

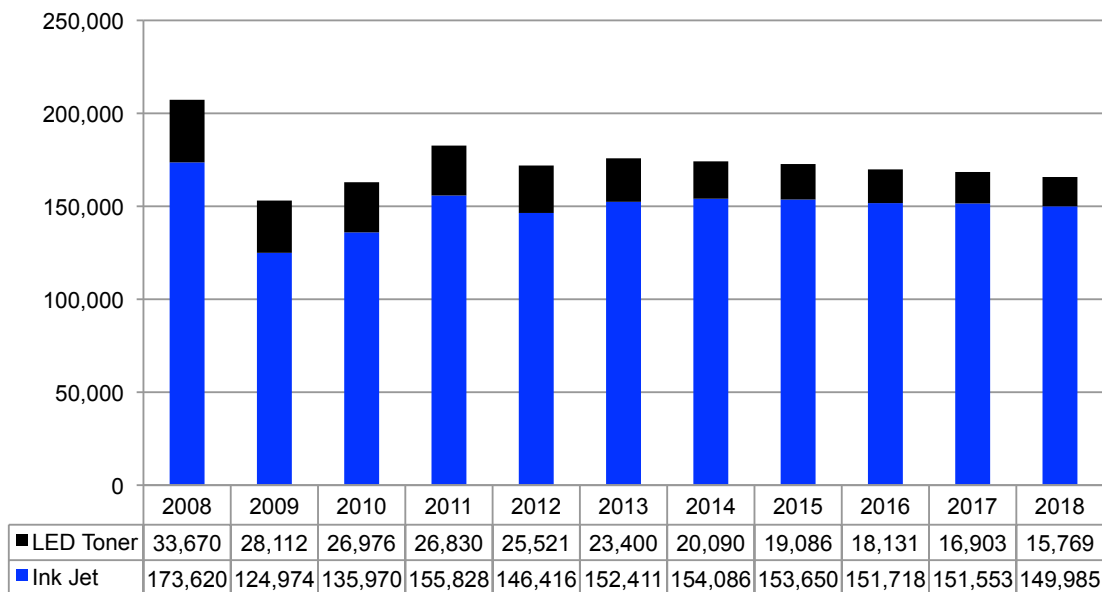
## The Move to Color in CAD Market Causes Shift in R&D Investment from LED Toner to Ink jet Technology

The technical drawing – also known as the computer aided design (CAD) – market for printing equipment took a dramatic downward turn during the worldwide 2008/2009 economic recession. While it has recovered somewhat, irrevocable changes have occurred in the habits of CAD print users and demand for printing technology.

### Market Forecast of the CAD Printer Market

With approximately 70-80% of CAD output used by Architects/Engineers/Construction, the pressure upon the construction industry to become more efficient since the economic recession has never been stronger. One of the first implications of this was a shift towards a newer generation of lower acquisition cost CAD ink jet printers. Simpler to operate with less maintenance cost, ink jet technology has progressively become more productive and recaptured sales volumes since the depths of the recession, while advances in both LED monochrome toner technology and sales stalled.

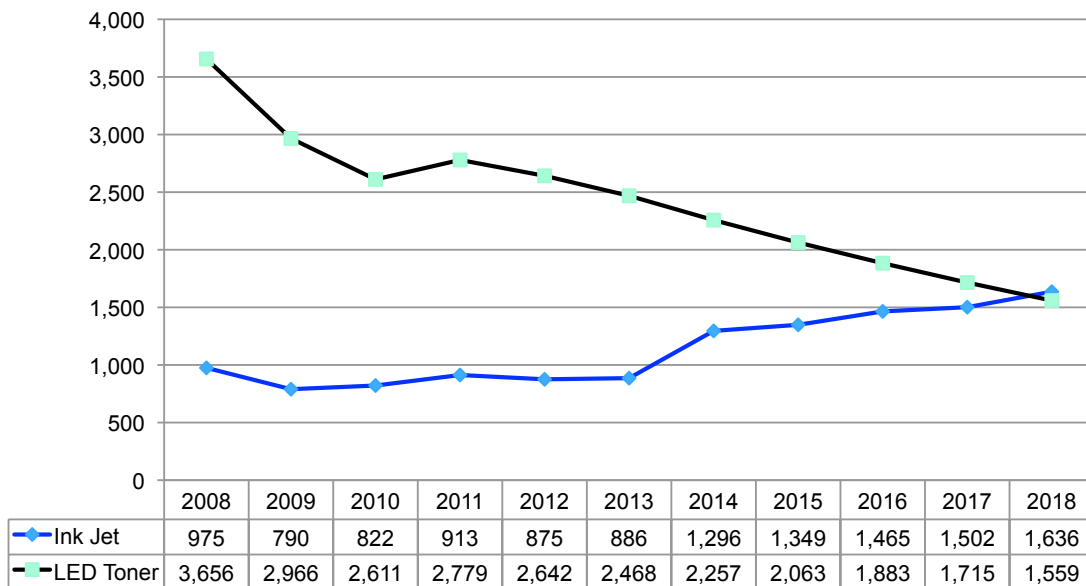
Figure 1 LED vs. IJ CAD Unit Shipment Forecast, WW 2008-2018



Source: IT Strategies, Inc. 2015

A second and more important implication is a shift towards the demand for color output in CAD drawings. With building and home designs becoming ever more complicated, mistakes were often made when the monochrome diagrams “hid” the details of specific infrastructure requirements. Europe was to first to standardize on color CAD drawings, and the North American market is gradually following. Other regions still lag in the adoption of color, mainly because of a perceived cost penalty for color print. With both the cost of color print declining, and the benefit of a reduction in construction mistakes becoming more transparent, the volume of color inkjet CAD output has steadily grown and is expected to surpass monochrome LED toner output within the next three years.

Figure 2 LED vs. IJ CAD Print Volume Forecast (million of square meters), WW 2008-2018



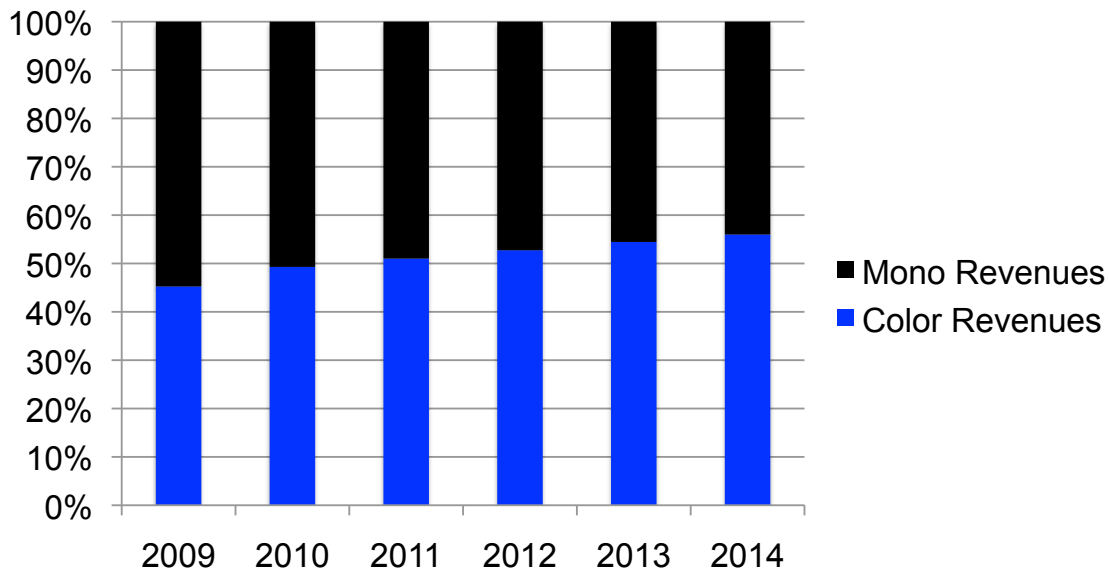
Source: IT Strategies, Inc. 2015

## Printer Manufacturer Analysis

All of these trends are not lost upon the major manufacturers of CAD printer technology. Canon/Océ, Xerox, and KIP account for nearly 70% revenue share among LED CAD toner printers. One of those leading providers, Xerox, exited the toner LED CAD printer business in 2011 because like other LED printer manufacturers, it could technically not make the transition to color LED toner printers. Its management at the time also foresaw Xerox’s inability to compete in color inkjet CAD due to a lack of prior investment in inkjet technology, so Xerox elected to stop investment in CAD printers and instead ride down the supplies annuity curve while its installed base gradually decays.

Another leading LED toner manufacturer, Canon/Océ, has also dramatically reduced (and some say has stopped) investment in LED toner printers. Based upon public investor data from Océ prior to its acquisition by Canon, as well as estimates by IT Strategies made based upon comments by Canon to investors, IT Strategies believes nearly 60% of Canon/Océ's wide format printer revenues are now derived from color wide format printers – all of which are ink jet based.

Figure 3 Canon/Océ Wide Format Printer Mono vs. Color Revenue Share, Hardware and Annuities Combined WW2009-2014



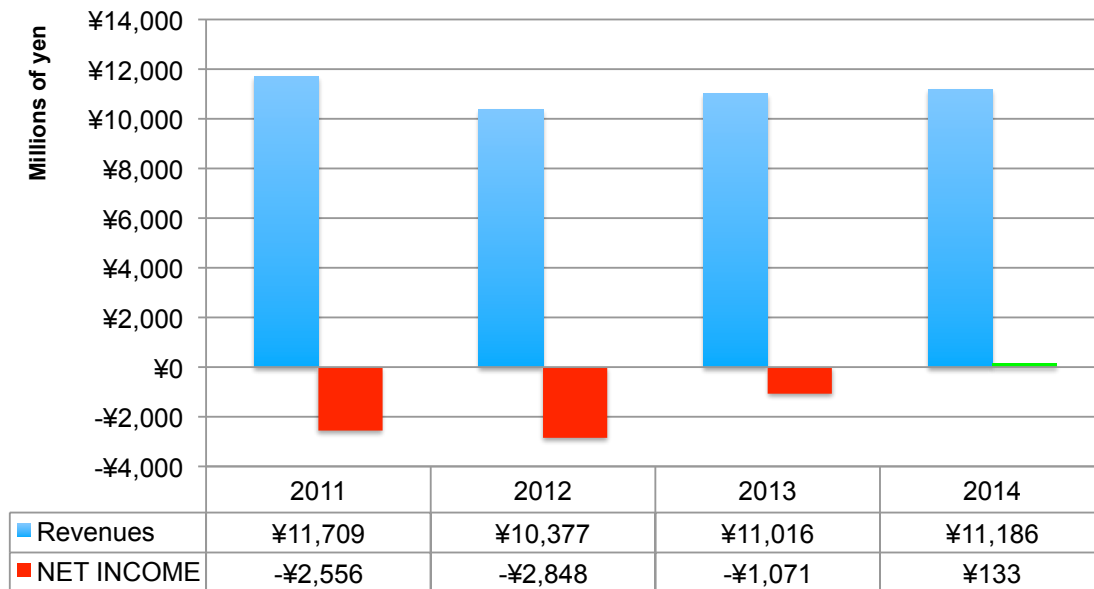
Source: Océ and IT Strategies, Inc. 2015

According to a 2011 article in the Dutch newspaper 'De Telegraaf', "Canon is especially looking at the new inkjet technology developed at the High Tech Campus in Eindhoven, The Netherlands. Research & Development is of enormous importance to Canon and Océ." Previously most R&D in the Netherlands for CAD printers was focused on LED toner systems. Since this article, it is said that Canon/Océ has invested cumulatively over 150 Million Euro in ink jet technology in The Netherlands.

Another significant player in the LED toner CAD printer market, Katsuragawa Electric Company (KIP), has faced challenging times financially ever since the economic recession. KIP, which sells almost exclusively toner LED printers, generated significant losses during the last four years, as it struggled to keep up sales by dramatically discounting mainly in Asian countries. The company made a profit in 2014 by dramatically cutting costs.

The inability to generate profit dramatically affects the ability to reinvest in new R&D – something that does not bode well for KIP since it has not made any known investments in color ink jet technology.

Figure 4 KIP Revenue/Income in millions of Japanese Yen, 2011-2014



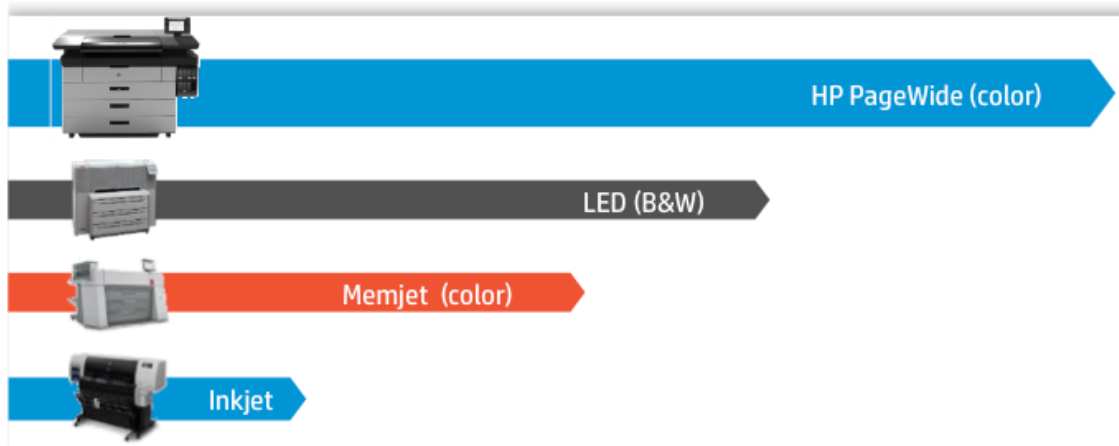
Source: KIP investor relations, 2014

Other players in the LED toner CAD market, such as SII, Ricoh, Kyocera, are not very dependent upon business from the toner LED CAD printer market. For all it represents less than 1% of revenues. Smaller regional players such as Roth & Werner in Germany appear to have faded out of the market during the recession.

### ***Ink Jet Investment and Innovation***

Meanwhile, while LED toner investment has stalled and is shrinking, innovation in ink jet technology continues to grow. On June 10, 2014 HP announced the development of a 40” wide single-pass CAD ink jet printer. Single-pass means the printheads remain fixed rather than traversing back and forth as most consumer ink jets do, using an exponentially larger number of nozzles to jet ink as throughput speeds that are up to 4-10X faster (see figure 5) than serial ink jet print technology. Aqueous single-pass ink jet technology is the single-most important development in HP’s printing business, based upon billions of dollars of investment. The reason for its importance is simple: due to its productivity advantages over scanning ink jet printheads, single-pass ink jet can now match offset and outperform toner print technology in productivity at equal or better levels in output quality and durability.

Figure 5 Relative Projected Throughput Comparison of HP Single-Pass Ink Jet to other technologies



Source: HP, 2014

HP's announcement is not just about an upcoming CAD/reprographics printer. It is really about a paradigm shift internally to HP towards single-pass technology and the associated technical breakthroughs required. The printheads have to be able to be fed a sufficient amount of data quickly enough to keep the 200,000 nozzles firing, the ink has to meet certain parameters relating to the amount of time the nozzles can be exposed to air without causing the ink to dry out in the nozzles causing nozzle failure, the substrate has to be able to be fed at the correct tension and speed across a 40" width while able to absorb copious amounts of water/ink, at a price that can be supported the hardware price charged, and the ink has to be able to dry without the need for expensive drying technology.

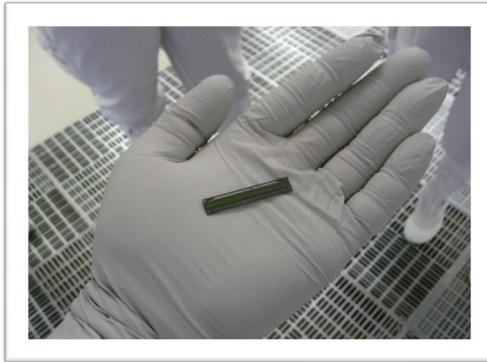
Epson is said to be following similarly in HP's footsteps with a \$300M investment in its version of ink jet printhead technology (which Epson calls PrecisionCore) that can be deployed in a single-pass arrangement. While Epson has yet to publicly announce a single-pass inkjet printer, rumor has it that Epson intends to deploy its archival, photo print quality technology for single-pass printing in both wide format printer technology as well as label printing technology.

What sets both HP and Epson apart is their ability to make these enormously large investments on the basis of leveraging the technology across multiple printing applications, from CAD ink jet printing to production document printing and beyond.

Figure 6 Epson's PrecisionCore printhead technology

## The PrecisionCore Print Chip

Performance | Flexibility | Scalability



	PrecisionCore Chip Speeds
Nozzles per inch	600
Nozzle line length / Width	1.33" (33.78mm) X 3mm
Nozzles per print chip	800
Drop size	1.5-24 picoliters
Operating frequency	Up to 50kHz

New PrecisionCore MEMS Print Chip

Source: Epson, 2014

Canon/Océ has yet to make public announcements about their research directions in single-pass ink jet technology with their own printheads, but the company has been active incorporating other partners printhead technology in a single-pass manner for production printing for over seven years.

### ***What is Driving the Investment Towards Inkjet Technology?***

Printer manufacturers are investing in ink jet technology for a number of reasons, with the main reason the technology's upside for further development and innovation. Once the core investment in printhead technology is made, the printheads can be assembled into single-pass arrays. This enables ink jet printing systems at their extreme to print at speeds up to 300 linear meters per hour, at print widths ranging from the width of a page to up to 1.5 meters wide. Another reason is that inkjet technology has inherently fewer moving parts than toner print engine technology, making it simpler and more cost effective to develop color printing systems. Those color printing systems, when using pigmented color inks, create output that can be archived in storage with no fading for up to 200 years or more.

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More importantly than technology innovation for technology sake is serving end user demands. Now that speed and archiving have been removed as the two barriers for inkjet adoption in the past with the introduction of single-pass ink jet color CAD printers, IT Strategies projects an accelerated adoption in the near future towards color. As mentioned in the beginning of this paper, the ability to migrate from monochrome to color drawings is bringing immediate savings to users in the reduction of costly mistakes made during construction process due to misinterpretation of the technical drawing plans.

Another significant benefit to the user is the lower cost of operation of ink jet technology than toner LED CAD printers. The cost of operation consists of two components:

1. Initial acquisition cost of the hardware
2. Running cost of the hardware, comprised of ink, electrical consumption, and service cost

The first generation of single-pass inkjet CAD printers as first announced by HP are expected to be priced at similar acquisition prices (and similar productivity) as monochrome LED toner printers, with the addition of color printing capability at no extra cost. IT Strategies expects the hardware prices of the single-pass inkjet CAD printers to decrease with each generation as the economies of manufacturing scale improve.

The other key cost saving attributes for users with ink jet technology are electrical cost savings (since there is no fuser to adhere the toner to the page or a heater to dry the ink required) and service cost savings. The service cost savings are significant since as an inherently simpler technology with fewer moving parts less maintenance is required to keep the unit operating.

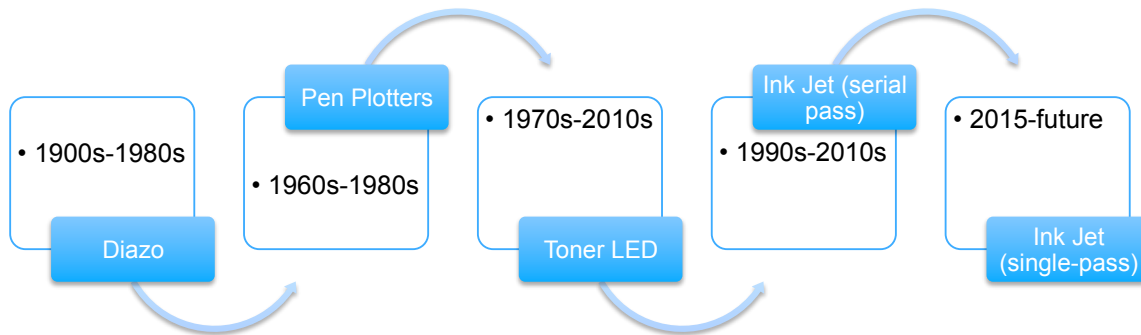
### ***The Bottom Line***

A seminal shift has occurred in the CAD printing industry, one that is similar to the transition from diazo blue prints to pen plotters. Ink jet technology is on a journey to replace toner-based LED printers. This won't happen overnight as the installed base of toner-LED printers remains quite large, but with the introduction of single-pass, color, inkjet CAD printers, there is little investment expected in the future by any manufacturer in LED toner printer technology.

The world is moving to color. Canon/Océ, the world's largest LED toner CAD printer manufacturer, last made a LED toner product upgrade in 2012, when the TDS 900 replaced the TDS8xx-series and the Plotwave 350 replaced the Plotwave 300. Both of these introductions were upgrades of existing LED printers rather than new innovations. During that same time period, Canon/Océ has made more than 10 new color ink jet printer introductions, with the most recent major introductions being the solid ink jet printers called the ColorWave 500 and ColorWave 700.

It is very clear were CAD printer development and market demand is headed. The leading indicator to watch is the annual print volume trends, rather than unit sales. With ink jet printers getting significantly more productive with the introduction of single-pass technology, fewer units will be needed to meet the demand for printed output.

Figure 7 The transition of CAD Printing Technology



Source: IT Strategies, Inc.

It is a not so well kept “secret” that the printer manufacturers make most of their profit from the sale of ink and toner. The historical data and projections in figure 2 tell the story best: the bet has been made, and color ink jet is the technology of choice for both CAD printer manufacturers and users alike.

## About IT Strategies

I.T. Strategies, Inc. is a 23-year old research consultancy dedicated to serving printing equipment and supplies manufacturers with critical decision making information and guidance about the market trends for print. The company delivers intelligent data, analysis, strategy and implementation practices to vendors in the digital printing industry around the world on applications ranging from 3D printing to production printing to wide-format CAD printing, for both toner and inkjet technology development. From offices in Boston and Tokyo, I.T. Strategies conducts and delivers research data, offers interpretation and advice, identifies specific opportunities, and helps organizations implement these strategies to achieve effective solutions.