but essentially it contains test setup procedures, test runtime procedures, and reporting requirements covering everything from voltage to the print-driver settings used in the test. It also provides a choice of several document test suites, each containing a variety of pages designed for letter-sized output, and targeting categories such as b&w vs color, graphics or word-processing, and presentation. For my speed tests, I chose the 4-page ISO document "***Office-PDF(A&A4).pdf***" which includes a mix of color images, graphs, and charts typical of a business presentation document.

While the ISO document itself must be purchased (approx. cost is $129 US, www.iso.org), the actual test documents are available for free download from the ISO site, and you can get a copy of the document I used here (LINK). For more information on this standard, visit the ISO web site, or check out the Canon white paper.

This ISO standard defines three print-speed ratings that companies can use in advertisements and promotions:

1) **EFTP**: Effective throughput, which is "the average speed at which a device produces pages measured from the initiation of the job through the complete exit of the last page."

2) **ESAT:** Estimated saturated throughput, which is the "rate at which a device produces pages measured from the complete exit of the last page of the first test set through the complete exit of the last page of the last test set."

3) **FSOT:** First set out time, which is the "number of seconds between the initiation of the job to the complete exit of the last page of the first test set".

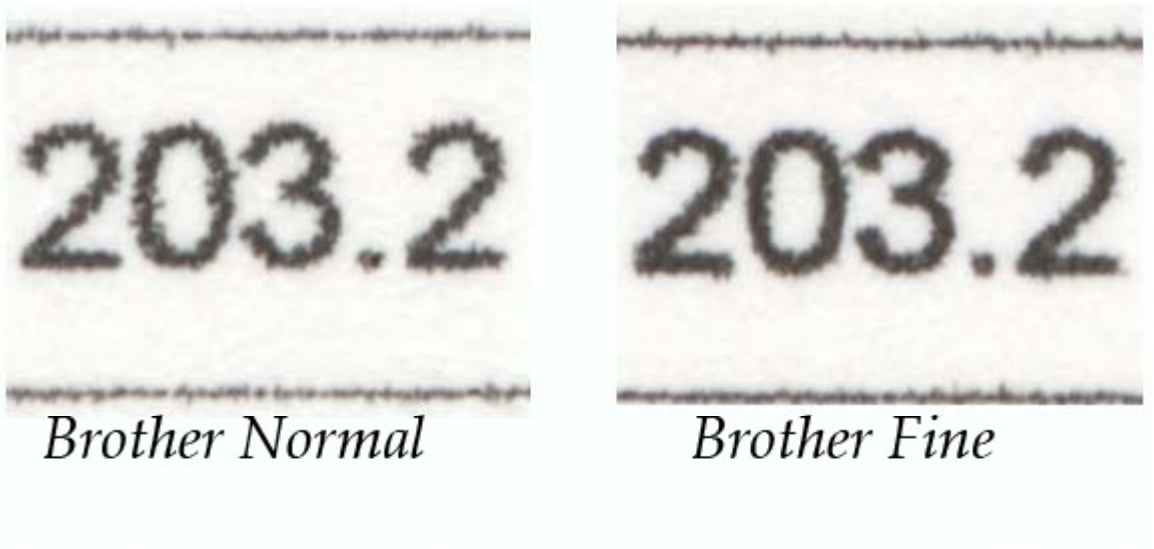
Of the three, ESAT is usually the fastest page-per-minute rating since it doesn't factor in the processing time or paper load time prior to the beginning of ink hitting the paper. However, I believe the FSOT speed rating is more important for small office or home office users, as it measures how long it takes from the time the user presses the print button to completion of the last page of a print job. As a comparison between the two ratings, the Canon MX860 took nearly 30 sec to begin printing the 4-page ISO document, but then finished all 4 pages 43 sec later at the 1 min 13 sec mark. Based on these times, the Canon's ESAT speed rating would be nearly 6 ppm (4 pages in 43 sec= @6pages in 60 sec), while its FSOT speed would be approximately 3.5 ppm. As this case shows, for one-up document printing—more typical in a small office or home office—processing time is a significant factor. That's why I chose to measure the FSOT for each printer when printing out a single copy of the 4-page ISO document "*Office-PDF(A&A4).pdf*".

NOTE: Connectivity:

Nearly all of these printers feature USB, wired LAN, and WiFi connectivity (the Kodak offers WiFi as an option). Wireless network speeds vary greatly based on your distance from the WiFi router or the protocols used by the router, and are affected by walls and other devices near the printer. Wired LAN networks also vary in speed based on the number of devices active in the network. To avoid these variables, I used each printer's USB 2.0 connection for all ISO-based printing speed tests. Each printer was attached with the same USB 2.0 cable directly to a Lenova W700 laptop computer running 64-bit Microsoft Vista, and loaded with the most recent printer drivers available from the manufacturer. The 4-page ISO document was opened using Adobe Acrobat Reader 8, while full-page color photos and 4x6-inch prints were made using Microsoft's Photo Gallery viewer.

B) Print speed vs. font and image quality:

Speed ratings based on the ISO standard are much move viable than in the past, but there's still a gray area in the ISO standard when it comes to print quality vs speed. For example, the standard allows you to manually select the paper type instead of relying on the printer's auto detect function, which may affect print processing speed and image quality. All AIO printers offer a range of print quality settings from Draft to Fine, but it's not always clear which of these settings is chosen by the print driver as the default for a particular style document. Therefore, it may take trial and error to reach settings that deliver a balanced combination of fast print speeds and competitive photo and text quality in the output. The key word here is "competitive". For the majority of the printers tested, I found the driver's auto select function worked best when printing the ISO document on plain paper, as each defaulted to the Normal (middle) quality setting. At that setting, the Brother finished the 4-page ISO document in 1 min, 27 sec., placing it even with the Lexmark model (in fourth place). However, even though the Brother MFC-790CW's printer driver automatically chose the Normal quality setting for plain paper, it was obvious to the naked eye that resulting image quality and font sharpness were closer to the Draft-quality modes on the other printers. That isn't a fair setting to use for the test, since setting draft mode quality on the other printers would significantly boost their print speeds as well.

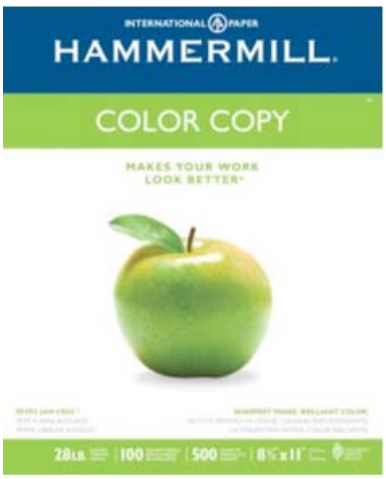


Therefore, I manually set the Brother to the Fine quality mode in order to bring its output up to a competitive (but not class-winning!) level with the other printers (see magnified comparison above). This resulted in a longer print time of 3 min 31 sec and a last place finish in the race.

C) Image quality on plain paper:

Since the majority of print jobs from an AIO Office printer will be made on plain paper, I printed several test images and test targets, including a MacBeth Colorchecker chart, on each device to determine color accuracy and overall image quality when printing photos. To determine font sharpness and readability, plus image quality in charts and graphs, I examined the ISO test document which contains a mix all three. High res scans of black fonts on page 3 of that document were also used to help analyze font sharpness and readability. **Note:** With small black fonts, contrast is a more significant contributor to text readability than the precision of the shape of each font. Since the paper brightness remained the same in my tests, contrast varied based on the black density of the ink and the amount of ink laid down by each printer (see and example between Brother Normal and Fine settings in section B above). This explains why the Kodak ESP 7, which had some of the best “shaped” fonts but a lighter black density than the Lexmark, Canon, or Epson, had lower contrast and therefore a lower readability rating. It also explains why the Epson Workforce 610, which had the highest black density (and therefore high contrast black fonts), yet showed some rough edges around highly magnified fonts, still earned a higher rating than the HP or Brother printers (both of which had lower contrast fonts.)

D) Paper choice matters!



For speed, plain paper image quality, and font-sharpness tests I chose Hammermill's Color Copy Digital paper (28lb, 100 brightness rating. $6.95 for 500 sheets), an ideal stock for presentations and letters. Since HP recommends using papers incorporating Colorlok technology for maximum quality, I also ran the more expensive Hammermill Ultra Premium Inkjet Paper with Colorlok technology (24lb, 98 brightness. $9.95 for 500 sheets) through all printers to see if there was a noticeable difference in print quality. Surprisingly, despite its higher cost, image quality and font contrast actually decreased across the board when using this paper! The loss was especially noticeable in full-page photos of a MacBeth Colorchecker chart on plain paper that showed lower color saturation and in some cases, banding that wasn't visible when using the Color Copy Digital paper. The only improvement I noticed was a slight increase in shadow detail for black and white photo prints made from the HP—but at the same time the lower thickness of the Colorlok paper (24lb vs 28lb) increased ink bleeding through the paper and curl after drying, and all prints showed lower color saturation and black density. To be fair, the results discovered here only apply to the Hammermill Colorlok paper used, and may not be the same for other paper brands featuring Colorlok technology. So before spending extra money on a large supply of paper with Colorlok technology, do your own comparison with a smaller package.

E) Photo Printing:

The ISO standard isn't designed to regulate print speed claims for prints made on glossy or matte photo papers, which is why there isn't a full-page or 4x6 high-res photo included in the available ISO test suites. In order to test photo print speed and quality (as I've done in hundreds of tests

over the last 20 years), I loaded each printer with its own brand glossy 4x6 paper and fed the same colorful portrait and still life 4x6-inch test images (at 200dpi resolution) to each printer, first via the PC's USB connection, and second directly from an SD card.
After printing, and in some cases considerable drying times (HP the main culprit), I made high-res scans of the images printed directly from the SD card (at 1200 dpi with an Epson Perfection 1680 scanner) to reveal close up attributes of each print. See the test movie and Test Results section for side-by-side comparisons and analysis.

F) Copy Speed and Quality:

A related ISO standard for testing copy speed, ISO/IEC 24735 (www.iso.org), uses the same 4-page ISO document chosen for the print speed tests to measure copy speed. However, to save time, I chose to copy a single photo print to test for scan lines, color accuracy, contrast, copy speed, and the capability of the ADF to handle thicker photo paper. The test print was a high quality glossy photo print produced on an Epson Stylus Pro 3800 printer using its Premium Glossy Photo paper stock, and the copy paper was the Hammermill Color Copy Digital stock (no Colorlok technology) used in the speed tests.

G) Print Moisture Resistance:

There's been a lot of testing and debate regarding the longevity of photo prints in display conditions and when stored in albums. But for the majority of the office document and photo print jobs from an AIO, fine-art printing and long display life isn't a big concern. What's more important is how long a printed advertising flyer, custom business card, or even a photo of a missing dog will last when exposed to rain outdoors, a spilled cup of water, or really high

humidity. Therefore, to test moisture resistance, I taped a plain-paper page from the 4-page ISO document (see video) containing a colorful chart onto a white poster board, sprayed it with water continuously for one minute, then let the print dry for several minutes before peeling it from poster board. Generally, pigmented inks are more moisture resistant than dye inks on plain paper, and this test confirms that the inks used in the Epson, Lexmark, and Kodak are far more resistant to moisture than the majority of inks used in the Brother, Canon, or HP. (See chart in Test Results and Summary Pages).

H) File transfer speed:

Stand-alone memory card readers vary widely in speed when it comes to moving files from a card to a PC, and that's no different with the built in readers found in AIO printers. (It may say USB 2.0 reader in the specs, but there's a big difference between Hi-Speed and Full-speed USB readers, with Full speed significantly slower than Hi-Speed.) To test the speed of the built-in card readers, I copied a 100MB movie file stored on a Sandisk Extreme III 16GB SDHC (class 6) card from each printer to a Lenova W700 laptop using the same USB 2.0 cable. Results varied widely, from 15 sec (Epson) to 1 min 45 sec (Kodak), and are listed the Speed Result charts for each printer. **NOTE:** Since most AIO devices don't ship with a USB cable, make sure you use a USB 2.0-certified cable when connecting your AIO device. Otherwise, scanning times and card reader transfer times will be much longer than expected.

I) Power usage:

With multiple electronic devices attached to the sparse wall outlets in a typical home or commercial office, plus the rising costs of electricity, it's wise to choose lower power devices when available. To determine how these printers compared in their power usage, I measured the wattage drawn by each during active document printing and in sleep (LCD off) modes. I then calculated yearly power usage (in Watt Hours) based on average print time (from document speed test) and an output of 1500 document-pages per year. (See chart in Test Results and Summary Pages).

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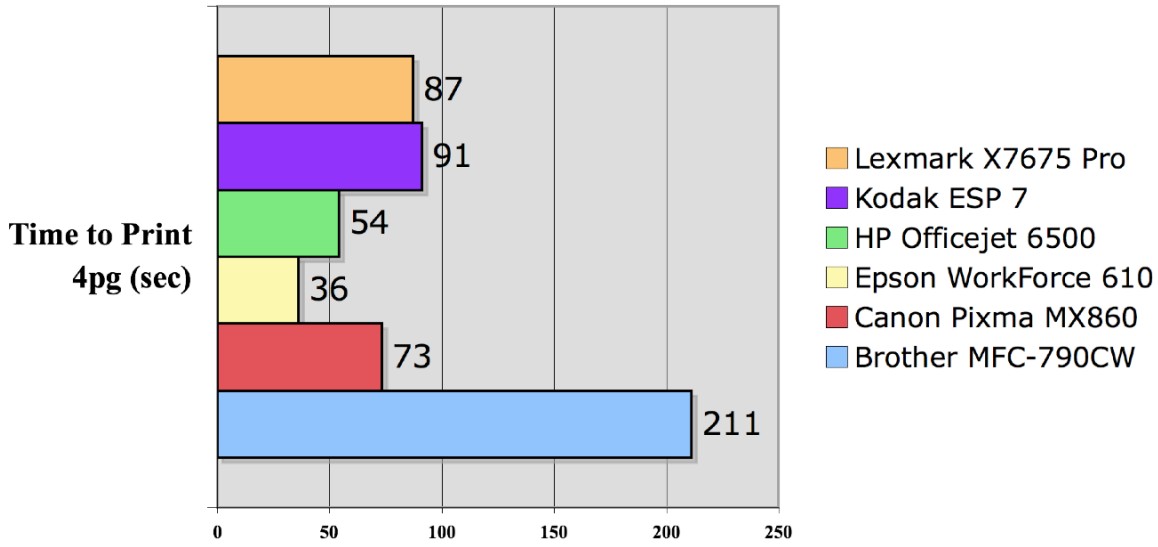
Section III: Test Summary Pages:

1) Print Speed on Plain Paper: First Set Out Time for 4 page ISO document *Office-PDF(A&A4).pdf*, on Hammermill Premium Digital Copy Paper.)



Printer Model	FSOT Speed 4 pg ISO Doc		Pages Per Min	Ranking
Brother MFC-790CW*	3 min 31 sec		1.1 ppm	Last Place
Canon Pixma MX860	1 min 13 sec		3.3 ppm	3rd Place
Epson WorkForce 610	36 sec		6.5 ppm	1st Place
HP Officejet 6500	54 sec		4.4 ppm	2nd Place
Kodak ESP 7	1 min 31 sec		2.7 ppm	5th Place
Lexmark X7675 Pro	1 min 27 sec		2.8 ppm	4th Place

FSOT: First Set Out. Measures time from pressing print button to completion.
*Brother set to Fine quality mode to produce competitive font and image quality.

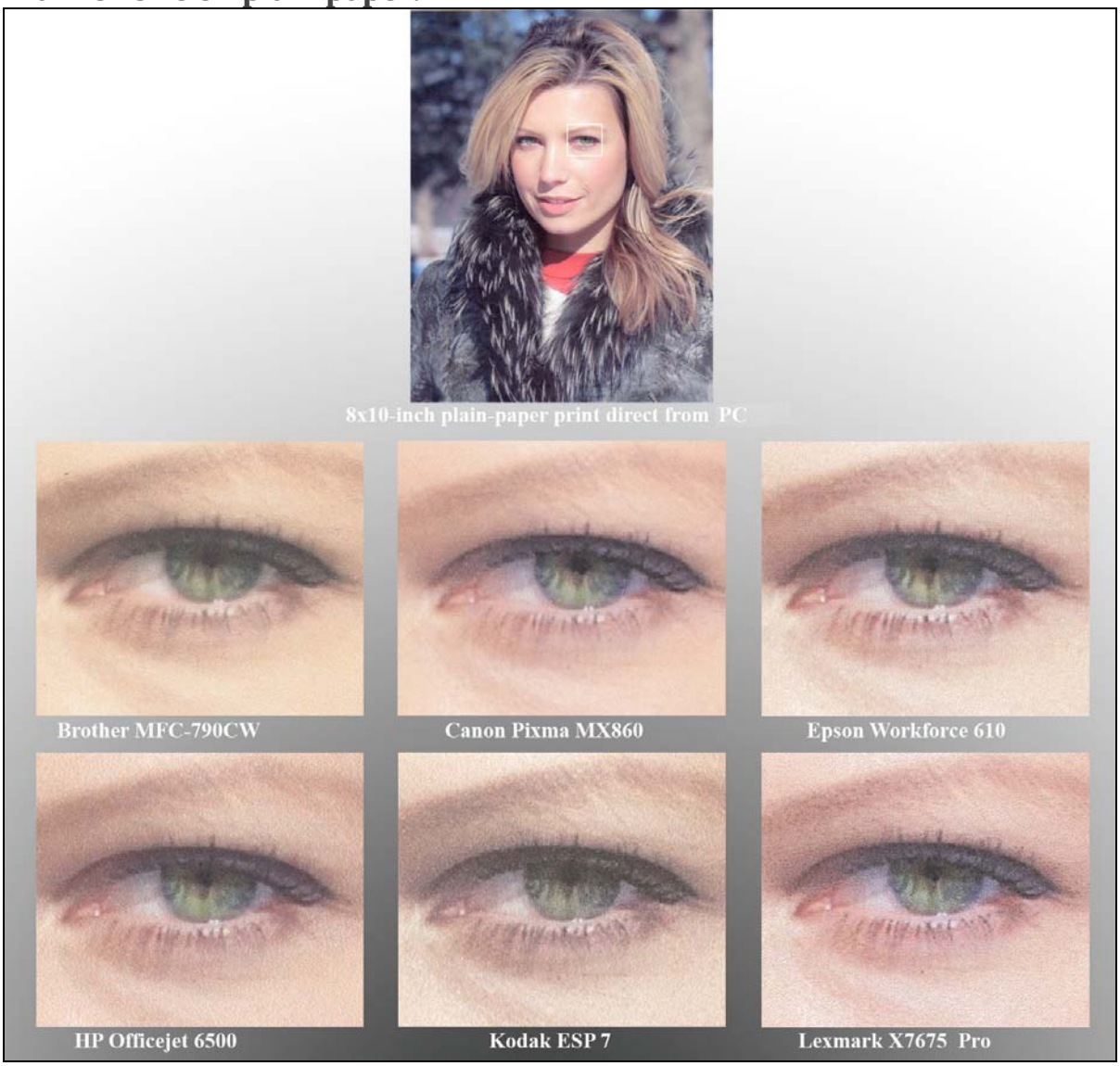
2) Font Sharpness and Readability: Black text on plain paper. Enlarged text from page 3 of ISO document *Office-PDF(A&A4).pdf*.)

For high res scans of the images above, go to the image gallery at www.mcnamarareport.com.

Printer Model	Contrast on Plain Paper*		Font Quality Rating	Comments
Brother MFC-790CW	Low		Last Place	Rough Edges
Canon Pixma MX860	High		2nd Place	Slight overspray
Epson WorkForce 610	High		4th Place	Rough Edges
HP Officejet 6500	Slightly Low		5th Place	Noticeable Overspray
Kodak ESP 7	Slightly Low		3rd Place	Good Edges
Lexmark X7675 Pro	High		1st Place	Good Edges

* Black text on white Hammermill Premium Digital Copy Paper, 28lb, 100 Brightness.

3) Plain Paper Photo Quality: From 200 PPI JPEG file printed from PC to 8x10-inch size on plain paper.

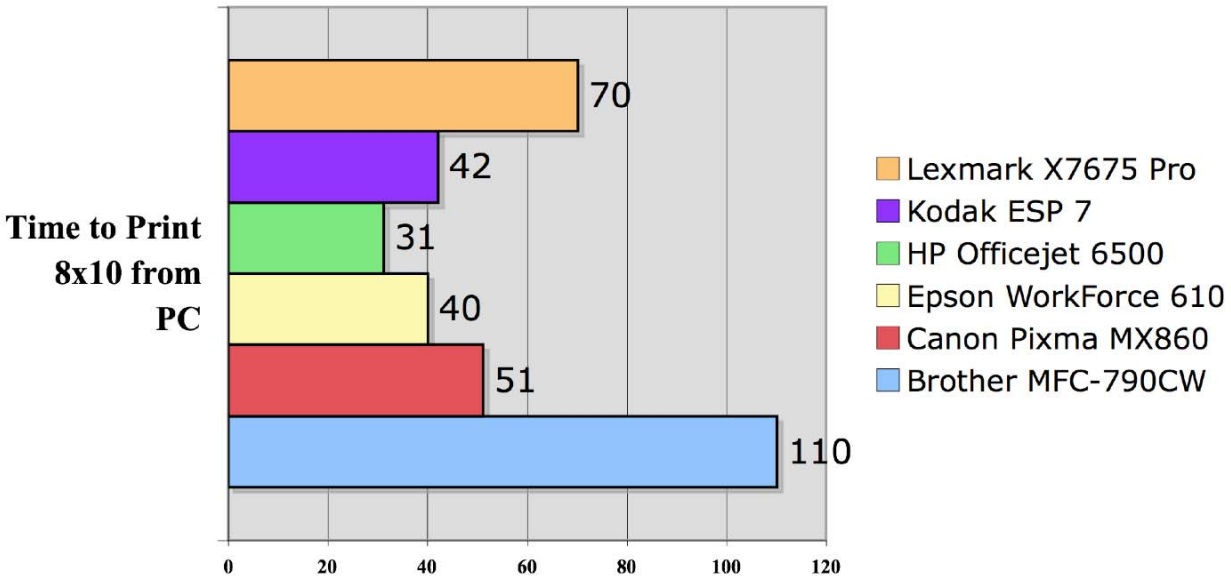


For high res scans of the images above, go to the image gallery at www.mcnamarareport.com.

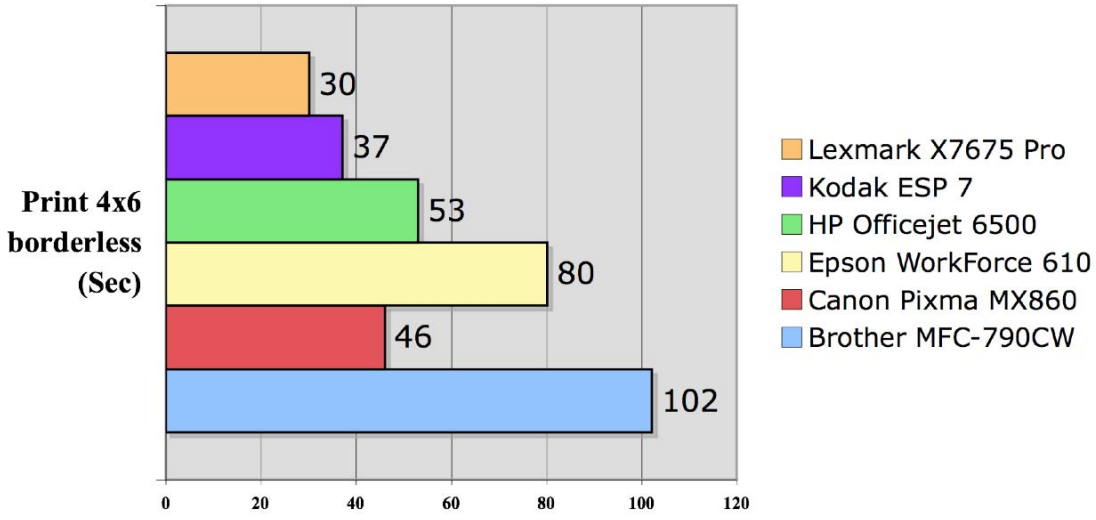
Printer Model	Color Saturation		Highlight & Shadow detail	Contrast	Image Quality Ranking	Comments
Brother MFC-790CW	Low		Low	Low	Last Place	Yellow cast, flat appearance
Canon Pixma MX860	High		High	Medium	1st Place	Smooth dot pattern, great skintones
Epson WorkForce 610	Slightly High		High	Medium	2nd Place	Some banding in midtones, good color
HP Officejet 6500	Slightly Low		Slightly Low	Slightly Low	4th Place	Slightly blownout highlights
Kodak ESP 7	Low		Slightly Low	3rd Place	5th Place	Yellow cast, flat appearance, curled
Lexmark X7675 Pro	Slightly High		Moderately High	Medium	3rd Place	Some blownout highlights

*From 200ppi JPEG file printed from PC
8x10-inch enlargement on Hammermill Premium Digital Copy Paper, 28lb, 100 Brightness.

8x10 PHOTO PRINT ON PLAIN PAPER SPEED



4x6 PRINT SPEED FROM SD CARD



4) 4x6-inch Photo Quality on Glossy Photo Paper: From 200ppi JPEG file direct from SD card.

For high res scans of the images above, go to the image gallery at www.mcnamarareport.com.

Printer Model	Color Saturation	Highlight & Shadow detail	Contrast	Image Quality Ranking	Comments
Brother MFC-790CW	Low	Low	Low	Last Place	Yellow cast, flat appearance
Canon Pixma MX860	High	High	Medium	1st Place	Smooth dot pattern, great skintones
Epson WorkForce 610	Slightly High	High	Medium	2nd Place	Some banding in midtones, good color
HP Officejet 6500	Slightly Low	Slightly Low	Slightly Low	4th Place	Slightly blownout highlights
Kodak ESP 7	Low	Slightly Low	3rd Place	5th Place	Yellow cast, flat appearance, curled
Lexmark X7675 Pro	Slightly High	Moderately High	Medium	3rd Place	Some blownout highlights

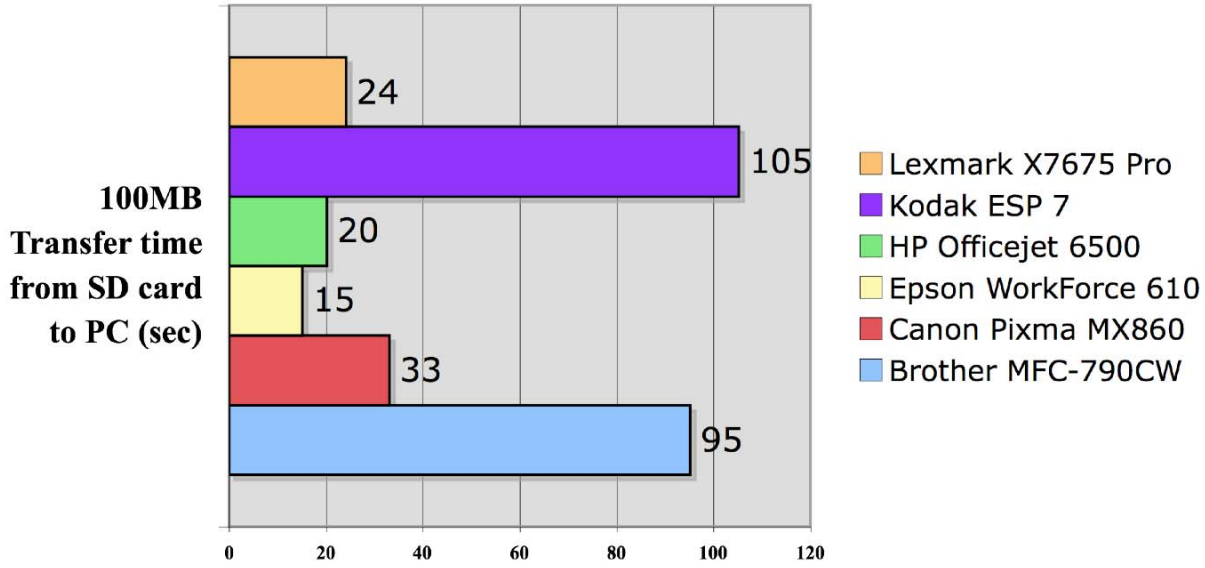
*From 200ppi JPEG file printed from SanDisk Extreme III SDHC card
Glossy 4x6 paper samples supplied by manufacturer in AIO printer box.

4) Moisture Resistance on Plain Paper (for images, see TEST VIDEO).

MOISTURE RESISTANCE RANKING

Printer Model	Moisture Resistance	Rating Rating	Comments
Brother MFC-790CW	Low	4th Place	Some inks ran and bled through
Canon Pixma MX860	Very Low	Last Place	Most inks ran and bled through
Epson WorkForce 610	Extremely High	1st Place	Pigment inks all water resistant
HP Officejet 6500	Very Low	5th Place	Most inks ran and bled through
Kodak ESP 7	High	2nd Place	Black text smudgeable when wet
Lexmark X7675 Pro	Slightly High	3rd Place	Black inks run, no bleed through

5) File Transfer Speed from Card Reader to PC.

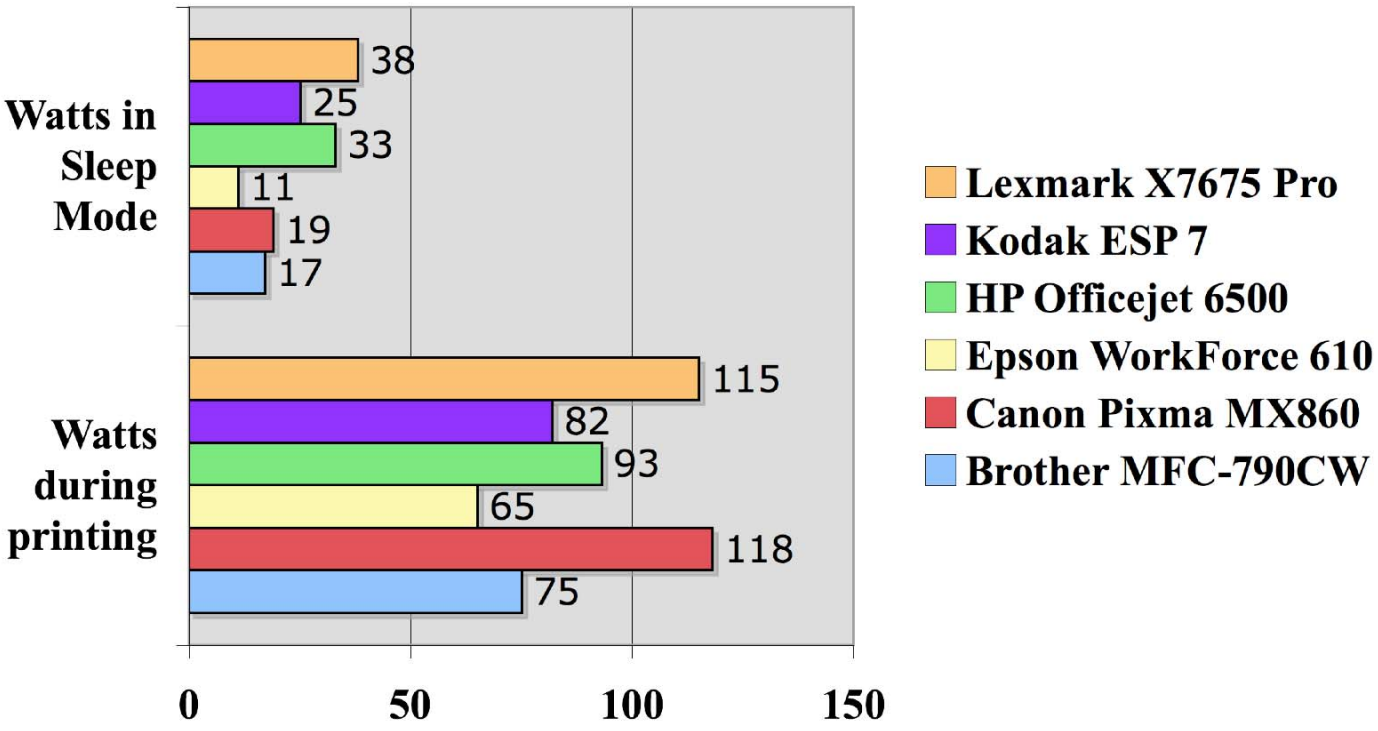


CARD READER TRANSFER SPEED

Printer Model	Claimed USB Speed	Transfer Speed to PC	MBytes/Sec	Ranking
Brother MFC-790CW	USB 2 HiSpeed	1min 35 sec	1.05MB/sec	5th Place
Canon Pixma MX860	USB 2 HiSpeed	33 sec	3.03MB/sec	4th Place
Epson WorkForce 610	USB 2 HiSpeed	15 sec	6.7MB/sec	1st Place
HP Officejet 6500	USB 2.0	20 sec	5MB/sec	2nd Place
Kodak ESP 7	USB	1 min 45 sec	.95MB/sec	Last Place
Lexmark X7675 Pro	USB 2 HiSpeed	24 sec	4.2MB/sec	3rd Place

* 100MB movie file on Sandisk Extreme III 16GB SDHC Class 6 card.

6) Power Usage:



POWER USAGE (PRINT&SLEEP) AND ESTIMATED YEARLY USAGE (PRINT)

Printer	Printing Avg. watts	Sleep Mode* Avg. watts	Time to Print ISO 4 pg (sec)	Est. Power to Print 4 pages (watt-secs)**	Est. Print Pages Per Year	Est. Annual Power Usage (Watt Hours)
Brother MFC-790CW	75	17	210	15,750	1500	1,641
Canon Pixma MX860	118	19	73	8,614	1500	897
Epson WorkForce 610	65	11	36	2,340	1500	244
HP Officejet 6500	93	33	54	5,022	1500	523
Kodak ESP 7	82	25	91	7,462	1500	777
Lexmark X7675 Pro	115	38	87	10,005	1500	1,042

Note: Brother unit set to Fine quality. Normal quality takes 87 sec to print but with draft results.
*LCD monitor off
**1 watt-sec= 1 joule, 1 Watt Hour=3600 joules
The formula to determine Est. Annual Power Usage (Watt Hours) is: (Printing Avg Watts x (Time to print/4) x Est. Pages per Year) /3600

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Section IV: AIO MODEL COMPARISONS:

Brother MFC-790CW ($160 street):

I) Overview: At first glance, the standout features on the MFC-790CW are its compact size, low weight (18.4lbs), large 4.2-inch color touch screen panel, and an integrated phone with answering machine (left side of printer). For printing, it includes a paper tray that holds up to 100 sheets of plain paper, plus a separate 4x6 print tray that holds up to 20 sheets. On top, a document feeder accepts up to 15 sheets of up to 24lb stock plain paper, but not thicker stock or glossy photo papers. The Brother is capable of producing prints up to 8.5 x 14 (legal sized) using sheets stored in its extended paper cartridge. It uses a dye-based, 4 ink system that boasts up to 6000 x 1200 dpi resolution with 1.5 picoliter drop sizes. Premium features include a Super G3 Fax, WiFi connectivity, and built in photo editing functions that are accessible through the 4.2 inch (diagonal) color LCD monitor, the largest in this roundup and the only touch screen. Compared to the other printers, I found the Brother's main paper tray to be rather flimsy, and doubt it would hold up in a busy office environment. I also had some difficulty loading the drivers onto a Vista 64-bit system, and found it difficult to select the 4x6-print tray when printing directly from a memory card (shouldn't that be the default?) Also, towards the the end of my testing both this printer and the HP Officejet 6500 flashed low ink warnings. In the Brother's defense, some extra ink was used up making the extra prints needed to fine tune image quality settings, but I was surprised at its appetite nonetheless.

II) Speed: As mentioned in Section II, the MFC-790CW is extremely slow when set to the Fine quality mode for plain paper printing—a choice I found necessary in order to produce competitive quality output. The print speed for 4x6-glossy photos from an SD card was also the slowest in the test at 1 min 42 sec (and that was at default setting). Copy speed for an 8x10 photo print took 36 sec, but the auto feed mechanism couldn't handle a glossy photo paper (only the Lexmark and Canon could handle thick photo stock in the auto-document feeders.)
File transfer speed for a 100MB file from an SD card to the PC was also very slow, at 1 min 35 sec, leading me to believe the integrated card reader is a slower Full Speed USB 2.0 device and not a Hi-Speed USB 2.0 reader.

Brother MFC-790CW

Speed test	Time	Ranking	Comments
4-page ISO doc.	3 min 31 sec	Last place	Based on Fine setting*
Borderless 4x6 from SD	1 min 42 sec	Last place	Default setting, glossy photo
Copy 8x10	36 sec	4th place	Photo placed on scan bed.
8x10 photo plain	1 min 50 sec	Last place	On Plain Paper
Transfer 100MB	1 min 35 sec	5th place	Slow card reader

*See Speed vs Quality in Section II.

III) Image Quality: Even at the Fine setting, the Brother's image quality on plain paper was the worst of the six tested printers, with lower black density, lower color saturation, and rough-edged fonts. 4x6-inch prints on photo paper had flat contrast and slightly low saturation, but both could be improved using the printer's Color Enhance function (at the cost of a few seconds print time). Copy quality from a glossy 8x10-inch photo to plain paper was poor—closer to a draft quality copy on other units.

Brother MFC-790CW

Image Quality	Rating	Ranking	Comments
Plain Print 4-page ISO	Acceptable	Last place	Fine Setting used*
Borderless 4x6 from SD	High quality	5th place	Low contrast, low sat.
Copy of 8x10 photo	Poor quality	Last Place	High contrast
8x10 Photo on plain paper	Normal quality	Last Place	Slightly low contrast
MB Colorchecker	Normal quality	Last Place	Low saturation and black density

IV) Print Moisture resistance: Low, especially on plain paper. Reds and magentas wash out and bleed through plain paper when exposed to moisture.

V) Power usage: At 82 watts during printing, the Brother power draw was just slightly higher than the Epson. However, its extremely long 3min 31 sec printing time placed it in last place. In sleep mode the unit drops to 19 watts—well below the 38 watts of the Lexmark.

VI) Bottom line? Considering the relatively high price for this AIO printer, the MFC-790CW comes in at the bottom or near bottom of the list for print speed, image quality, file transfer speed, and copy quality. To most users, the benefit of having an integrated (but not hands free!) phone and answering machine, or up to 8.5 x14 inch printing won't be enough to offset the poor performance in the areas that really count. If you want a lower-priced version, Brother's MFC-5490CN ($130) features a beefed–up auto-document feeder capable of handling glossy photos but comes without the phone features, WiFi, or large color LCD monitor. However, it uses a similar print engine, and you can expect similar print speeds, image quality, and low moisture resistance as from the 790CW.

Canon Pixma MX860 ($189 street)

I) Overview: While it's the largest in terms of size and heaviest in terms of weight (26.4 lbs), the Pixma MX860 boasts a sleek design and a versatile paper supply--with a cartridge underneath that holds up to 150 sheets of plain paper, and a second feeder in the back for thicker photoquality stock. It gains an image quality edge due to its 5-ink system which includes CMYK Chromalife 100 dye based inks, plus a pigment black. Its print engine also features 9600 x2400 dpi resolution and drop sizes down to 1 picoliter. There's an integrated 35-sheet auto-document feeder tucked below the rim on top, and a bright 2.5-inch color LCD monitor on the front. Notable premium features include automatic duplex printing that produces double-sided prints faster than the HP, Kodak, or Lexmark (the only other printers with fully-auto duplex printing), a Super G3 Fax, a 2400 x 4800 dpi scanner, and WiFi connectivity that lets you access the printer or card readers from remote computers.
Setup time was the longest of all the printers, but straight forward. After installing a print head, followed by the 5 ink cartridges (Brother, Epson and Lexmark have permanent print heads), the printer goes through a head cleaning procedure (nearly 4 min) followed by the automatic print-head alignment that takes nearly 11 minutes. I used the wait time to load the drivers onto the PC and familiarize myself with some of the useful printing utilities that come with the MX860.

II) Speed: The MX860 started out slow, taking nearly 30 sec to pop out the first page of the 4-page ISO document, but it really got moving after that—which may be why Canon routinely describes the printer's speed using the ISO Standard ESAT results. The MX860 came in 3rd place at 1 min 13 seconds for the 4-page ISO document, and output 4x6 prints in just 46 sec from a PC or from the SD card (4th place). With the test photo print placed on the copy glass, copy speed was very fast (30 sec.) As mentioned, the Canon auto-feed (ADF) mechanism can handle glossy photo paper, but using it increased copy time slightly (to 33 sec) and added banding artifacts to the paper copy.

Canon Pixma MX860

Speed test	Time	Ranking	Comments
4-page ISO doc.	1 min 13 sec	3rd place	Speed increases after 1st page
Borderless 4x6 from SD	46 sec	3rd place	
Copy 8x10	30 sec	2nd place	Can handle photo paper in ADF
8x10 photo plain	51 sec	4th place	
Transfer 100MB	33 sec	4th place	Very fast card reader

III) Image Quality: The MX860 produced the highest quality photo prints on plain paper in the roundup (although there was a slightly cool tint in neutral gray areas of the MacBeth Colorchecker chart.) It also produced the best overall 4x6-prints on glossy paper, and it produced the second highest quality ISO text documents on plain paper (font sharpness was superb, but some ink overspray around colored fonts and along sharp borders took it down a notch). The copy quality rating was also affected by its less-appealing higher contrast.

Canon Pixma MX860

Image Quality	Rating	Ranking	Comments
Plain Print 4-page ISO	High quality	2nd place	
Borderless 4x6 from SD	Very High quality	**1st place**	
Copy of 8x10 photo	Good quality	3rd Place	Slightly High contrast
8x10 Photo on plain paper	High quality	**1st Place**	
MB Colorchecker	High quality	2nd Place	Slightly Cool Grays

IV) Print Moisture resistance: Very low, especially on plain paper. Nearly all colors wash out and bleed through plain paper when exposed to moisture. It appears that only the pigment black holds its breath when submerged.

V) Power usage: The MX860 drew the most power during printing—at a measured 118 watts—but it still bested the Brother for total power needed to make the 4-page ISO document. Plus its fast print time for 4x6-inch prints helps it conserve power in that area. In sleep mode, the unit drops to 19 watts—well below the 38 watts of the Lexmark.

VI) Bottom line? Prints made on plain paper or 4x6 glossy photo paper from the MX860 are the best of all in this roundup. While its FSOT tested speed is half as fast as the Epson, once this printer gets going it's very fast. It has a beefed up document feeder and fast duplex mechanism, plus plenty of premium features, but the MX860 takes a hit for its poor moisture durability (on plain paper) and higher power usage. I'd give it a second place overall rating behind the Epson.

Epson WorkForce 610 ($130):

I) Overview: Epson AIO printers are usually known for photo quality and not their speed, especially in this class. However, the Epson WorkForce 610 may help to change that perception. It won the ISO printer speed race (4 pages in 36 sec!), as well as the copy speed and file transfer speed tests. As for image quality, the WorkForce 610 uses a 4-color DURABright Ultra pigment ink system, and a print engine that delivers up to 5760x1440 dpi resolution with drop sizes down to 2 picoliters. Premium features include a tilting 2.5-inch LCD monitor, WiFi connectivity (which also lets you access memory cards), a 2400x2400 dpi scanner, direct-from-PC fax capability, a 30-page auto-document feeder, and the ability to print images up to 8.5 x 44 inches long through the back feed (but only up to letter-sized cut sheet paper in the cartridge). While it doesn't feature an auto duplex mechanism, there's an efficient manual 2-sided printing function that only adds a few seconds to the one-side printing process. In addition, the printer includes PC-free photo editing capabilities that include red eye reduction and color restoration.

Setup time is fast and straightforward. The print head is permanent, so you only have to install the four ink cartridges (all of which are either high capacity or extra-high capacity cartridges). After that, you manually set the date and time via the LCD monitor, load the print drivers on the PC, attach an optional USB cord, and you're ready to print. (Of course, it will take some time to setup WiFi connectivity if you want to use that option, but that's the case with all the Wi-Fi enabled printers in this test.)

II) Speed: The WorkForce 610 took home first place in 3 out of 5 categories, and its print speed rivals that of many laser printers. Prints made on plain paper or photo paper are dry to touch, smudge and water-resistant, while prints made on specialty photo media have a claimed display life of up to 118 years. It also features a Hi-Speed USB 2.0 card reader that blew away the slow readers in the Brother and Kodak printers.

Epson WorkForce 610

Speed test	Time	Ranking	Comments
4-page ISO doc.	36 sec	**1st place**	First page out in 11 secs
Borderless 4x6 from SD	1 min 20 sec	5th place	Using Premium Glossy Paper
Copy 8x10	21 sec	**1st place**	Text + Image setting
8x10 photo plain	40 sec	2nd place	Text + Image setting
Transfer 100MB	15 sec	**1st place**	Extremely Fast card reader

III) Image Quality: The WorkForce 610 produced the second highest quality photo prints on plain or photo paper in the roundup (high color accuracy and good saturation, but slight bronzing on the glossy photo paper.) It produced the fourth highest quality ISO text documents on plain paper (font sharpness was good to the naked eye, with high contrast and solid black, but magnified images showed some rough edges). Copy quality was also good at the standard copy setting.

Epson WorkForce 610

Image Quality	Rating	Ranking	Comments
Plain Print 4-page ISO	High quality	4th place	
Borderless 4x6 from SD	Excellent quality	2nd Place	Slight Bronzing
Copy of 8x10 photo	High quality	2nd Place	Slightly High contrast
8x10 Photo plain	High quality	2nd Place	
MB Colorchecker	High quality	**1st Place**	Good color accuracy

IV) Print Moisture resistance: Extremely high. All colors remain stable and there is no noticeable color bleed through the paper.

V) Power usage: The Epson WorkForce 610 is the ECO-Star in this category, with the lowest power usage during printing (at 72 watts) or sleep mode, and the shortest printing times.

VI) Bottom line? For the price, the Epson WorkForce 610 delivers the highest performance and best blend of image quality and features. What's missing in this printer is a true duplex mechanism and a separate paper feed cartridge. (More expensive Epson Artisan AIO's have the separate paper cartridge and dual 4x6 tray, but they aren't as fast during printing.) However, the time and power you save printing documents and photos makes up for those inconveniences, and the moisture durability of its prints makes it an ideal choice for creating outdoor posters, flyers, and business cards.

HP Officejet 6500 ($140):

I) Overview: The HP Officejet 6500 offers most of the features typically found at this price in the office AIO class, except a color LCD monitor for viewing photos from memory cards. The HP uses 4 Vivera inks, including a double-sized black ink, and features up to 4800 x 1200 dpi resolution when printing in color. HP claims that the 6500 has the lowest cost per page of any sub-$200 inkjet AIO, but that claim is based on using the high capacity ink cartridges that don't ship with the printer. Premium features found on the 6500 include an auto document feeder capable of holding up to 100 pages (normal plain paper, not glossy photo stock which doesn't feed through), WiFi connectivity, and a high-speed fax. It also has an auto-duplex mechanism for double-sided printing, a 250-sheet input tray that can hold up to legal (8.5 x11-inch) sized papers (like the Brother, it can print legal-sized documents) and a 2400 dpi scanner that can handle up to legal sized documents when fed by the ADF.

Like the Canon, the HP's setup took a bit longer than expected since you first have to load a printer head, then the 4 inks and finally the duplex cartridge in the rear. After charging the inks, the printer runs through an automatic print head alignment that takes about 9 minutes. Again, I used that time to install the printer drivers and was pleased to find that once attached to the PC, the printer automatically set its date and time. Bonus? The HP shipped with a USB 2.0 cord.

II) Speed:
In the ISO 4-page speed test, the HP 6500 took second place with a 57 second speed. It also took 1st place when printing an 8x10 photo on plain paper. However, that fast speed doesn't hold up when sending the same document to the printer as a double-sided print job, which in this case took slightly longer than 3 minutes despite using the auto-duplex mechanism. The reason was that each time a page was printed the 6500 displayed a "Wait" message (see photo below) that let the paper dry for nearly 20 sec before being pulled back to be printed on the other side. In comparison, the manual duplex method on the Epson took less than 10 sec longer to accomplish the task, albeit with operator assistance to flip the pages.

HP Officejet 6500

Speed test	Time	Ranking	Comments
4-page ISO doc.	57 sec	2nd place	
Borderless 4x6 from SD	53 sec	4th place	Took minutes to dry. No LCD preview monitor.
Copy 8x10	33 sec	3rd place	
8x10 photo print plain	31 sec	**1st place**	Some paper curling
Transfer 100MB	20 sec	2nd place	Extremely Fast card reader

III) Image Quality: The HP Officejet 6500 produced decent quality prints on plain paper, with slightly low contrast and some off-color greens. As mentioned earlier, HP suggests using papers with Colorlok, and while some may improve the image quality, the Colorlok paper I tested produced less satisfactory results, with a warm color cast. With 4x6 prints on either HP's Advanced photo paper or Everyday photo paper, image quality was actually the worst of the bunch. The Advanced paper prints took forever to dry, and wound up with a some mottling in shadow areas. Dry time was also long with the everyday paper, with more pronounced surface mottling. Photo enlargements on plain paper also curled more that usual, but not as badly as the Kodak prints. The HP came in forth place for image quality in the ISO text documents on plain paper (font sharpness was good to the naked eye, but close-ups revealed notable overspray.) Paper copies from the 8x10 photo had great color and saturation, but lost points for higher contrast skin tones.

HP Officejet 6500

Image Quality	Rating	Ranking	Comments
Plain Print 4-page ISO	High quality	4th place	Noted font overspray
Brderless 4x6 from SD	Normal quality	Last Place	Mottled appearance
Copy of 8x10 photo	High quality	3rd Place	Slightly High contrast
8x10 Photo plain	High quality	4th Place	Low black density
MB Colorchecker	High quality	5th Place	Green colors off

IV) Print Moisture resistance: Very low, especially on plain paper. Nearly all colors wash out and bleed through plain paper when exposed to moisture. It appears that only the pigment black holds its breath when submerged.

V) Power usage: The HP uses 93 watts to print—the 4th highest in the group—but thanks to its fast print times, it takes second place for power use during printing. However, in sleep mode, it still draws 33 watts, the second highest in the test.

VI) Bottom line? If the HP included a color LCD monitor it would be a much better choice for an AIO device. It features decent speed and a good scanning mechanism, plus good quality photo prints on plain paper. Many users will appreciate its legal-sized printing capability and auto duplex mechanism. However, the print drying time on photo paper and plain paper will slow down your workflow, and its poor performance in the moisture resistance test rules it out for making outdoor flyers and posters.

Kodak ESP 7 ($180):

Overview: At first glance, the Kodak ESP 7 looks more like a dedicated photo printer since it lacks the distinctive auto document feeder found on top of every other AIO in this test. (It also lacks a fax, another trademark of an "office" AIO.) However, it features up to letter-sized printing on plain or photo paper, a large 3-inch color LCD monitor, copy and scanning functions, memory card readers, and a separate paper tray for 4x6 print paper. (An optional Bluetooth adapter is available for $50). Kodak claims its photo print cost is the lowest of any, which may make it more attractive to dedicated photographers. And as the test results show, its image quality on photo paper is very high.

To setup the printer, you have to load a print head first, followed by only two ink cartridges and the driver software. Kodak calls this a 6-ink printer, but there are only five color inks involved: one cartridge contains 4 color pigment inks (CMYK) and a clear coat (not a color), the second contains black ink. A problem I had early on with this device is the bottom paper tray. When I tried to load it with paper the first time, it came out half way and appeared jammed, so I pulled harder. The tray popped out, but it's not designed to be pulled all the way out, just half way! It took some time to get it back in, but I did so without breaking anything. Another problem I had was with the print-quality menus, which were too simplistic and don't offer a range of options found in the other printers. For example, the printer makes up its own mind about what paper is loaded, so if you load 3rd party glossy photo papers it will set the printer to plain paper. Also, the copy mode defaulted to a 4x6 inch size on letter-sized paper, not a very good preset.

II) Speed: The Kodak ESP 7 doesn't earn many points for its speed, coming in 5th place for the ISO document at 1 min 31 sec. It improves performance for 4x6-inch photo prints, earning a 2nd place for its 37 sec print time, but then falls to last place for its copy speed. Dead last, but not least, is its sluggish card reader, which took 1 min 45 sec to transfer a 100MB file to the PC.

Speed test	Time	Ranking	Comments
4-page ISO doc.	1 min 31 sec	5th place	Slightly low contrast
Borderless 4x6 from SD	37 sec	2nd place	
Copy 8x10	1 min 10 sec	Last place	
8x10 photo print plain	42 sec	3rd place	Paper curled dramatically
Transfer 100MB	1 min 45 sec	Last Place	Extremely slow card reader

Image Quality: Plain paper printing isn't the Kodak's forte, as evidenced by dramatic curling on photo prints, low black density, and noticeable uneven areas on saturated colors in the MacBeth ColorChecker prints. On the other hand, font sharpness and form were very good, and glossy photo paper print quality is extremely high—albeit with some bronzing noticeable. Copies from photo paper to plain paper were dark, with low shadow details and banding.

Image Quality	Rating	Ranking	Comments
Plain Print 4-page ISO	High quality	3rd place	
Borderless 4x6 from SD	Very High quality	3rd Place	
Copy of 8x10 photo	Low quality	Last Place	Dark, with banding
8x10 Photo plain	High quality	5th Place	Slightly overexposed
MB Colorchecker	low quality	Last place	Banding in colors

Print Moisture resistance: Extremely high. Colors remain stable and there is no color bleed through the paper. However, some black fonts showed slight smearing.

Power usage: The Kodak uses a moderate amount of power during printing, at 83 watts, then drops to a respectable 25 watts during sleep mode. But since it takes longer to print on plain paper, the total wattage is nearly the same as the Canon.

Bottom line? For the price, the Kodak ESP 7 is a gamble, even if you purchase it for making more than the average share of photo prints and snapshots from your memory cards. To keep paper curl down with plain paper, you'll need to purchase Kodak's higher-priced Ultimate paper. Doesn't that work against the claim for lower print costs? In its favor, it does a great job at photo prints and has highly moisture resistant inks.

Lexmark X7675 Professional ($130):

I) Overview: The Lexmark X7675 Professional includes most of the main features required for decent office AIO printer, including a 2.5-inch color LCD, 25-page auto-document feeder, copy and fax capability, and memory card readers. It boasts a 5-year warranty, which is the longest offered in this roundup. It uses 4 color pigment inks, and has a print engine with up to 4800 x 2400 dpi resolution with color prints. Premium features include WiFi, a super fast fax, an auto-duplex mechanism for double sided printing, and an included USB 2.0 cord (marked: For wireless installation). The only design elements I didn't like were the dual ink cartridges (containing 4 inks total. An optional color cartridge is available for 6-color printing). Even though these were XL high capacity cartridges, I prefer separate ink cartridges.

Setup time was slightly longer than the Epson due to an auto head alignment procedure that took place after loading the inks. Otherwise, the driver installation and setup went very smoothly, and I was impressed with the auto paper sensing mechanism that was able to identify plain paper and photo papers accurately. It also sent an early warning to the PC when it ran low on paper, but the low cut paper guides in the paper cartridge are bound to cause some miss-feeds over time.

II) **Speed:** At 1 min 27 sec for the 4-page ISO document, the Lexmark just beats out the Kodak. Speed results for 4x6 photo prints were split: with extremely fast results when printing directly from the memory card (30 sec, a 1st place), and moderate speeds from the PC (1 min 10 sec for borderless 4x6). Copies and 8x10-inch prints both took longer than 1 min, but all prints were fairly dry to the touch after printing, another time savings. It also boasts an fast card reader.

Lexmark X7675 Pro

Speed test	Time	Ranking	Comments
4-page ISO doc.	1 min 27 sec	4th place	
Borderless 4x6 from SD	30 sec	**1st place**	
Copy 8x10	1 min 03 sec	5th place	
8x10 photo plain	1 min 10 sec	5th place	
Transfer 100MB	24 sec	3rd Place	Extremely Fast card reader

Image Quality: The Lexmark produced very high quality photo prints on plain or photo paper (skintones were a bit bright, but acceptable, while color saturation was slightly low.) It also produced sharp fonts and decent charts on the ISO text documents on plain paper. Copy quality took a hit due to darker colors and some oversaturated yellow skin tones, however, these were still higher quality than copies from the Kodak or Brother printers.

Lexmark X7675 Pro

Image Quality	Rating	Ranking	Comments
Plain Print 4-page ISO	High quality	**1st place**	
Borderless 4x6 from SD	Very high quality	4th Place	Bright skin tones
Copy of 8x10 photo	Normal quality	3rd Place	Dark, yellow skin
8x10 Photo plain	High quality	3rd Place	
MacbethColorchecker	High quality	3rd Place	

Print Moisture resistance: Extremely high. All colors remain stable and there is no noticeable color bleed through the paper.

Power usage: The Lexmark used the second highest wattage during printing—115 watts—and only dropped to 38 Watts in sleep mode (LCD off). When the LCD monitor is on and the printer isn't doing anything, it still uses 69 watts, nearly the same as the Epson during printing!

Bottom line? The Lexmark is a decent buy for the price, especially when you compare its feature set to that of the HP, and note its water resistant prints and a color LCD monitor. Despite featuring an auto duplex mechanism, its slower document printing times and high power usage bring it down several notches, and it's dual cartridge system isn't a plus.