1963

Development of a Statistical Method of Determining "Bleed" for Offset Reproduction

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DEVELOPMENT OF A STATISTICAL METHOD OF DETERMINING "BLEED" FOR OFFSET REPRODUCTION

BY

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A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Department of
Printing and Journalism, South Dakota
State College of Agriculture
and Mechanic Arts

August, 1963

DEVELOPMENT OF A STATISTICAL METHOD
OF DETERMINING "BLEED" FOR
OFFSET REPRODUCTION

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to his thesis adviser, Mr. Paul H. Jess, Assistant Professor of Printing and Journalism, for his valuable guidance and encouragement during the course of this study.

Special recognition is given to Mr. J. K. Hvistendahl, Associate Professor of Printing and Journalism; to Dr. S. Ray Schultz, Associate Professor of Economics; to Dr. Bruce L. Miller, Associate Professor of Physics; all of South Dakota State College, for their valuable advice during the study.

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CHAPTER I

INTRODUCTION

Magazine covers, labels, packages or advertising printed matter often have authentic colored design printed to attract people's attention. In order to obtain the effects of color harmonies and color contrasts, a designer frequently places one color next to another color, with two colored areas sharing a common border. When this kind of arrangement is printed, and because the very nature of the registering system of the press permits slight variations throughout the press run, three situations may arise at the border of the two-color areas:

1. The two-printed color areas match each other exactly. The edge of one color is printed just in contact with the edge of the other color. This is the most desirable situation because the printed piece will carry out the effect the designer desired.

2. A white gap occurs between the two-color areas. This is the most undesirable situation. The white line is so distinct that it might easily destroy the effectiveness of the artwork.

3. An overlap zone of the two colors occurs. The edge of one color prints on the top of the other color. In such circumstances, a line of "third" color will be formed at

the border. For example, if the two-color areas are yellow and blue, a green line could be formed between them. Due to the contrast of the colors, this is less noticeable than the white line and, if the overlap is small enough, it might even be invisible to the eye.

To print an entire job under the circumstances outlined in No. 1. is impossible because of inevitable registering system variation. Of the remaining two situations, the overlap zone is preferred because it does not hurt the design as much as does the white gap. Thus it is common practice in the printing industry to purposely extend the printing area of the lighter color somewhat so that an overlap zone will be printed and that no white gap will exist. This extension of the printing area is called "bleed" in printing terminology. A concise definition of "bleed" follows.* (2-328)**

> A slight extension or thickening of printed detail, usually of the lighter color or tint, to produce color overlap zones, so that a white gap will not show in printing when slight variations in register occur throughout the press run.

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* There are two other meanings of "bleed" in the printing industry:
1. A printing area that extends to the edge of the sheet or page after it is trimmed.
2. Pigment of ink dissolved by fountain solution.

** Numbers in parentheses identify the literature cited, the first number cites the entire work and the number following the hyphen indicates appropriate page.

Reasons for undertaking the study

The flow chart of lithography operation can be simply expressed as:

COPY → CAMERA → STRIPPING → PLATEMAKING → PRESS

Depending on the situation, the amount of bleed to be printed may be determined in any of the first three processes. The artist, cameraman and stripper extend bleed by their experience or intuition. They know that a certain amount of bleed is necessary, but do not always know how much the bleed allowed will over-overlap or whether it will cause white gap in some part of the job.

In order to examine what printers allow for bleed in some cases, the author took 65 measurements of the amount of bleed from magazines, labels and packages. Forty of these measurements were taken from the magazine "Print"* which is one of the highest quality printed magazines in this country. The overlaps in "Print" ranged between 0.0140 and 0.0440 centimeters. Assuming that all bleeds measured were printed from a press or presses of similar characteristics, the magazine is then using an "average" bleed of 0.0290 with a range of variation 0.0300 centimeters (0.0440-0.0140). Because the overlap never went

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* Published by Kaye-Cadel Publishing Corp.

below 0.0140 centimeters, it can be concluded that the magazine used that much "overbleed". This bleed could be reduced to 0.0150 centimeters (0.0290-0.0140) without allowing white gap.

The remaining 25 measurements were randomly taken from various magazines, labels and packages. It was found that some bleed printed up to 0.01000 centimeters whereas others had white gap as wide as 0.0200 centimeters. These facts suggest that the amount of bleed used by printers is probably arbitrary. It probably also indicates that many printers do not know how much bleed they should allow under all circumstances.

Objectives of the study

This thesis is an attempt to determine a logical method of arriving at the least amount of bleed required to account for inherent variation of the registering system of a press. Determining that optimum amount of bleed would permit the closest possible adherence to the design of the artist, yet avoid white gap and excessive overbleed.

Printers sometimes want to print with less bleed at the expense of having some of the sheets printed with white gap. This study will discuss this matter in an attempt to determine differing amounts of bleed and the resulting corresponding percentages of white gap.

There is also a possibility that the bleed can be made so small as to be unnoticeable with the naked eyes. To achieve this, the register system would have to be highly accurate. The minuteness with which the human eye can detect depends upon the eye's resolving power, the distance of the object to the eye and the intensity of the color of the object. Generally speaking, the eye of the average person is not able to resolve objects less than about one minute apart. (5-304) The resolving limit is determined by optical defects in the eye or by the structure of the retina. Computing from the angle of one minute limit, a person with normal vision viewing an object two feet from his eye would not be able to detect the object if it were only 0.000349 inches or 0.000887 centimeters wide*. Viewed from three feet, normal resolving power is 0.000524 inches or 0.001331 centimeters. A register system would be ideal if it could achieve this small a degree of variance.

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* Appendix I shows the computation.

CHAPTER II

METHODOLOGY OF THE STUDY

This chapter will briefly discuss the registering system of a press to see what variables involved cause bleed variation. It will also discuss the fundamental theories and methods to be used in the study.

Registering system

Registering devices are used to make every press sheet receive its impression the same distance from both the "feeding" edge and the "guide" edge.

There are several systems of registering: the three-point register system, the feed-roll system and the swing-feed or transfer-gripper system. The most popular system is the conventional three-point guide system. This consists of two front guides and one side guide. The front guides both align the sheet or "square" it and determine the front margin. The side guide determines the sideways register. The other systems are modifications or improvements of the three-point system, the fundamental principles are the same.

Before the sheets enter the registering system, there is a feeder which separates individual sheets of paper from the pile and delivers the sheet forward toward the registering position. The sheet moves down the ramp and is stopped by the front guides. It is then pushed or pulled to a side stop by rollers or wheels. Simultaneously, the grippers close on the front edge of the sheet and the front guides move out of the way. The sheet is then free to move forward with the grippers. Because the front guides cannot descend into normal position until the sheet has passed and the cylinder gap is under them, this system has some critical timing elements.

All of these guiding operations must occur while the cylinder gap is passing under the guide point. The elapsed time is small on presses operating at upwards of 6,000 impressions per hour. Elapsed time often is no more than 1/4 second. When the guiding system is aligning the sheet during this short time, the sheet is likely to buckle or bounce off the guides. This phenomenon of buckle or bounce greatly affects the amount of variation of the registering system.

Variables which affect the variation of register

The variation of register is not determined only by the registering system of the press. Many other variables contribute to this variation. The following list explains how the register can change with the variables.

1. Characteristics of the press -- The type of registering system used is the most important single factor in register variance. The accuracy of the press cylinders and the grippers in the impression cylinder also affect the

variation.

2. Pressman -- The way a pressman practices his makeready is another important factor in variance. The pressman must adjust many devices in order to register the sheet; square the guides against the sheet, time the guiding operation, adjust the pressure of the hold-down bar and the pressure between the two rollers of the pull-type side guide, position the auxiliary conveyor wheel at the back edge of the sheet, etc. All such adjustments will have an effect on register variance.

3. Speed of the press -- If the speed is high, the sheets move rapidly down the ramp. When stopped by the front guide, they will buckle or bounce more than when the speed is slower, causing a larger variation on faster presses. Also, because the elapsed time for the guiding operation is shorter, the accuracy is not as high.

4. Size of the sheet -- It is harder to handle a large sheet than a smaller sheet. Accordingly, greater variation occurs in larger sheets.

5. Weight of the stock -- Buckling happens at the guides if the sheet is light weight, whereas bounce off happens if the sheet is of heavy weight. Generally speaking, the buckling of the light weight stock causes a larger variation than does the bouncing of heavy weight stock.

6. Moisture -- when the sheet runs through an offset lithographic press, it picks up a certain amount of

moisture. The sheet thus expands and causes internal registering troubles for later runs. In such cases, the pressman usually has to change the packing under the plate or under the blanket in order to obtain a good register.

7. Static electricity -- If the paper is extra dry or the pressroom humidity is too low, static electricity may develop due to friction between the sheet and the feedboard. The sheets will then stick to the feedboard and cause registering trouble. Static usually causes no trouble on offset presses if the relative humidity is above 30 to 35% and if the paper has been properly conditioned. (8-33) Because static electricity also causes trouble on the delivery end of the press and causes "set-off" (ink transfer to the back of succeeding sheets), plants without humidity control may air-condition the plant or use static eliminators for grounding or neutralizing the static charge.

Fundamental theories

Before developing a method to determine minimum bleed, certain basic statistical concepts must be understood. In establishing realistic positions of the register mark,* a fundamental condition of scattering of data must be assumed. The process variation or "error" in measurement

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* The realistic position of the register mark is determined by the distance between guiding edge of the sheet and register mark in the sheet.

follows a normal frequency distribution such as that shown in the histogram, Figure 1. For a particular register mark on the sheet, the horizontal axis has been stepped off and divided into increments of measurement on either side of the actual desired position of the register mark. The vertical axis indicates the frequency with which each of these measurements occurs.

Sheets which have been printed and measured under controlled conditions will fall generally within characteristic zones of the position of the register mark if the pressman keeps process variables in control. Under these conditions it will be found that most of the positions measure close to the desired mean specification.

This is the case for the frequency distribution of the histogram (Figure 1.) The pattern of normally distributed data is a symmetrical "bell". The center line intersects the horizontal axis at the arithmetic mean, or average, and its position may be calculated by summing up the individual values and dividing the sum by the number of measurements.

A characteristic of the normal frequency distribution is the standard deviation, which is the root mean square of deviations of all measurements from their mean. This is commonly indicated by the small Greek letter sigma (σ), and is obtained from ungrouped data by determining the difference between each measurement and the mean, squaring each of

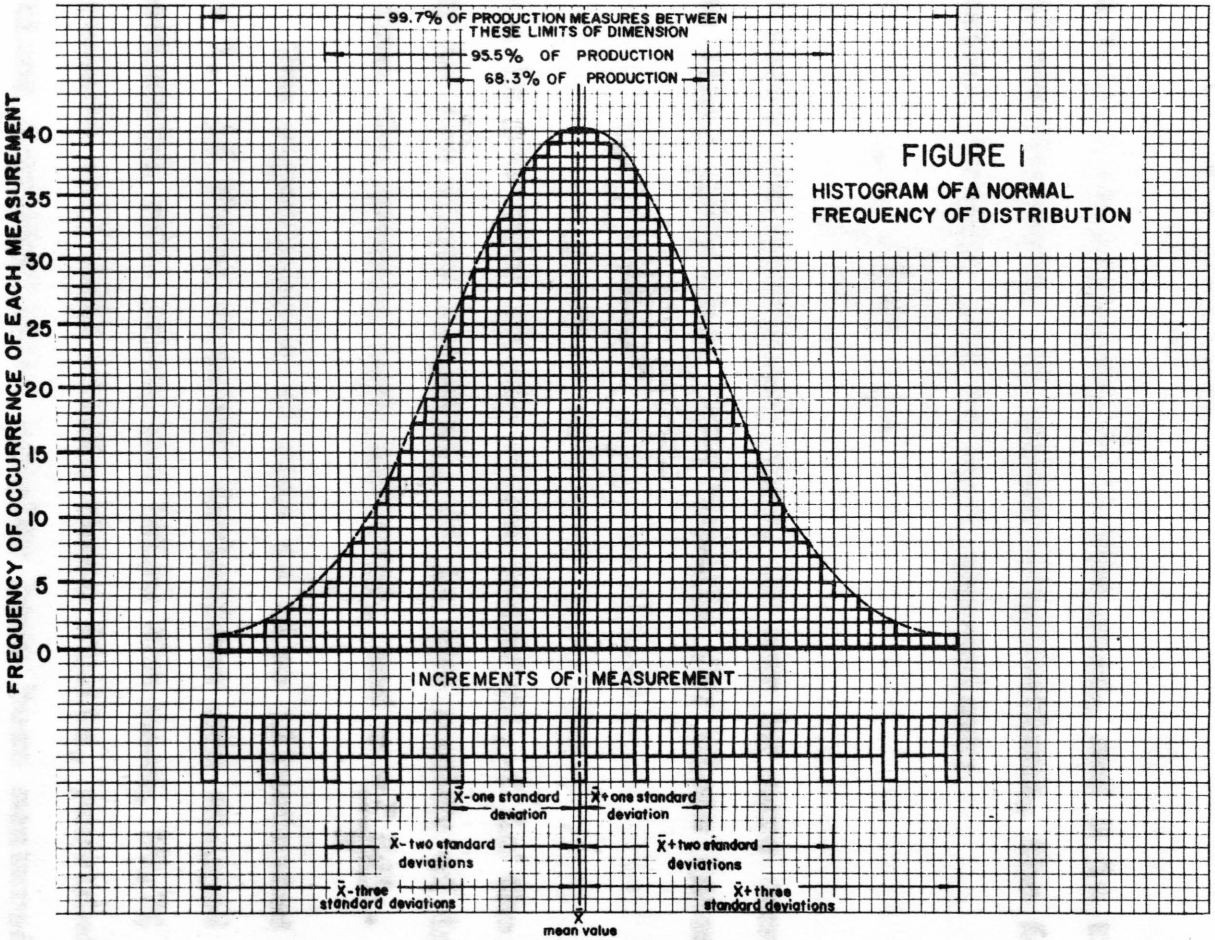

FIGURE I
HISTOGRAM OF A NORMAL FREQUENCY OF DISTRIBUTION

these differences, summing them, dividing by the number of measurements, and extracting the square root according to the formula:

$$\sigma = \sqrt{\frac{\Sigma(X-\bar{X})^2}{N}} \qquad (1)$$

where X is a measurement, $\bar{X}$ is the mean, and N is the number of measurements. In making computations, the following equivalent formula will be more convenient:

$$\sigma = \sqrt{\frac{\Sigma X^2}{N} - \bar{X}^2} \qquad (2)$$

Where there are sufficient data, it may be more convenient to use class intervals. The formula for class interval is

$$\sigma = i\sqrt{\frac{\Sigma f d'^2}{N} - c^2} \qquad (3)$$

where i is the size of the class interval, f is the frequency in the class interval, d' is the number of intervals away from the guessed mean interval, and $c = \frac{\Sigma fd'}{N}$.

The significance of this is also illustrated in Figure 1. If three standard deviations are stepped off on the horizontal axis above and below the mean, 99.7% of the measurements will fall within these limits, provided that sufficient representative samples have been measured.

Because bleed is used to cover the inevitable variation of the registering system of presses, statistical methods should be applied to determine the inherent characteristics of the registering system, using standard deviation as a basic measurement to determine bleed.

Assuming that the pressman could print the register marks of the colors together, the variable factors of moisture and static electricity need not be considered. This does not mean that the pressman is expected to print the register mark of one color exactly on top of the other color on each sheet, but it does mean that the pressman should have the mean position of the register mark of the first color coincide with that of the second color.

It is a common practice for pressmen to run small sheets or heavy weight stock at higher speeds than used for larger, lighter sheets. Thus the factors of sheet size, stock weight and press speed will compensate each other in their effects on register. Although the change of variations from job to job still exists, it will be relatively small because of this compensation.

Generally speaking, a pressman or a team of pressmen is assigned regularly to a particular press. This enables the combination of the press and pressmen factors as a single factor. Also because of this, it is not possible to obtain a certain bleed for all purposes. For each press operated by different pressmen, a standard bleed determination must be made.

In order to determine the amount of bleed for a press, calculation of the standard deviation which will be dictated by the characteristics of the registering system of that press must first be made. But because there are many variables involved, two steps must be taken:

1. Calculate the standard deviation of register variation for each job, or more exactly, for each makeready.

2. Although the combined effect of sheet size, stock weight and press speed are relatively small, the standard deviation of register variation changes slightly from job to job. Thus the standard deviations of the jobs run on the press have to be compiled into another distribution of frequency. Calculation of the mean of standard deviations and standard deviation of standard deviations can then be made so that maximum standard deviation of the press can be obtained according to the following formula:

$$S_{max} = \bar{X} + 1.96\ S_s \qquad (4)$$

Where $\bar{X}_s$ is the mean of standard deviations, S_s is standard deviation of standard deviations. S_{max} is maximum standard deviation.

The 1.96 standard deviation for calculating maximum standard deviation has been used because it will cover 97.5% of the standard deviations.

The maximum standard deviation S_{max} is then assigned to the press as being characteristic of its registering system. This will be the basis of our calculation of the amount of bleed.

CHAPTER III

DEVELOPMENT OF THE METHOD

After determination of the standard deviation of the registering system of a press, it is possible to develop a method for determining minimum bleed.

In the process of printing, in most cases, all the colors printed on a job are printed on the same press. It may sometimes be necessary to print different colors on different presses, however, and this chapter will discuss the two cases separately.

Two colors printed on different presses

Because bleed is the result of printing two colors, it is a problem of mating. The problem resolves itself into how a sheet printed with the first color will mate when the second color is applied.

As an example, assume a job is printed with yellow and blue, as illustrated in Figure 2. The yellow is printed on a press which has a registering system characteristic of Y-distribution. The mean position of the left edge of the yellow image area is $\bar{y}$. The sheets are then printed with blue on another press which has a registering system characteristic of B-distribution. The mean position of the right edge of the blue image area is $\bar{b}$. The bleed applied is equal to the distance $\overline{yb}$.

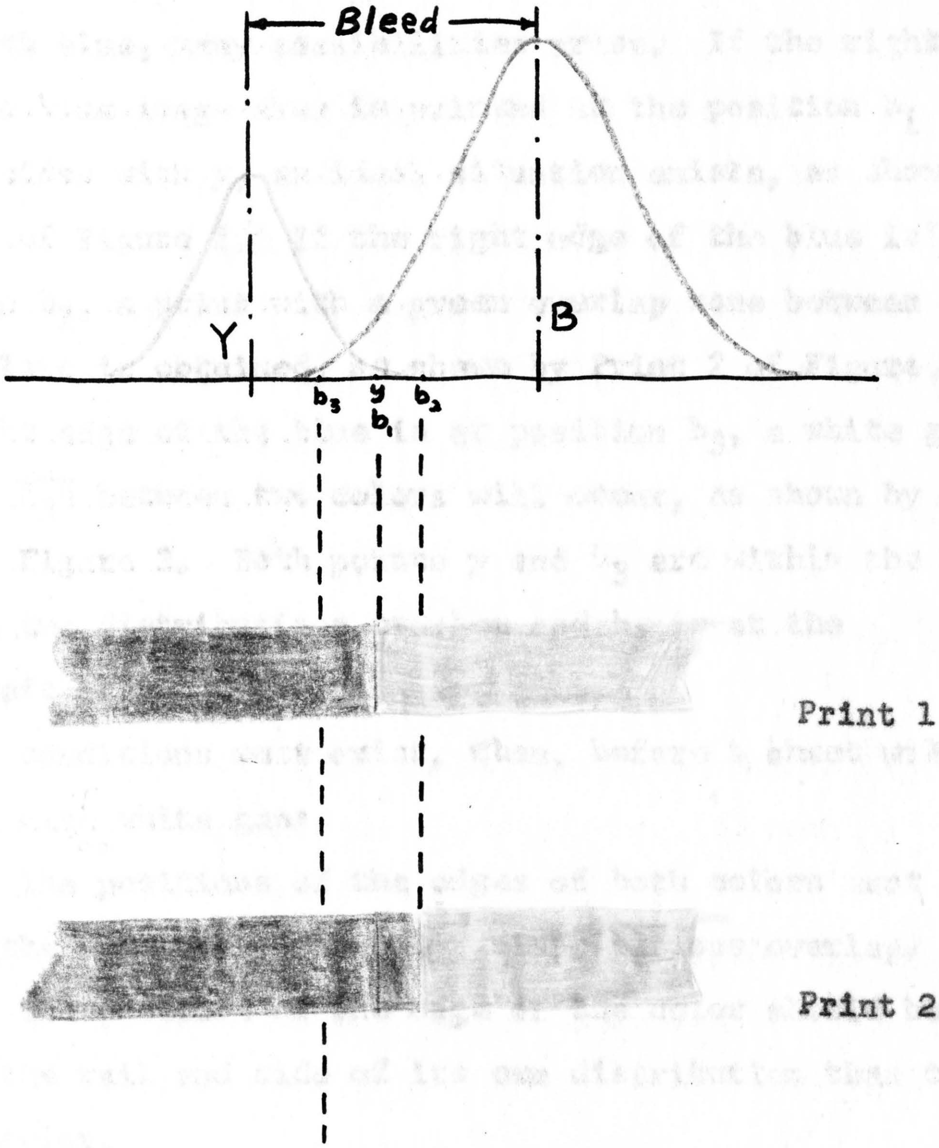

Figure 2. Two overlapping frequency distributions of register

If a sheet happens to have been printed at the left edge of the yellow at position y, when this sheet is to be printed with blue, many possibilities arise. If the right edge of the blue image area is printed at the position b_1 which coincides with y, an ideal situation exists, as shown by Print 1 of Figure 2. If the right edge of the blue is at position b_2, a print with a green overlap zone between the two colors is obtained, as shown by Print 2 of Figure 2. If the right edge of the blue is at position b_3, a white gap with width $\overline{b_3y}$ between two colors will occur, as shown by Print 3 of Figure 2. Both points y and b_3 are within the area where two distributions overlap and b_3 is at the position left of y.

Two conditions must exist, then, before a sheet will be printed with white gap:

1. The positions of the edges of both colors must be within the area where the color distributions overlap.

2. The position of the edge of the color should be closer to the tail end side of its own distribution than to the other color.

To decrease the possibility of printing white gap, the area where both color distributions overlap must be reduced. This means that the amount of bleed must be increased. The amount of bleed permitted then depends upon what percentage of the job can be risked to print with white gap.

A graph was developed in 1950 (3-26) to facilitate the calculation of overlapping frequency distribution. An extension of this diagram in which many more parameters have been included is shown in Figure 3. Its purpose is to enable accurate and rapid estimation of the bleed by the predetermined risk of white gap between two color groups of mated prints that follow a normal frequency distribution with respect to the position of the edge of image areas. These risks are indicated as percentages.

The application of Figure 3 in solving problems follows six steps:

1. Divide the larger standard deviation by the smaller.

2. Locate this ratio on the lower horizontal scale.

3. Locate the predetermined risk on the curve of probability of white gap.

4. Find the point located by the intersection of the curve of Step 3 and vertical line of Step 2.

5. From this point, find the ratio of bleed to smaller standard deviation on the vertical scale.

6. Multiply this ratio with the smaller standard deviation to obtain bleed.

An example of such calculation will be discussed in Chapter V.

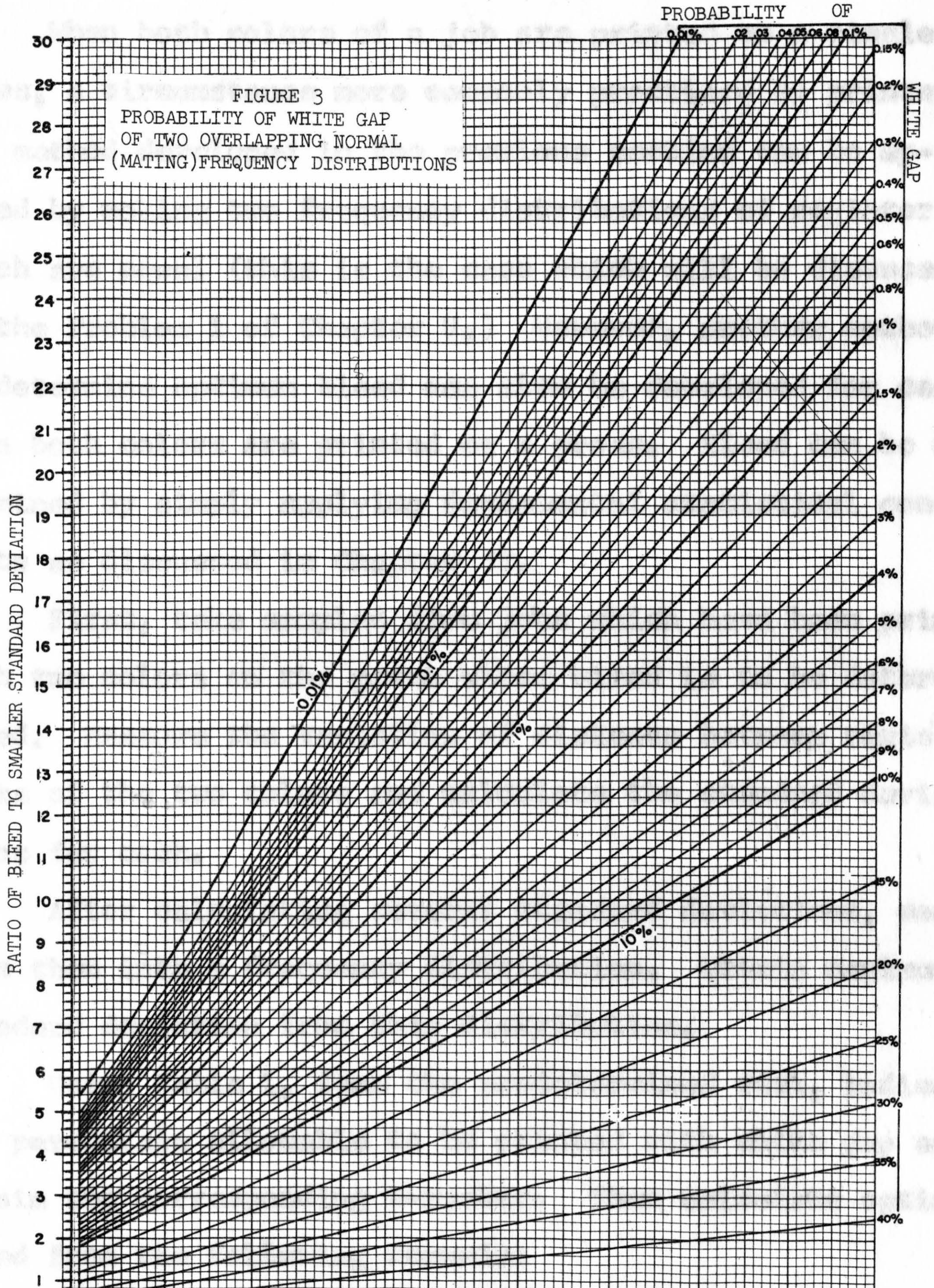

FIGURE 3
PROBABILITY OF WHITE GAP
OF TWO OVERLAPPING NORMAL
(MATING) FREQUENCY DISTRIBUTIONS

Both colors printed on the same press

When both colors of a job are printed on a single press, a circumstance more commonly practiced by printers, the method developed in the previous section can be applied by making two frequency distributions of register which are equal (this is the case which will be discussed in the Problem 1 of Chapter V.) However, another method to determine optimum bleed can also be developed for cases when both colors are printed on a press. Bleed can be determined by simply applying fundamental statistical concepts as discussed in Chapter II.

First, take samples from jobs which have been printed with two colors on the press whose bleed is to be determined. Measure the variation of distance between register marks of the two colors and calculate the standard deviations for each.

After calculating several standard deviations, compile them into a frequency distribution. Obtain maximum standard deviation from this distribution.

Using Table 1, from the predetermined risk, indicate the percentage allowable to be printed with white gap and obtain the corresponding t-number. Then calculate optimum bleed from the following formula:

$$\text{Bleed} = t \times S_{max} \qquad (5)$$

Table 1. risk vs. t

Risk %	t
0.05	3.291
0.5	2.576
0.1	2.326
2.5	1.960
5.0	1.645
10.0	1.282
15.0	1.036
20.0	0.842

An example of calculation will be discussed in Chapter V.

CHAPTER IV

INSTRUMENTS FOR MEASUREMENT

Because variation of register is a matter of thousandths of one centimeter, a highly accurate instrument should be utilized for measurement. The author used the comparator for measurement of data which will be presented in Chapter V. Another possible tool is the LTF register rule. It is not as accurate as the comparator, but it might prove suitable for the purpose.

The comparator

The comparator consists of a micrometer slide carrying a telescope; the whole apparatus is mounted on a heavy base. This combination is sometimes called a traveling telescope.

The micrometer slide consists of an accurate screw of one millimeter pitch with a micrometer head divided into 100 parts. The screw carries a plate along carefully scraped ways to which may be attached a telescope. Because the axis of the optical system is moved parallel to itself by means of the screw, the distance between any points which are successively brought to the intersection of the cross hairs is independent of any error in the optical system. A centimeter scale with one millimeter divisions is provided to keep track of complete revolutions of the screw, whereas fractional parts of a turn may be read from the wheel.

<u>LTF register rule</u> (6-232)

The Lithographic Technical Foundation, Inc. has designed a register rule for printer's purposes. This is a highly accurate guage for measuring distances. It has been designed to incorporate a dial vernier that is accurate to 0.001 of an inch.

CHAPTER V

EXAMPLE OF CALCULATION

Two examples of calculation applying the methods developed in Chapter III will be shown in this chapter. The data of both examples were actually taken by the author in the Printing Laboratory of South Dakota State College. Both examples dealt with the determination of optimum bleed for Harris Press Model 23" x 26" LUS in the Laboratory. The first example applies the method described in "two colors printed on different presses." The second example applies the simpler method described in "both colors printed on the same press."

Problem 1

Determine the bleed which allows risk of 0.1% of white gap for Harris Press Model 23" x 26" LUS in the Printing Laboratory of South Dakota State College. Use the method discussed in the first section of Chapter III.

1. Take a random sample of 50 sheets from a job of one color printed on Harris Press Model 23" x 26" LUS. Measure the distance of side guide edge to the register mark of each sheet. Table 2 shows the frequency distribution of the positions of register mark and computation of its standard deviation.

Table 2. Computation of Standard Deviation Of Positions of Register Mark

Distance, X cm	frequency, f	d'	fd'	fd'2
0.8421 - 0.8450	1	-6	-6	36
0.8451 - 0.8480	0	-5	-0	0
0.8481 - 0.8510	2	-4	-8	32
0.8511 - 0.8540	2	-3	-6	18
0.8541 - 0.8570	6	-2	-12	24
0.8571 - 0.8600	9	-1	-9	9
0.8601 - 0.8630	15	0	0	0
0.8631 - 0.8660	7	1	7	7
0.8661 - 0.8690	4	2	8	16
0.8691 - 0.8720	2	3	6	18
0.8721 - 0.8750	0	4	0	0
0.8751 - 0.8780	1	5	5	25
0.8781 - 0.8810	0	6	0	0
0.8811 - 0.8840	0	7	0	0
0.8841 - 0.8870	1	8	8	64
Total	50		-7	249

$N = 50$ $\quad\quad$ $i = 0.0030$ cm

$$c = \frac{\Sigma f d'}{N} = \frac{-7}{50} = -0.14$$

$$c^2 = 0.0196$$

From equation (3)

$$S = i\sqrt{\frac{\Sigma f d'^2}{N} - c^2} = 0.0030\sqrt{\frac{249}{50} - 0.0196}$$

$$= 0.0067 \text{ cm}$$

2. With the same procedure as in Step 1, calculate nine more standard deviations of nine jobs printed by the same press. Table 3 shows the standard deviations and computation of maximum standard deviation.

Table 3. Computation of Maximum Standard Deviation for Problem 1.

Standard Deviation X_s Cm	Coded X_s	X_s^2
0.0067	1	1
0.0071	5	25
0.0068	2	4
0.0066	0	0
0.0068	2	4
0.0067	1	1
0.0068	2	4
0.0068	2	4
0.0069	3	9
0.0069	3	9
Total	21	61

$$\bar{X}_s = \frac{\Sigma X_s}{N} = \frac{21}{10} = 2.1$$

From equation (2)

$$S_s = \sqrt{\frac{\Sigma X_s^2}{N} - \bar{X}_s^2} = \sqrt{\frac{61}{10} - (2.1)^2} = 1.3$$

Decoding $\bar{X}_s = 0.0066 + 0.00021 = 0.00681$ cm

$S_s = 0.00013$ cm

From equation (4)

$$S_{max} = \bar{X}_s + 1.96\, S_s = 0.00681 + (0.00013)(1.96) = 0.0071 \text{ cm}$$

3. In this case, the frequency distributions of the register of two colors will be equal because both colors were actually printed on the same press, even though the method is designed for the colors being printed on different presses. This means that the ratio of larger standard deviation to smaller standard deviation is equal to one. Referring to Figure 3, locate the vertical line of 1 on the horizontal scale. The intersection point of this line with the 0.1% curve of probability of white gap is 4.35 on the vertical scale, which is the ratio of bleed to smaller standard deviation. So:

Bleed = 4.35 x 0.0071 = 0.0308 cm

Problem 2

Determine the bleed which allows risk of 0.1% of white gap for Harris Press Model 23" x 26" LUS of the Printing Laboratory of South Dakota State College. Use the method discussed in the second section of Chapter III.

1. Take a random sample of 50 sheets from a two-color job printed on Harris Press Model 23" x 26" LUS. Measure the distance between the register marks of the two colors. Table 4 shows the frequency distribution of distances and computation of its standard deviation.

Table 4. Computation of Standard Deviation Of Distance Between Register Marks Of Two Colors

Distance, X cm	Frequency, f	d'	fd'	fd'^{2}
0.0419 - 0.0360	1	-7	-7	49
0.0359 - 0.0300	1	-6	-6	36
0.0299 - 0.0240	0	-5	0	0
0.0239 - 0.0180	1	-4	-4	16
0.0179 - 0.0120	3	-3	-9	27
0.0119 - 0.0060	5	-2	-10	20
0.0059 - 0.0000	9	-1	-9	9
0.0001 - 0.0060	16	0	0	0
0.0061 - 0.0121	7	1	7	7
0.0121 - 0.0180	3	2	6	12
0.0181 - 0.0260	3	3	9	27
0.0241 - 0.0300	0	4	0	0
0.0301 - 0.0360	1	5	5	25
Total			-8	228

$N = 50$ $\quad$ $i = 0.0060$ cm

$c = \frac{-8}{50} = -0.16$ $\quad$ $c^2 = 0.0256$

From equation (3)

$$S = 0.0060\sqrt{\frac{228}{50} - 0.0256} = 0.0128 \text{ cm}$$

2. With the same procedure as used in Step 1, calculate nine more standard deviations of nine two-color jobs printed by the same press. Table 5 shows the standard deviations and computation of maximum standard deviation.

Table 5. Computation of Maximum Standard Deviation for Problem 2.

Standard Deviation Xs cm	Coded X_s	X_s^2
0.0128	2	4
0.0126	0	0
0.0129	3	9
0.0128	2	4
0.0128	2	4
0.0132	6	36
0.0128	2	4
0.0127	1	1
0.0129	3	9
0.0127	1	1
Total	22	72

$\bar{x}_s = 22/10 = 2.2$

From equation (2) $S_s = \sqrt{\frac{72}{10} - (2.2)^2} = 1.536$

Decoding $\bar{X}_s = 0.0126 + 0.00022 = 0.01282$ cm

$S_s = 0.0001536$

From equation (4)

$S_{max} = 0.01282 + (1.96)(0.0001536) = 0.01285$ cm

3. Referring to Table 1, for 0.1% risk, t = 2.326. From equation (5)

$$\text{Bleed} = t \times S_{max} = (2.326)(0.01285) = 0.0300 \text{ cm}$$

Practical Application

In any shop situation, optimum bleed for any make or model of press could be determined in the same way as described in Problems 1 and 2. Depending upon the method of applying the second color, management would decide to use one method or the other.

CHAPTER VI

CONCLUSION

By the method developed in this study, the artist, cameraman or stripper must know which press is to print the job before he can determine bleed. In a printing plant where a formal production control system is used, the routing and scheduling functions will indicate which press is to be used on the operation sheet. It is recommended by the author that the production control department should be responsible for calculating the amount of bleed and should indicate it on the operation sheet. This would eliminate the necessity of high paid skilled craftsmen spending time in figuring out how much bleed should be allowed.

If the plant has a quality control department, data concerning variation of registering systems of press could probably be supplied most easily by this department.

There is no definite amount of bleed for a particular press. Bleed allowed will depend upon what percentage of white gap management is willing to risk on each job. Reduction of the amount of bleed will result in the increase in the number of white-gap-printed sheets in the job.

As discussed in Chapter II, the registering system consists of front guides and side guide. In the examples in Chapter V, because measurements were taken from side guide to the register mark, the computed bleed is only applicable for the determination of sideways bleed. If optimum bleed is to be determined for forward sheet movement, the measurement of variation should be taken from front guide to register mark.

Because maximum standard deviation is used to calculate bleed, the percentage risk will also in a sense be maximum. That is, for a certain amount of bleed, white gap sheets will not exceed certain percentages.

Also in Chapter II, the variables of sheet size, stock weight and press speed are assumed to compensate for one another. The small range (0.0005 centimeters) of standard deviations on jobs in the example of Chapter V shows this assumption to be correct.

The bleed calculated for Harris Press Model 23" x 26" LUS in the Printing Laboratory of South Dakota State College was 0.0300 centimeters. It was about thirty times the minimum resolving power of the human eye (approximately 0.0010 centimeters as discussed in Chapter I.) If the registering system could be made to this small a degree of variation, the artist's design could be carried out more perfectly.

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APPENDIX

(1) L = Distance = 2 feet = 24"

θ = Angle = 1 minute = $\frac{1}{60}^{\circ} = \left(\frac{\pi}{360}\right)\left(\frac{1}{60}\right)$ radian

x = Width of the object

At small angle $\theta \doteq \sin\theta = \frac{x}{L}$

$$\therefore\ x = \theta \cdot L = \left(\frac{\pi}{360}\right)\left(\frac{1}{60}\right)(24)$$

$$= 0.000349''$$

$$= 0.000887 \text{ cm}$$

(2) L = 3 feet = 36"

$$\therefore\ x = \left(\frac{\pi}{360}\right)\left(\frac{1}{60}\right)(36)$$

$$= 0.000524''$$

$$= 0.00131 \text{ cm}$$