How Many COLORS Are Enough?

by Shane Steinman

The imagination is a great thing; it can conjure up images that inspire, baffle, motivate, sadden, frighten or uplift. And so often when we think of images, we think of color. Dark, light, sombre, joyful, passionate, soothing. In that there are as many colors in the universe of your imagination as there are stars in heaven, how do you get them to come out on paper?

With so much of today's design work being accomplished by electronic means, and an increasing portion of that being destined for digital delivery by the Internet or other interactive media, it might be a good time to review how such designs may fare in the more traditional medium of offset printing.

Billions of dollars are spent every year on print ads and promotional material. But more and more often the design of these projects is being entrusted to new artists who've cut their teeth on RGB, Flash and computer displays instead of CMYK, Quark and printing plates. Let's consider this a quick primer on the options for getting your color from mind&computer to ink&paper.

GAMUT — A RANGE OF COLOR

The first thing to consider is gamut; the amount of color that will fit in your chosen device. A respectable computer screen can usually accommodate 256 shades of each of its primary hues, Red, Green and Blue. When you include "no color" ("0" amount of R, G and B) and "all color" (full measures of each), you have a total of 16,777,216 colors from which to choose. Of course, when designing for the web, you're sometimes limited to a great deal less than this optimal gamut — perhaps as few as 216 or 256 total colors.

Regardless of how color-restricted any web job may be, it's always possible to create colors that will never reproduce properly in a commercial printing environment.

While your monitor can add color density in 256 increments per channel (3 channels = 256 x 256 x 256), giving you over 16 million possible combinations, a printing press is less flexible. For one thing, offset presses reproduce optimally at only one density per each of the four colors typically used; Cyan, Magenta, Yellow and Black.

Here, dots of ink form a halftone "rosette" pattern.

What appears to be a 10% shade of any of these colors is really just a trick. The press prints in full density, but in only 10% of the intended area. This *halftone process* is what allows the device to achieve a wider gamut than would otherwise be possible.

A good quality press is capable of reproducing perhaps 10,000 to 20,000 distinguishable colors—a far cry from the millions of mellifluously colorful tones you saw on the computer screen. Obviously, that will leave some colors lacking in saturation, while other tones may not be at all reminiscent of the intended target.

DIFFERENT MODELS OF COLOR

The other major difference between transmissive (monitor) color and reflective (printing) color is that they are based upon two entirely different color models. Transmissive color is based upon an additive hierarchy; you add increasing amounts of each color to reach the state called "white". The subtractive model used in print works in the opposite direction.

The print process also adds Black in order to reduce consumption of the more expensive hues, to reduce the amount of ink printing in any area (solid- or total-ink density), and to create more balanced tone in shadow areas. But rather than adding more available colors to the mix, the net effect is that the number of potential colors is somewhat reduced—although the entire gamut becomes more predictable from one press to another.

Some early color desktop printers only used CMY inks, rather than the full CMYK set, in order to reduce the cost of device production and, ultimately, the downstream consumables cost for the end user. Now, however, virtually all desktop printers utilize each of the four *process* colors.

FROM SCANNER TO PRINT

Web designers aren't the only ones contending with misplaced or lost color when making the trip to press. Traditional designers and scanner operators are intimately familiar with the reality of WYSINAWYG (What You See Is Not Always What You Get).

When working in Adobe Photoshop on a three-component color space (so named because it has three image channels) like RGB, it's best to select CMYK Preview from the View menu. This will give you a better idea of what the image will look like when it prints.

The range of color in a photograph, especially a transparency, exceeds what you can capture on most digital scanning equipment—and dwarfs what you'll be able to hit on press.

DESKTOP PRINTERS

Some people get fooled by their very cool and capable desktop inkjet printers because these machines can actually reproduce a greater gamut than what will be available further down the production line. But why? If they use CMYK inks just like big iron horses at the printing house, why don't they suffer from the same restrictions when it comes to color reproduction?

The truth is that they do, but to a lesser extent. An inkjet printer, most often in its medium and high quality modes, uses a different method for laying the ink onto the paper substrate. Like an offset press, it uses the CMYK subtractive color model, but it exceeds the anticipated gamut by doing two things that presses usually don't do. It varies the intensity (density of the ink spray) of each color as required, plus it also avoids using standard halftoning as the mode for allocating ink to areas of the imaging sheet. This specialized halftoning method is called stochastic or frequency modulated screening—a way of laying down ink in smaller splashes (or dots) in a seemingly random pattern of distribution.

Some desktop print devices can also use more than the standard four process inks, sometimes being equipped to handle even eight "flavours" of color that add up to a larger gamut.

WHAT CAN BE DONE AT PRESS?

We can borrow a page from the desktop printer book of tricks in order to make our presses more color-friendly. Plus, we can add one additional option—finer screens.

Let's have a brief look at these three possibilities.

Fine screens

When we increase the number of halftone dots used in printing, we gain certain advantages and lose certain benefits.

Since halftones are printed with dots of various sizes lined up along a grid, we can more finely distribute the ink by making these dots smaller and placing them closer together. You can see how this might add additional detail that would not otherwise be available with a coarser screen, but it also has the effect of increasing the gamut of the ink.

Since most people print on white (or at least light-colored) paper, the substrate actually has the effect of dampening the surrounding color. This happens because white is really a combination of the spectral wavelengths of all colors. By grouping the splashes of ink more tightly, we prevent the white reflected light from getting mixed in with the hues we use for printing. The result: cleaner, more saturated colors.

Stamp printing and fine art reproduction are two examples of jobs which may require this sort of treatment. In the case of stamp printing, where the image area is extremely small and is required to be of very high quality, it is not uncommon to print with dots arranged on a grid of 300 lines per inch or more.

What we lose in the process is a certain amount of flexibility. The finer the halftone screen, the better your press needs to be,

the more experienced a pressperson you need, and the less forgiving of mistakes is the process itself. This is why certain distributed production jobs—such as high-run magazines, which must be printed at several locations in identical fashion—mandate the use of a standardized frequency for their halftones, usually in the range of 100 - 150 lines per inch.

Frequency Modulated (FM) Screens

Like fine screen printing, FM screens use very small puddles of ink. But unlike typical fine screens, FM dot distribution is not quite so linear. This can potentially add even finer detail at the same pressperson's experience level and press quality. Furthermore, because the ink dots don't grow in size (we just put more of them in the same area) the detail level is pushed even higher in the midtone range.

The apparent saturation of a stochastic (FM) screen job can exceed that of fine screens, but not as many printers are as familiar with handling these types of jobs. In standardized device production, such as with desktop inkjet printers which require little or no operator intervention or decision-making, FM screens offer the best possible results. This type of minimized-variable process is coming to larger presses, but it may take some time before its advantages are fully realized and implemented.

In the case of both FM and fine screens, greater attention to process control is required in the imaging and proofing portions of the process. Direct-to-plate production benefits both these methods by reducing manual handling of films and plates, especially by eliminating the optical duplication typically required by film-based plate creation.

Adding Extra Colors — Hexachrome

The third method of increasing the printable gamut is by using more ink colors to define what will be printed. One of the most popular extended gamut ink sets is Pantone Hexachrome. Using software such as Pantone's HexWare 2.5, six plates are generated instead of a typical four-color separation. Cyan, Magenta, Yellow and Black are still used, but two new colors are added to the mix: Hexachrome Orange and Hexachrome Green. The basic CMYK colors are also found to differ (but only slightly) from the standard CMYK set.

By breaking images and layout objects into more colors, it's possible to hit certain colors which were previously unattainable through standard presswork. The enhanced gamut is approximately 18% larger by my estimation (although this figure may be contested in other papers and publications).

Obviously, in certain colors where problems are well-known (yellows and oranges that get too reddish and blues that get too purplish) this six—hence, hex—color process can be a tremendous benefit.

Most articles I've read on the subject seem to go out of their way to find green- and orange-intensive images to test the quality

of the separations that can be achieved. That's all good, but it strikes me that they should also be qualified for producing good, natural color response in other types of images as well. So, in the comparative images you find here, we've selected a few pieces which don't immediately appear to be very difficult, but this is a deception. One of the key qualifiers for any process is the ability to exceed what was previously available—without losing the benefits of the method being replaced.

So look at the test images and see if you can tell the difference between CMYK at 200-line screen, Hexachrome, and CMYK-FM. Hmmm. The last one sounds like a Top 40 radio station.

PROOFING

Earlier I mentioned a curious acronym which is derived from one more well known: WYSIWYG—What You See Is What You Get. Since it's tough to trust your computer display (sometimes even with proper color management controls in place), most people would tend to rely more heavily upon their calibrated and controlled desktop printer (preferably one of better quality) to create the proofs that they will eventually sanction as being fit for press.

Where film must be created for non-CTP (Computer to Plate) processes, it would be imperative that the mechanical proofing system which is employed use proper procedures and materials for duplicating the imaging gamut of the intended device. In the case of Hexachrome work, a system with the correct colors would obviously be required.

With inkjet proofing systems and other digital reproduction proofers capable of a great color range, special colors can even be simulated, but this may involve a certain amount of color management work—not something that most people would relish

Same image — four different results. Typical publication printing uses halftone screens between 120 and 150 lines per inch. The image at the top of the previous page reveals the sort of results one would expect from SWOP standard printing. The image at the top left of this page employs a 200 line screen, which will increase the available gamut of the paper:ink combination. The FM (stochastic) technique at top right also increases the amount of colors available, but specific density corrections must usually be made for this process. The version just below that uses the six-color Hexachrome process to achieve an even wider color gamut (without the need for special tonal corrections) but increases the number of inks used for printing. This can, however, be worth the expense if you have certain "must hit" colors in your layout — especially in the orange and green ranges. Our comparison image uses both saturated and realistic tones as a fair test.

tackling. I suppose that's why we go to experts (with lots of neat toys) to get some of our most complex work completed.

In talking over this job with Ron Verbaas at Astley-Gilbert Reproductions, we discussed a number of proofing possibilities. But he said that they would just image the plates live on press (a Speedmaster 74 DI) and run the job; it would cost almost as much to make mechanical proofs as it would to re-burn the plates—a testament to the efficiencies of DI production.

SO HOW MANY COLORS DOES IT TAKE?

Obviously, there are myriad issues to consider: price, quality, turnaround, color, proofing, and that all-important customer service relationship. But when you need to hit a certain color, e.g. a corporate identity color in a scanned photo, you'll know what options are available and be able to make an informed decision.

When deciding how many colors are enough, I'd like to leave you with the impression that it's a personal choice, one that should be addressed on a job-by-job basis, depending upon the inherent need for specific color.

If four-color process is all you have in the budget, there are fine screens or FM screening. And for some additional increased gamut, particularly in the tough-to-hold blue-green and red-yellow range, there's always Hexachrome. Or Hex-fine-screen. Or Hex-FM for that matter. But, let's not get too carried away. Come to think of it, we've run each of these in past issues of Graphic Exchange—constantly pushing that envelope.

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