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

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A primary objective of GCA is to assist the graphic communications industry's employment of technologies and management skills to achieve greater efficiency in the manufacture and distribution of a quality product. One of the conditions standing in the way of this efficiency has been the segmentation of the management of the various phases of product creation and manufacture. Production of a four-color national magazine advertisement, for example, involves no less than six distinct entities, each with individual goals that may potentially conflict with the overall goal of efficient manufacture of a product that meets the realistic quality expectations of the advertiser.

In 1978 GCA began the pursuit of an improved climate for the application of current and future technologies to national magazine ad production. Its SPECTRUM forum, now an annual event, brought together for the first time management representatives from advertising agencies and their clients, separation houses, publishers, printers and suppliers. The purpose was and continues to be an improved level of communication and coordination among all industry segments, through education, dialogue and research. The effectiveness of the program has been felt, through a better understanding and acceptance of the responsibilities of each segment to the cost and quality of the ultimate product, expanded implementation of industry specifications for coordination of materials and procedures, and an increased willingness to capitalize on opportunities afforded by advancing technologies.

The research effort of SPECTRUM has not always had pursuit of knowledge as its goal. Much of what has and will be found is a confirmation of what has been known and proven in other research environments. The purpose of the research may more realistically be defined as the pursuit of a greater understanding of this knowledge among those who are in a managerial position to put it to work in day to day operations.

**Graphic Communications Association, a National Affiliated Association of Printing Industries of America, Inc.*

The specific stated goal of the research effort is the control of variables in four-color web offset advertising reproduction. The first project, in 1979, focused on the significance of surface characteristics of production paper. Following a survey of six characteristics–brightness, gloss, shade, smoothness, absorbtivity and opacity–of common four and five grade publication stocks, three factors were selected for testing. S.D. Warren Research Laboratories manufactured five rolls of stock with varying brightness, gloss and shade levels that reflected the range found in the production stocks. The test form consisted of eight ads covering a broad range of subject matter and ink coverage. Separations were all performed in the same facility and were in proper gray balance in controllable ranges. The production run used SWOP inks and a well maintained press. The five manufactured-to-order stocks were run along with a common number five groundwood.

While slight variations were noticable on a side-by-side comparison, results on all six stocks were judged by the advertising agency representative involved to be well within commercially acceptable tolerances. It was the test conclusion that these surface characteristics were not a major contributor to variation in printing results. However, the test further demonstrated the incompatibility between normal light weight production stocks and the SWOP specified proofing stock used in the test. Measurements indicated that substantial differences existed between the proofing and the production stocks in both brightness and gloss.

The purpose of a proof, according to the SWOP Committee, is to reflect what the film will produce on press and provide a customer-approved guideline to the pressman. The 1979 test indicated that the surface property differences, between the standard proofing stock and normal lighter weight production stocks, did not permit proofs using the standard stock to fulfill either of these functions.

Accordingly, the SPECTRUM testing effort in 1980 diverted from its goal of determining a source of variations in printed results, to explore the availability of an alternative proofing stock. Desired surface measurements were provided to a converter, Appleton Paper Company, which applied a coating in relative conformance with specifications, to a freesheet base. A test form comparable to the prior year's form was assembled and the film was proofed on both the Appleton and the SWOP specified stocks. A subsequent press run using light weight production stocks permitted an evaluation of the two proofing papers. Certain refinements in the test proof stock were indicated; however, the test did prove the viability of the concept.

In 1981 a new tool was made available to the test effort, the Eastman Kodak Color Analyzer System. The system makes use of the computer to analyze spectrophotometer readings of a specially designed four-and-one-

half-inch square print target. Eight proof presses and as many separation houses printed the target on a new version of the Appleton proofing stock. Kodak used its analyzer system to measure solid ink densities, dot gain, dot smear, trapping and other qualities. Tone reproduction curves were calculated for the presses. A new press form was assembled incorporating some of the ad material from prior years' tests, plus the Kodak target and other materials. Each of the four service houses in this second phase followed the tone reproduction curves developed from its press results to produce separations to run on the same press. In addition, a production run on a member web offset press used light weight publication grade letter press and offset stocks.

The comparability of the four sets of proofs with one another and with the production run was quite exciting. It led to the 1982 effort where the aim was to analyze production presses with the same detail that had previously been developed for the proof presses.

Obviously separations for a magazine advertisement cannot be made for the individual press or presses on which that ad will run, since the ad may run on a multitude of presses and, in any event, the specific press or presses are not known at the time of the separation operation. However, if one set of tone reproduction curves could be developed based on a "par" of all periodicals presses, that set of curves could be put to use for all the ads that will be run on those presses.

Thus the purpose in 1982: to determine the extent of variability in the output of production presses, to determine to what extent press conditions contributed to variations in printed results, and to evaluate whether or not a "par" for the presses could be developed. Sixteen magazine printing plants participated using an approach which GCA believes came as close as practicable to reflecting the realism of day to day operations.

Under the press procedure, each volunteer printer was provided with four pages of test targets. The printer was asked to select a normal press form of 4-color ads that was due to be run on the test date. After the plates for the production form were made, the printer was told to substitute for four of the pages on that form the four pages of test targets, and make a new set of plates.

Immediately after the production form was run, the printer was told to replace the plates with the test form plates, restart the press and get back to color using the ads remaining on the test form as his color guide. Barring the possibility of including a test target in a production form, which would have proved to be immensely complex, the committee felt that the approach used would come as close as possible to reflecting normal production conditions.

In addition to printed results, analyses covered samples of ink, fountain solution, and unprinted paper taken from the press feed.

The amount of data accumulated was monumental, and GCA invites inspection by any interested TAGA member of any of the data amassed in the test. Presentations at SPECTRUM '82 and TAGA '83 encompass only a portion of the dozens of pages of analytical material derived.

Incorporated in this report are four charts which present much of the raw data developed by one analyzer. The charts cover each of the four inks, fountain solution samples, and printed results; plus minimum, maximum, average, and standard deviation for each set of readings. The letters A through P represent each of the printing plants whose identity has remained confidential.

Ink analysis revealed nothing unusual. Fountain solution data suggests that some of the new solutions on the market are close to neutral. Mechanical dot gain revealed wide variation.

The fifth chart enclosed deals with paper properties. A cover sheet and two freesheet body stocks are included. The light weight coated groundwood fell basically within the visual tolerance ranges established in 1979.

The 1982 results pointed to mid-tone dot gain and contrast as being primary causes of variation in printed results, with reliance on solids alone, an inadequate print control. The test also confirmed the viability of the concept of establishing a "par" for production presses from which tone reproduction curves could be established for preparatory operations. With this information, and with the availability once again in 1983 of the Kodak Analyzer System, plus System Brunner, courtesy DuPont Company, the committee is now engaged in a comprehensive multi-phase project encompassing a still broader base of web offset presses.

Phase I of the current test involves thirty presses including several narrow webs as well as some of the largest full-size webs. Each printer has been provided with eight test targets which, when assembled, make up an eight page form. The printers have been provided no proof; alternatively, they have been instructed to use their densitometers to reach ink film thickness densities that match those of the SWOP color reference provided to them. In addition to the printed impressions, ink, fountain solution and paper samples, plus detailed press data are being collected from each printer.

Analysis of Phase I will lead to selection of six presses on which operational or materials changes may be instituted to help narrow the range of variability of output. New film, separated in accordance with a uniform set

of tone reproduction curves, will be provided to the printers. A second test run will be conducted on these six presses to determine if the changes instituted in press and pre-press operations do, in fact, produce a greater uniformity of printed results.

It is the hope of the Print Properties Committee that the test will result in: (1) specific recommendations to the industry on tone reproduction curves for national magazine advertisement; (2) guidelines for printing plants on steps that may be instituted for greater press control; and (3) a greater understanding of the advantages of the various analytical systems. Plans call for final analysis of test results in time for presentation at SPECTRUM '83 in September. Recommendations to the industry emanating from SPECTRUM review of the test will be pursued through the industry SWOP Committee.

The Graphic Communications Association expresses its appreciation to Mr. Frank Sullivan of Collier Graphic Services for his guiding efforts as Chairman of the GCA Print Properties Committee; the DuPont Company, the 3M Company, the Eastman Kodak Company, Spectragraphic, Inc., American Color Corporation, S.D. Warren Company, Division of Scott Paper Company, Liberty Photo Engraving Company, the Graphic Arts Technical Foundation, Rochester Institute of Technology, and ink manufacturers Borden, Bowers, General Printing Ink, Inmont and U.S. Printing Ink for their many and various contributions to the project; all the members of the Print Properties Committee for their assistance in the design of the test programs, and to the separation houses and printers whose contributions of valuable production time have made the tests possible. The author is especially grateful to Thomas Basore of the DuPont Company, George Leyda of 3M and Paul Concannon of S.D. Warren Company for supplementing this paper with their detailed reports at TAGA '83.

GCA SPECTRUM 82

BLACK

1982 GCA PRINT PROPERTIES COMMITTEE

INK	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TACK 1MIN-800rpm	8.9	9.1	10.7	10.7	10.8	12.3	11.6	9.2	9	8.9	12.2	12.8	11.1	15.1	7.6	13.3	7.6	15.1	11	2
STABILITY	1.6	1.7	2.5	1.8	2.5	1.6	2.3	1.5	1.3	1.8	1.8	1.8	1.4	2.2	1.6	1.6	1.3	2.5	2	0.37
% SOLVENTS	39	38.1	38	39.8	36.2	40	34.4	35.4	41.6	37.5	38.3	40.4	42.3	35.2	38.9	37	34.4	42.3	38	2

FOUNTAIN SOLUTION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TOTAL ACIDITY	269	461	192	288	508	499	614	192	192	634	701	200	134	816	634	403	134	816	421	217
CONDUCTIVITY	1000	2150	1150	825	1550	800	2000	1090	800	1200	2500	1000	750	3100	2050	800	750	3100	1435	727
pH	5.3	3.8	4.1	3.6	2.9	3.9	3.4	6.8	2.9	3.6	3.2	4.2	6.4	3.2	4.4	5.8	2.9	6.8	4	1.22

PRINTED PAPER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
120 LINE																				
INK DENSITY	1.36	1.79	1.47	1.55	1.92	1.31	1.53	1.3	1.72	1.3	1.95	1.54	1.72	1.66	1.57	1.34	1.3	1.95	1.56	0.21
EQ DOT GAIN	67	73	76	67	80	66	63	65	60	66	68	61	84	66	69	58	58	84	68	7
MECHANICAL GAIN	17	23	26	17	30	16	13	16	10	16	18	11	34	16	19	8	8	34	18	7
150 LINE																				
INK DENSITY	1.5	1.97	1.54	1.58	1.84	1.56	1.61	1.21	1.7	1.73	1.98	1.46	1.64	1.76	1.63	1.37	1.21	1.98	1.63	0.20
EQ DOT	73	76	82	69	77	71	69	68	61	66	68	62	84	70	75	56	56	84	70	7
MECHANICAL GAIN	23	26	32	29	27	21	19	18	11	16	18	12	34	20	25	6	6	34	20	7

NOTE: MECHANICAL GAIN IS CALCULATED USING 40% AS THE FILM DOT AND 10% AS THE OPTICAL GAIN.

GCA SPECTRUM 82

1982 GCA PRINT PROPERTIES COMMITTEE

CYAN

INK	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TACK 1MIN-800rpm	11.8	10.3	7.5	12.2	10.5	14.4	14.5	10.7	12.9	15.1	12.4	11.9	12.7	13.4	11.9	9.6	7.5	15.1	12	2
STABILITY	1.5	2.2	1.9	1.7	2.3	1.5	2.1	1.6	1.7	2.6	2.1	2	1.1	1.5	1.4	1.1	1.1	2.6	1.77	0.43
% SOLVENT	37.1	41.6	38.8	38.1	33.1	38.4	38.7	37.4	36.5	35.6	35.4	37.5	40.5	38.8	40.2	42.2	33.1	42.2	38	2

FOUNTAIN SOLUTION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TOTAL ACIDITY	710	499	211	288	470	490	614	192	NO	557	701	234	134	787	634	403	134	787	482	210
CONDUCTIVIY	900	2200	1075	900	1500	755	2000	1090	SAMPLE	1050	2600	800	850	3500	2100	900	755	3500	1481	820
pH	5.3	3.8	4.1	3.4	2.9	4	3.4	6.8		3.9	3.2	6.8	6.6	3.3	4,4	5.8	2.9	6.9	4.5	1.4

PRINTED PAPER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
120 LINE																				
INK DENSITY	1.01	1.17	1.08	.86	1.02	1.23	1.18	1.06	1.44	1.14	1.25	.88	.84	1.12	1.28	1.01	.86	1.44	1.11	0.15
EQ.DOT GAIN	60	60	74	57	56	60	54	74	54	58	61	61	61	55	63	52	52	74	60	6
MECHANICAL GAIN	10	10	24	7	6	10	4	24	4	8	11	11	11	5	13	2	2	24	10	6
150 LINE																				
INK DENSITY	1.05	1.12	1.13	.88	1.13	1.28	1.28	.93	1.49	1.04	1.34	.85	1.08	1.24	1.33	1.08	.85	1.49	1.14	0.18
EQ.DOT	64	64	82	60	59	65	61	76	58	58	63	66	70	58	67	57	57	82	64	6.95
MECHANICAL GAIN	14	14	32	10	9	15	11	26	8	8	13	16	20	8	17	7	7	32	14	7

NOTE: MECHANICAL GAIN IS CALCULATED USING 40% AS THE FILM DOT
AND 10% AS THE OPTICAL GAIN.

GCA SPECTRUM 82

1982 GCA PRINT PROPERTIES COMMITTEE

MAGENTA

INK	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TACK 1MIN-800rpm	8.2	11.3	7.5	8.4	11.3	12.1	12.7	9.4	11.9	11.4	12.4	11.7	12.2	12	12	8.5	7.5	12.7	11	1.68
STABILITY	2.3	1.3	1.9	1.6	2.3	1.7	1.8	1.5	2	1.8	1.9	5	1.3	1.7	1	1.1	1	5	2	0.91
% SOLVENT	40.8	43.7	38.8	40	35.8	40.6	36.7	40.2	36.3	40.5	37.3	37.9	40.8	41.4	34.9	41.9	34.9	43.7	39	2.49

FOUNTAIN SOLUTION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TOTAL ACIDITY	365	499	211	288	461	480	614	192	173	557	720	230	154	1248	634	288	154	1248	445	281
CONDUCTIVITY	1400	2200	1075	675	1325	775	2000	1090	475	1100	2600	800	750	3850	2100	900	475	3850	1445	895
pH	4.1	3.8	4.1	3.8	3	4	3.4	6.8	4.2	3.8	3.2	6.5	6.6	2.8	4.4	6.2	2.8	6.8	4.42	1.33

PRINTED PAPER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
120 LINE																				
INK DENSITY	1.15	1.12	1.14	.93	1.18	1.33	1.3	.99	1.28	1.2	1.38	.99	1.08	1.21	1.48	1.06	.93	1.48	1.18	0.15
EQ.DOT GAIN	63	52	62	53	56	60	53	70	60	56	66	60	63	57	63	58	52	70	60	5
MECHANICAL GAIN	13	2	12	3	6	10	3	20	10	6	16	10	13	7	13	8	2	20	10	5
150 LINE																				
INK DENSITY	1.15	1.14	1.16	.94	1.13	1.35	1.28	.83	1.28	1.16	1.37	.96	1.18	1.22	1.44	1.14	.83	1.44	1.17	0.16
EQ.DOT	67	56	70	59	60	66	59	73	67	60	71	66	72	63	70	67	56	73	65	5.28
MECHANICAL GAIN	17	6	20	9	10	16	9	23	17	10	21	16	22	13	20	17	6	23	15	5

NOTE: MECHANICAL GAIN IS CALCULATED USING 40% AS THE FILM DOT AND 10% AS THE OPTICAL GAIN.

GCA SPECTRUM 82

1982 GCA PRINT PROPERTIES COMMITTEE

YELLOW

INK	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TACK 1MIN-800rpm	7.6	8.7	11.8	8.3	7.3	8.3	12.1	8.6	9.3	11.8	10.3	10.5	10.2	9.5	7.5	8.1	7.3	12.1	9	1.59
STABILITY	1.6	1.1	2.1	1.5	1.5	1.6	1.5	.6	2.1	1.7	1.3	1.9	1	1.4	1.2	1.4	.6	2.1	1.47	0.39
% SOLVENTS	42.1	45.1	47	41.7	36.7	43.4	40.5	43.5	41.8	39.7	45.6	39.1	45.6	43.3	44.3	46.2	36.7	46.2	43	2.85

FOUNTAIN SOLUTION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
TOTAL ACIDITY	672	461	163	307	480	480		192		614	710	292	154	826	634	288	154	826	448	220
CONDUCTIVIY	1000	2100	825	925	1475	750	NO	950	NO	1075	2600	1075	725	3100	2100	900	725	3100	1400	763
pH	5.6	3.8	4.1	3.6	3	4		6.8		3.9	3.2	5	6.6	3.2	4.4	6.1	3	6.8	5	1.30
							SAMPLE		SAMPLE											

PRINTED PAPER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	MIN	MAX	AVE	STDV
120 LINE																				
INK DENSITY	.85	.71	.79	.69	.85	.88	.9	.85	.96	.93	.84	.78	.84	.75	.96	.79	.69	.96	0.84	0.08
EQ.DOT GAIN	65	59	70	55	61	61	58	82	60	58	53	76	66	62	60	60	53	65	63	8
MECHANICAL GAIN	15	9	20	5	11	11	8	32	10	8	3	26	16	12	10	10	3	32	13	8
150 LINE																				
INK DENSITY	.93	.79	.84	.8	.86	.84	.96	.8	.94	.92	.81	.78	.88	.79	.97	.83	.78	.97	0.87	0.07
EQ.DOT	76	59	78	60	64	66	62	84	62	60	56	78	68	68	66	65	56	84	67	8
MECHANICAL GAIN	26	9	28	10	14	16	12	34	12	10	6	28	18	18	16	15	6	34	17	8

NOTE: MECHANICAL GAIN IS CALCULATED USING 40% AS THE FILM DOT
AND 10% AS THE OPTICAL.

UNPRINTED PAPER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
GLOSS	43.3	40.8	45.2	58.8	53.6	44.2	47.4	54.6	62.9	49.1	43.4	51.8	51.3		48.7	62
OPACITY	87.3	86.3	90.1	95	90.2	87	85.1	88.7	92	90.3	85.9	89	88.3	NO	85.6	90.7
BRIGHTNESS	87.6	70	70.8	76.8	77.3	73.4	70.7	67.7	71.4	76.2	73.7	70.7	69.1		71	70
K&N	.08	.12	.08	.1	.08	.11	.14	.08	.08	.12	.1	.07	.07	SAMPLE	.07	.08
L	85.26	86.61	87.57	90.56	90.72	87.52	87.47	85.71	86.75	89.63	88.04	84.15	82.43		82.93	84.09
a	-.43	-.34	-.36	-.46	-.83	-.58	-.97	-.62	-1.57	-1.75	-.57	-1.3	-1.36		-1.46	-1.50
b	4.74	4.82	5.49	4.61	4.75	3.75	5.17	4.86	4.51	4.51	3.49	3.17	2.18		2.21	3.32

NOTE: -a= GREEN
+a= RED
-b= BLUE
+b= YELLOW