We Put Ink on Paper

When asked what we do, a lot of us on the sales side — especially those of us who have been doing this for a while — simply say, "We put ink on paper." As a person whose life is governed by physics and chemistry (and I joke about this), I find the myriad concepts of inkjet printing fascinating, and I still get a kick out of watching a printer go back and forth with the image developing right before my eyes.

In one form or another, this has been going on in a mechanized fashion since Johannes Gutenberg invented the printing press around 1440, but things have come a long way since then. Commercial drop-on-demand printing, as we know it, began in the 1980s. Both HP and Canon were developing thermal inkjet printheads, and the now-popular piezo printhead came along at roughly the same time. Even as advancements continue to be made to this day, each technology still requires different chemical and physical properties in the ink in order to fire properly.

No doubt you have seen differences in print quality or color from one media to another or even from one roll to another. Variations in print quality can depend on the time of day, the length of print runs, changes in temperature or humidity, the age of the printer, different ink lot or third-party ink, and the list goes on. These make up the variety of physical and chemical factors, all of which can affect the final result, i.e. the quality of your finished print.

Printhead Technologies

Though thermal printing is one of the earliest popular printhead technologies in graphics, it is still very much in use, most commonly in the Canon Prograf series (aqueous, or water-based) and HP Designjet series of aqueous printers, as well as HP's latex printers. To put it simply, a thermal printhead works by the ink flowing into a chamber where it is quickly heated upon demand, with the vaporization burst firing the ink droplet out of the nozzle. You may have noticed that all of the printer types listed using thermal heads are aqueous printers. That's because the stability and non-volatility of water make this a working combination. Early attempts to utilize solvent inks in thermal printheads were met with frustration, as the delicate physical volatility of solvents did not mesh with the printhead design and intent. Getting back to the physics side — just imagine the difference in boiling points between different solvents and you get the idea why this could cause problems. Water is water, anywhere you go. This is also one reason why some latex printers have altitude settings, as we all know water boils at different temperatures depending on altitude.

Enter piezo printheads. Again, simply put, the ink flows into a chamber and is fired out of the nozzle by a piezo membrane (derived from the Greek piezein, which means to squeeze or press), which, when excited or fired, mechanically forces the ink droplet through the nozzle. Compared to thermal printheads where the vaporization point of the ink is critical to the process, one can readily see that a mechanical means of firing the ink droplet could be far more friendly and adaptable to a variety of ink technologies, including solvent, UV-curable, dye-sublimation and aqueous.

Bob Flipse, Owner, Grafx Network

Typical Printing Process

Either technology can be effective to fire millions and billions of ink droplets on a variety of materials in order to generate your images. That firing of the ink droplets takes place as the printheads pass back and forth over your media, doing so typically in a number of print passes that are generally controlled by your RIP. You will notice that your printer goes back and forth with "stripes" of various widths while slowly developing the image until it is fully represented. Print modes can be two, four, six, eight or more, even up to 16 pass. These modes depend on many factors — printer, printhead and ink technology, plus the media being printed on — with its ink absorption and capability to hold the ink droplets in position until they dry sufficiently for the next pass. When the ink droplet hits the media, it will generally spread out a bit depending on the ink, the media, the temperature and humidity, etc. Think of holding a Sharpie® on paper and watching the ink spread out. This phenomenon is called dot gain. Dot gain can be your friend. The spread of ink often compensates for misplaced or missing droplets and generally blends the inks and various colors to generate the pleasing images that we have all come to love. The combination of all these factors is why your printer uses multiple passes. The ink dries just enough on one pass to accept the next stripe of ink without running or smearing, then drying enough just in time for the next pass, and so on, with dot gain being an anticipated part of the process.

Printing in single pass and putting down the full ink load to depict the image results in an overwhelming amount of ink that is incapable of drying quickly enough to depict a crisp image, not to mention having a softer featured edge that allows it to blend with the previous pass. I can't recall a single graphics printer I have worked with that even has a single-pass mode.

Temperature and Humidity Overview

Knowing what we know now, imagine the effect that temperature and humidity can have on these processes and ultimately the quality of your prints. Wet clothing will dry faster on a hot day than a cool day, faster on a dry day than on a humid day. Obvious, right? The same applies to inkjet prints. Checking three models of popular printers, I found the recommended operating temperature ranges from as low as 59 degrees Fahrenheit to as high as 90 degrees Fahrenheit, while humidity ranges from 20 percent to 80 percent, with 80 percent being the high figure on all three models.

Keeping your print room at 85 degrees to optimize your drying will likely result in unhappy and sluggish employees and a loss in productivity. Frankly, we have seen printer performance deteriorate in warmer printing environments. One shop I visited in North Carolina with no air conditioning ran their jobs from midnight through 8:00 am. When it got over 85 degrees in his shop, the print quality became unusable. Extreme? Perhaps, but a good example nonetheless.

Considering humidity, vapor-saturated air cannot readily absorb additional vapors (including solvents). Your prints won't dry as well on a damp day for obvious reasons. If you have a damp and cool day — imagine the results.

Recommendation: For the best and most consistent printing results, keep your shop environment as consistent as possible. For most any print technology, the best numbers to aim for would be 72–75 degrees and 55-percent humidity, and invest in a hygrometer to measure your shop conditions.

All this may mean air conditioning or dehumidifying as necessary, and humidifying in the winter when the humidity can get too low. Static is often a result of low humidity, usually with severe effects on print quality and even on the equipment itself.

Your Printer in Winter

I have gone into shops where they leave the heater down to conserve in winter. One shop was at 55 degrees and everyone there was in jackets! Several problems here: Since their printer and its entire assembly were cold (its range was 59–86 degrees), it took 30 minutes to warm up to generate even a test print. Needless to say, that does not enhance shop productivity. Additionally, the cold media, even though warmed by the printer, was not really at its usual printing temperature and quality was affected, not to mention that the colder media tends to contain more static, causing further quality issues.

Recommendation: Even if you have the need to keep your overall shop cooler, such as for a large bay or on weekends, invest in the necessary technology to maintain your print room at least at a temperature close to its usual operating range. Also, at a minimum, keep your commonly used materials and next

upcoming rolls or sheets in the print room area so they can stabilize temperature and static prior to use.

Not uncommonly, we go into print shops where the printer is near a door that opens frequently, causing large temperature and humidity fluctuations. Obviously it's pretty tough to maintain consistent quality under those conditions.

Environmental Effects on Color

Take all of the physics involved so far in printing even the simplest of images — printhead technology, ink chemistry, media chemistry, temperature and humidity — and you can see where it can be a challenge to get even a single dot down correctly, on time and in position, and with the right dot gain. Imagine the effects these elements have on your quality, especially on color.

Several of the more popular RIP software companies are in Salt Lake City, which has an average elevation of 4,327 feet. Though right on the lake, it is generally a desert environment with an average low humidity of 22 percent on July afternoons. You can reasonably expect that the RIP software companies have air conditioning to cool down their facilities, but I do not recall that the ones I have visited have humidification equipment in their color labs where they generate their (which are actually your) color profiles. Read the fine print or expert articles on the subject. They often state that the "canned" profiles that you receive with the RIP are a good starting point or reference standard, but that you should recalibrate if you wish to have accurate color. Faster drying equals lower dot gain, so imagine that effect on print quality.

Considering what you now know about the effect of temperature and humidity on dot gain, which both affect color rendering, do you think that a profile generated on July 15 in Salt Lake City would be color accurate in Baltimore on that same day?

Fact and Hint: Many of the newer printers have built-in color measuring devices, also known as spectrophotometers. The better RIPs have built-in color engines, and some have a routine in the RIP where you can automatically use this device to recalibrate. Make friends with that device if you have one, and use it often! If you don't have one and your RIP readily supports it, buy one.

Print Passes

When describing the typical printing process, I mentioned the concept of print passes, which are the number of times the printer must pass back and forth to complete the rendering of the image. Typical numbers are between four and 16, and they depend on a number of factors as described. A pretty good rule of thumb is the more passes, the better the quality. The math is simple — you will be able to print twice as fast in four-pass mode as in eight-pass mode since the print swath will be twice as wide. Not only may your quality be affected, but your heating and drying capabilities will be affected as well.

Printer Heaters

Depending on the printer and ink technology, most, if not all, have a series of two to three heaters on them, often a pre-heater, a print heater and a post-heater. The pre-heater warms the material prior to the ink droplets being fired on to the media. Warmer material is more ink-receptive and will take a higher ink load, which will generally allow you to print faster. That does not always mean that it will dry faster. The faster the media passes through the printer, the less total time it is over all the heaters, and the less time it has to dry before it hits the take up roll.

This is a delicate balance, so consider the factors involved: the number of heaters on the printer and their surface area, the thickness of the media you are using, its backing material and overall ability to absorb the heat, the speed of transport of the media over the heaters (dwell time), not to mention the density of your prints in terms of overall ink load, etc. Remember also that overly high temperatures may cockle (warp) the material and cause head strikes or other anomalies.

Considering all the factors involved in the printing and heating process, there are a few simple rules:

- It is all a matter of media absorption of temperature and time at that temperature. If printing faster, you may be able to raise your temperatures slightly. Experiment with different medias and different ink loads of materials at various speeds and heater settings. Settings are generally made in the RIP.
- If printing slower, conversely you may need to lower your temperatures.
- If you have a stubborn and slow-drying material such as clear or translucent that won't take heavy ink loads, or if you need to lay down two or

more ink passes, consider printing at a higher number of print passes and/or lower carriage speed (slower, more time to dry between passes), or even unidirectionally. Unidirectional printing is where the printer only lays down ink in one direction, meaning that it will have even more time to dry.

- Doing some quick math: Going to 16 pass versus eight pass will cut your speed in half, and printing unidirectionally will cut it in half again, meaning you are now at a quarter of the normal speed. This now becomes exotic work, so charge more for it! That job is tying up your equipment, and if your competitors don't know this trick and can't do the work, it is your job to gain.
- If you tinker and find settings that work, back them up! Check with your RIP manufacturer to see if there is an easy routine to back up the media and print setting preferences.

Walking the Walk

In our industry, we know how much goes into making the perfect print. As technology continues to grow, we must always consider the variables that can affect our print quality in order to produce a great product. If you remember these factors and adjust your environment and process accordingly, you will not just be putting ink on paper — you will stand out as a true professional printer.

A 25+ year industry veteran, Bob Flipse was an early innovator in wide format digital printing. Starting in aqueous, his knowledge now covers solvent, UV, and other ink technologies. Bob is a partner in Grafx Network, a nationwide service company for wide format printing equipment. Their services include maintenance, repair, training, color management, and moving and logistics. Much of their work is performed for dealers and manufacturers, some of outsource to them for overflow work while others use them as primary service providers.

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