CONTROLLING COLOR BY VARYING SOLID INK DENSITY

By Miles Southworth*

Abstract: Four-color lithographic presses have many printing variables that can affect color quality and consistency. A color proof is calibrated to match the controlled press conditions to be used as a control tool for the press control. The press is then controlled by varying the ink amount to compensate for the many printing variables that affect the printed result. A densitometer properly used could monitor the color hue and strength as compared to the OK sheet that would monitor the printed color in a manner consistent with the customer's desires.

Current Control Procedures

From the customer's point of view color control is producing a product with no variation of color hue or strength throughout the pressrun. We have always assumed that controlling the solid ink density for consistency will control the color for consistency throughout the run. But this author feels that the evidence indicates this theory is wrong. In fact, the opposite may be true. The following statement would best sum up what is currently happening on four-color presses:

> Pressmen running a four-color lithographic press control the color hue and strength of important halftone areas in a color reproduction by varying the solid ink density to compensate for the many other variables of the printing process.

There are many printing conditions that can vary on a printing press. To properly control a press for all those variables a control panel of the press would have to look like that in Figure 1. Instead they have only one control for ink and one for water for each printing unit.

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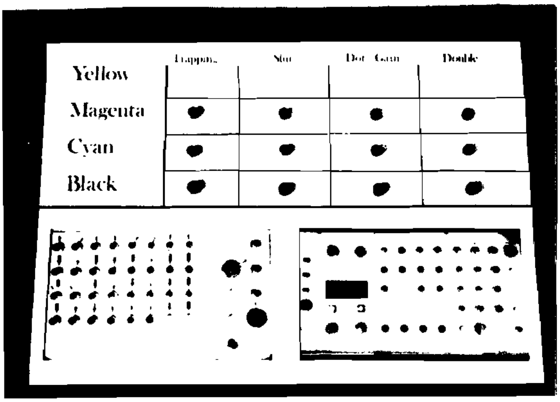

Figure 1. A hypothetical press control panel for the major press variables.

Color Control Sequence

Present color control technology usually follows the sequence outlined below:

1. Optimize the press solid ink density for maximum print contrast compromising for overprint hues, dot gain, and trapping.
2. Calibrate a color proofing system to simulate the controlled printing conditions established above.
3. Produce a color proof of a set of separations utilizing the calibrated proofing method.
4. Customer OK's the color proof fully expecting the press will duplicate the visual appearance of the proof.
5. Run the four-color lithographic press in such a way as to adjust the overprint halftone areas to visually match the OK proof for color hue and strength.

It would appear that our industry calibrates the proofing method to visually match the press results, then varies the printing press to match the proof. It would give us and the customer the idea that we are chasing our tail in an attempt to control color—but it is a process that has been proven to work successfully over a period of time.

Gary Field stated at the 1983 TAGA Color Committee Meeting that "to specify color we must either use words to describe it, use measurements to quantify it, or use a physical reference as an example of the desired attribute." The color proof is in effect a contract of what the customer expects his printing to look like. Using the color proof as the standard is a technique that has proven very effective for color control.

Examining the Evidence

Investigating acceptable color variation, John Gaston in his RIT Master's thesis reported that quality control persons in the graphic arts were more critical of changes in hue than they were of changes in solid ink density.[2] Chikashi Hashimoto in his RIT master's thesis investigated color control of label printing.[3] He found that control of the hue in the image area was more effective when a densitometer was used in combination with visual judgments made by the press crews. Daniel Lake in his RIT master's thesis found little correlation between the measurements of the solid ink density and the change in hue in the halftone image areas.[4] He also noted that a press in control that produced consistent acceptable quality allowed the magenta to vary as much as .20 in density.

GCA Press Test Run of 16 Presses in 1982

	Cyan	Magenta	Yellow	Black
Solids				
High	1.44	1.48	.96	1.95
$\bar{X}$ Average	1.11	1.18	.94	1.56
Low	.86	.93	.69	1.30
Range	.58	.55	.27	.63
Total Dot Gain				
High	34	30	42	46
$\bar{X}$ Average	19	20	23	28
Low	12	12	13	18
Range	22	18	29	28
Hue Error				
High	46	63	8	
$\bar{X}$ Average	26	49	5	
Low	23	43	3	
Range	23	20	5	
	Red	**Green**	**Blue**	
Trapping				
High	76	102	79	
$\bar{X}$ Average	63	84	71	
Low	45	65	67	
Range	31	37	12	

Figure 2. A summary of the 1982 GCA press test as published by the Quality Control Scanner.[5]

Felix Brunner stated publicly at Spectrum 1983 and in Eurostandard Cromalin that dot gain changes can have a much larger affect on the color of a printed reproduction than changes of soid ink density.[1]

The 1982 Graphic Communications Association (GCA) pressrun test of 16 web offset presses pointed out the importance to the press crews of the overprint colors. Analysis by this author of the GATF Hexagons plotted by George Leyda of 3M would suggest that each crew produced similar overprint colors by varying the ink film thickness to compensate for various conditions of trapping, dot gain, and other printing factors.[5]

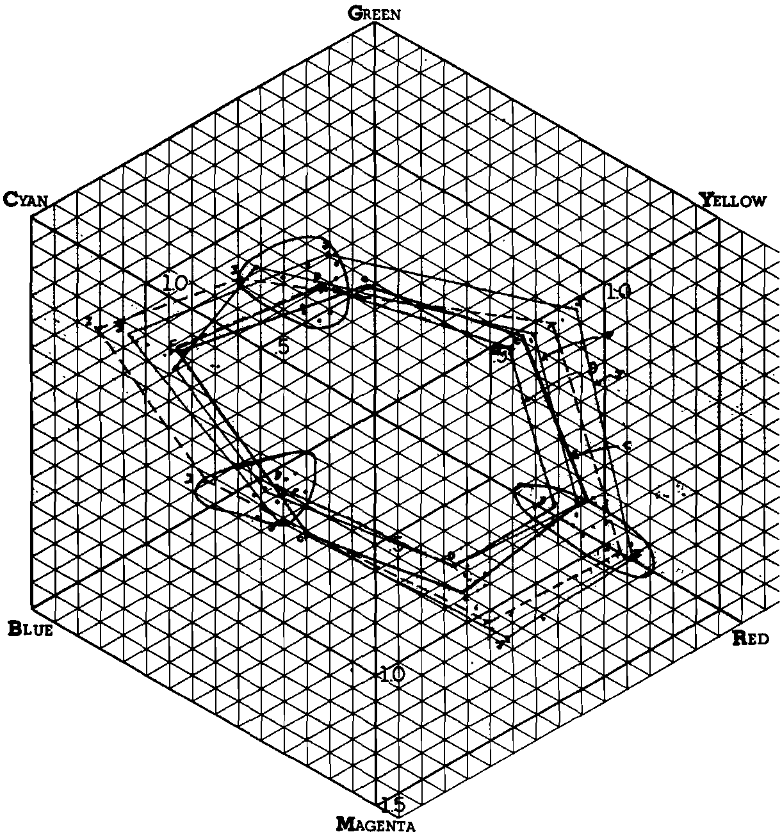

Figure. 3. GATF Color Hexagons plotted of the GCA run to show the similar overprint hues.

Hypothesis

It is this author's belief that since we are controlling a press by varying the amount of ink we apply, it would lead us to the conclusion that better control of the process could be gained if we were to automate the process by quantifying the desired halftone values in the image areas as seen for color hue and strength, rather than the solid ink densities. The changing dot gain and trapping can have a significant affect on the resulting printed color. Because of mosaic fusion the observer sees the total color in an area as the amount of red, green, and blue light reaching the eye. If we can monitor that amount of red, green, and blue as it compares to the OK sheet, it should be possible to control it for consistent hue.

While some persons are investigating the use of colorimetery as a means to control color, it may not be necessary. The densitometer should be sufficient if used properly.

The procedure would utilize a densitometer to measure the color proof or OK press sheet to determine the aim control values in selected areas. Any smart densitometer can display three-filter readings of any area measured. The red, green, and blue filter density readings on the OK press sheet of the same inks and paper would serve as the aim values. During the pressrun the press sheet in the corresponding image areas would be read with the same densitometer for its total cyan, magenta, and yellow content. If the densitomter is nulled on the OK sheet, it would indicate if there was an equal amount of cyan, magenta, and yellow content in that area as compared to the OK sheet. If those values change, it would indicate that it may not match the OK proof and that corrective action is needed. The corrective action needed would be displayed by the three simultaneous readings of the densitometer. While the densitometer would not indicate what printing condition changed, it would indicate what change in ink film thickness would compensate and bring that area of the press sheet back into the same red, green, and blue balance.

The needed correction would be indicated by the level and balance of the readings. This author feels that maintaining the color balance is more critical to the customer than the exact strength of a color. What is not known at this point in time is the exact amount of acceptable variation for color hue and strength to determine the algorithm to program into the system. Determination of those tolerances and a proof of this theory is the aim of a master's thesis now in progress by Curtis Smith at RIT.

Closing the Loop

With the technology available today it should only be a matter of time until the discussed principles are applied in an automated manner to sound the alarm when a press is drifting out of control. Instituting a closed loop for press ink fountain key control may also be successful once a suitable detector for water amount is included. Densitometers with microprocessors can make many computations. One could program any number of control points on a press sheet to control for consistency. The specific x & y coordinates for each reading to be taken could be specified with the use of a digitizing tablet. Densitometers have been designed to learn to position themselves at predetermined x & y coordinates as was displayed at DRUPA 1982. On-press or off-press densitometers could be used to make red, green, and blue filter readings of given image areas within the sample press sheet of a pressrun. These readings would solve the problems created by the missing control bar which is so often the case on publication pressruns.

Based on today's technology and understanding of color control we should control color in a more automated fashion. Only when we can control all of the printing variables on a press can we expect to keep the ink film thickness consistent for a consistent product. The result should be better control of color printing and a more consistent product.

References

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