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Use of the Vandercook Proof Press to Predict Rotogravure Print Quality

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to Predict
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by

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Abstract

The object of this thesis is to investigate a new idea in predicting printability for rotogravure printing. Present proof presses in the gravure industry are clumsy, expensive, and in most cases, impractical for regular use.

In order to understand the relationship between ink, paper, and plate, it is necessary to consider many variables such as smoothness, ink receptivity, porosity, moisture content, formation, surface strength, and opacity.

The laboratory work performed and presented in this paper shows that a Vandercook proof press may be used to predict printability in the gravure process.

Introduction

As the title implies, this thesis is an investigation into the use of the Vandercook proof press for predicting rotogravure print quality. More specifically, this paper evaluates the appropriateness of a new method to solve a pressing need.

The rotogravure industry is a rapidly growing industry with unlimited promise. The gravure process has until recently been limited to large volume, less articulate types of printing jobs--mostly within the packaging field. However, as the process grows, so does the technology and the need for more sophisticated application. Printing quality, while hardly a problem in past rotogravure printing work, is of paramount importance today. The gravure industry is moving into other fields and will not be able to delegate print quality to a back seat behind register and color. For an example of bad printing quality and good within the same job, see Figure 2.

There is, therefore, a definite justification for immediate work in developing a reliable proofpress for the rotogravure industry. To this author's knowledge, there is no such press in use today.

In order to discuss proof presses and print quality, it is necessary to have an understanding of what properties or qualities are being dealt with. In the literature survey, several of the most important paper properties

which effect gravure print quality as will as letterpress print quality are discussed. Also, printability and print quality are defined.

The Vandercook proof press is a letterpress. There is no evidence in the present literature that the success or failure in halftone reproduction on a letterpress press has any relation to the same type job run on a gravure press. It can not be assumed that the quality of print obtained on a letterpress will corelate with that obtained on a rotogravure press for the same stock. It is the purpose of the experimental work of this paper to investigate this problem and show whether there is any reliable correlation. If there is, then this thesis is meaningful and the appropriateness of at least further work is thus defined.

Printability and Print Quality

The desire for specific information concerning those qualities of paper which contribute to satisfactory results in printing has become of great interest to papermakers and paper consumers. To the paper mill, this information is important in preventing the production of unsatisfactory printing paper. To the printer, such information enables him to determine unsatisfactory paper before it reaches the presses, and also permits him to tell the papermaker in advance the characteristics that are desired in paper.

"Printability" and "printing quality"--just what do these terms mean? According to Edge(1) and Koestler(2), printability is synonymous with the following factors: low ink consumption, rapid drying of prints, and uniform appearance of the printed matter. As is aptly stated by Engelhart(3): "Printability is like that bug-a-boo in calculus-a variable that is a function of, and dependent on, other variables such as ink, stock, printing process, press, plate, job, atmospheric conditions, and sometimes the condition of the pressman himself." Printing quality on the other hand, is concerned with the appearance of halftones, solids, and type matter.

Papermakers are interested in the quality of their products and they normally perform tests in an effort to forecast "printability." The tests performed usually can be classified into two categories:

1. Those in which prints are actually made and are examined for quality.

2. Those in which measurements are made on the physical properties which seem to be important. Efforts are made to corelate these measurements with the commercially printed results.

Most papermakers make use of one or both of these approaches. However, interpretation of the printed results is very difficult. The most desirable method of determining the printability of paper or really the suitability of paper for a job is, of course, to make a trial of the actual commercial job on the commercial machine, and, if the results are satisfactory, future orders are made as similar as possible to the satisfactory paper. This method, however, is not entirely satisfactory. Besides being time consuming and otherwise costly, it often fails to give the basic reasons why the paper is or is not satisfactory from the print quality standpoint. It is, therefore, difficult if not impossible to improve print quality of an unsatisfactory sheet except by qualified guess work.

Paper Properties Which Affect Printing Quality

Defective gravure printing is caused by three basic classes of problems(4):

1. Printing substrate surface characteristics
2. Ink drying and flow characteristics
3. Mechanical press defects, such as worn or damaged cylinders, worn press components, or incorrectly engraved cylinders.

Only the first category will be considered in the following discussion. The various characteristics that printers expect in paper will be discussed in detail(4,6,16, 17,18): smoothness, ink receptivity, porosity or air permeability, moisture content, formation, color, surface bonding strength, and opacity. Any weakness in these characteristics necessarily limit quality in the finished products, no matter how careful the printer is or how much skill he may apply to his job.

Smoothness

Printing is the process of transferring ink from forms to the surface of paper. The closer the contact of the inked form with the paper surface, the more perfect is the transfer. Therefore, the covering power or specific coverage of an ink on a given paper is influenced not only by its absorbability but also by the smoothness of the paper surface. A rough printing surface will require more ink than a smooth one to attain a definite degree of coloring

or ink intensity. Smoothness may be regarded as an index of the facility of a paper to make close contact with a printing surface under the influence of pressure. Smoothness is, therefore, one of the most important printing properties of paper. The smoother the sheet, the better the contact between the paper and the printing plate. In order to obtain good smoothness, the pulp must be handled in beating and jordaning and on the paper machine in such a manner as to yield a well closed sheet. Heavy calendering produces a surface hardness and may blacken or crush the sheet. Smooth papers obtained in this manner show uneven ink receptivity. Smoothness in recent years is being obtained with less calendering due to the introduction of fillers with finer particle size. These finer particles, it is claimed, increase the rate of the ink receptivity and make for uniform absorption over the entire sheet. Because of their small particle size, they respond readily to the calendering pressure in the manufacture of the paper and close the interstices between the paper fibers. In conclusion, fine pinpoint smoothness is far and away the most important characteristic. In the case of coated paper for web gravure, smoothness is almost the only measure of quality.

Ink Receptivity

Ink receptivity is defined as that property of a sheet of paper which causes it to absorb ink.

The quality of the ink used is of great importance,

but the composition of the surface of the paper also exerts an important influence. In general, the smoother and less porous the paper, the less ink will be required. The nature and distribution of the paper filler also exert influences upon the printing quality of the ink, depending on the ease with which it is wet by the vehicle in the ink. The influence of fillers as an absorptive constituent of paper is also evidenced by the fact that the wire side of most kinds of printing papers apparently requires less ink than the felt side, although the felt side is normally smoother and less porous. In coated papers, the amount of coating, adhesive and pigment, as well as the ratio of adhesive to pigment influence the ink receptivity.

The penetration of printing inks into absorbent paper such as news and book is dependent primarily upon the vehicle used in the manufacture of the ink. Some of the ink vehicle penetrates the paper but the pigments themselves tend to remain on the surface, except for a small portion which may be forced into the open paper structure by the printing pressure. A measurement of such penetration is informative in that it furnishes an indication of the ink receptivity of the paper. The performance of a paper in any particular job of printing may be predicted reasonably by oil penetration and surface absorption tests before the paper reaches the press. For example, strike-through may be predicted if the absorption of the oil by the paper is very rapid. On the other hand, a very slow rate of oil absorption measurements will tend to cause offset.

Porosity or Air Permeability

Porosity has been defined as the property a sheet has of containing connected air voids. It is dependent upon the number of the voids and their distribution in size, shape, and orientation. It is the property of a sheet which allows the passage of air when a pressure difference exists across the boundaries of the specimen.

The more readily air passes through the sheet, the greater the porosity. This test is sometimes referred to as density, which is really the converse of porosity.

Porosity is a factor in the quality of printing papers. For example, in the offset process, porosity controls to some extent the spreading of the ink under the pressure of the rubber blanket. In illustration printing by the offset process, the porosity, especially that of the upper surface of the paper, is of particular importance. More ink will adhere to the rubber blanket than to the smooth metal plate of the letterpress printing form; and thus, after an impression is taken, a quantity of ink will still cling to the rubber blanket.

The amount thus adhering will depend upon the porosity of the upper surface of the paper. In order to attain a desired degree of blackness, there must be a reserve supply of ink on the blanket, the amount depending on the porosity of the paper. The larger this excess of ink is, and the less porous the paper, the more tendency there is for the ink to spread or smear.

Moisture Content

Moisture content is the percentage of water in paper or paperboard. Paper, being composed of minute vegetable fibers, contains an essential proportion of water. An absolutely dry paper, deprived of its natural moisture content, is brittle and breaks readily. Oven dry paper is, therefore, unsatisfactory for use. Paper is hygroscopic; that is, it is susceptible to humidity changes. It absorbs or gives up moisture with every change in the amount of water vapor in the air. Determination of moisture content should, therefore, be carefully made to obtain accurate results.

The measurement and control of the moisture content of paper particularly that intended for multicolor work, is essential in the production of quality printing. Moisture should be determined for the control of register, static, cockling, creasing, and curling.

Paper should be ordered from the mill with a slightly higher moisture content than that of the pressroom air.

Formation

A closed and uniform formation is an important factor for good printing paper. The effect of poor formation is one of uneven thickness corresponding to fiber clumps and open spots in the sheet. The impression pressure will be uneven and the printed areas will appear mottled and spotty.

Poor formation also decreases opacity which results in show-through.

Color

Color in the paper and printing industries is considered chiefly from physical rather than psychological aspects. The basis of color is light consisting of waves which spread out from the source in all directions. The color of the sheet, therefore, depends upon its spectral reflectance as compared with a standard when illuminated with a specific illuminant and viewed under definite conditions. Paper is said to be white when it reflects light non-selectively and absorbs no color. Commercial white papers vary in shade such as blue-white, cream-white, natural-white, etc. They do not reflect all components of white light in the same ratio.

In paper specifications color is generally referred to simply as "color" such as white, green, blue,pink, buff, and must match a selected standard.

Variation in color of book paper, writing, bond and ledger papers is not only encountered among shipments from different contractors, but sometimes occurs within the same shipment. The difficulties which arise from variation in color of paper, cannot be corrected or allowance made for such variation in the pressroom. On a longrun job, it is sometimes necessary to supply the pressroom with paper taken from different shipments. If the color of successive lots of paper differs somewhat during the press run and the ink remains the same, there will be a variation in the tone value of the printed page, since ink formula and its tonal quality

have previously been adjusted to the color of the paper first used. This objection becomes a very strong one when the paper deliveries cannot be segregated to individual jobs, but must be used in large edition runs.

Surface Bonding Strength

The surface bonding strength of paper is the resistance of paper to removal of coating or fibers or to cleavage parallel to the sheet direction.

Paper is said to pick when coating, fibers, or small portions of the paper itself, separate from the body of the sheet while it is being printed. Coated paper picks due to the fact that the adhesion of the ink to the coating is greater than the adhesive power of the coating for the paper, or because there is insufficient bonding strength in the base stock to prevent its splitting. Picking of the coating is not always due to a weakness of the coating material, but may be caused by the use of an excessively tacky ink. If such is the case, the tackiness of the ink must be reduced, since the physical interaction between the ink and the paper coating depends upon their relative cohesive powers.

The surface bonding strength test has become a matter of importance since the development of multicolor printing and the speeding up of equipment.

Picking leaves small white spots on the printed image and is especially noticeable in solid areas. The particles lifted from the sheet may lodge on the printing plate or be

carried back through the inking system of the press. If there is much picking, it necessitates frequent washups of the plates and even the rollers and the ink fountains. Picking also clogs the type and halftones, producing mussy printing.

The best known test for picking is the wax test which employs the use of sealing waxes that can be stuck to the paper. These waxes have graded adhesive powers, so that when the wax is cooled and pulled from the sheet there is an increase in the amount of pull administered to the surface fibers or coatings and the number of wax in the series which breaks the surface of the paper is the numerical ranking of pick.

Opacity

Printing demands paper having a high degree of opacity, especially when halftones or solids are printed on one side of the sheet with type or light printing on the other side. Deficiency in opacity is responsible for show-through of the printing which interferes with legibility and also causes bad general appearance of the work. Lack of opacity causing show-through should not be confused with strike-through caused by too deep penetration of the oil vehicle of the ink into the paper fibers, causing the printing to become visible from the opposite side of the sheet.

There are many factors which affect the opacity of paper: the type of pulp, the degree of beating, sizing,

such as starch and glue, mineral fillers, loading materials, and manufacturing operations such as calendering have a bearing upon the opacity of the sheet. Because of the short fibers of soda pulp and its high scattering power and ability to resist hydration, this pulp is used for opacifying printing papers, such as machine finish and supercalendered book papers. The addition of mineral fillers such as clay, chalk, and titanium dioxide increases the opacity of the sheet. Titanium dioxide is particularly effective in increasing opacity. The utility of printing, writing, and bond papers is, therefore, enhanced by high opacity.

A thorough listing of important paper characteristics that affect printability is presented in the appendix(6).

Determination of Print Quality

Overall print quality is a composite of several individual print properties. The observer combines judgements of these individual print qualities, using different "weight" factors for the various properties, to obtain the overall quality of any print. In black and white reproductions it is necessary to distinguish between the following individual print properties (19):

I. Print properties of a solid
   1. Uniformity: uniformity is the eveness of the color or density of the ink film over the total area of the solid. A perfectly uniform solid should show no mottle or speckle, no creepiness and no picking.

   2. Contrast: contrast is the difference in brightness or density between the printed and unprinted sheet.

   3. Finish: finish is the glossiness of the ink film.

II. Print properties of a halftone
   1. Tone reproduction: tone reproduction is the faithfulness of the reproduction of the original tone values of the printing plate on the print.

   2. Uniformity: uniformity in a halftone, as in a solid is the eveness of the density of the printed areas. In addition, however, a perfectly uniform halftone print should show no missing dots in the highlights.

It is clear that such different print qualities as uniformity, contrast, finish, and tone reproduction cannot be evaluated objectively or measured quantitatively by one method alone. Various methods to measure gloss(8) and contrast have been known for a long time. There also have

been a number of publications dealing with tone reproduction measurements of halftone prints(9,10,11,12,13). However, these papers were either not concerned with or did not achieve a numerical evaluation of the quality of tone reproduction in terms of tone reproduction measurements. Finally, the evaluation of uniformity of solids or halftones has been given little attention(14).

The first method of print evaluation is one devised by Diehm(15). It is strictly numerical. Halftone screen patterns ranging from 85 to 133 line screens are used while the printing area ranges from 10 percent to 90 percent within each screen size. Figure #1 is an example of the plate used.

The first step in analyzing the print consists in determining the ink coverage. The following equation yields a numerical value for ink coverage (IC):

$$IC = \frac{B10 - B90}{BP} \times 100$$

where B10 = the brightness of the 10 percent tone
B90 = the brightness of the 90 percent tone
BP = the brightness of the paper

The next step proposed by Diehm is to evaluate print fidelity. This value is divided into three separate measurements: the number of halftone dots not present, the number of dots which show variation in size, and the number of dots with distortions or irregularities are counted. The presence and the size and shape of the dots are all important in making a print of good fidelity. By assigning an equal

weight to each and summing the results, a numerical value for printing fidelity can be obtained. These observations permit a new definition of printing quality based on ink coverage and print fidelity. Printing quality is the percent ink coverage obtainable in perfect print fidelity. It is expressed numerically by :

$$PQ = \frac{IC \times PF}{96} \times 100$$

where PQ = printing quality
IC = ink coverage
PF = print fidelity
96 = constant

Another method which permits a numerical evaluation of tone reproduction of a halftone print and uniformity of a solid print is presented by Buchdahl, Polglase, and Schwalbe(7).

The measurement of tone reproduction quality is based on the assumption that the tone values of the best obtainable print are identical with the tone values predicted by the printing plate. A comparison of the ideal or theoretical brightness values with the actual brightness values of the halftone prints leads to an objective evaluation of the tone reproduction. Each of these values can be easily determined. The actual brightness can be obtained from spectrophotometric measurements. The ideal tone values of a print can be calculated, using the following equation:

$$Y_{ideal} = aY_1 + (1 - a) Y_0$$

where "a" is the print area of the printing plate and Y_1 and Y_0 are the tristimulus or brightness values for a=1 and a=0, respectively. (a=1 represents the solid print; a=0

the unprinted paper surface). Similar equations to calculate tone values have been given by Murray(9) and Poulter and Croney(10). Murray sets the brightness of the unprinted paper equal to one and Poulter and Croney fix both brightness values arbitrarily; $Y_1=0$ and $Y_0=1$. Such a procedure is certainly not justified in an evaluation of tone reproduction quality. The tone values of a halftone print are not completely determined by the ratio of print to nonprint area as differences in the brightness of the unprinted sheet and solid play a considerable factor in the quality of tone reproduction.

The authors find it necessary to define a parameter so that results obtained in this manner can be compared with subjective evaluations of tone reproduction. This parameter is calculated and is found to depend on the overall density curve from the ideal curve. The derivations involved in both these methods of print quality evaluation as well as a detailed procedure are explained sufficiently in the literature cited.

Comparison and evaluation of gravure prints is done by observation of the halftone dots. Any flaw in the printed image will show up ultimately in the dots. Dots will be missing or distorted. There are three things that most often cause bad halftone reproduction. The cylinder might be worn or engraved poorly. The ink may be drying in the etch. This will leave dried ink on the cylinder, leaving streaks, etc. in the dot pattern. The paper is the main factor. Imperfection

in the finish will cause dots to be left out in the same area through each color. If the flaw does not repeat itself through each color, it will have to be the cylinder or the ink.

Experimental Procedure

Sampling

All of the paper and printed samples were donated by Brown Paper Company in Kalamazoo, Michigan. The prints were printed on rotary gravure presses. Printed samples were taken off the front of the press, while raw stock samples were being collected off the back. Care was taken to pull the samples as close as possible to each other, without disturbing the normal operation of the press. In all cases the samples were at least within the same roll and from the same job, press, and set of cylinders. Twenty sets of samples were collected and numbered from one to twenty. All the samples were stored under standard temperature and relative humidity identical to the eventual laboratory printing conditions.

Printing

A Vandercook 4 Proof Press equiped with a patent base is used to proof the samples. A 7½ x 9 inch typographical electrotype which is divided into six different tone ranges (5, 10, 30, 50, 70, and 90%) and five different screens (60, 85, 100, 110, and 133 lines) was used in the proofing operations (See Figure #1). A heavy bodied jet black ink was used to ink the plate.

Before printing the samples, the press packing, speed, and ink control were adjusted to assure the best possible print. During the actual printing, the packing and the press

speed were kept constant. The ink was regulated by the Vandercook Ink Monitor and kept at a constant value consistent with the predetermined value.

Commercial Print Evaluation

Reflectance readings at 614mu were taken on the commercial prints (See Figure #2). Ten readings from each set were taken and averaged. It was found by visual comparison and trial and error selection, that reflectance readings in the red region (614mu) were reasonably good numerical ratings of the print quality. The readings obtained were of no value as an absolute value of printing qualities, but merely an effective means of ranking the samples. The results are found in Table I in order of best to worst.

Laboratory Print Evaluation

The method to be used is that of Dr. Robert Diehm which was previously discussed in the literature survey. The first step in the evaluation of results obtained by this method will be to determine the ink coverage(IC); this will be accomplished by measuring the brightness of all 10 and 90% tones, averaging each, and then substracting the 90% average from the 10% average. This difference will then be divided by the brightness of the paper and multiplied by 100 in order to obtain the ink coverage.

The next step will be the evaluation of the fidelity of reproduction of the plate image on the paper by the ink. Each tone will be observed with a suitable magnifying glass and given a value according to the three specific rules. (1) If all dots are present, a value of two will assigned; if up to one-fourth of the dots are absent, a value of one will be given; and if more than one-fourth of the dots are missing, the tone will receive a value of zero. (2) If all dots are unbroken and undistorted, the tone will be assigned a value of two; if up to one-fourth of the dots are broken and distorted, a value of one will be given; and if more than one-fourth of the dots are broken and or distorted, the tone will receive a value of zero. (3) If each dot is uniform in size, a value of two will be assigned; if up to one-fourth of the dots are nonuniform in size, a value of one will be given; and if more than one-fourth of the dots are ununiform, the tone will be zero. Thus, it will be possible to obtain a fidelity rating of 120 for a perfect print.

By interrelating (IC) and (PF) it will thus be possible to obtain a numerical evaluation for printing quality (PQ); that is, printing quality is the percent ink coverage attainable in perfect print fidelity.

$$PQ = \frac{IC \times PF}{96} \times 100$$

The constant 96 is the product of perfect ink coverage, which is the difference between the lightest and deepest tones (.90 - .10 = .80), and perfect print fidelity.

$$120 \times .80 = 96$$

Experimental Results

Table I presents the results of the laboratory work. In the first column, the values obtained for printing quality using Diehm's method are listed in order of from best to worst. In the second column the reflectance values are listed for the commercial print in order. Tables II, III, and IV list the data used in obtaining the final figures for print quality.

In order to demonstrate the definite relationship between printing quality as produced on the proof press and th at of the commercial press, the data is blocked off into Groups A, B, and C.

Figure #3 displays the corelation between the two printing processes graphically.

An examination of the two samples attached to figure #2 will show the range of quality which was present in the commercial prints.

TABLE I

Laboratory Print(1)			Commercial Print(2)	
Printing Quality	Number		Reflectance	Number
49.79	17		60.6	17
49.06	15		60.4	15
48.44	10		59.5	8
47.74	13	Group A	58.5	10
47.50	8		58.1	5
47.32	14		58.0	14
46.89	5		58.0	13
46.54	4		58.0	7
46.01	11		57.9	4
45.38	7		57.8	12
45.32	9	Group B	57.7	11
45.17	2		57.6	9
44.75	12		57.4	3
44.55	3		57.3	2
44.08	16		57.0	18
43.02	18		56.8	19
42.91	19		56.4	6
40.77	1	Group C	55.3	16
38.32	6		54.0	1

(1) Values are those obtained by Diehm's method as described, and as computed in Tables II, III, IV.

(2) Values are percent reflectance at 614mu of a solid red area.

TABLE II

$$I.C. = \frac{B10 - B90}{BP} \times 100$$

Sample No.	B10(1)	B90(1)	B10 - B90	I.C.
1	55.4	14.3	41.1	59.3
2	63.7	16.8	46.9	59.4
3	62.7	14.8	47.9	62.9
4	64.3	15.8	48.5	61.2
5	61.7	16.1	45.6	57.7
6	53.7	15.0	38.7	50.4
7	64.2	15.8	48.4	60.5
8	63.4	15.6	47.8	60.8
9	63.9	16.2	47.7	59.6
10	61.1	13.7	47.4	62.0
11	64.3	16.6	47.7	60.6
12	63.2	16.1	47.1	60.5
13	62.3	14.3	48.0	61.1
14	60.1	14.0	46.1	64.9
15	63.8	14.3	49.5	62.8
16	64.2	16.6	47.6	59.6
17	65.3	15.2	50.1	62.9
18	61.3	15.6	45.7	59.0
19	63.4	16.5	46.9	59.7

(1) Brightness values are an average of three sheets with five readings on each.

Table III

Print Fidelity

Sample No.	I	II	III	Total	Ave.
1	34	18	15	67	66
	34	16	14	64	
	31	22	13	66	
2	31	24	14	69	73
	34	26	16	76	
	34	25	13	72	
3	32	24	13	69	68
	34	27	12	73	
	33	23	11	67	
4	32	25	12	70	73
	33	30	15	79	
	34	24	15	71	
5	35	28	15	78	78
	34	28	17	79	
	35	27	15	77	
6	29	24	18	71	73
	29	26	17	72	
	32	26	19	77	
7	30	26	17	73	72
	25	26	18	69	
	30	26	19	75	
8	31	27	18	76	75
	31	26	17	74	
	31	26	17	74	
9	31	27	17	75	73
	30	25	18	73	
	27	26	18	71	
10	33	26	19	78	75
	28	27	19	74	
	28	26	19	73	
11	30	23	17	70	73
	33	25	19	77	
	31	26	16	73	
12	30	25	18	73	71
	30	24	19	73	
	30	23	16	69	
13	30	23	18	71	75
	33	29	18	80	
	31	25	18	74	
14	31	23	16	70	70
	29	25	16	70	
	28	24	19	71	
15	33	28	14	75	75
	31	25	19	75	
	30	28	17	75	

(continued)

Table III (continued)

16	30	25	15	70	71
	30	26	15	71	
	29	26	16	71	
17	30	27	18	75	76
	32	26	18	76	
	34	26	16	76	
18	-	-	-	-	-
19	32	26	18	76	70
	29	23	15	67	
	28	24	16	68	
20	32	23	12	67	69
	30	23	15	68	
	32	24	15	71	

Column I lists the value out of a possible 40 assigned to the presence of dots.

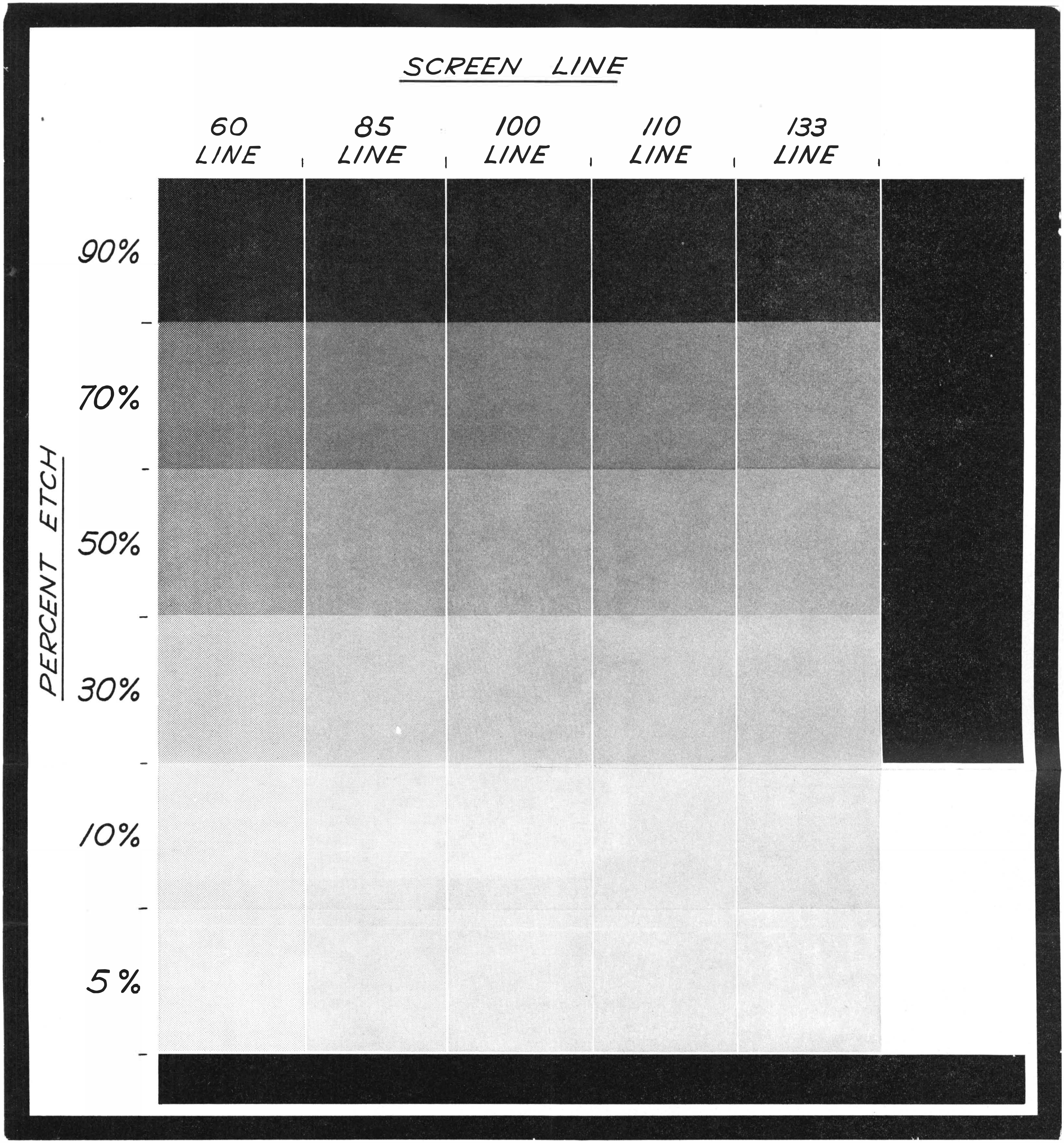
Column II lists the value out of a possible 40 assigned to the distortion of the dots.

Column III lists the value out of a possible 40 assigned to the uniformity of size of the dots.

Table IV

$$P.Q. = \frac{I.C. \ X \ P.F.}{96} \ x \ 100$$

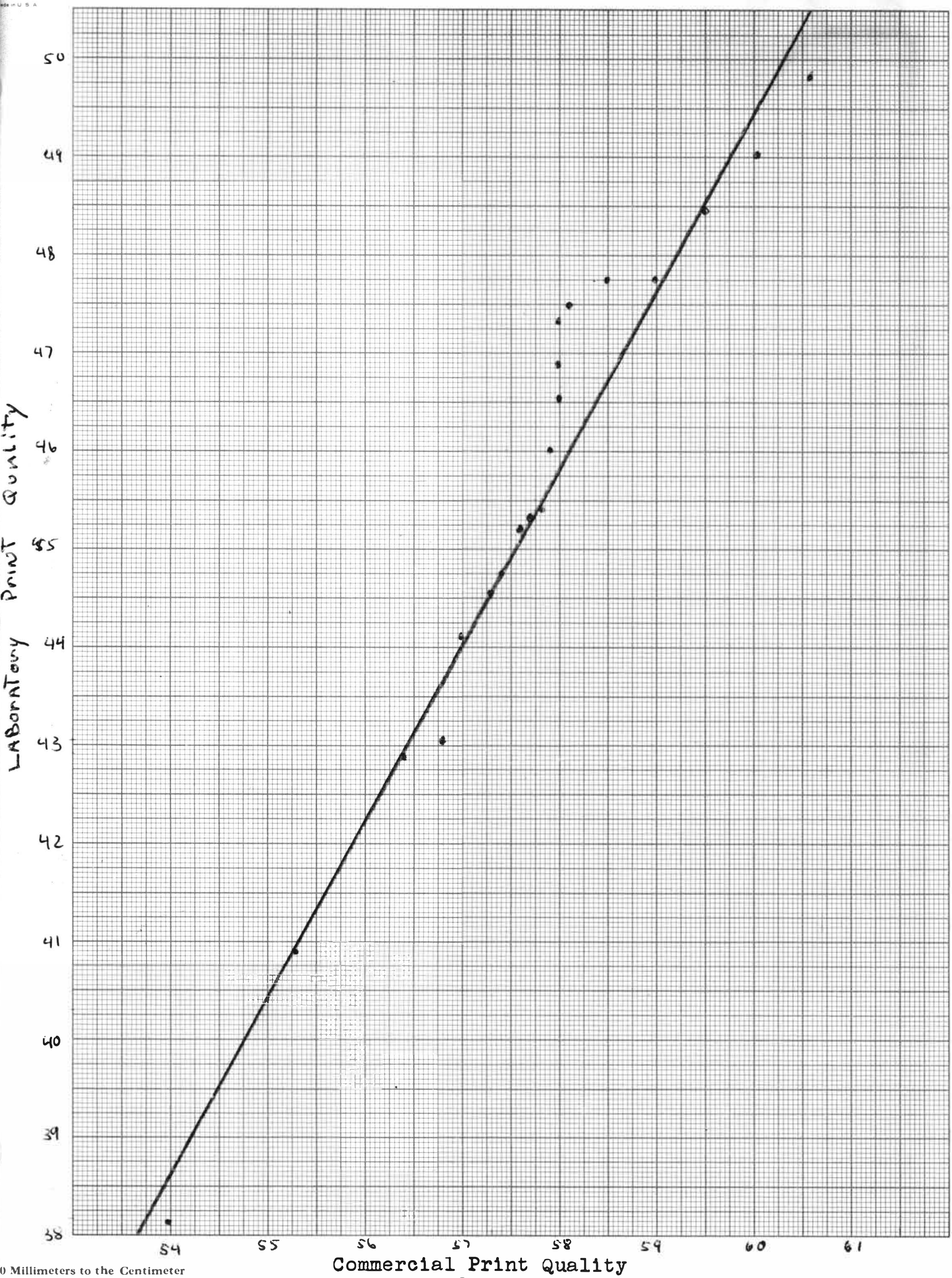
ample Number	% I. C.	P. F.	I. C. X P. F.	P. Q.
1	59.3	66	3914	40.77
2	59.4	73	4336	45.17
3	62.9	68	4277	44.55
4	61.2	73	4468	46.54
5	57.7	78	4501	46.89
6	50.4	73	3679	38.32
7	60.5	72	4356	45.38
8	60.8	75	4560	47.50
9	59.6	73	4351	45.32
10	62.0	75	4650	48.44
11	60.5	73	4417	46.01
12	60.5	71	4296	44.75
13	61.1	75	4583	47.74
14	64.9	70	4710	47.32
15	62.8	75	4232	49.06
16	59.6	71	4780	44.08
17	62.9	76	4543	49.79
18	----	--	----	-----
19	59.0	70	4130	43.02
20	59.7	69	4119	42.91


SCREEN LINE
60 LINE
85 LINE
100 LINE
110 LINE
133 LINE
PERCENT ETCH
90%
70%
50%
30%
10%
5%


0.946 Litre
ARCO
ARCO
Motor Oil
One
U.S. Quart
Atlantic
Richfield
Company
9.3028
Sample # 17
Sample # 1

Figure #2

Figure #3



Laboratory Print Quality
50
49
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Commercial Print Quality

CONCLUSION

The legitimacy of the method used to evaluate the printing quality of the printed commercial samples was somewhat doubtful. However, the results agreed with visual appraisals as well as could be expected. The overall results, Table I, show that the Vandercook Proof Press can be used to indicate printability for rotogravure papers.

The procedure outlined in this paper is a preliminary step to establish the feasibility of using a letterpress proof press to print gravure proofs.

The gravure industry might well consider looking further into some new procedures and equipment for testing the printability of paper.

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Appendix

The more important paper characteristics that effect printability are summarized in the following(6):

1. Surface Smoothness
   a. Initial smoothness
   b. Smoothness under impression
      1. Compressibility
      2. Resilience
      3. Uniform thickness

2. Ink Receptivity and Affinity
   a. Surface porosity or permeability to ink and oil
   b. Surface wettability to ink or oil. Low contact angle to ink and/or its vehicle-must not repel same. Together with porosity, smoothness and pressure govern "ink transfer."

3. Surface Strength or "Pick" Resistance

4. Color and surface reflectance
   a. Hue-white, tinted, or colored; brightness if white or near-white.
   b. Cleanliness-absence of specks, etc.
   c. Specular reflectance or "finish" and uniformity of same.

5. Opacity
   a. Actual opacity relative to "show-through."
   b. Opacity in relation to ink penetration or "strike-through".
   c. Density-caliper and substance weight which are indirectly associated with most all our characteristics are listed here for want of a better place.

6. Dimensional Stability
   a. Hygroscopicity-hygroexpansivity or shrink in varying relative humidity.
      1. expansion
      2. contraction
      3. curl

7. Body Strength
   Physical or mechanical strength in relation to the mechanics of the printing process.
   a. Tensile
   b. Fold
   c. Tear
   d. Burst

8. Chemical Reactivity
    a. Surface and body pH and reactivity regarding ink oxidation, driers, etc.
    b. Chemical corrosion of metals used for letterpress or gravure plates.

9. Surface Abrasiveness
    Physical or mechanical erosion tendencies for the printing form or plates in whatever process used.

10. Fiber Orientation (grain) and Formation
    a. Grain direction-degree of such orientation. Direction to be specified-usually to run the long way of the sheet.
    b. Order of formation-as uniform, well-felted, irregular, or "wild."

11. Moisture Content
    a. Percentage moisture content. To be specified so as to be in equilibrium with printing conditions. Such content and/or equilibrium, influences:
        1. Curl, wave, dimensional stability(register)
        2. Mechanical strength and plasticity of stock
        3. Drying rate of oxidizing and moisture-set inks
        4. Brittleness or blistering with heat dry inks.
        5. Static