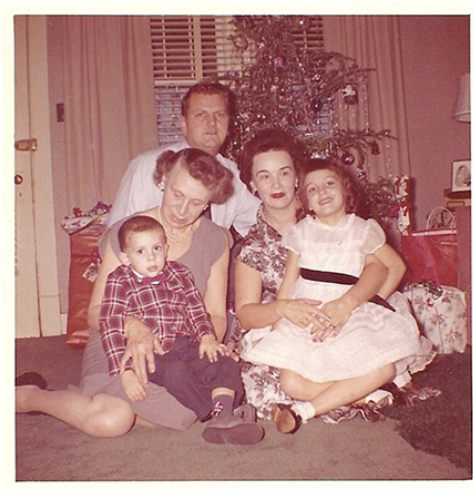


A Guide to Digital Printing: Inkjet Pigment Prints vs. Digital C-Prints



"The negative is the equivalent of the composer's score, and the print the performance." – Ansel Adams

Introduction

In order to secure a place in history, top photographers understand their vision must live on in print. To produce a beautiful lasting work of art, the print must exhibit certain qualities, remaining faithful to the subject matter and emotion present at the time of capture. Color fidelity and gamut, as well as archival media and fade resistant inks, are each critical components of an enduring print.

The modern era of digital printing has ushered in an explosion of commercial photo labs and print studios, each battling for your printing dollars, promising the highest quality, most archival prints, along with top notch service and support. Researching whether these claims are true is one of the most frustrating and time-consuming experiences a photographer must endure.

From inexpensive chemical dye prints, metal and wood prints, to inkjet pigment prints, the industry has rapidly mushroomed. There are the 'we print it all on everything' giant commercial labs, smaller boutique fine art print studios focused solely on pigment printing, to everything in between. It seems each week another print business opens, offering a cornucopia of products.

With the gargantuan array of print companies on the market today, even experienced photographers have difficulty deciding on the right one for the job. The choices can simply be overwhelming. Quality and technical support ranges from superb to downright substandard. Sorting the wheat from the chaff is difficult. In part because of this frustration, most images today never make it into print form, remaining forever ensconced in monitors only to be viewed on the web. This is a tragedy, for viewing your images in print makes you a better photographer.

Yet understanding the differences between various print technologies, media and terminology is a critical part of your creative process. In order to make the right choices, you need at least some basic understanding of printers and methodologies, and the pros and cons of the two major print types.

As prices for photographic prints in the fine art market continue to skyrocket, demand for greater levels of print permanence and color gamut has never been higher. But sadly, some of today's most famous photographers selling prints for millions on the high-end fine art market don't subscribe to this vision, offering chemical dye prints instead of inkjet pigment prints, a much better choice.

The prevalence of such sales at stunning prices for a chromogenic print that may only last 40 years on display has the effect of misinforming both art buyers and the public at large. It also confuses many photographers new to printing as to how to price their work and what type of print is best for sales.

In this two-part article we will examine the differences between today's two major printing technologies – digital C-prints and inkjet pigment prints. We will clearly define confusing terminology and set the record straight on marketing hype and longevity claims. We will scientifically compare the color gamuts of various printer/paper profiles. We will discuss the latest print permanence studies. And we will take a look at the high end art market with all its contradictions.

By the end of this series, you will be in a better position to make an informed decision on what type of print works best for your images and needs. Let's begin by reviewing how chromogenic prints are made and the various types of printers used.

What Is a Chromogenic C-Print?

In simple terms, a chromogenic print or C-print is a photo lab print produced on light-sensitive color paper then processed in wet chemistry. Although traditionally created from color negatives, most of today's chromogenic prints are produced from digital image files. The latter are known as digital C-prints. Note that sometimes C-prints are mistaken for Cibachrome (Ilfochrome), a positive-to-positive process used to reproduce film transparencies (aka slide film) on photographic paper.

Digital C-prints are photo lab prints produced by minilabs like the Fuji Frontier, or wide format photo printers like the LightJet or Lambda, on papers such as Fuji Crystal Archive or Kodak Endura. They are much less costly than inkjet pigment prints output on a fine art paper. Instead of light from a traditional darkroom enlarger lamp, these machines use lasers or LEDs to expose photosensitive papers. In essence, a digital C-print is the same as a conventional photographic print, in that sensitized paper is exposed to light and then chemically processed. Thus the term photo 'lab' print, as wet chemistry is used.



An old-school Bogen Enlarger Lamp

Many terms are used for these types of prints: photo lab; digital C; laser chromogenic; digital RA-4; chemical dye; lab print; or just plain C-print. Whatever the name, the process is basically the same – a digital front end exposing to light-sensitive color paper, which is then fed into a wet chemistry backend just like the olden analog film days. Chromogenic papers have layers of silver halide emulsion containing dyes and couplers that form a visible color image upon reaction with a special color developer.

Many people are unaware that today's digital C-prints are still created using this wet chemical process. Young photographers who have never shot film have no clue how traditional darkroom prints are made. In fact, I have students who think ordering the typical photographic print from Bay Photo constitutes an inkjet print, despite the large price difference. They are shocked to learn these are still chemically processed.



Jean-Pol Grandmont, Darkroom Self-Portrait, Belgium

Obviously chromogenic printing is a totally different process than inkjet printing. Digital C-prints have a completely different look and feel because they are true continuous tone (con tone) prints, unlike inkjet prints which are halftone prints. Proponents of C-prints often tout what they view as the superiority of a con tone print, even going so far as to state they are the only 'true' photograph. Continuous tone simply means there is no break in the tone; this is due to the fact that the resulting color dyes meld into one another.

On the other hand, inkjet prints are produced by spraying thousands of very fine, minute (picoliter) droplets of ink varying in size and spacing on paper, giving the illusion of continuous tone. From afar, they trick the eye and look continuous. Yet only at a microscopic level would you be able to see spacing between these droplets. However, today's professional inkjet pigment printers have extremely high resolution, more so than dpi figures often quoted by photo lab printer manufacturers, therefore eliminating a former advantage of con tone printers.



Photomicrograph of Inkjet Droplets on Paper, via [The Print Guide](#)

That said, there are those that simply prefer the look and feel of chromogenic prints – the aesthetics so to speak. They like the way light reflects off a C-print and the glossiness and saturation of dye inks. But because inkjet pigment inks are placed on top of, rather than within the paper (like dyes in C-prints), pigment prints can appear more vibrant under certain lighting conditions in the eyes of some.

Due to different methodologies, acceptable image file specs and color spaces differ widely between photo labs and inkjet print studios. This is a sore point of contention for many photographers working in Camera Raw and editing tiff or psd files in 16-bit mode, using the ProPhoto RGB color space. Photo labs, especially minilabs, most often request sRGB jpegs (naturally 8-bit) from customers.

In particular, the print-on-demand (POD) services offered through e-commerce photography sites such as SmugMug, Zenfolio, Fine Art America and others are based on the assumption that customers will predominantly purchase small format photo lab prints. In addition to upload bandwidth, this is one of the reasons the PODs request sRGB jpegs, considering them 'good enough' for general purposes on a variety of substrates. In fact, this very issue was addressed in a [podcast I guested on last year](#).

If you like the look of C-prints, keep in mind that print quality varies widely among labs, as does technical support acumen. The skill of the technician, how often the chemistry is changed and the printer is calibrated, and the quality of the ICC profiles all make a huge difference. These factors impact not only color fidelity and gamut but print permanence. We will discuss these issues later.

What Types of Chromogenic Printers Are There?

Let's take a look at various types and makes of chromogenic printers. There are two basic flavors: small format minilabs and wide format machines. Minilabs can be found at businesses from your local Costco and Mom and Pop photo lab, to large commercial labs, and are known for their ability to rapidly produce high volumes of prints at low cost.

The bulk of minilab print sales are geared to the consumer market as well as wedding, portrait and event photographers who need large quantities of inexpensive prints with fast turnaround times. Unlike the fine art photography market, longevity and color gamut are not deciding factors here.

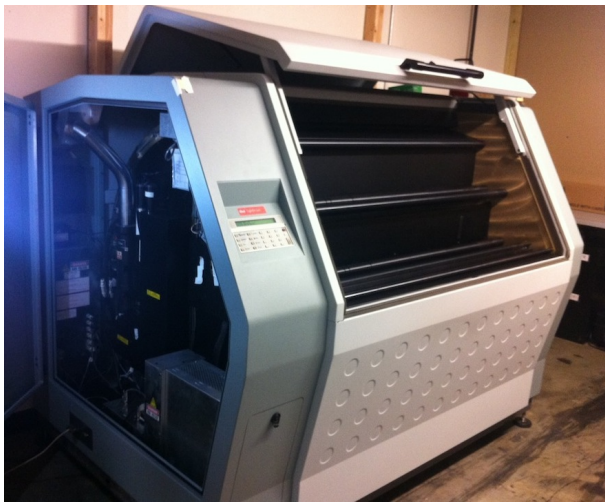
Typical brands are the Fujifilm Frontier and Noritsu QSS. Only sRGB jpegs are usually accepted and, as a general rule, ICC profiles for minilabs have somewhat smaller gamuts than those of wide format machines. This is most likely due to the fact that older, non-custom, generic paper manufacturer profiles are used. I will provide color gamut plots to demonstrate this later on.



Noritsu QSS Minilab Printer

Since these are continuous tone printers, dpi resolution figures claimed by manufacturers are often confusing and misleading. Then there are the terms used such as 'apparent' versus 'effective' resolution, further complicating the issue, often by a factor of ten. However, note that not all minilabs have lower resolution than their wide format counterparts. For example, Noritsu claims their QSS-3801 HD minilab has a 'true photo printing' resolution of 640 dpi. In all the calls I've made to photo lab technical support over the years, not one manager has been able to explain how resolution is calculated on a con ton printer, since they do not lay down dots or droplets of ink like inkjet printers.

In contrast to minilabs, wide format photo lab printers such as the Océ LightJet, Durst Lambda, ZBE Chromira and Polielettronica LaserLab (Polie for short) are most often found in higher end, custom photo labs or print studios. Note that the LightJet and Lambda machines are no longer made, but still widely in use. Naturally most custom photo labs also offer inkjet pigment printing services.



Océ LightJet C-Printer

Wide format C-prints are usually more costly than minilab prints, but still less expensive than a well-made inkjet print on a fine art paper. Inkjet prints take longer to produce, and the inks and papers are much more costly. However, labs who produce wide format C-prints are often more flexible as to acceptable file formats and color spaces. For example, many will accept a tiff or psd file in Adobe RGB.

So what are the main differences among wide format printers? The light source and how the paper is exposed. The disadvantage of the Chromira printer is that it uses LEDs to expose the paper, resulting in somewhat softer prints compared to the LightJet, Lambda and Polie, which use lasers. Lasers produce sharper prints than LEDs. Then there is the matter of how the paper is exposed by the lasers.

With the Lambda, the drum-mounted paper is rolled past lasers (projected by a stationary spinning mirror) as it is exposed. So the paper is moving while the lasers remain still. In contrast, the LightJet and Polie keep the paper stationary while the lasers (projected by a moving spinning mirror) move across the paper. Although this is debated, edge-to-edge sharpness appears better in the eyes of some when the paper remains stationary. Therefore, some people feel the Lambda is at a disadvantage due to the movement of the paper.

The cream of the crop, the 50x100 inch [Polielettronica LaserLab](#) HD C-Printer, excels with a 610 dpi resolution (6100 dpi 'apparent' resolution) and 48-bit color. Due to its high resolution, the Polie is favored by cartographers and fashion photographers. [Duggal Visual Solutions](#) in New York City is the only company that has this size Polie HD C-Printer, although a few others have the smaller models such as [Dickerman Prints](#) in San Francisco, a well-respected custom printer.

To see the Polie in action, watch the YouTube video [A Look Inside the Polielettronica LaserLab Photographic Printer](#) by Dickerman Prints.

For an overview of HD C-prints, watch the YouTube video [Duggal Services: HD C-Prints](#) by Duggal.



The Italian-Made Polielettronica LaserLab (Polie)

There will always be heated discussions about which chromogenic printer is best, as comments demonstrated in my [2015 podcast on this topic](#). Added to the mix are the so-called dry labs using either dye or pigment inkjet technology, still in use today. Although the longevity of these dry lab prints exceeds that of wet prints, they take longer to produce, are more costly, and only offered in limited sizes. A discussion of dry labs is beyond the scope of this article.

The Pros and Cons of C-Prints Versus Inkjet Prints

Let's take a close look at the pros and cons of lab and pigment prints based on important factors. Hopefully this information will help guide you in making the right decision. While there will always be fierce debate between supporters of traditional photo lab prints and proponents of inkjet technology, the facts speak for themselves. The ultimate decision depends on how much you value color gamut and longevity versus cost, personal aesthetics, and the target market if selling your work.

1. **Print permanence:** I am listing this factor first as it should be of paramount concern to any photographer who cares about longevity and is selling their work in the fine art market. Let there

be no doubt that inkjet pigment prints will outlast C-prints by a wide margin, despite the claims of OEM printer/paper manufacturers and most photo labs, which still use the outdated 'century' mark for Fuji Crystal Archive paper longevity. Since C-prints are dye-based, they are more susceptible to deterioration than inkjet pigment prints when exposed to light, heat and humidity, even when framed behind glass. In addition, dye coupler staining is an issue with C-prints over time.

In fact, inkjet dye prints have greater longevity than chemical dye prints. Revised studies by Henry Wilhelm (Founder of Wilhelm Imaging Research) using improved test criteria dropped longevity estimates for Fuji Crystal Archive paper (under typical display conditions) to 30-40 years, down from the 60-year figure quoted in older studies. In stark contrast, inkjet pigment ink prints can last for over 200 years on a true archival paper, under proper environmental and display conditions. We will discuss print permanence in detail later on.

2. **Color gamut:** The advantage goes to inkjet pigment prints. There is no doubt that today's professional inkjet pigment printers can reproduce colors beyond that of the Adobe RGB color space, into ProPhoto RGB territory. *ProPhoto RGB is the only color space large enough to contain all the colors a camera's sensor can capture.* Of course color gamut depends on the quality of the ICC profile, ink set, printer and paper used. I will demonstrate this fact using color gamut comparison plots later on. In contrast, photo lab print gamuts range from sRGB coverage (or less), to partial Adobe RGB coverage. One exception lies in the area of very saturated blues and magentas; C-print gamuts may slightly exceed those of inkjet pigment prints, depending on the image colors, profile quality, and printer used. Profile analysis confirms this. Most likely this is due to the use of dyes versus pigments.

Inkjet printers use a greater range of color inks, both dye and pigment, than any other printing process. In addition, inkjet pigment prints exhibit greater contrast, smoother color gradations, deeper blacks (Dmax), and finer shadow details than chemical dye prints.

3. **Paper selection:** Again, the advantage goes to inkjet pigment prints. Today there is an astonishing number of excellent papers, both photo and matte, available for inkjet printing. From canvas, cotton and kozo (mulberry), to baryta and bamboo, this diverse selection of papers allows for the personalized expression of your image in print. On the other hand, photo lab print paper selection is very limited in comparison. Note that overall, C-prints are more sturdy and less fragile than inkjet prints, and are less susceptible to scratching and scuffing. Of course this depends on the paper.
4. **Price:** The advantage goes to the smaller minilab prints, followed by wide format C-prints then inkjet pigment prints, which are usually the most expensive of the three. Keep in mind, though, that I have seen LightJet and other wide-format chromogenic prints priced as much or more than a comparably sized pigment print on a fine art cotton paper at certain custom labs. This is atypical, however.
5. **Print volume and production speed:** The advantage goes to C-prints in terms of speed and the sheer volume these machines are capable of producing. Inkjet printing is a slower process.
6. **Print size selection:** In discussing available print sizes, I do not mean the largest size a given printer can make. Instead, the consideration here is whether or not the native aspect ratio of your image is respected. Meaning you are not forced to crop your image to fit the restricted paper sizes offered by many photo labs and POD services. Therefore, the advantage here goes to inkjet prints, although some custom photo labs may not impose these restrictions. But try ordering a 12x18 C-print at a business like Costco or from MPix. Or a 16x24 canvas print.

Most photographers understand the frustration of uploading images for print, only to discover they need to be cropped to fit odd sizes such as 8x10, 11x14, 16x20, etc., meant to fit into standard

consumer frames. Such cropping can ruin your composition.

We discussed this issue in prior podcasts. Most of today's full-frame DSLR cameras use an aspect ratio of 2:3 (1:1.5). This in turn translates to print sizes of 8x12, 10x15, 16x24, 20x30, etc.

7. **Acceptable file formats and color spaces:** Here is another area where the rubber meets the road. The advantage goes to inkjet prints. As we discussed previously, photo labs usually request 8-bit sRGB jpegs, although some custom labs will accept Adobe RGB tiff or psd files. It all depends on the lab and their overall quality.

When it comes to POD services offered by e-commerce photography sites, you usually have no choice other than sRGB jpegs that most likely need to be cropped. Again, the thinking is that most customers will opt for the cheaper C-prints. And you are not allowed to upload two separate files for each image, one optimized for inkjet pigment prints and the other for photo lab prints. Therefore, the inkjet print is sacrificed for the C-print.

However, note that if you are outsourcing your inkjet printing, you may still find it difficult to get a fine art print studio to accept a file in ProPhoto RGB or a tiff/psd. Let alone in 16-bit mode. Most claim there is no difference in output quality, which is untrue for certain images. It all depends on the subject matter and what colors are in the image. As well as the paper used and quality of the print studio's ICC profiles.

8. **Environmental considerations:** Because C-prints are wet-processed using hazardous chemicals requiring special disposal, the advantage clearly goes to inkjet prints. In addition, chromogenic prints require high quantities of rinse water during development to have any chance of archivability. Inkjet prints are better for the environment, but be sure to recycle your spent ink cartridges.
9. **Continuous tone versus halftone:** As mentioned previously, C-prints are continuous tone, while inkjet prints are halftone. Many people swear by the look of a continuous tone print, relishing its traditional photographic appeal. But advances in inkjet printer technology have far surpassed any prior limitations with early printer models in terms of resolution and detail – keep in mind that you would need a microscope to see the spacing between ink droplets. Again, some people just prefer how light reflects off a continuous tone C-print. This is a personal choice and a matter of aesthetics.
10. **Control:** Simply put, if you are concerned about maintaining full control of the printing process from input to output, then producing your own inkjet prints is your best bet.
11. **Museum and gallery acceptance:** In the early years of inkjet printing technology, this advantage went to digital C-prints, as the process was very familiar and C-prints had the traditional darkroom look. Inkjet prints had a negative connotation early on; therefore, digital C-prints were accepted as the standard for fine art color prints. But that advantage has diminished as technology and education have improved. Inkjet prints are now widely accepted alongside C-prints in galleries and museums worldwide. We will review this later in discussing why some of today's famous photographers continue to sell chemical dye prints on the multi-million dollar fine art market.

(to be continued...)

– *Renée M. Besta*