FURTHER ANALYSIS OF FACTORS CONTRIBUTING TO VARIABILITY IN WEB OFFSET COLOR ADVERTISING REPRODUCTION

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A primary purpose of GCA's SPECTRUM program is to find the means for control of variability in web offset color advertising reproduction. Because SPECTRUM encompasses virtually the entire advertising reproduction community, from agency to printer, it offers a unique opportunity for testing and implementing total system approaches, crossing the traditional industry lines that could otherwise stand as barriers to coordination.

The SPECTRUM testing program began in 1978, immediately following the first SPECTRUM forum. An annual event, SPECTRUM brings together management representatives from advertising agencies and their clients, separation houses, publishers, printers, and suppliers to improve levels of communication and coordination among industry segments, and otherwise to create a better climate for the application of current and future technologies to national magazine ad production. Education, dialogue and research are principal ingredients to the SPECTRUM formula. The research takes place primarily in commercial production facilities. It basically draws upon much of what has been known through laboratory research, into a day to day operating environment. In a sense, it is a means of packaging information in a manner that can produce action responses on the part of those who can implement resulting recommendations through purchasing, procedural, and other operational decisions.

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The industry has said for a number of years that there are at least 148 variables that affect web offset output quality. Managers also know, however, that large problems can generally best be solved by breaking them into small, definable segments. Thus each of our research steps has attempted to focus on a small number of variables and, in the evaluation, analyze results for the single most important factor that affected those results. This GCA SPECTRUM approach has often been called the "elephant hunt."

In its initial testing for SPECTRUM '79, our Print Properties Committee chose paper surface characteristics as the subject for study. Results indicated that uniform separations and controlled production conditions produced printed results for eight of the advertisements involved that were well within commercially acceptable tolerances, regardless of the variations in brightness, gloss and shade of the paper stocks used.

After a diversion in the 1980 testing to find an alternative to the standard proofing stock (which the 1979 test indicated as being incompatible with production stocks) the 1981 test pursued the key factor of uniformity in separations. Through the use of the Eastman Kodak Color Analyzer System, tone reproduction curves were calculated for proofing presses in four member color service houses. Comparability of results, between the four proofing presses and with the follow-up production press run, confirmed the importance of uniformity in film preparation and pointed out the significance of dot gain to press output variability.

With dot gain identified as a major elephant, or variable, in the effort to get uniform proofing press results, the research in 1982 pursued its significance in the production pressroom. The 1982 test, which used live ad material as the color guide, was reviewed in detail at TAGA in 1983. The results showed that, indeed, mid-tone dot gain was a primary cause of variation in printing results among

production web offset presses. The test also confirmed the viability of the concept of defining a "par" for production presses from which tone reproduction curves could be established for preparatory operations. With this information the Committee engaged in the comprehensive multi-phase Spectrum '83 test project.

Thirty web offset periodicals production presses took part in the Spectrum '83 test. All were provided an eight page test form which consisted of four pages of test targets from System Brunner, courtesy E.I. DuPont Company; the Color Analyzer Target of Eastman Kodak Company; the GATF and RIT Color Bars and the Stouffer Gray Scale, courtesy 3M Company; the Spectragraphic, Inc., Color Bar; the GCA/GATF Proof Comparator and an Under Color Removal Test Target. In addition, each participant was provided a SWOP High-Low Color Reference, courtesy International Association of Photoplatemakers. The Color Reference, while intended for use with a sheet fed proofing press, did permit the establishment of a uniform tolerance for ink density for all presses, a primary consideration for print performance comparision purposes and for developing the "par" tone reproduction curve.

In addition to printed sheets, the 28 printers who completed the test run submitted to GCA for analyses: ink and fountain solution samples from the press; unprinted paper from the press feeds; and the plates used in the test run.

Analyzers included the 3M Company, the DuPont Company, Eastman Kodak Company, S.D. Warren Company, General Printing Ink Division of Sun Chemical, Bordon Ink, Inmont, Bowers Printing Ink, and U.S. Printing Ink. GCA is most appreciative of the hundreds of staff hours devoted by these firms to the test project. We also express our appreciation to Sterling Regal and Spectragraphic, U.S. News and World Report, Edwin Bird Wilson, J. Walter Thompson/Detroit, and the 28 printers who made up the test group.

Some of the specifics which resulted from this exhaustive test effort and analysis include:

1. A better comparative understanding of dot gain and other performance measurement techniques.

2. An appreciation for the range and extent of dot gain in the industry.

3. A calculation of a "par" tone reproduction curve for the participating presses and a follow-up test of that curve.

4. A lead to a major cause of dot gain.

5. A better knowledge of pressroom conditions both overall and for the individual participating printers.

6. Guidance for further refinement of the search to control the variability in web offset color reproduction.

In the final analysis, fairly comparable results were produced by the several approaches to dot gain measurement. However, differences in the measurement base (GATF's 40 percent dot, Brunner's 50 percent), means of accounting for optical gain, approach to sampling (single location versus multiple averaged locations), and the various instrumentation methods and devices, create a degree of confusion on the part of press crews and managers who should be making use of this information in a constructive way, and erect a communications barrier that the industry can ill afford. Other than this negative factor, the various test objects used produced an array of data that is exciting in its scope. We may anticipate that several years will elapse before the full impact of the usefulness of all this data--much of it never before available--will be felt.

The range of dot gain among the

participating presses proved to be quite broad, as may be determined from Exhibit 1. It is important to note that the participating presses do not represent a scientific sample. Almost as many plants as presses were represented; some of those plants have only one or two presses while others contain dozens of presses. Test speeds were not controlled. SWOP ink densities used were designed for proofing purposes, not production purposes.

In spite of these concerns, a drop-out of extremes did permit the creation of the desired par tone reproduction curve. This work was performed for GCA by Eastman Kodak Company and details of the approach appear elsewhere in these proceedings. Equipped with that par curve, our Committee constructed a new test form that encompassed, along with most of the previously used test objects, pictorial images separated both to the par curve and to a "conventional" curve normally used by a separation house for this type of work.

This new test form was used in Phase II of the Spectrum '83 test program. Run on four production presses, both to density and to a color match based on a supplied proof, the par curve in all cases resulted in a more appealing image than was produced by the conventional curve, was better matched to the proofs, and produced greater uniformity between sites.

Samples of the host of additional data compiled from the test project appear in Exhibits 2 and 3. An analysis of these data indicates a relationship between dot size and ink film thickness. Ink film thickness, in turn, appears to have an inverse relationship with ink strength. Obviously many other factors enter into the determination of dot gain causes. None, however, stand out as prominently as this one item of ink strength. Further data from the test may also be found in "The Quality Control Scanner," Volume 2, No. 11, published by Graphic Arts Publishing Company, Miles and Donna Southworth, Editors.

The benefit of participation to the

individual printers appears to have been extremely high. A current survey of these printers is providing a tally of steps that have been and are being taken to provide greater operational control. One printer, for example, found that his pH readings were out of line with those of other participants. Improved fountain solution measurement techniques and daily monitoring of this important factor are, in the printers words, bringing about greater consistency in printed results. Some now claim to have a more intelligent basis for making supplies purchase decisions. Revised equipment maintenance procedures are also common. GCA's slogan, "Until you measure you cannot control," is proving its truth once again.

GCA is now well into its 1984 test program. Once again, publishers, printers, separation houses, suppliers, and advertising agencies are showing their strong support through significant contributions including materials, press, scanner, and other equipment time; staff time and talent; travel budgets, and laboratory analysis capabilities. With control of density and dot gain the primary objective, the test committee is looking first at the ink strength factor, followed by other items as may pertain to the individual presses involved. Industry specifications for production ink strength and hue appear to be conceptually sound. The 1984 tests will hopefully prove them out.

Narrowing the range of dot gain in the production pressroom is essential if the par curve concept is to prove relevant. The Committee's work thus far has already narrowed that range for participating printers. Definitive steps for all to follow is our next goal.

In closing, it must be pointed out that a tone reproduction curve to accommodate a tolerence window of dot gain on production presses can only be acceptable as a systemic improvement if it can be accommodated by and useful to other elements of the system. Before an ad can be printed in a magazine, the ad must

be sold to the advertiser. The proof plays an important role in that sale. The proof must reflect in its best light what the film will produce on press. A production press-oriented tone reproduction curve will not be effective if proofing conditions vary greatly from those in the production pressroom. A major condition is the proofing stock itself. The proofing stock now accepted as the industry specification differs significantly from production stock used in the majority of magazines. Exhibit 3 shows the properties of those production stocks. All but one are within two points of a 70 brightness level. The current industry specified stock carries an 80 brightness. The par tone reproduction curve would in all likelihood be ineffective for use with that stock. Fortunately, the industry committee SWOP (Specifications Web Offset Publications) has authorized a 70 brightness stock for testing. Hopefully the results will prove satisfactory so this important coordinating step between proofing stock and production stock can be achieved.

We have said that a primary purpose of SPECTRUM is to find the means for control of variability in advertising reproduction. Finding those means is only the first step, however. Acceptance and application must follow. The cooperation from throughout the industry that has been afforded GCA in its test efforts indicate, we believe, the interest and willingness that exists to take advantage of the research and the tools available to us. We welcome the recommendations and assistance of all the TAGA membership in our past and future research, to assure the proper direction and practicality of our work.

GCA 1983 PRESS TEST - CONTINUED

	DOT SIZE PLATE				DOT SIZE PRINT				DOT GAIN PRINT				BRUNNER DOT GAIN				GATE DOT GAIN				GREY SCALE			
TEST #	Y	M	C	K	Y	M	C	K	Y	M	C	K	Y	M	C	A	Y	M	C	K	Y	M	C	K
GCA11B	43	42	43	42	56	54	55	61	16	14	15	21	13	12	15	24	.0	6.0	5.0	6.5	7.00	7.00	7.00	7.50
GCA12	0	0	0	0	69	71	68	68	29	31	28	28	25	33	24	22	.0	8.5	7.5	8.0	6.00	7.50	6.00	6.50
GCA14	0	0	0	0	75	54	56	58	35	14	16	18	39	12	9	16	.0	6.0	6.0	6.0	8.00	7.50	7.00	.00
GCA15	41	41	42	41	56	64	62	59	16	24	22	19	14	33	22	21	.0	8.0	6.5	6.5	4.00	4.00	3.50	4.50
GCA15A	0	0	0	0	61	66	65	61	21	26	25	21	19	39	24	22	.0	8.5	7.0	7.0	4.00	4.00	3.50	4.00
GCA17	0	0	0	0	64	64	65	71	24	24	25	31	19	31	19	42	.0	8.5	7.0	8.5	8.00	8.00	8.00	8.00
GCA18	0	0	0	0	52	54	60	63	12	14	20	23	8	14	19	18	.0	7.0	6.0	6.0	5.00	5.00	5.00	5.00
GCA19	0	0	0	0	63	62	57	60	23	22	17	20	20	24	24	13	.0	7.0	5.5	6.0	6.00	5.00	6.00	5.00
GCA20	43	43	44	43	56	56	61	64	16	16	21	24	11	16	16	28	.0	7.0	6.0	7.5	5.00	5.00	5.00	6.00
GCA21	40	40	40	39	72	74	71	80	32	34	31	40	30	39	25	41	.0	8.0	8.0	8.5	4.00	5.00	5.00	4.00
GCA22	45	44	45	43	63	63	63	62	23	23	23	22	22	24	17	16	.0	8.0	6.0	6.0	6.50	5.50	7.00	6.00
GCA23	45	44	45	44	57	55	62	60	17	15	22	20	11	12	18	15	.0	7.0	7.0	7.0	9.00	8.00	8.00	8.00
GCA24	35	34	35	35	51	56	55	57	11	16	15	17	7	16	10	15	7.0	6.5	4.0	4.5	6.00	6.00	6.00	6.00
GCA25	44	44	44	44	63	67	71	74	23	27	31	34	17	22	28	41	.0	8.0	8.0	8.5	9.00	9.00	9.00	9.00
GCA26	41	41	40	40	61	64	58	62	21	24	18	22	23	30	15	24	6.0	8.0	3.5	5.0	3.00	4.00	2.00	3.00
GCA27	43	44	44	0	59	57	64	72	19	17	24	32	13	20	30	43	.0	6.0	7.0	8.0	6.50	6.50	6.50	6.50
GCA28	44	43	41	40	55	54	59	58	15	14	19	18	15	12	12	11	6.0	7.5	4.5	6.0	6.00	5.00	4.50	5.00
GCA29	42	43	0	41	64	56	53	58	24	16	13	18	15	16	16	22	.0	6.5	6.5	8.0	5.00	5.00	5.00	5.00
GCA30	44	45	46	44	68	72	76	78	28	32	36	38	19	36	36	33	.0	9.0	8.0	8.0	8.80	8.80	8.80	8.80

GCA31	42	42	43	41	55	60	58	55	15	20	18	15	10	22	20	11	.0	8.0	6.5	5.5	5.00	5.00	5.00	5.50
GCA32	43	43	42	42	74	54	57	68	34	14	17	28	21	13	17	33	.0	6.0	6.5	8.0	5.00	4.00	4.00	4.80
GCA34	0	0	0	0	48	53	57	60	8	13	17	20	6	23	16	20	.0	6.0	6.0	5.5	9.00	8.00	9.00	8.00
GCA35	44	43	45	43	62	65	67	71	22	25	27	31	19	29	26	36	.0	8.0	7.0	8.0	6.00	6.00	6.00	6.00
GCA36	43	43	42	42	56	58	64	65	16	18	24	25	14	21	21	22	6.0	7.5	7.0	7.0	5.00	5.00	5.00	5.00
GCA37	36	37	37	35	55	60	54	63	15	20	14	23	13	27	16	21	.0	7.0	4.0	6.0	6.50	7.00	7.00	6.80
GCA38	44	43	45	43	68	71	71	90	28	31	31	50	14	28	22	30	.0	9.0	7.5	6.0	5.00	4.80	4.80	4.80
GCA39	44	44	44	44	56	63	65	64	16	23	25	24	11	28	22	17	.0	8.0	6.5	5.5	7.00	6.50	6.50	6.50
GCA41	46	44	44	45	57	69	68	72	17	29	28	32	15	37	33	36	.0	8.0	7.5	7.5	7.00	6.90	6.90	6.90
GCA42	44	44	44	44	64	63	63	61	24	23	23	21	19	22	20	17	.0	.0	.0	.0	8.00	8.00	8.00	6.80
GCNMP	0	0	0	0	63	65	64	66	23	25	24	26	9	13	10	15	.0	2.5	2.0	2.5	3.00	4.00	3.00	4.00
GCPMPG	0	0	0	0	62	64	63	64	22	24	23	24	14	15	13	16	.0	3.5	3.0	3.5	3.00	3.00	3.00	3.00

GCA 1983 PRESS TEST - CONTINUED

TEST #	HUE ERROR			GREYNESS			HUE ERROR			HUE INK			GREY INK			CONTRAST				MAJOR FILTER DENSITY			
	Y	M	C	Y	M	C	R	G	B	Y	M	C	Y	M	C	Y	M	C	K	Y	M	C	K
GCA11B	7	47	19	12	17	20	-95	77	63	4	44	20	2	10	8	25	27	27	30	1.14	1.43	1.27	1.53
GCA12	9	47	16	11	18	19	-97	55	91	5	43	18	0	11	7	19	23	32	15	1.09	1.46	1.47	1.57
GCA14	7	46	18	10	20	22	-72	-90	96	3	41	20	3	13	8	-1	19	30	45	1.36	1.23	1.19	1.59
GCA15	11	48	16	13	17	21	97	61	82	9	44	18	1	10	8	29	13	29	33	1.01	1.41	1.27	1.47
GCA15A	10	46	17	14	17	20	99	58	87	8	43	19	2	9	7	15	13	28	31	1.07	1.48	1.38	1.49
GCA17	10	46	18	13	18	20	96	49	88	5	41	19	3	12	9	9	16	32	17	.96	1.30	1.42	1.62
GCA18	10	48	18	14	19	21	-97	62	95	6	44	19	2	11	9	17	30	33	33	1.03	1.38	1.36	1.50
GCA19	6	43	21	12	21	17	-82	100	94	3	40	21	7	16	7	11	8	26	33	1.14	1.20	1.04	1.04
GCA20	10	51	19	13	19	21	-93	55	95	7	47	20	2	12	9	25	35	26	42	1.04	1.26	1.30	1.61
GCA21	9	47	18	10	18	22	-94	84	65	6	43	20	1	12	8	18	9	11	6	1.15	1.43	1.19	1.44
GCA22	9	48	17	11	19	21	-91	65	86	5	43	18	2	13	10	32	26	33	18	1.21	1.48	1.46	1.85
GCA23	9	49	16	13	18	22	-95	74	75	6	45	20	1	10	8	19	29	27	33	1.08	1.40	1.29	1.30
GCA24	11	50	18	10	17	21	97	68	68	6	46	19	2	12	9	23	23	27	45	1.11	1.45	1.24	1.62
GCA25	10	46	18	14	19	22	-99	61	98	5	41	19	3	11	8	-2	19	26	19	.95	1.29	1.29	1.58
GCA26	10	47	18	11	17	20	99	73	80	7	44	19	2	10	8	11	19	32	37	1.14	1.41	1.33	1.53
GCA27	8	52	18	12	19	19	-91	67	87	5	49	19	2	13	8	17	32	27	17	1.11	1.34	1.37	1.45
GCA28	9	49	17	11	18	21	-80	90	73	5	45	18	1	10	8	24	32	28	36	1.10	1.31	1.21	1.43
GCA29	9	43	18	15	23	22	-90	91	97	7	40	18	2	11	7	36	26	31	32	1.27	1.23	1.34	1.54
GCA30	8	51	17	17	17	22	100	60	87	4	48	18	5	9	10	9	17	15	11	.96	1.35	1.33	1.42

GCA31	12	48	19	12	18	19	-98	67	84	10	45	20	2	12	9	28	24	39	44	1.09	1.43	1.46	1.61
GCA32	9	54	20	18	20	24	-97	55	57	5	49	22	3	11	8	-10	24	28	28	.84	1.19	1.19	1.52
GCA34	11	48	18	13	17	22	95	51	85	7	43	20	3	11	8	23	24	28	34	.94	1.27	1.20	1.52
GCA35	10	46	18	14	19	20	95	48	82	6	42	19	3	11	7	23	14	26	17	1.09	1.38	1.31	1.53
GCA36	12	44	17	12	18	20	99	73	80	9	41	18	3	12	8	32	25	18	29	1.18	1.46	1.25	1.50
GCA37	11	47	19	12	18	21	93	78	81	7	41	21	3	12	7	27	20	32	27	1.16	1.41	1.33	1.50
GCA38	12	49	19	16	20	23	96	55	71	9	45	20	2	11	8	13	21	17	16	.99	1.39	1.21	1.51
GCA39	8	48	17	12	17	18	96	56	91	4	44	18	2	10	7	20	21	32	20	1.14	1.46	1.46	1.42
GCA41	13	46	17	14	18	22	-97	82	56	10	43	19	2	11	8	10	25	19	13	1.02	1.50	1.18	1.43
GCA42	11	45	17	10	16	18	96	78	82	10	42	18	1	10	8	18	29	29	35	1.08	1.49	1.30	1.47
GCNMP	8	48	19	7	20	18	-93	76	86	6	46	19	0	16	11	26	32	30	36	1.07	1.36	1.28	1.62
GCPMPG	7	50	19	7	15	18	-86	91	78	6	48	19	3	12	12	32	35	34	45	1.15	1.34	1.28	1.74

GCA 1983 PRESS TEST - CONTINUED

TEST #	MACBETH VALUES L	A	B	PAPER GLOSS	PAPER OPAC.	PRT SURF ROUG SOFT	BRIGHT -NESS	K&N ABS OEWS	% GROUND	E.S. CONDUCTIVITY YEL	MAG	CYAN	KEY
GCA11B	87.04	-.11	4.46	45.80	92.20	1.43	71.20	.13	20.0	450.00	700.00	650.00	700.00
GCA12	87.04	-.48	4.52	57.40	92.40	1.01	68.90	.10	20.0	1950.00	1950.00	1900.00	2300.00
GCA14	87.81	.93	5.14	49.60	93.30	1.33	69.50	.07	30.0	1000.00	1250.00	1125.00	1000.00
GCA15	86.22	-.46	5.87	55.80	92.00	1.39	68.90	.10	30.0	1850.00	1825.00	1850.00	1900.00
GCA15A	86.22	-.46	5.87	55.80	92.00	1.39	68.90	.10	30.0	1850.00	1825.00	1850.00	1900.00
GCA17	88.35	.71	5.29	49.80	93.70	1.36	70.50	.10	30.0	530.00	530.00	500.00	510.00
GCA18	86.54	.22	3.98	45.90	90.40	1.50	68.80	.09	30.0	1.00	1.00	1.00	1.00
GCA19	92.15	.06	2.72	57.40	93.00	1.48	.00	.00	1.0	1250.00	1200.00	1100.00	1200.00
GCA20	.00	.00	.00	.00	.00	.00	.00	.00	.0	.00	.00	.00	.00
GCA21	86.27	-.44	4.70	46.60	86.40	1.34	70.40	.07	40.0	2200.00	2200.00	2150.00	2200.00
GCA22	85.24	.45	5.14	45.00	85.80	1.30	68.00	.07	40.0	890.00	890.00	1000.00	890.00
GCA23	85.15	-.18	4.74	47.70	91.90	1.40	67.90	.10	20.0	1400.00	1350.00	1250.00	1375.00
GCA24	87.85	-.28	5.55	50.70	89.60	1.29	72.30	.10	40.0	2325.00	2475.00	1900.00	1890.00
GCA25	87.08	.13	5.18	46.00	90.00	1.16	70.90	.12	50.0	1925.00	2700.00	1950.00	2000.00
GCA26	86.08	-.49	5.21	58.10	91.40	1.28	69.00	.08	20.0	1600.00	1600.00	1575.00	1400.00
GCA27	.00	.00	.00	.00	.00	.00	.00	.00	.0	.00	.00	.00	.00
GCA28	88.24	.30	5.03	45.20	91.70	1.53	70.50	.08	40.0	1650.00	1575.00	1550.00	1650.00
GCA29	.00	.00	.00	.00	.00	.00	.00	.00	.0	.00	.00	.00	.00
GCA30	86.91	-.46	6.09	46.50	91.00	1.51	68.90	.09	.0	2800.00	2800.00	2800.00	2800.00

GCA31	86.77	.25	4.95	58.80	92.20	1.61	70.00	.10	40.0	600.00	750.00	790.00	725.00
GCA32	85.25	-.71	4.27	48.00	87.60	1.18	69.10	.07	50.0	725.00	725.00	650.00	725.00
GCA34	87.81	-.93	5.14	49.60	93.30	1.33	69.50	.07	30.0	1000.00	1250.00	1125.00	1000.00
GCA35	85.65	-.25	4.65	50.70	88.30	1.29	69.20	.07	40.0	2475.00	2500.00	2400.00	2400.00
GCA36	86.64	-.32	4.61	55.50	89.90	1.25	70.90	.06	40.0	2350.00	2350.00	2350.00	2350.00
GCA37	87.77	-.16	5.56	45.50	91.00	1.29	71.80	.10	30.0	1925.00	1850.00	1875.00	1875.00
GCA38	84.30	-.65	3.99	47.60	88.90	1.07	67.90	.06	50.0	1100.00	1150.00	1150.00	1100.00
GCA39	86.26	.63	4.76	50.70	92.00	1.29	69.50	1.00	1.0	1100.00	1125.00	1025.00	1050.00
GCA41	87.58	-.62	4.96	49.00	87.90	1.30	69.30	.07	40.0	3400.00	3600.00	2825.00	3400.00
GCA42	90.69	1.37	5.15	43.70	91.30	1.77	75.60	.12	1.0	1100.00	1100.00	1100.00	1050.00
GCNMP	.00	.00	.00	.00	.00	.00	.00	.00	.0	.00	.00	.00	.00
GCPMPG	.00	.00	.00	.00	.00	.00	.00	.00	.0	.00	.00	.00	.00