

"PLATE CHARACTERISTICS AND IMAGE SCANNING FOR PRINTING AREA DETERMINATION"

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ABSTRACT

The need for automatic plate image area determination for press presetting and control is increasing. In order to satisfy this need, Rockwell International initiated a multiphase test program to determine characteristics of plates and scanners. Ten samples of off-the-shelf plates were studied, and were tested using a commercially available plate scanner. Readings obtained for the plate characteristics using densitometer and photomicrographic techniques compared favorably. A selected plate type was further tested on a plate scanner, and the results were compared with those obtained on a negative scanner for the negative associated with the sample plate and with microscope readings. Again the results were positive.

BACKGROUND/OVERVIEW

Printing, by its inherent nature, is an unusual "Manufacturing" procedure. Its output product is produced in volume yet each production run is different. The various settings which determine the process are, therefore, different for each run. Among the most critical integral printing system components is the plate used in the modern offset process. The integrity of the plate image representation is a prime input which the press must utilize in order to strive to produce an output which emulates the image.

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Automation of many of the printing system operations has significantly contributed to the major improvement in productivity, cost reduction and product quality witnessed in recent years. Image area determination techniques have been used to obtain data by which press ink presetting can be utilized. Until recently the negatives from which the plates are exposed were used. In fact, Rockwell has offered a PAR (Printed Area Reader) for many years which produces this information.

A trend has been emerging in recent years which has evidenced the user's desire to entirely eliminate the photographic negative from the plate making process. Laser platemaking offers a "Computer-to-plate" approach. Perhaps some revolutionary breakthrough or on press imaging technology may someday occur. Rockwell, therefore, concluded that more had to be known about the parameters of printing plates and their interaction and performance influence on image scanning devices. A study and evaluation program was, therefore, initiated in 1982.

The program was divided into four phases.

- o Phase one focused on a study of commercial printing plates to determine their characteristics and to generally baseline the nature of such plates.
- o The second phase consisted of tests run on a commercially available plate scanner to obtain parametric data for comparison to the basic "raw" plate analysis of phase one. The performance of selected representative plate samples, containing specific evaluative image configurations was determined. This effort was further detailed by means of densitometer and photomicrographic analysis.
- o The third phase of the study encompassed the data collection and analysis of test results for plates having specified images run on a plate scanner. This consisted of analysis of scanned parameter values versus the plate densities, and

a comparison of those values to the values derived from scanning the negatives of the respective plates.

- o The fourth phase will aim to measure the effectiveness of scanning techniques as applied to presetting and control in real-world environment. It will consist of the integration of an automated on-line evaluation system with a press both with/without automatic press control features. This evaluation series has not been performed as yet.

PHASE I - PLATE STUDY

The initial phase of our program was structured to obtain baseline data as to the inherent characteristics of a representative series of plates. The study was set up to:

- a. Determine the plate materials/manufacturers which are representative of those used for commercial applications.
- b. Determine, for this representative group:
 - 1. background density
 - 2. variation of this density across the plate for exposed plates fabricated by accepted methods
 - 3. image/background contrast ratio
 - 4. other potential influences such as lacquer color and gumming

To conduct this study the RIT Research Corporation of Rochester, NY, was contracted to assist in the plate selection process and to perform the plate characteristics analysis.

RIT selected presensitized photopolymer negative working plates for this study since the majority of the printing plates used in the commercial market are of this type.

Ten different plates produced by five manufacturers were evaluated. These plates offer a representative sampling of the commercial area types. The plates and the color of their image coating are listed in Table 1 below.

<u>PLATE TYPE AND MANUFACTURER*</u>		<u>IMAGE COATING COLOR</u>
Enco	N-50	Blue Green
	N-100	Purple
	N-200	Light Blue
Kodak	L	Dark Blue
	M	Purple
	S	Pink
3M	X-N	Blue
	K-Plus	Magenta
S.D. Warren	QS-100	Cyan
	Rhino	Blue

* The listed plates and/or manufacturer names may be trademarked or copywritten.

TABLE 1

Table 1 shows that the plate samples evaluated were of several different colors. This selection was purposefully done since light (filtered and/or unfiltered) impinging on a plate will be reflected/absorbed differently for each color. The determination of the possible effects of a scanner's light source on the accuracy of image reading was a major consideration of the test program.

The basic photopolymer material is colorless and there would, therefore, be no visual difference between the image and non-image area of an exposed and processed plate. Manufacturers, however, incorporate a colored lacquer into their photopolymer coatings to provide this visual difference and to strengthen the photopolymer

physically, which serves to reduce wear and increases plate life. The difference in optical reflectance between the lacquered photopolymer image area and the aluminum plate non-image area is interpreted as plate contrast.

Plate contrast can be expressed in a variety of ways. In this study plate contrast ratio was reported in two ways:

1 - Contrast Ratio-Image (R_I)

Where: R =Contrast Ratio
 I =Density of Image
 B =Density of Background
 C =Contrast Number = $I-B$

$$R_I = \frac{I-B}{I} = \frac{C}{I} \quad \text{or}$$

Normalized with respect to the Image Density.

2 - Contrast Ratio - Background (R_B)

$$R_B = \frac{I-B}{B} = \frac{C}{B}$$

Normalized with respect to the Background Density

It is the latter expression that is used in this study. One of our prime concerns is plate background density variation. We therefore felt that normalization with respect to plate background might provide additional insights into plate characteristics.

The reflection density of an image will vary with the amount of image area present on the plate, ranging from 0 to 100 percent for solids. Contrast Ratio will therefore vary and can be plotted against percent image area. Normalization with respect to image density would produce contrast ratio curves that approach 1.0 for 100 percent image for all cases. However, by using background normalization the effects of any background variation as

well as the significance of the spectral effect of the scanning system can more easily be seen. A clear example of this is shown in the case of the 3M plates (Figures 1 & 2) where for 3M type K-Plus the red filtered system would give extremely poor results but for the 3M type X-N plate it would produce the best results.

These figures show the behavior of these plates under red, blue, green and visual (broadband) filter conditions.

The Contrast Number (C) is simply the numerator of the Contrast Ratio and is the density difference between the image and the background. This value is useful in comparing different spectral responses for a given plate. It is also used for comparison between plates.

The contrast data was obtained by reading several steps of a 150 line halftone scale exposed in four different areas in one quadrant of each plate type. The data was recorded from these four locations and is identified on the data sheet (Table 2) as image location I, II, III or IV. Table 2 shows the measured density readings; using light filters of red, blue, green and visual (broadband); at each of the four plate locations. Dot areas ranging from 0 (background) to 100 percent (solid) were used. Table 3 lists the mean density values, using the data for the four locations. The Contrast Ratio and Number are calculated from the mean values. Each point for the Contrast Ratio plotted on a graph, therefore, is the mean of a sample size of four covering one quadrant of the full-plate area. (See Figures 1 and 2 as examples)

The contrast ratios for the test plates, normalized with respect to the background, is listed in Table 4. Figure 3 shows these ratios plotted versus dot area percentage.

One of the prime considerations in determining whether scanning of a plate can produce reliable data with which one can preset/control the printing process is the degree of uniformity of the plate background. If the background

CONTRAST RATIO VARIATION USING COLORED FILTERS

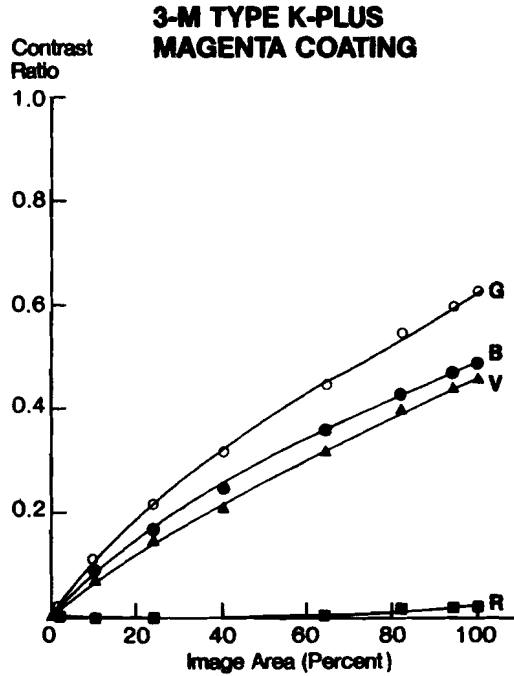


FIGURE 1

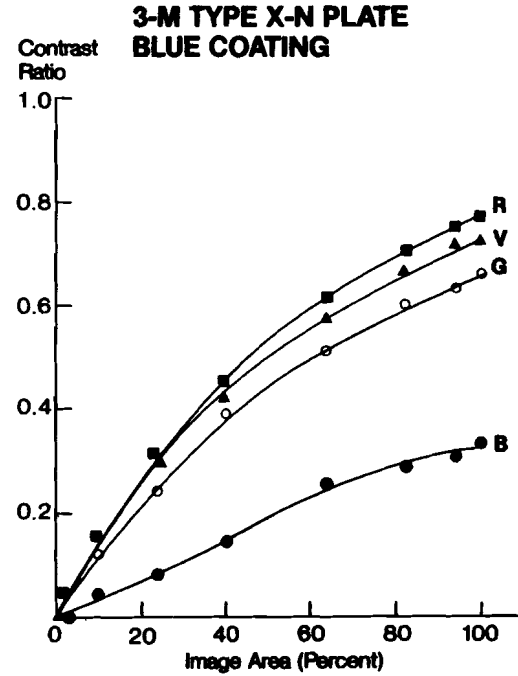


FIGURE 2

PLATE DENSITY MEASUREMENTS

SPECIFICATIONS:

 MANUFACTURER OF PLATE 3M
 TYPE OF PLATE K-PLUS
 COATING COLOR OF PLATE MAGENTA
 NO. OF TEST IMAGES (N) 4

IMAGE LOCATION:

 II : I

 III : IV

IMAGE LOCATION:

II

I

(POSITIVE) FILM DOT AREAS (X)	DENSITY READINGS				DENSITY READINGS			
	V	R	G	B	V	R	G	B
0(BACKGROUND)	0.42	0.41	0.41	0.40	0.42	0.42	0.42	0.41
2	0.43	0.41	0.41	0.41	0.43	0.41	0.41	0.41
10	0.43	0.41	0.45	0.43	0.45	0.42	0.47	0.43
24	0.47	0.41	0.50	0.44	0.50	0.41	0.52	0.49
40	0.52	0.40	0.58	0.51	0.53	0.42	0.60	0.53
64	0.60	0.40	0.72	0.61	0.61	0.41	0.73	0.62
82	0.68	0.40	0.87	0.68	0.69	0.43	0.90	0.70
94	0.74	0.43	1.02	0.75	0.74	0.42	1.01	0.75
100(SOLID)	0.77	0.43	1.09	0.77	0.76	0.43	1.10	0.77

* V,R,G,B : FILTERS OF VISUAL, RED, GREEN, AND BLUE RESPECTIVELY.

IMAGE LOCATION:

III

IV

(POSITIVE) FILM DOT AREAS (X)	DENSITY READINGS				DENSITY READINGS			
	V	R	G	B	V	R	G	B
0(BACKGROUND)	0.39	0.40	0.39	0.38	0.42	0.40	0.40	0.39
2	0.40	0.40	0.39	0.39	0.42	0.42	0.43	0.41
10	0.44	0.41	0.45	0.42	0.44	0.40	0.44	0.43
24	0.49	0.41	0.51	0.48	0.48	0.40	0.52	0.49
40	0.53	0.42	0.60	0.53	0.52	0.39	0.57	0.52
64	0.61	0.41	0.73	0.61	0.60	0.41	0.73	0.61
82	0.68	0.43	0.89	0.68	0.68	0.41	0.88	0.69
94	0.73	0.41	1.00	0.73	0.73	0.42	1.02	0.74
100(SOLID)	0.76	0.43	1.09	0.78	0.74	0.41	1.09	0.78

* V,R,G,B : FILTERS OF VISUAL, RED, GREEN, AND BLUE RESPECTIVELY.

TABLE 2

PLATE CONTRAST RATIOS

(POSITIVE) FILM DOT AREAS (X)	MEAN DENSITIES (N=4)				MEAN DEVIATIONS			
	V	R	G	B	V	R	G	B
0(BACKGROUND)	0.41	0.41	0.40	0.39	0.012	0.007	0.010	0.010
2	0.42	0.41	0.41	0.40	0.010	0.005	0.010	0.010
10	0.44	0.41	0.45	0.43	0.005	0.005	0.007	0.002
24	0.48	0.41	0.51	0.47	0.010	0.002	0.007	0.020
40	0.52	0.41	0.59	0.52	0.005	0.012	0.012	0.007
64	0.60	0.41	0.73	0.61	0.005	0.002	0.002	0.002
82	0.68	0.42	0.88	0.69	0.002	0.012	0.010	0.007
94	0.73	0.42	1.01	0.74	0.005	0.005	0.007	0.007
100(SOLID)	0.74	0.42	1.09	0.77	0.002	0.010	0.002	0.005

* V,R,G,B : FILTERS OF VISUAL, RED, GREEN, AND BLUE RESPECTIVELY.

(POSITIVE) FILM DOT AREAS (X)	CONTRAST RATIOS				CONTRAST NO.			
	V	R	G	B	V	R	G	B
0(BACKGROUND)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.00	0.02	0.02	0.01	0.00	0.01	0.01
10	0.07	0.00	0.11	0.09	0.03	0.00	0.05	0.04
24	0.15	0.00	0.22	0.17	0.07	0.00	0.11	0.08
40	0.21	0.00	0.32	0.25	0.11	0.00	0.19	0.13
64	0.32	0.00	0.45	0.34	0.19	0.00	0.33	0.22
82	0.40	0.02	0.55	0.43	0.27	0.01	0.48	0.30
94	0.44	0.02	0.60	0.47	0.32	0.01	0.61	0.35
100(SOLID)	0.46	0.02	0.63	0.49	0.35	0.01	0.67	0.38

* V,R,G,B : FILTERS OF VISUAL, RED, GREEN, AND BLUE RESPECTIVELY.

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TABLE 3

**CONTRAST RATIO CALCULATION
(VISUAL RESPONSE FILTER)**

$$\text{Contrast Ratio} = \frac{\text{Image Density} - \text{Background Density}}{\text{Background Density}} = \frac{\text{Contrast Number}}{\text{Background Density}}$$

$$R = (I-B)/B = C/B$$

Dot Area-%	Encon M-50 B=0.24		Encon M-100 B=0.32		Encon M-200 B=0.38		Kodak L B=0.26		Kodak M B=0.27	
	C	R	C	R	C	R	C	R	C	R
0 Background	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.01	0.03	0.01	0.03	0.02	0.07	0.01	0.04
10	0.03	0.125	0.03	0.09	0.03	0.08	0.06	0.23	0.03	0.11
24	0.07	0.29	0.08	0.25	0.10	0.26	0.14	0.54	0.09	0.33
40	0.12	0.50	0.03	0.41	0.16	0.42	0.24	0.92	0.16	0.59
64	0.19	0.79	0.20	0.62	0.29	0.76	0.41	1.58	0.27	1.00
82	0.26	1.08	0.27	0.84	0.41	1.08	0.59	2.27	0.36	1.33
94	0.32	1.33	0.32	1.00	0.51	1.34	0.74	2.85	0.43	1.59
100 Solid	0.35	1.46	0.34	1.06	0.55	1.45	0.84	3.23	0.46	1.70

Dot Area -%	Kodak S, B=0.26		3M M+, B=0.41		3M X-N, B=0.23		Warren QS-100, B=0.23		Richardson Rhino, B=0.34	
	C	R	C	R	C	R	C	R	C	R
0 Background	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.04	0.01	0.02	0.01	0.04	0.01	0.04	0.02	0.06
10	0.03	0.11	0.03	0.07	0.04	0.17	0.04	0.17	0.05	0.15
24	0.08	0.31	0.07	0.17	0.10	0.43	0.10	0.43	0.12	0.35
40	0.14	0.54	0.11	0.27	0.17	0.74	0.17	0.74	0.20	0.59
64	0.22	0.85	0.19	0.46	0.31	1.35	0.25	1.08	0.32	0.94
82	0.30	1.15	0.27	0.66	0.44	1.91	0.32	1.39	0.44	1.29
94	0.35	1.35	0.32	0.78	0.56	2.43	0.36	1.56	0.54	1.59
100 Solid	0.37	1.42	0.35	0.85	0.60	2.61	0.38	1.65	0.58	1.71

TABLE 4

CONTRAST RATIO (BACKGROUND NORMALIZATION)

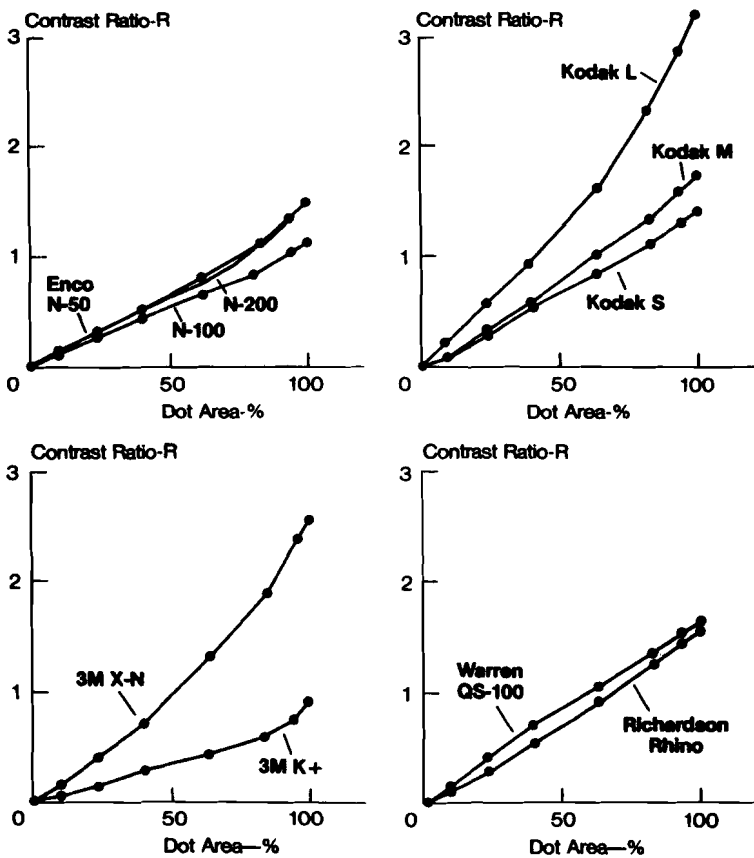


FIGURE 3

density is indeed uniform across the entire plate surface then scanning may produce accurate, useable image-density readings.

Although RIT experience has shown this to be the case, a test series was set up to actually measure the background densities at various points (See Table 2). In addition a broader area test was used to verify that larger plates also demonstrated this uniformity. An Enco N-50 plate was tested in all four quadrants. The results in any one quadrant were not significantly different from any other. The mean deviation in background density was never greater than 0.01 (which is the accepted precision of a densitometer). A note of caution must be interjected here. A possible significant contribution to non-uniformity could be poorly applied gumming. Gumming is a user applied material generally required as the last stage of plate processing to protect the plate surface image/integrity.

A summary of the key results of this Phase I study shows that:

1. Plate background density does not vary across the plate surface. The ten samples tested were all gummed using accepted industry techniques.
2. The characteristics of the light source used for the density readings are important, particularly since plates use different colored lacquers. The results indicated, however, that a normal visual (broadband) light source provided adequate reflectance with the plates tested.

PHASE II - PLATE PATTERN/SCANNER EVALUATION

A series of tests using the baseline plates were run. The effects of several plate patterns and solid and half-tone bars and plate color-incident light variations were checked. Twenty-seven plates, three patterns with each of the nine plates, were tested.

The three test patterns were designed by Rockwell for this test series. The pattern configurations considered evaluative factors such as:

1. Field of view accuracy
 - Resolution of column sweep
 - Column overlap/response interaction as the images are scanned
2. Image dependence
3. Uniformity of scanned readings.
4. Linearity across a selected plate area.

The patterns tested present various combinations of shapes (triangular and rectangular) and solid areas and screen bars of 10, 50 and 90 percent of 85 lpi (lines/inch) for the tests. Figure 4 shows a drawing of the latter solid/screen test plate.

The nine plates, which had the solid/screen test pattern referred to above, were analyzed to verify that the solid and screen percentages in the original design layout had been transferred properly via the artwork-negative-plate process. The dimensions of the solid areas were measured and found to be accurate to 1 percent. Photomicrographic analysis of the various screens showed that significant transfer errors had occurred. The 10 percent screen actually measured 6.2-7.6 percent while the 50 percent screen showed a range of 40.0-45.4 percent and the 90 percent screen measured 90.7-93.1 percent. Table 5 summarizes the scanner readings and the associated actual measured/computed plate images. Table 6 lists the average scanned reading for each solid and screen type and the standard deviation for the readings.

The scanned results were good. Solid patterns* showed small variations for the 50 percent and 90 percent samples of between 1-4 percent absolute (actual plate values varied). The 10 percent solids tended to show a +1 percent, -0 percent absolute variation. Scanning of

TEST IMAGE 3

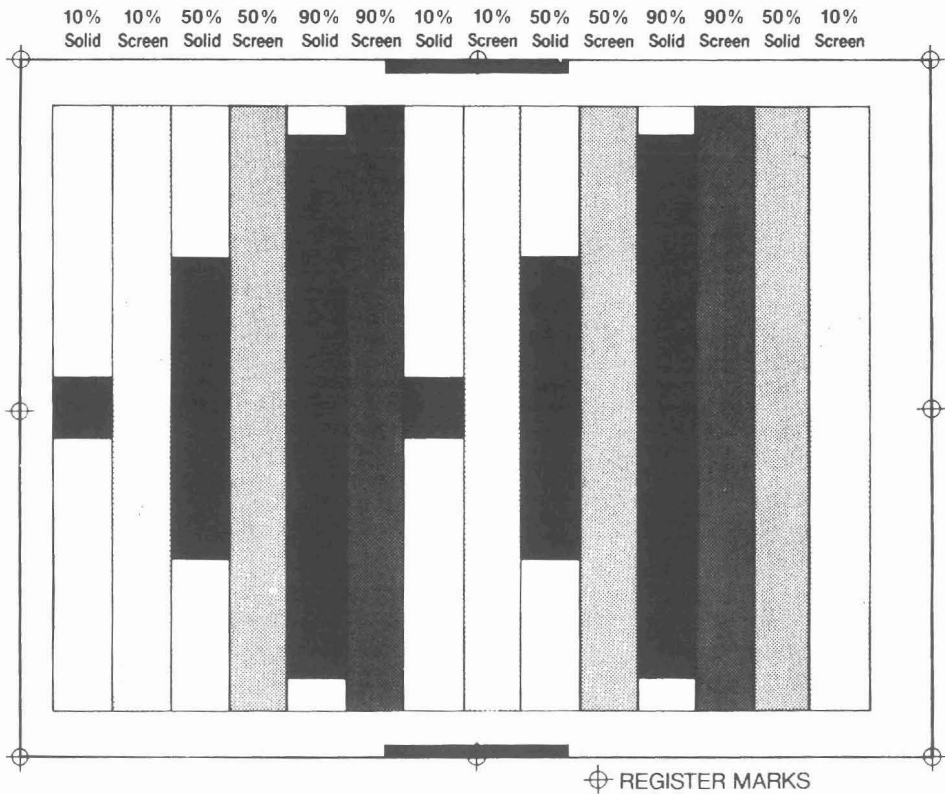


FIGURE 4

SCANNER/PHOTOMICROGRAPH TEST RESULTS

PLATE TYPE	COLOR	CONTR. RATIO	10% SOLID		10% SCREEN		50% SOLID		50% SCREEN		90% SOLID		90% SCREEN	
			SC	PH	SC	PH	SC	PH	SC	PH	SC	PH	SC	PH
Warren QS-100	CYAN	1.65	10	—	5	7.6	49	—	44	45.4	90	—	95	93.1
Richardson Rhino	BLUE	1.75	10	—	5	7.4	49	—	43	44.0	90	—	94	92.9
3M K+	MAGENTA	0.85	11	—	5	7.1	50	—	39	43.2	89	—	93	91.7
3M X-N	BLUE	2.61	10	—	5	6.8	48	—	40	43.0	86	—	89	92.4
Kodak M	PURPLE	1.70	10	—	4	7.4	49	—	41	42.1	88	—	91	90.7
Kodak S	PINK	1.42	10	—	6	7.4	49	—	40	44.8	88	—	91	92.7
Kodak L	DARK BLUE	3.23	11	—	7	7.4	51	—	46	43.1	91	—	94	93
Enco N-50	BLUE- GREEN	1.46	10	—	8	7.2	47	—	40	42.1	89	—	91	92.5
Enco N-200	LIGHT BLUE	1.45	10	—	2	6.2	48	—	39	40	87	—	89	93

SC = SCANNER
PH = PHOTOMICROGRAPH

TABLE 5

SCANNER READING FOR EACH PLATE: AVERAGE AND STANDARD DEVIATION

PLATE	TYPE	10%				50%				90%			
		SCREEN AVG.	SD	SOLID AVG.	SD	SCREEN AVG.	SD	SOLID AVG.	SD	SCREEN AVG.	SD	SOLID AVG.	SD
Warren	QS-100	5.3	0.62	10.0	0.00	43.7	0.49	48.9	0.35	94.0	1.41	89.5	0.53
Richardson	Rhino	6.3	0.97	10.0	0.00	43.5	0.67	49.5	0.53	91.9	2.03	89.0	0.76
3M	K+	4.8	2.72	10.4	0.74	40.8	1.36	50.0	0.00	92.9	0.35	90.1	0.99
3M	X-N	5.5	1.17	9.4	0.52	39.6	0.67	47.3	0.89	87.3	1.67	85.4	1.06
Kodak	M	3.7	0.49	10.0	0.00	40.7	1.30	49.5	0.53	91.8	0.71	89.1	0.99
Kodak	S	5.5	1.17	10.0	0.00	40.4	0.51	49.4	0.52	91.6	0.52	88.9	0.99
Kodak	L	6.4	0.90	11.6	0.74	45.2	1.27	50.8	0.46	94.0	0.00	91.1	0.35
Enco	N-50	5.1	3.80	9.5	0.53	37.6	1.88	46.8	0.46	89.8	1.58	88.1	0.99
Enco	N-200	1.7	0.49	10.0	0.00	38.7	0.89	47.8	0.46	88.4	0.92	87.4	0.74

TABLE 6

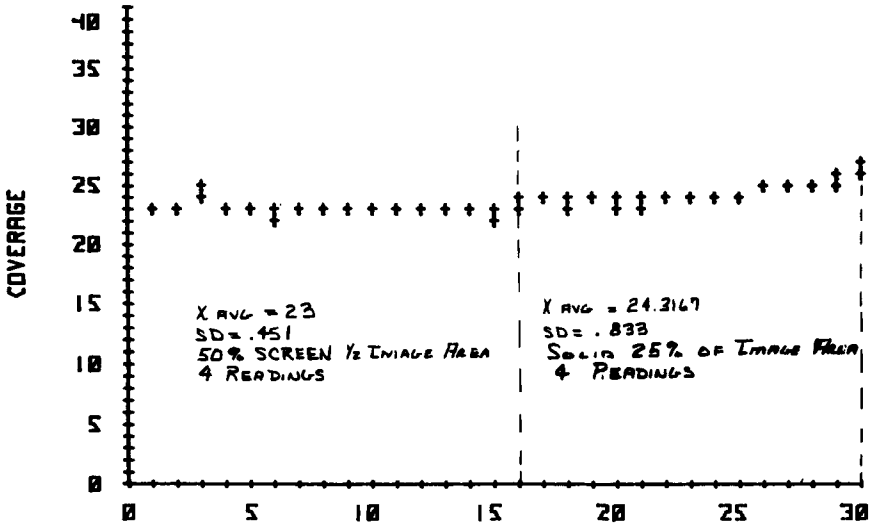
the screens resulted in scanned readings that varied by 1-4.8 percent for 50 percent screen and by 1-4 percent for the 90 percent screen. The 10 percent screens evidenced a wider spread of readings. Photomicrographic analysis showed that the average plate actually had a 7 percent screen. Seven of the plates read within 2 percent or better absolute, one sample read 4 percent and the ninth sample only measured as a 2 percent screen.

Densitometer checks of the low percentage screens showed that for the low reading plate, above, almost the same reading was obtained for the background as for the screen, due perhaps to some vagary in the plate background and/or lacquer color. Color seemed to be a factor - the two darkest read closest to the actual 7 percent number - but no substantive evidence is available.

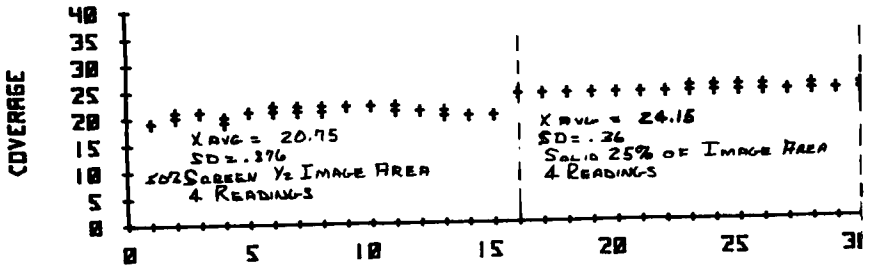
* Solid percentages refer to the ratio of solid image area to the total area of the rectangular bar sample (See Figure 4)

Uniformity of scanning was tested using a plate with an image composed of a 50 percent screen rectangle for half the plate width and a solid of half of the screen area for the balance of the plate. As the plate is scanned, the image "coverage" readout should be the same for all readings. A microscope analysis showed that as with previous screens, image transfer errors had occurred such that the 50 percent screen read low (41.5 percent for one plate sample and 46 percent for another). However, the scanned readings were indeed uniform (Figures 5 and 6 show the results for two samples). The standard deviation for the readings were less than 1 percent for all cases.

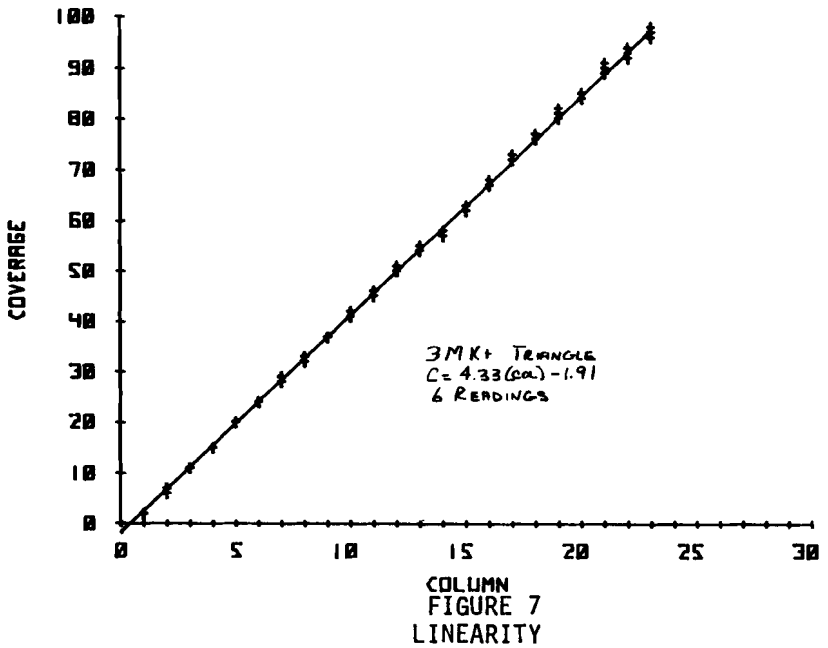
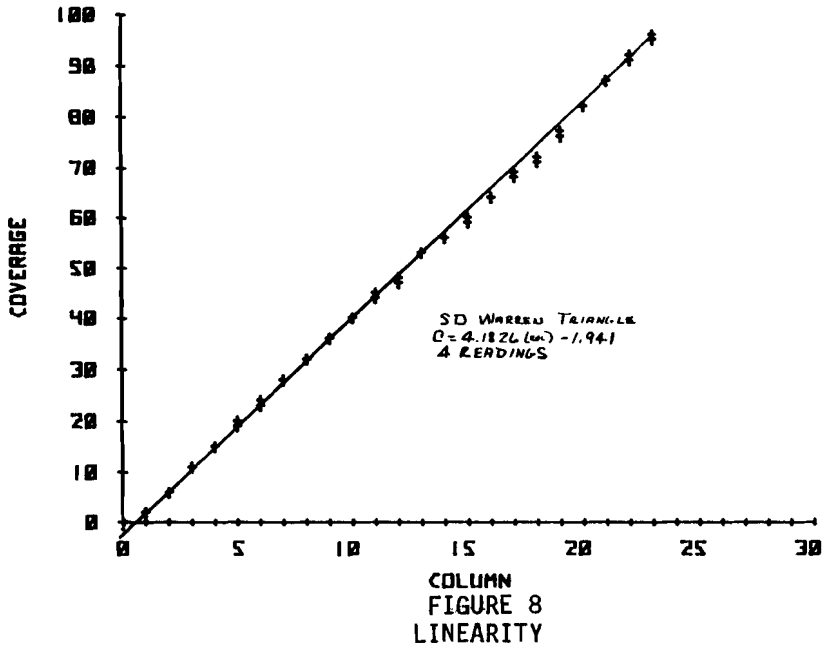
Linearity was checked using a solid triangle image. As this image is scanned the output reading should increase from a 0 coverage reading up to full or 100 percent coverage. Figures 7 and 8 show plots of the results for two samples. The correlation coefficient was +1 for each, thereby indicating a high linearity.



COLUMN
 FIGURE 6
 WARREN QS-100 25% Plate



COLUMN
 FIGURE 5
 3M K-PLUS 25 Percent Plate



All of the tests were performed using a broadband fluorescent light source. Although color "tweaking" can be used, in theory, to improve the results, it is our feeling that real-world operation would not likely use a colored light source since available plates vary in color. Another test series would have to be run to verify this possibility.

The measurement and utilization of density/reflectance data is not simple. Factors influencing these include the light source, filters, geometry of the measuring system and spectral sensitivities. Various sources of detailed information regarding these considerations are available.

The results of the scanner tests were very positive. This test series, although not totally definitive, indicates that the readings obtained were sufficiently accurate to be applicable to real-world operation. Additional work, both in terms of controlled testing and comparative analysis and in interface with operational presses is required.

PHASE III - PLATE COVERAGE AND PERFORMANCE ANALYSIS

In the third phase of Rockwell's study, it was decided that a comparison would be made to the scanning of negatives which has, for some time, been an industry accepted approach to presetting of ink keys. This phase consisted of two tasks: 1) the evaluation of scanned data vs. final press settings, and 2) the comparison of the printing plates to the negatives from which the plates were made.

Tests made during phase two of the study indicated that a potential area of difficulty would be found when scanning screens of low density. In order to verify this and in order to more accurately determine the nature of the expected difficulties, two sets of plates were designed, one consisting entirely of 150 lines per inch half-tones,

the other consisting entirely of 85 lines per inch half-tones. The composition of the set of plates is as follows:

<u>Average Density (%)</u>	<u>Lines Per Inch</u>
5	85
5	150
10	85
10	150
20	85
20	150
30	150
50	150
70	150

Plates used in these tests were ENCO-200 which were left ungunmed.

These plates were scanned using a commercial plate scanner. Values determined by the plate scanner were compared against values calculated by an ink algorithm. The scanned values were within the ranges shown in Table 5 for each of the nine plates. The values derived for all plates with screens of 20 percent or greater fell within a + 3 percent variation. The 5 percent and 10 percent screens demonstrated a variance of 9-10 percent.

An interim test was performed to determine the performance of the key settings provided by the plate scanner. In this test, a plate was scanned which provided preset values which were then entered in the press control system. The press was run and the ink settings adjusted until acceptable output was achieved. (It should be noted that the level of acceptability was determined visually rather than by densitometer measurement and was, therefore, subjective.) Table 9 shows the preset values, final values, and difference for each of the 32 ink keys of the couple upon which the test

was performed. It is worth noting that in 53 percent of the columns the difference was less than 10 percent and that in 37 percent of the columns, the change was 5 percent or less. The majority (81 percent) of the variances in excess of 10 percent occurred when the coverages were 10 percent or less. The ink algorithm used in determining these settings is a general algorithm. In the development of the data collection/analysis system, an algorithm which more accurately reflects the physical properties of the inking system of the press is employed. This will be utilized in the next phase of testing.

The next step in the Phase III study was to compare the setting values given by the plate scanner to the read out by Rockwell's negative scanner or PAR (Printed Area Reader). In order to accomplish this, the negatives had to be cut to allow them to fit on the platen of the PAR. Each negative was sectioned to a size of 24.5 inches by 15.6 inches. Sectioning was done on the same location on each negative in order to strive for consistency. These sectioned negatives subtended areas (as configured) of columns 1-15 on a printed page.

The negative scanner was first calibrated for 0 percent and 100 percent coverage using clear and opaque negatives. The plates made from the negatives were scanned again. The results of the comparative readings from both the negative and plate scanners are given in Table 7. The average of the columns scanned for the negative or plate is given and the standard deviation between columns is given.

Following the comparison, the half-tone dots of Column 1 of each plate were sampled with a 100x microscope with a field scale of .01 mm. The areas were calculated assuming the dots to be perfect circles. Results from these calculations are shown in Table 8.

An additional follow-up test was performed by constructing a mockup of a plate with a 10 percent solid stripe. The plate was made with a white posterboard

Plate Scanner and Negative Reader Static Accuracy

<u>Plate Cvg.</u>	<u>Plate LPI</u>	<u>PAR Avg.</u>	<u>Scanner Avg.</u>	<u>PAR Std. Dev.</u>	<u>Scanner Std.Dev.</u>
5	150	5.4	3	.3	1.0
5	85	6.9	6	.5	4.0
10	150	8.3	5	.3	1.2
10	85	11.6	9	.2	3.0
20	150	18.6	19	.2	1.0
20	85	21.8	22	.5	1.4
30	150	28.6	31	.2	1.6
50	150	49.9	56	.7	1.3
70	150	68.9	74	.2	2.0

Table 7

Column 1 Dot Diameter Measurements

<u>Plate Cvg %</u>	<u>Plate LPI</u>	<u>Dot Size (mm) Comments</u>
5	150	.05
5	85	left half - elliptical dots .09 x .13 right half - .1, .095, .09
10	150	.06
10	85	.11, .12
20	150	.082, .085
20	85	.16, .162
30	150	.11
50	150	.14
70	150	.1 (clear area dot, not solid)

Table 8

Scanner Preset vs. Final Key Values

<u>Ink Col.</u>	<u>Preset Values</u>	<u>Final Values</u>	<u>Percent Difference</u>
	scale = 250		
	offset = 3		
	osc = 32		
1	88	98	10
2	95	89	6
3	3	0	3
4	39	30	9
5	33	39	6
6	3	10	7
7	42	34	8
8	41	43	2
9	41	43	2
10	41	40	1
11	3	10	7
12	85	84	1
13	91	96	5
14	95	93	2
15	71	66	5
16	69	66	3
17	97	99	2
18	93	99	6
19	93	96	3
20	3	8	5
21	13	9	4
22	3	0	3
23	42	41	1
24	41	42	1
25	41	38	3
26	41	42	1
27	13	17	4
28	35	20	15
29	39	43	4
30	3	3	0
31	97	90	7
32	90	99	9

Table 9

background and a black stripe. This test was performed to verify, at the current point in time, that the plate scanner would read the density of uniform material to an accuracy of 1 percent, which was the case.

In performing an analysis of the data, the main criterion must be the usefulness of the plate data. Usefulness of plate coverage data is determined by its accuracy and linearity. An accuracy goal of 3 percent, absolute, had been established since greater difference could have an adverse impact on the usefulness of the ink algorithm values. Linearity is important because an ink algorithm is more dependent upon the linearity of scanned coverage to actual coverage rather than the absolute accuracy of the coverage. The goal for linearity is that the scanner produce values within the error tolerance across the entire range of coverage, 0 - 100 percent. The data collected was analyzed for these characteristics.

The maximum standard deviations in the column-by-column readings of screens obtained with the Rockwell PAR and the plate scanner were 0.7 percent and 4 percent, respectively. This is attributable to variations in plate making since:

- some plates had visible changes in the screen
- coverage estimated from measured dot diameter varied from the scanner average by 1 to 3 percent

The Rockwell PAR (Printed Area Reader) and the plate scanner both remained relatively linear for 85-line screens of low coverage. The 85-line results for the Rockwell PAR, plate scanner and microscope are plotted in Figure 9. All three methods stayed within the 3 percent difference from the nominal values. The conclusion drawn from this is that the plate coverage data is acceptable for 85-line screens.

The Rockwell PAR maintained a relative linearity for 150-line screens but the plate scanner deviated for the 10 percent-150 line screen. The 150-line results were plotted against the nominal values as shown in Figure 10. The result was that the plate scanner diverged significantly from the PAR readings and the microscope estimates for the 10 percent and 5 percent screens. Outside this range the scanner yielded a linear response. Some values reported were more than 3 percent greater than nominal but were within 3 percent of the microscope estimate. This is attributed to error in the plate making process that presumably made the dots larger than nominal.

The non-linear performance for 150-line screen Enco N-200 plates could be due to either the optical characteristics of the plate materials or due to non-linear response of the plate scanner. In an attempt to determine which is the case, the plate scanner readings for the ENCO N-200 plates were plotted with coverage as calculated from the RIT results (from the Phase I study).

The RIT results were given as density values but the coverage was calculated two ways. Reflectance was used because the plate scanner measures reflectance.

$$R(x) = 10^{-D(x)}$$

$$\text{Percent Coverage} = (R(x) - R(0\%)) / (R(100\%) - R(0\%))$$

The density values were also used as a first degree equation on an empirical basis

$$\text{Percent Coverage} = (D(x) - D(0\%)) / (D(100\%) - D(0\%))$$

The result was that the RIT calculated coverage based on the reflectance showed some non-linearity but, at the 5 percent and 10 percent points, the RIT coverage curve was close to the nominal values. Of interest is that the plate scanner data was approximately parallel to the RIT data but shifted away from the nominal for the 0 percent

to 20 percent range. A tentative conclusion drawn is that the optical characteristics of the plate will determine the shape of the calculated coverage curve and that the device used to read the coverage will primarily shift the curve around the nominal line without making fundamental changes in the slope of the curve.

As seen in Figures 9 & 10, the slopes of the curves are approximately the same, particularly for screens of 20 percent coverage or greater. As such, it was determined to continue the study by conducting a test in a "real-world" application.

PHASE IV - REAL WORLD TESTING

The fourth phase of this study will be a test using a Rockwell press. Having obtained positive findings thus far in the study, it was decided to attempt to determine the viability of presetting an operational press, using a plate scanner. In order to do so, Rockwell has developed a Data Collection/Analysis system to be placed on-line with the press console, allowing the collection of plate and ink key data and the monitoring of ink key changes.

The Data Collection/Analysis System has been designed to measure the effectiveness of presetting a press using ink key data input from a plate scanner. The scanner's column percent coverage data is stored and, if required by the job, is modified by any one of four specified ink algorithms in the Data Collection/Analysis Systems. Upon operator request, the preset data is transmitted to the remote press console which, in turn, sends the preset data to each unit of the press. After the press console has received the data, the Data Collection/Analysis System initiates Makeready II monitoring. It automatically records all changes made to the ink key settings on the press until the press is ready to initiate a production run. The job's data base is then time-stamped with the elapsed time of the Makeready II cycle.

**RECORDED VALUES VS. NOMINAL VALUES
85 LPI SCREENS**

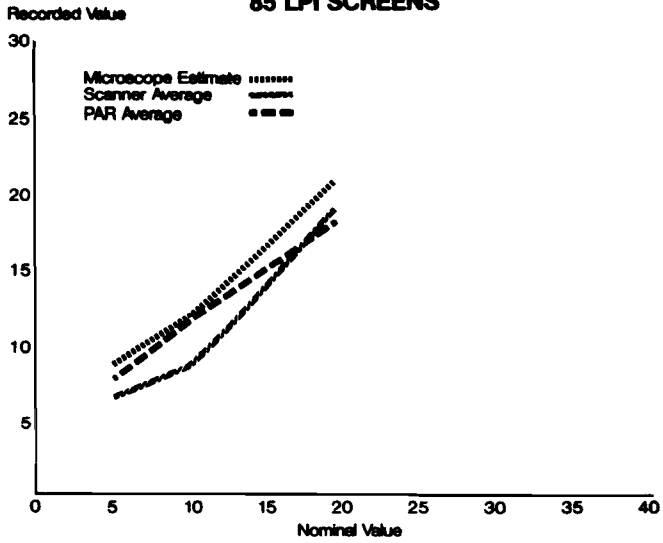


FIGURE 9

**RECORDED VALUES VS. NOMINAL VALUES
150 LPI SCREENS**

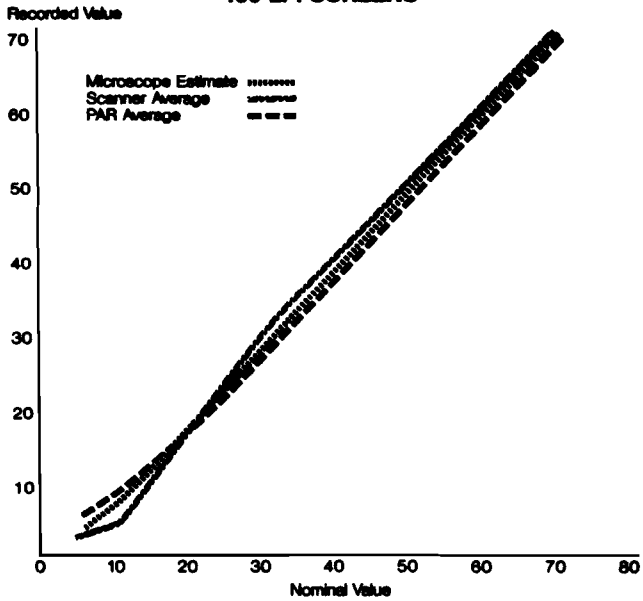


FIGURE 10

At this point, the Data Collection/Analysis System operator can request a series of reports from the system regarding the job which had been preset and gone through Makeready II. The system will produce quantitative reports based on job number, ink algorithm used, ink color, unit and plate identifier. Additionally, the system will monitor all ink key changes made to the press throughout the production run. As of this writing date, this phase has not commenced.

SUMMARY

In Rockwell's study of plate characteristics and image scanning, certain plate and image factors were examined. The study, divided into four phases, 1) study of commercial plates to determine inherent characteristics, 2) investigative tests with plate scanner, 3) data collection and analysis for presetting and plate/negative comparisons, and 4) integration of scanner data collection/analysis system to an on-line press, has yielded pertinent information.

- . Plate background density does not vary across plate surface
- . Gumming, applied subsequent to imaging, can affect density, but modern applicators are generally uniform
- . Light source is important factor, but visual broadband light appears to be adequate
- . Plate lacquer color influences reflectivity
- . Linearity and uniformity of scanned data is very good
- . Image fidelity may change from layout to negative to plate
- . Device used to read coverage may shift curve nominally without fundamentally affecting slope

- . All three methods employed agree within 3% in mid-tone range

While the results found thus far are not absolutely conclusive, Rockwell has been encouraged by the findings of the study. It is recognized that the areas investigated in this study are not all-inclusive and it could be useful to investigate other areas, such as, low-end scanability (plates of less than 20% coverage), system-wide effects of laser platemaking, use of wipe-on plates, and effects of different color lacquers.

Acknowledgements and thanks to the many people within Rockwell Graphic Systems for their assistance and review. In particular, the technical contributions of Lloyd Jones to this study were of major importance. Special thanks to Linda Longo for her efforts in deciphering our writing and producing the paper, and the assistance of Phyllis Heiberger in typing portions of the paper is appreciated.