



the **solid** advantage

Introduction

In the eleven years since its introduction, solid ink printing technology has proven itself a powerful performer, demonstrating unique and important benefits in the desktop color printer market. The technology has benefited from enhancements that have extended its fundamental virtues of brilliant color print quality, high performance, ease of use, reliability, media flexibility and low cost.

This white paper presents an overview of solid ink printing, with discussions of application areas and comparisons to other color printing technologies.

Solid Ink Timeline

III	300	340	350	360	380	600	840	850	860	8200
1991	Phaser® solid ink printer timeline									2003





The Application Challenge

Desktop color printers are expected to address a broad range of applications. The major application areas of office printing, business graphics and graphic arts place different demands on a color printer. User expectations range from fast printing of text documents, to flawless rendering of complex PostScript® files, to accurate color matching for graphic arts or pre-press work.

The design and implementation of desktop printing technology is further challenged by the “human factor.” For instance, what is the typical user required to know to successfully use the printer day in and day out? How well does the driver software integrate the printer into the user’s workflow? How quickly can printing consumables be replenished? How many users can share the printer before print times become unacceptably long?

The desktop color printer market is served by two major technologies: solid ink and laser. Each of the technologies uses a significantly different method of printing an image. From its inception, solid ink technology has been a color printing technology. Color laser printers are an adaptation of pre-existing monochrome (black and white) office printers, so they are familiar to most users of desktop workgroup-class printers. But, as we will discuss further, color laser’s evolution from monochrome laser technology results in some inherent limitations.

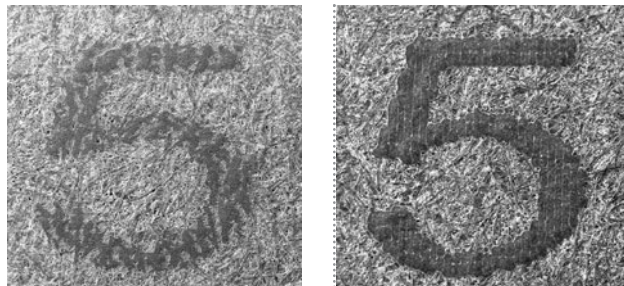
Solid ink technology uniquely addresses key user requirements, expectations and human factor issues by virtue of its image creation method, simplicity, ease of use and remarkable print quality on the broadest range of print media.

Science Elevated to an Art

The success of solid ink requires the union of physics, chemistry, electronics and manufacturing expertise. This begins with the ink, which has the critical property of remaining in solid form until heated to a very specific temperature whereupon it turns to liquid; cool it just slightly and it almost instantly returns to a solid. This is the key to the vibrant color solid ink provides on just about anything: molten ink is jetted from the print head to a heated drum, where it remains in a malleable state that ensures precise transfer to the paper. This reduces the amount the ink can wick into the paper fibers, keeping the colors vivid while controlling the dot spread that can reduce image quality.

Worth the Effort

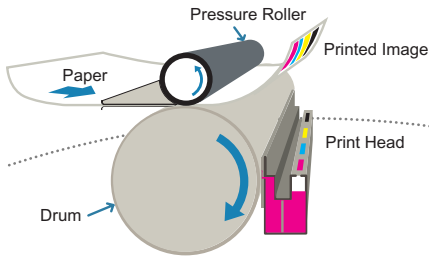
A well-designed printer should be as close to invisible as possible. The goal of the user is to get printed pages, not think about the printer. That sums up the target of solid ink technology. But, it’s worthwhile to note that there are some extraordinary things going on behind the scenes to make it all happen. For example, solid ink is applied through orifices smaller than a human hair; the successful manufacture of the print head requires stringent clean room processes. Years of investment, research and experience have been required to develop inks and print heads that work together as a system. Xerox is committed to this technology for one simple reason: it delivers user benefits no other color printer technology can provide.



Highly magnified views of color laser (left) and solid ink (right). Note the gaps in the printed areas in the laser image vs. the dense, crisp appearance of the solid ink image.



High Performance Solid Ink Technology



Major Components of a Solid Ink Printer

Fewer Parts for Better Reliability

A solid ink printer consists of only three major assemblies: the print head (applies ink to print drum), the print drum (transfers image to paper) and the controller (the brain of the printer that converts data from the computer to information required to print the image on paper). Add a cabinet and a paper tray and you have a solid ink printer.

This simplicity is responsible for the high reliability, ease of use and low cost of solid ink. With fewer parts, there's simply less to go wrong. In short, solid ink printers do a lot more with a lot less.

Rugged Construction

Rather than using the more common bent sheet metal, Xerox uses a one-piece cast aluminum frame in its solid ink printers. This allows for tighter mechanical tolerances that yield both improved mechanical reliability and print quality. The solid construction also contributes to the printer's durability.

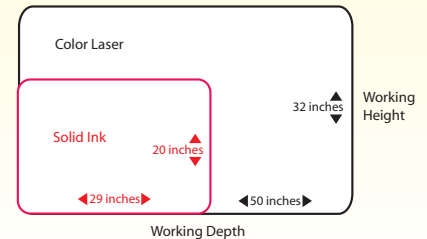
Stringent Manufacturing

Xerox manufactures the solid ink print head in clean rooms to ensure performance, consistency and reliability. Xerox operates a world-class chemical plant to produce solid ink, with a state-of-the-art controller to ensure batch consistency. To deliver the reliability that solid ink has become known for, Xerox employs 100% inspection rather than the more common statistical sampling—every ink batch must meet specifications before it is shipped to the customer.

Compact Size

For many organizations, floor space is a critical resource. Here is where the compact design of solid ink printers provides another benefit. Compared to color lasers, solid ink printers require much less space. While its footprint, or physical size, is smaller, even more important is solid-ink's smaller working space requirement. Working space includes access for print trays and routine printer maintenance. In the comparison diagram, the significantly smaller working space needed for a solid ink printer compared to a laser becomes evident. Solid ink printers can be integrated into more environments with less impact than color laser printers.

Smaller Working Space



less is more

two paths to go by

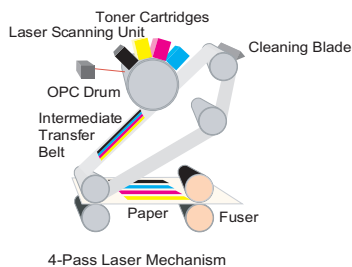


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Looking at Laser

Color laser printers create an image by fusing powdered toners to paper—the toner is melted onto the paper. Depending on their architecture, they can have almost three times as many parts as a solid ink printer. Color laser printers typically include parts such as photoconductors, transfer rollers, fuser rollers, fuser oilers, waste toner bottles and four toner cartridges, all of which wear out or whose contents are consumed during printing. The life expectancy of these components is tied to either the number of pages or the amount of each color printed. Even worse, these parts need to be replaced independently of each other. This requires frequent maintenance and user interventions. It also means that adding even a little color to an otherwise black and white page can significantly increase the cost of that page.

Another advantage of the solid ink architecture is the simplicity of the imaging process itself. A wide variety of media can be easily and



reliably fed through the simple paper path. Heavier stock and certain common envelope types can be fed through the manual feed path.

All of these attributes contribute to an exceedingly simple automatic two-sided printing capability. After printing the first side of the sheet, the paper is re-fed from the exit rollers back into the printer through a very short path. It then quickly passes through the high-speed imaging process a second time and is delivered to the output bin.

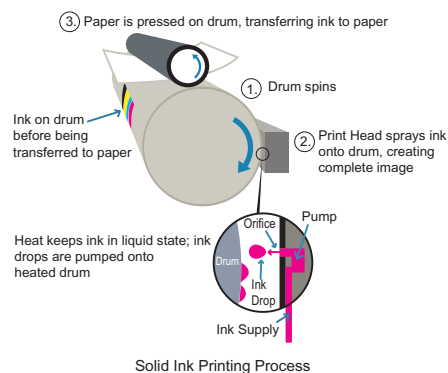
Increased Image Quality

Solid ink printing delivers superior quality in three key areas: media flexibility, color consistency and transparency printing.

Because solid ink is transferred from the print drum to paper in a precisely controlled malleable state, there's little spreading of ink into the paper. This makes its color quality far less dependent on the surface allowing it to maintain excellent color quality on the broadest range of media types. In demonstrations, color solid ink images have even printed on paper towels, and while this is not a typical application, it shows the capability of the technology.

Solid ink has exceptionally consistent color quality from page-to-page, an important attribute for long print jobs or multiple prints of the same page. Again, the characteristics of the technology deliver the benefit. Millions of colored dots are applied to a page to create a color image. The quality of the image depends on consistent dot size and consistent dot placement. Solid ink does both extremely well. It's more difficult for color laser to maintain this accuracy. Dot size varies (laser dots are clumps of toner particles that can scatter on the paper) and there's sufficient jitter in the laser system so that misplacement of dots occurs. As a result, color shifts can occur with laser, as well as banding within areas of solid fill color.

Solid ink also has a major advantage in its ability to print superior overhead transparencies. Producing high quality overhead transparencies is a demanding color



How Many Passes Does a Laser Need?

While solid ink technology has always printed pages with a single pass through the printer, the vast majority of color lasers in use today use 4-pass print engines. This means three important things:

- The mechanical complexity of the printer is much greater
- The printer is more prone to print quality problems—the shuttling of the paper can cause misalignment of the tiny dots that create the image
- The printer will take longer to print than a solid ink printer

The newest generation of color lasers includes models that print with a single pass. They're faster than the older 4-pass designs, but they're still slower on most office print jobs (see page 5), have more maintenance items than solid ink printers and relatively speaking, there aren't many of them installed yet.

printing application. While the mechanical process of applying the colorant (ink or toner) to transparency film is the same as printing on paper, the way the resulting image is viewed is significantly different. When viewing a paper print, the viewer is looking at ambient light (the light illuminating the viewing area) reflecting from the image area (where colorant is applied) and the blank paper, which typically forms the white areas of the image. When viewing a transparency, light from the projector is transmitted through the transparency film and colorant and then focused through a lens onto a screen. This places different demands on the colorant; issues such as flatness (to avoid creating a lens effect) and uniformity of thickness (affecting density of color) become very important. During printing, the print drum in a solid ink printer smooths the solid ink, creating a flat surface that transmits light well, making for dense, saturated colors. Laser toner has a rougher surface that doesn't transmit light as well, resulting in less vibrant color.



High Performance Solid Ink Technology

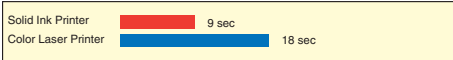
How Long is a Print Job?

Xerox tabulates solid ink customer usage. Most jobs are under 5 pages and many are 2 pages or less!

First and Fastest

A paramount measurement of printer performance and one that Xerox labors over unceasingly is print speed. The most complete measurement of print speed is called “throughput.” It’s the elapsed time between clicking the “print” button on the computer screen and the moment the finished print job arrives in the printer’s output tray. Solid ink excels in overall throughput by delivering fast first-page-out time and fast color print engine speed.

First Page Out Time



Color Letter



Power-Point Presentation (8 pages on transparencies)



The combination of color-optimized architecture and fast controller/processor leads to what is perhaps the most important advantage of all for typical office color printing: fast first-page-out time. Since most print jobs are only one to five pages long and only one copy of the document is printed, the time it takes to print the first page can be a significant factor in total color printing throughput.

On the first page of a print job (which is often the only page) a color laser must synchronize its imaging components and paper path. This lengthens the print time. Also, most color lasers must warm up their fuser roller before printing can begin. In fact, color lasers typically achieve their rated speed only on multiple copies of the same image. This is because they must have more than one sheet of paper in the paper path to achieve optimum timing.

Xerox’ solid ink printers have a very short paper path so the paper has a minimal distance to travel to receive the image. It starts printing without any special synchronization. As for a warm up period, solid ink printers do not have a fuser roller to heat, but they do need to melt the solid ink at the beginning of the working day. This is accomplished by software that tracks the printer’s usage and warms up the ink just before the first page of the day is due to arrive. All of this results in a first-page-out in as little as nine seconds, the fastest in the industry. Solid ink printers have the fastest speed for small, frequent print jobs.

Solid ink has been designed from the ground up as a color-optimized printer. Xerox uses this technology in printers that are rated up to 16 color pages per minute. Color laser technology is essentially a monochrome (single color) print technology that has been adapted to print with four colors, using cyan, magenta, yellow and black toners. In many ways, it is like putting the complexity of four printers into one cabinet.

Easy to Operate

Loading ink in a solid ink printer is often compared to loading another common office device: the stapler. The shape-coded inks are simply dropped into slots on the top of the printer. Even a child could easily match the solid ink colors and shapes to the appropriate slot and drop them in. There’s nothing to spill or vacuum out of the carpet. Inks can be replenished at any time, even during printing.

Reloading on the fly is not possible with any other printing technology because they store ink or toner in sealed containers inside the printer. When the ink/toner is exhausted, the entire container must be replaced with a fresh one. Obviously, to avoid wasting money, this is not done until the contents are completely depleted, which interrupts printing.

The simple task of adding solid ink can be done at any time— there is no need to wait until the ink runs out. By simply topping-off the ink before a big job, or whenever convenient, users can be assured that their print jobs will be completed without interruption. Again, this is not possible with any other printing technology for the same reason as described above.

These attributes make solid ink the best choice for the majority of users, who are concerned about getting their prints, not about maintaining their printers.

how **easy**
is that?



High Performance Solid Ink Technology

True Productivity

For a printer to be truly productive in a busy office it must be easy to set up, easy to use and easy to share. The hidden costs of printer downtime, user frustration, and delayed print jobs can be enormous. For example, purchasing a low-cost but underpowered or hard-to-share color inkjet printer can be far more costly in the long run than investing in the right tool for the job. Likewise, the complexity of using and maintaining a color laser can have significant productivity costs from the very beginning.

Nowhere are the differences in solid ink and color laser design more apparent than in the experience of day-to-day printer use. Color laser printers have up to nine different mechanical consumables (assemblies that are depleted during printing), while Xerox high-performance solid ink printers have only one. The number of user interventions and the skill level required to maintain a solid ink printer is a fraction of that required by even the simplest of color lasers. The only mechanical consumable in solid ink printers is a long-life maintenance roller that supplies the oil for the imaging drum. The environmentally friendly replacement rollers last for up to 40,000 pages and can be installed in less than a minute.

What Price Solid Color?

As anyone who's been around computers for a while knows, the performance keeps increasing, while prices decrease. The price/performance ratio for color solid ink printers has followed the same trend. It's now possible to buy a color solid ink printer for about the same price as a network monochrome laser printer.



Environmentally Sound

The unique solid ink printing process provides yet another benefit: minimal environmental impact. As previously noted, solid ink printers have only one consumable item, compared to numerous consumables in color laser printers. The result is dramatic: after 100,000 prints, a color laser can produce over 122 pounds of waste, while a solid ink printer produces only 6.5 pounds. Solid ink printing results in less waste going into landfills.

What about Liquid Ink Jet?

Liquid ink jet technology does not work well in multi-user network environments. The major issues are slow print speed, low consumables capacities, high levels of user intervention and high print cost. Low acquisition cost might make liquid ink jet printers appear attractive, but they present a case of false economy for workgroup use as organizations discover how much attention they require and how surprisingly expensive they can be to operate. These printers require special, expensive, coated paper to deliver their best print quality.

Solid Ink Measures Up

By virtue of its unrivalled simplicity and unique strengths, solid ink technology satisfies a broad range of user expectations and requirements.

- Fastest printing of most common office print jobs
- Unsurpassed ease of use means printers can be used by anyone with maximum productivity
- Ability to print bright, vivid colors on the broadest range of paper types
- Rugged, durable design goes the distance
- Small size allows printers to fit in almost any environment
- Low acquisition cost for superior value
- Minimal environmental impact

For More Information

To request printer information and a print sample, just click on this link:
www.xerox.com/officeprinting/solidinfo