Evaluation of Inkjet Materials.

Alan J. Herbert
Austin Community College, Austin Texas.

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1. Introduction.

Inkjet materials are rapidly becoming the favorite for output of digital images. Printers are available that can produce output in sizes from Postcard to Billboard, and at affordable prices. A huge variety of media is on the market, suited or claimed to be suited, for all applications. How then is the consumer to determine which material is best for their particular application? Producers of the media have large laboratories and expensive instrumentation to evaluate their product. Only one independent lab seems to have taken the problem under it's wing (the Wilhelm Institute), and even their most-excellent work is unable to cover the vast range of products. This article is a guide as to how you, with little equipment or budget, can evaluate a particular combination of printer, ink and substrate, and obtain truly useful results.

2. Inks, papers and printers.

Here first are some problems: if you use ink not supplied by the printer maker, you have little recourse if the ink ruins your printer. I have a jammed Epson resulting from an attempt to use a non-Epson, but alleged-archival ink. It also is important in some cases to match ink to medium. Dye fade is not just a characteristic of the dye; it is dependant on the environment in which the dye finds itself. There is some logic to the view that one should use ink and media sold by the printer manufacturer. They can't point a finger at someone else. Still, alternatives can be used successfully. HP sells you a new set of jets with each new cartridge. (They're built into the cartridge.) Epson only sells you the ink; their heads are piezoelectrically driven, and remain with the printer when the

ink cartridge changes. Thus you stand a better chance of being able to avoid problems with HP look-alikes than with Epson.

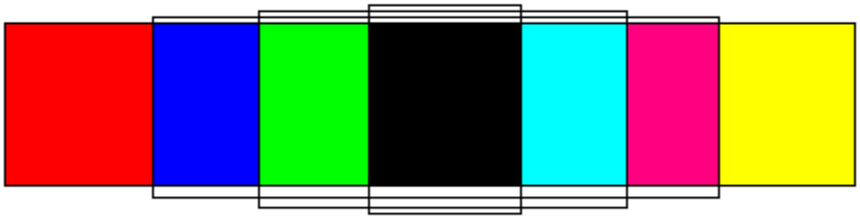
With media it's not quite so risky. I've yet to damage a printer by sending a reasonable material through it. (I have done so trying to run some weird substrates.) Nevertheless, you are still faced with evaluating the quality of the results.

Here are some tests.

3. Fade.

Go into *Paint*, or a program that can draw boxes and then fill them with solid color. Draw a row of seven boxes and fill them with red, green, blue, black, cyan, magenta and yellow. (See Figure 1 for an example.)

Figure 1. Test patches.



Copy this test pattern, and paste a second copy just below the first. Fill a page this way, and then print it. Place the print in an oven at 150 ^{o} F for 10 minutes. (There are a few tests you can perform before this test even, but more on those later.) Write by each pattern, in pencil, the date, and what you intend to do with each. Place one in a cool dark place - in a drawer for example, and pin the other to a strip of board and place it outside in the sun for a few days. Take the sample in each night (to avoid dew), and if it looks like rain. Then after a week, compare exposed and unexposed strips. If you see no difference, then your prints will last indoors fairly well. If they last a month, you are in very good shape. Chances are though, that you will notice that one or more of the cyan, magenta, yellow or black patches will have changed color. There is no way to predict which one will die first, although I'd bet that HP's black is very permanent. (It's a carbon black suspension, and not much destroys a carbon black layer, except perhaps scraping.) If you have access to a densitometer, you can quantify the fade, but you've already extracted most of the information visually.

One other thing to watch for: has the paper changed color? Cheap papers will yellow in bright light, and may even become brittle.

4. Drive mechanism damage.

The inked paper is somewhat, or even very, sensitive to handling. Examine the surface of an inked area, by reflected light, for drive marks. If your printer drive mechanism is rough, it may make a surface line in the output direction. (Note I mean the actual mechanical parts of your printer, not the "Printer Driver" you load into your computer when you configure your system.)
This test is a non-destructive test. You can perform it on an image without changing it in any way.
Drive mechanism marks may disappear when the media dries, or may remain. Some media - rough papers, may not show marks even with a defective machine.

5. Wet sensitivity, dry sensitivity.

Run a pencil point (a Number 2B) across the wet image. Is it removed? You can live with a defect like this; it just means you use very careful handling until the print is dry. Take a dry print and attack it with the eraser end of the pencil. Can you rub the image off? How many rubs in comparison with a print on something else?

Here I'm introducing again, the idea of a standard, or "control" sample. You need one sample to be a baseline to compare to others. This is correct scientific practice. Never rely on your brain to store appearances.

6. Resistance to moisture.

The first inkjet print I ever sold came back. Someone had sneezed near it, and the moisture had generated speckles on the print. Multigrade and Portra prints don't do this!
You can be gentle - press a piece of damp paper against the print, leave it in contact for a minute and peel it apart. Has any ink transferred? You can be rough - hold a sample under a faucet for a minute. Dry the sample and look for runs. You may see everything from image going down the drain in the first few seconds to no change at all. You can also match the washed colors to the control strip. This last test will also tell you something else. If the strip goes limp, it is made of ordinary paper. If it stays rigid, it is RC "paper" or some other polymeric substrate.

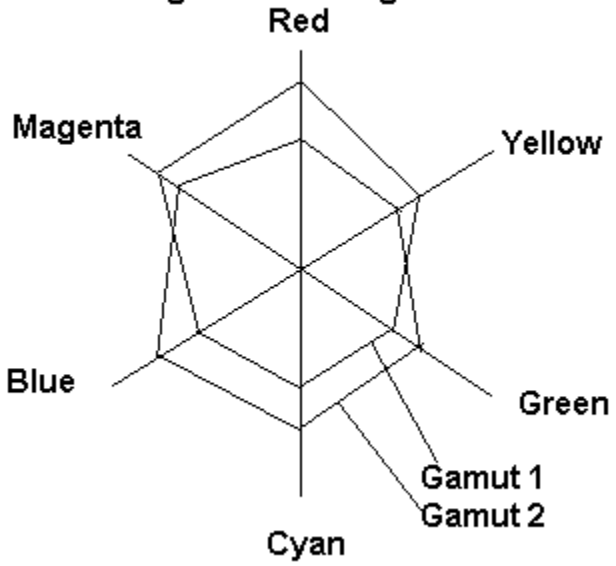
7. Color gamut.

The word "gamut" means "range", or "extent". Each printer, ink and paper can generate it's own gamut of colors. This can be controlled somewhat by the choosing various settings in your print dialog box. "Photo glossy paper" setting puts down a thicker layer of ink than "plain paper", and it should therefore look more colorful. Of course, if you use the wrong setting you can end up with soggy paper and crinkled paper. (There, that's another thing you can note. Does the paper buckle with normal ink load?)

It is difficult to measure gamut without some fairly sophisticated instrumentation, but that doesn't mean that you can't do comparisons. The eye is very sensitive to differences in color, so side-by-side comparisons are very effective. What you need to do is to make a series of prints - different inks, papers and printers, each combination being made under a variety of conditions so that you are getting the very best result from each. Then you compare the appropriate color patches. What you are looking for are the brightest, most vivid, colors. The combination that has the brightest colors has the largest gamut, and can generate the widest range of colors.

That was simple wasn't it? Well, now the bad news. You may find that the sample that generates the brightest magenta has a most dismal yellow, which will result in a poor red. Punchy cyans and yellows may offset a ho-hum magenta. You could plot these observations along a six-armed graph. One arm for each color, and dull is near the center. Each combination will generate a different irregular hexagon, and the area of it is a measure of the total gamut. Figure 2 shows how this could be done.

Figure 2. Color gamut.



Well what to do when you have conflicting results? There is no good answer; it is to some extent a matter of personal taste. You will have to decide for yourself what is the most important color in your picture making and make that combination the winner.

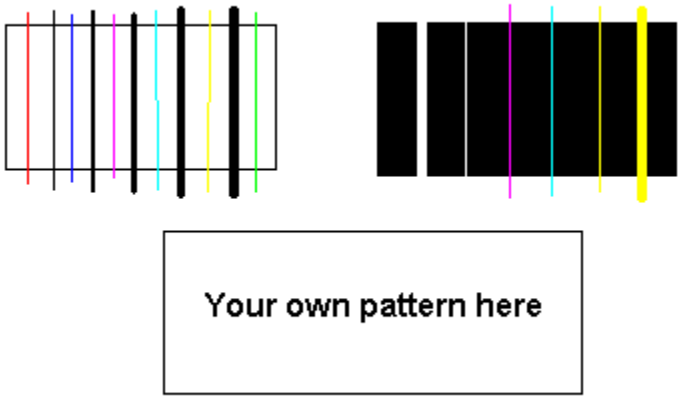
8. Bleed.

Bleed is a condition that only appears with time. It is a characteristic of prints that are left incompletely dried. What happens is that the deposited dye doesn't stay where it was initially placed, and moves slightly sideways on the media surface. It is observed as a loss of sharpness. I first saw a practical example when I made a print with some fine text overlaid on the color picture. I then put

the material into a frame having plastic front and back covers. After about six months, I realized that the text was unreadable, so reprinted the image on a different substrate. and dried it thoroughly before placing it in the frame. I haven't had any further problem; the substrate that worked was EK's Inkjet glossy paper. (Expensive substrates usually contain a "mordant", from the Latin "to bite", which reacts with the dye and holds it fast in one place.)

Heat and humidity accelerate bleed, but unless you are prepared to put together special conditions, you may have to be patient to test for this characteristic. However, if you have a warm closet, you can make a humidity chamber by taking a large Mason jar, placing a wet paper towel in the bottom, placing samples around the inner walls of the jar, and putting the lid on. Leave this jar in the warm place for a week, and re-examine. Hold it, I didn't tell you what kind of test pattern to use! Well, it has to have narrow lines on a background color, and also some narrow lines on un-inked substrate. See Figure 3.

Figure 3. Bleed test patterns.



You could cut a sample in half and keep one half in a cool dry place. This is not quite a control in the true sense, as it too may bleed, so when you are convinced that a change has taken place, make a new sample from the pattern, and look at all three prints. If you have a loupe, place a ruler (preferably with 1/2 mm rulings) over the lines and, looking through the loupe, try to measure the width of the lines. Note this down.

N.B. all writing on samples should be done in pencil. Pencil doesn't run, fade or wash off.

9. Keeping.

You don't expect your color film to stay the same if you keep it in a hot place for a year, so why should inkjet substrates be any different? (Inks don't keep either, but I use them up, and buy when I run a cartridge out, so it isn't so much of a problem.) Keeping is easily checked, given patience. Just don't use the last sheet of anything. Put it away, and run a test on it in a year's time. Compare it with an earlier print and with a similar print made on new material.

Manufacturers do improve and change their products and may not tell us, so a problem with last year's product may have been cured, and you won't know.

Printers can age, nozzles can clog, and if you are that ultimate sinner, the refiller of cartridges, your nozzles will age and deteriorate. (Manufacturers of ink cartridges *hate* you. They make most of their profit on cartridges!) The answer to aging, is, of course, to run a routine check, weekly or monthly, depending on your use-rate. Funnily enough, a good test for aging is not a color picture, but a black and white print. It has been said that the best test of a color system is how it reproduces gray scale. If you have a printer system that makes gray by modulating the color inks, rather than by just using the black ink, your eye will readily pick up changes from neutrality. Then you can either tweak the system to restore color balance, or you can get your printer repaired.

10. Mounting.

One of the last processes you will use, with your carefully made inkjet print is mounting. There are two major methods: Dry Mounting, with tissue and a hot press, and Spray Adhesive with exactly that. Both may present hazards to your print, and before major use, your new materials should be tested for compatibility with the methods. I can only report what I have observed, and this will tell you what to look for.

Dry Mounting worked well. The print didn't melt, the heat didn't damage the colors, however a most-objectionable surface mottle was seen, and the test sample was ruined. Thoroughly drying the media in a print drying cupboard didn't help the problem. It is quite likely that the problem is very media-specific. I cannot imagine that a matte heavyweight paper would do the same. (Murphy would predict that something else would be wrong.)

Spray Mounting worked well, until, as sometimes happens, adhesive appeared on the front of the print. With silver prints, and most color materials, a wipe with Paint Thinner removes adhesive, and leaves no traces. With the inkjet material I was using, the colors rubbed off. I didn't try the other removal method, which is to place a strip of masking tape over the unwanted adhesive, press it down and carefully peel it off. With luck the adhesive is removed, with no luck the image layer comes off with the tape.

There you have it with mounting. Try your favorite method on a junk sample, and see what goes wrong.

11. Mottle.

Mottle is the name for a condition that I've observed on RC-base materials. It shows up as non-uniformity in ink deposition. What I believe is happening is that the ink is not being immediately absorbed and is starting to bead up on the

surface. The effect is similar to that of photographic grain, and is even less acceptable. I don't know what the cure may be. My papers are stored at reasonable temperatures, and reasonable humidities, and used under the same conditions. Pre-drying paper has not helped. This fault prevents the production of acceptable prints.

12. Color hiding.

This is a rather subtle problem that rarely occurs with papers intended specifically for inkjet use. With the ability to print on almost any substrate, it is tempting to use all those great papers that are available to the paintbrush people. I'm not against this; it really is a great way to produce prints unlike any of the standard photo materials, meaning the silver halide ones. If the inks penetrate deeply into the paper, you may find that some of the inks penetrate further, and the other inks and light scattering mask their color by the paper fibers. This effect I first observed when printing some card stock - greeting cards actually. I could obtain pleasant images, and the cards were acceptable, but they didn't look "right". I finally figured out what was happening when I placed a card on a light box. All the colors were there! It was just the way I had intended it to be. With the light box off, the colors returned to their less-than-perfect form.

So when you have the urge to use a novel paper, make a test print on something suggested by the printer manufacturer. I.e. if you have an Epson printer, use Epson's Matte Heavyweight stock. Then print on your new favorite. Compare the two prints, looking at the bright areas of color for loss of intensity, or change of hue. If you suspect a change, examine by transmitted light.

If you do see a change, it may be correctable by re-adjusting color balance, or it may not. You will have to decide for yourself if the results are satisfactory. Note there is reason to think that pigment-based inks should suffer less from this problem than their dye-based cousins. I haven't checked this yet.

13. Conclusion.

You have now in your hands, most of the tools needed to control your print production system, and to differentiate good materials from bad. There is a rapid rate-of-change in the inkjet printer business right now. New printers are being introduced, along with many new substrates. Archival ink sets are appearing, but are at a stage where volume is small, and expense is high. Expect new products, in the first six months, to be less than reliable. Finally keep a notebook with dates, descriptions and samples. If anyone questions your data, you can go back and examine exactly what you did, and when. Go test.