

# The reinvention of LED printing: New Xerox HiQ LED delivers colorful, high-resolution output

## Contents

- 2 Executive summary
- 3 Conventional LED vs. laser printing: why laser predominated
- 6 The case to revisit LED technology
- 7 An innovative LED printhead revolutionizes the printing process
- 9 The results: exceptional image quality
- 10 HiQ LED debuts in new Xerox color devices for 2009
- 12 For more information

March 2009

Authors:

Robert E. Nuuja

Senior Systems Engineer

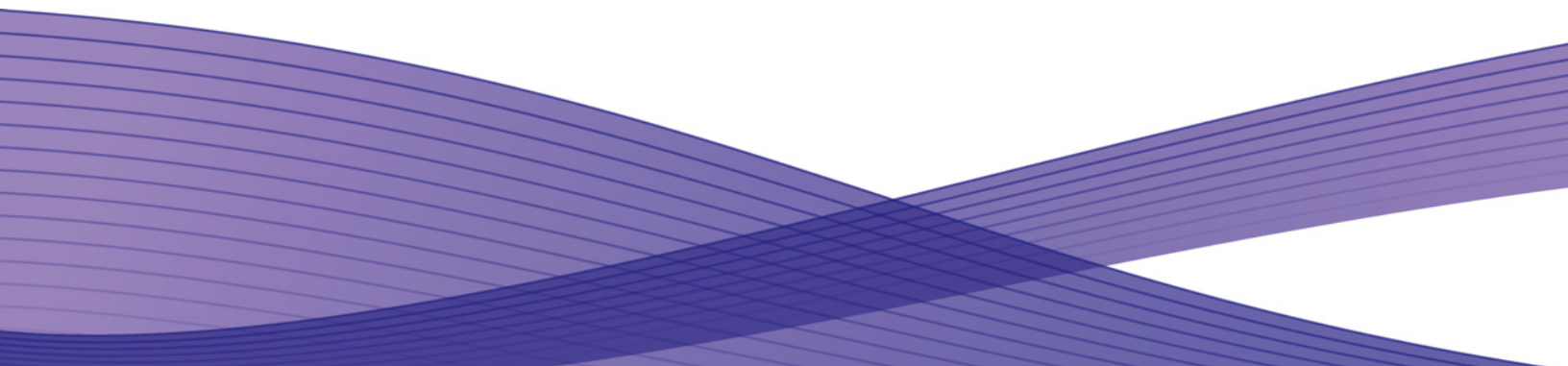
Xerox Corporation

Suma Potini

Worldwide Product

Marketing Manager

Xerox Corporation



# The reinvention of LED printing:

## Xerox HiQ LED

### Executive summary

Almost 25 years ago, a new type of page printing called LED (light-emitting diode) was developed, specifically because it promised to make office printers smaller, quieter, more reliable and less expensive than laser printers. LED technology used the same fundamental electrostatic method of applying toner to paper. But instead of the complex series of lenses, rotating mirrors and scanning system employed in laser printers, LED worked by means of a straight array of diodes. When flashed, they created a latent image, through a pattern of dots, on a rotating photo-receptive drum. The image was then transferred, via toner to an intermediate belt or directly to paper, to produce printed pages. This method was not only mechanically simpler and less expensive to manufacture, but was also much more compact than a laser system.

But LED's simplicity was also its downfall. Due to the fixed horizontal position and maximum 600 dpi resolution of the LEDs, along with their varying intensity, printed results were often disappointing compared to laser output. LED pages frequently featured blurry type, jagged edges on images, fuzzy halftones and mis-registered color reproduction. As much as users liked the space-saving design and quieter operation of LED printers, the need for laser print quality often won in the end.

Enter Fuji Xerox and Nippon Electric Glass Co. Ltd., two companies that specialize in high-resolution print technologies and cutting-edge optics. Xerox is the world's leading document management technology and services enterprise, with the industry's broadest portfolio of offerings, while Nippon Electric Glass Co. is one the world's leading manufacturers of specialty glass. Glass tubing and CRT (cathode ray tube) glass are two of their core products. By working together to develop a new printhead controlled by advanced, high-resolution calibration technology, the two companies created an innovative HiQ LED printhead. The new printhead solves conventional LED's print quality issues due to diode positioning as well as variation in output timing and intensity, and is now available in the new Xerox WorkCentre<sup>®</sup> 7425/7428/7435 Multifunction Device and in the new Xerox Phaser<sup>®</sup> 7500 Color Printer.

The WorkCentre<sup>®</sup> 7400 series delivers true 1200 x 2400 dpi color print resolution. It also leverages the attributes that conventional LED printer users appreciated—a much smaller size, quiet and environmentally friendly operation, plus exceptional reliability and affordability. The Phaser<sup>®</sup> 7500 Color Printer offers similar attributes with 1200 x 1200 dpi resolution and print speeds of up to 35 ppm.

LED print technology has been reinvented, to deliver on its initial promises—and more. New Xerox HiQ LED helps the WorkCentre<sup>®</sup> 7400 and the Phaser<sup>®</sup> 7500 series drive document production to a new level, with an additional emphasis on environmentally conscious engineering for today's offices.

# The reinvention of LED printing: Xerox HiQ LED

## Conventional LED vs. laser printing: why laser predominated

Back in the mid-1990s, LED (light-emitting diode) page printing was poised to be the next big thing in the workplace. Invented by Casio and Panasonic, championed by Oki and incorporated into some Lexmark and Xerox devices, LED offered a less complicated and quieter method of using the same basic technology as laser printers. And due to their simpler design, LED systems, even color printers, were much more compact than their laser counterparts. These design factors also made LED devices less expensive to manufacture, which encouraged buyers. In addition, LED printers used significantly less power and were much quieter than comparable laser printers. But five years after they were introduced, LED systems still hadn't made much of an impact on the market—or on users.

While traditional LED devices provided more reliability than laser printers in some ways, their design limitations also proved to be problematic. LED printers featured a simpler, more straightforward design, with a shorter light path and paper path, along with fewer moving parts. But the light intensity and timing accuracy varied from LED to LED—which meant the image quality also varied. Resolution was typically no better than 600 dpi, and LED printers often produced images with fuzzy, jagged edges, gaps in fine halftone lines, and poor color registration.

Print quality, especially in terms of resolution and reliability, became LED's primary disadvantage, and led to laser's dominant position in the marketplace today.

### **Both systems utilize similar printing technology.**

LED and laser systems employ the same basic method of applying toner to paper, by utilizing static electricity—the electrical charge that is built up on an insulated object—and light emitted from lasers or LEDs.

Here's a highly simplified description of how the process works:

- In the case of both LED and conventional laser printing, a static charge is applied to a photoreceptor, typically a revolving drum or cylinder. The drum assembly is manufactured from highly photoconductive material that is discharged by light photons.
- As the positively charged drum revolves, the printer shines light across the surface to discharge certain points—effectively “drawing” the letters and images to be printed on the drum as a pattern of electrical charges, also called an electrostatic image.
- Next, positively charged toner is applied, which sticks to the negatively charged areas of the drum.
- The toner image is then transferred from the drum to an intermediate transfer belt or directly to the paper.
- Using heat and pressure, the toner is then melted to the paper through a fuser, producing the printed page.

### **The difference is how the two technologies distribute the light source.**

In traditional LED printers, the printhead consisted of a wide linear array of digitally controlled, light-emitting elements, which were often built into the cover of the printer. Instead of scanning the image, as a laser printer does, the LEDs selectively flash to create a pattern of dots on the photo-receptive drum as it rotates, creating a latent image that is transferred to paper via electrically charged toner.

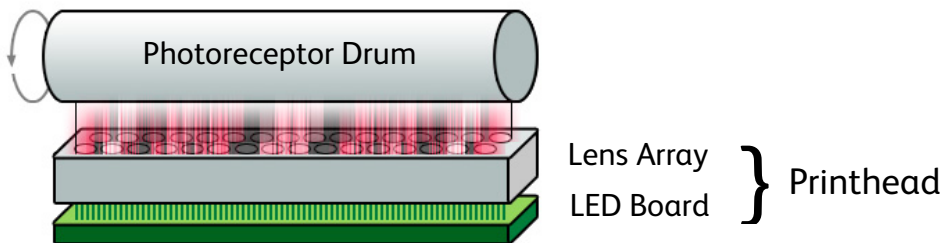
# The reinvention of LED printing: Xerox HiQ LED

## Conventional LED vs. laser printing: why laser predominated; cont'd

While this row of LEDs was simpler and less expensive to make than the complex moving parts of a laser system, the simplicity of its design didn't allow for the fine timing or intensity control of the LEDs to correct print quality and registration issues. In addition, the LED bar would frequently be skewed or bowed and deliver poor color registration—creating jagged edges, missing detail in halftone images, and telltale color gaps in prints. Manual mechanical intervention at the factory or by the end customer was the only way to recalibrate the LED bar and correct these quality problems. Making matters worse, if individual LEDs failed in a traditional LED device, the entire printhead had to be replaced by the manufacturer.

Only so many LEDs can be packed into a horizontal linear space, so a printer with 600 dpi (dots per inch) resolution must have 600 LEDs per inch in its LED array. In addition, the horizontal resolution of the LED array was absolutely fixed, while the vertical resolution was based on how quickly the LEDs flashed as the photoreceptor rotated past the diodes.

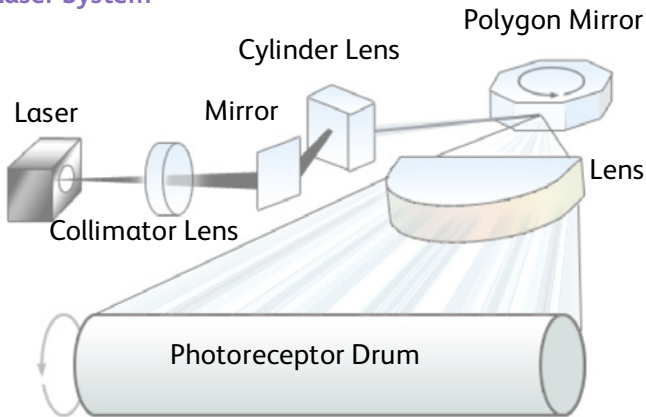
### LED System



# The reinvention of LED printing: Xerox HiQ LED

Conventional LED vs. laser printing:  
why laser predominated; cont'd

## Laser System



With a laser printer, an optical scanning system distributes a light beam not only through a polygon mirror, but also through focusing lenses in order to make the fine adjustments needed for better print quality. The laser scans from one end of a line to another, then starts the next line, to form the latent image bit by bit on the photoreceptor drum. The components of a laser system must stay in alignment throughout their use in order to deliver the best results. Automatic adjustments are built into many of today's laser printers to maintain this level of accuracy. One of the primary characteristics of laser printers is their high resolution—or how many dots per inch they lay down. Today's laser printers commonly print at up to 1200 dpi. By comparison, in offset printing, resolution generally ranges from 2400 to 9600 dpi. The laser system's moving parts also contributed to greater noise in the workplace.

# The reinvention of LED printing: Xerox HiQ LED

## The case to revisit LED technology

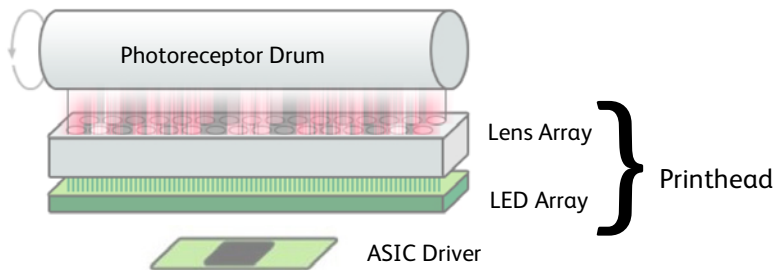
Important aspects of LED printing worked well and offered real advantages to users. LED's mechanical reliability and compact design were major attributes. And its simpler design, with fewer moving parts than laser printers, also meant that LED printers could be manufactured much more affordably than most laser printers. It all came down to image quality and resolution: if these could be improved, LED promised to offer exceptional print technology at an affordable price for users.

Working together, Fuji Xerox and Nippon Electric Glass Co. leveraged new technologies, including self-scanning integrated circuitry and optical technology. Researchers paired these with a newly developed ASIC (application specific integrated circuit) chip driver to create the new Xerox HiQ LED Printhead, which offers uniform optical characteristics to provide high-resolution imaging. When combined with market-leading Xerox toner and electrophotographic marking technology, the result was a new generation of LED printing technology, one that redefines the process and offers major improvements in image quality.

# The reinvention of LED printing: Xerox HiQ LED

An innovative LED printhead revolutionizes the printing process

## The new Xerox HiQ LED Printhead



The new Xerox HiQ printhead contains an array of 14,592 light-emitting diodes, or LEDs. Miniaturized, self-scanning driving circuitry is partially located adjacent to each LED, with the remaining circuitry integrated into the ASIC driver chip, located on the LED bar itself.

Each HiQ printhead also features a new self-focusing lens array design. The array is configured in clusters of lens elements with uniform optical characteristics that systematically overlap to produce high-resolution imaging. The LEDs flash through this lens array to form latent images on the photo-receptive drum.

In a color printer, there are four individual printheads. With each LED array packing 1200 diodes per inch, the printhead can create many more, and much finer, dots for exceptional resolution, while also saving space in the system's overall design.

The "brain" behind the entire print-head process is Xerox's new integrated application specific circuit (ASIC) driver chip. This high-performance driver precisely controls the intensity and timing of the 14,592 dots of light (LEDs) in each printhead to achieve 1200 x 2400 dpi resolution—print quality that's equivalent to, and often better than, comparable laser systems. By continually and automatically monitoring information about each LED, the ASIC driver can adjust each diode's light intensity and timing. This ensures uniformity across the entire LED array—and produces consistently high print quality.

# The reinvention of LED printing: Xerox HiQ LED

The results: exceptional print quality

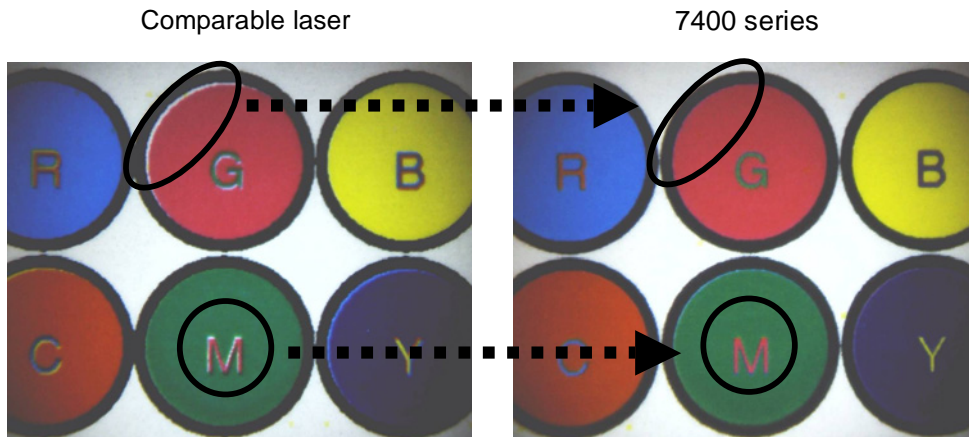
With Xerox HiQ LED technology, users can benefit from the first true 1200 x 2400 LED printhead to offer high-resolution output that rivals and even outperforms comparable color laser printers. HiQ LED overcomes the problems that drove consumers away from conventional LED imaging—poor image quality due to the position and intensity variations of the diodes. In addition, its LEDs are engineered to never need replacement and the printhead is designed to last the life of the device.

## Precise color registration with digital correction

With an ASIC driver to control the light intensity of the LEDs in each printhead, HiQ LED offers better dot-to-dot intensity and timing control, and produces more precise color registration. Conventional LED has imperfections due to skewing and bowing of the LED bar, and differences in LED-to-LED placement within the array, requiring mechanical intervention to correct. HiQ LED handles all three of these mis-registration issues automatically, simultaneously and continuously, from LED to LED. In fact, tests show that HiQ LED corrects color mis-registration even better than comparable laser printers.

## Color to color registration

The 7400 series digitally adjusts for mis-registration. Notice the white lines on the laser product. Also notice the white edges on the “M”. The 7400 series adjusts the registration.



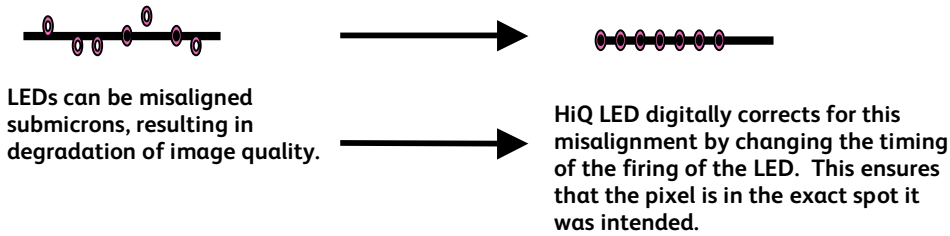
# The reinvention of LED printing: Xerox HiQ LED

The results: exceptional print quality cont'd

## New edge and image enhancing technology for better resolution

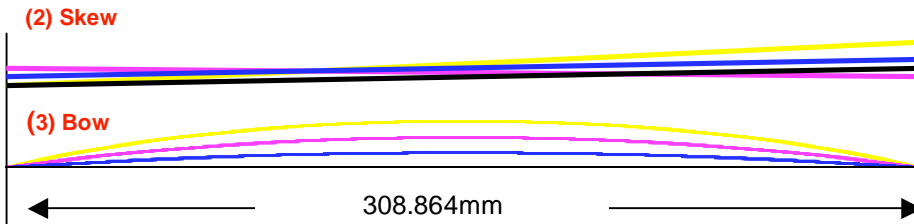
Conventional LED technology generally produced only 600 x 600 dpi. While skewing and bowing of the LED bar is inherent in all LED printers, now both problems can be digitally, versus mechanically, corrected—simultaneously. New Xerox HiQ LED technology delivers true 2400 dpi resolution, using ultra-fine pixel control that fills in gaps and smoothes jagged edges. The results are improved reproduction of individual characters and fine lines, and smoother edges on printed solids and halftone images.

### (1) Correction of image mis-registration of individual LEDs from scan direction



### (2 & 3) Correction of color mis-registration – skew and bowing of the LED bar

The LED bar can be slightly skewed, resulting in color mis-registration



HiQ LED *digitally* corrects for the skew to ensure high Image quality

Corrects (1) + (2) + (3) all at the same time

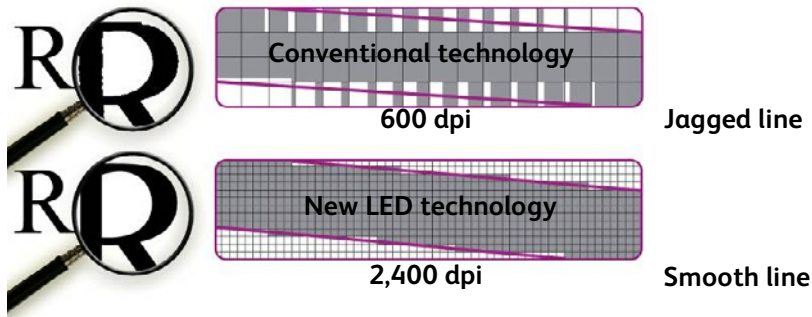


# The reinvention of LED printing: Xerox HiQ LED

## HiQ LED debuts in new Xerox color devices for 2009

The Xerox WorkCentre® 7425/7428/7435 Multifunction Device launched in March 2009 and features new Xerox HiQ LED printheads, in addition to other breakthrough technologies. These include Emulsion Aggregate HG Toner, which features a smaller, more consistent particle size for higher resolution and sharper image quality.

With its digital print resolution of 1200 x 2400 dpi, the WorkCentre 7425/7428/7435 delivers exceptional image sharpness and clarity, whether for fine line drawings, solids or halftones. Smoother lines, without the jagged edges of traditional LED printers, and gap-free halftones with edge enhancement, are produced via ultra-fine 2400 dpi pixel control and Xerox's Emulsion Aggregate HG Toner.



The new WorkCentre 7425/7428/7435 also leverages all the other advantages of LED versus laser systems—fewer moving parts, a smaller size and much quieter, environmentally friendly operation. It replaces the Xerox WorkCentre® 7328/7335/7345 Multifunction Device, and offers up to 35 ppm color output. Its compact imaging system, made possible by HiQ LED, lets users add integrated finishing capabilities without increasing the device footprint—what Xerox refers to as “zero footprint finishing.” And like its LED predecessors, it offers exceptional mechanical reliability and affordability.



**WorkCentre 7435 with Work Surface, High Capacity Tandem Tray and Integrated Office Finisher.**

# The reinvention of LED printing:

## Xerox HiQ LED

HiQ LED debuts in new

Xerox color devices for 2009, cont'd

### **Exceptional engineering for the environment**

The new WorkCentre 7425/7428/7435 is not only Energy Star and Blue Angel compliant, it also consumes less power than other laser devices in its class. Its sleep power consumption is less than 2 watts. It's also much quieter than similar laser printers—in full operation, the noise level is just 56dB. The cooling fan is turned off in sleep mode, reducing noise levels to 20dB. And it has altogether less mass and complexity, with fewer moving parts than laser devices. Where feasible, biomass plastic—derived from organic residues—is used. This produces 16 percent fewer CO<sub>2</sub> emissions during the manufacturing process, compared with traditional plastic. In addition, Xerox EA toner emits 65 percent less carbon dioxide during manufacturing.

# The reinvention of LED printing:

## Xerox HiQ LED

For more information

Are you looking for tools to support your organization's IT needs, including color devices that offer better print quality? Do you need to improve your end users' productivity in the short- and long-term? Our online resources, experienced sales teams, and extensive reseller network can help you find new sources of value within your workplace and improve the performance of your business.

Xerox, renowned for its technological innovation, has focused that innovation on the challenges IT faces on a daily basis. We offer proven expertise in improving document and business processes, and put that expertise to work every day around the world, liberating thousands of IT professionals from the tedious and resource-intensive hassles of managing their output infrastructure.

Whether you're implementing MFPs, printers, software, services or new innovative ideas, our people and technology can help you with cost savings, efficiency, security, document workflow, and sustainability in network management and beyond.

Learn more about how Xerox can put our forward thinking to work for you. Contact your local Xerox provider, or visit [www.office.xerox.com](http://www.office.xerox.com)

### HiQ LED wins technology award

The HiQ LED, a high-resolution LED (light-emitting diode) print head developed by Fuji Xerox Co., Ltd., won The Imaging Society of Japan's Technology Award.

HiQ LED print head technology is featured in WorkCentre 7400 Series and WorkCentre 7500 devices.

The development of this 1200 dpi, self-scanning LED, together with a dedicated ASIC (application-specific integrated circuit), has overcome the issues presented by conventional LED print heads while also achieving high-resolution output.

The Imaging Society of Japan Technology Award recognizes digital photography technology, Non-Impact Printing (NIP) technology, and peripheral technology that displays outstanding originality and exceptional applicability.

The award is limited to technology used in products that have been on the market for more than one year and less than three years.

# The reinvention of LED printing: Xerox HiQ LED

## About the Authors

### **Robert E. Nuuja**

**Senior Systems Engineer  
Xerox Corporation**

Rob Nuuja works in the Xerox Enterprise Office line of business, where he's responsible for technology assessment, with a particular emphasis on imaging and imaging quality. During his 14 years with Xerox, Rob has worked in a wide variety of engineering capacities. He's a graduate of the Rochester Institute of Technology, with a bachelor's degree in imaging and photographic technology.

### **Suma Potini**

**Worldwide Product Marketing Manager  
Xerox Corporation**

Suma works as a worldwide product marketing manager for Xerox, where she's involved in elevating the relevance of Xerox MFPs among the company's IT-centric customers. Suma has been with Xerox for the past ten years and has extensive experience working with enterprise customers. She started her career as a systems and network engineer. Suma is Lean Six Sigma Green Belt certified, and has a master's degree in computer science from Southeastern University in Washington, DC, and an MBA from the University of Rochester in Rochester, NY.

© 2009 Xerox Corporation. All rights reserved. Contents of this publication may not be reproduced in any form without permission of Xerox Corporation. XEROX® and WorkCentre® are trademarks of Xerox Corporation in the U.S. and/or other countries. W74WP-01UC