1963

An Experimental Study of the Effects of Selected Roller Settings on the Ink Transfer Capabilities of a Polyurethane Roller

Christian Christian Hein

Recommended Citation

Hein, Christian Christian, "An Experimental Study of the Effects of Selected Roller Settings on the Ink Transfer Capabilities of a Polyurethane Roller" (1963). *Electronic Theses and Dissertations*. 2896.
https://openprairie.sdstate.edu/etd/2896

AN EXPERIMENTAL STUDY OF THE EFFECTS OF SELECTED ROLLER SETTINGS ON THE INK TRANSFER CAPABILITIES OF A POLYURETHANE ROLLER

3)

BY

CARL CHRISTIAN HEIN III

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

AN EXPERIMENTAL STUDY OF THE EFFECTS OF SELECTED ROLLER SETTINGS ON THE INK TRANSFER CAPABILITIES OF A POLYURETHANE ROLLER

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.

Thesis Adviser

Head of the Major Department

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to Assistant Professor Paul H. Jess and Associate Professor J. K. Hvistendahl for their kind guidance and encouragement throughout the preparation of this study.

Special thanks to Professor R. D. Anderson for permitting use of the Engineering Shops' equipment for construction of the test apparatus, the Chemistry Department for loan of the balance, the Physical Education Department for loan of the timer, and to Associate Professor Oscar Abel for his cooperation in providing an area in which to carry on the experiment.

The author wishes to express sincere appreciation to the Sam'l Bingham's Son Mfg. Co., Minneapolis Office, for generously supplying the polyurethane rollers and to the Flint Ink Company, Minneapolis Office, for generously supplying the inks.

Additional and much deserving thanks is extended to the author's wife, Miriam G. Hein, for her encouragement, patience, and understanding throughout the course of this work.

CCH

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

The basic mechanics of the printing operation are the controlled transferring of ink to paper. It seems obvious, therefore, that performing this operation at peak efficiency is essential to competitive success. In letterpress printing this basic mechanical operation takes place in three steps: one, breaking the ink down into a thin, even film; two, depositing the ink film on the raised surface from which the print is to be made; and three, transferring the ink film from the raised surface to the paper or substance being printed upon. Deficiencies in any of these three critical areas may result in a product of unacceptable quality.

In letterpress printing, the second step, that of depositing the ink film on the raised surface from which the print will be made, is accomplished by means of an inking roller. It is with this aspect of the printing operation that this thesis is concerned.

The ink roller is essentially a cylindrical object which must possess the following properties:

(1) Inking rollers must be soft: this is necessary to insure that the roller can mold itself easily to small irregularities in the type surface and exert a uniform pressure on each part.

(2) They must not swell or shrink when brought into contact with printing ink or cleaning solvents so as to avoid any change in pressure over the form during a long run.

(3) They must have surface tack, i.e. the roller surface must have a high degree of affinity for the ink, which enables it to produce a very smooth film on the roller which is then transferred to the type surface.

(4) They must be capable of being easily cleaned.[1]

Lack of any of these properties in a roller may result in breakdown of the entire operation, because the roller plays such an important part in the printing process. It has been estimated that as much as 70% of press down time may be caused by the rollers.[2] The best presses and pressmen can be no better than their rollers, which actually perform the critical transfer function.

<u>Brief History of Roller Development</u>

The inking roller is a development which has taken place within the past one hundred and seventy-five years. In 1812 Robert Harrild was successful in casting some of the first composition rollers from a mixture of treacle and glue.[3] This roller was improved in 1854 by Thomas de la Rue's suggestion of adding glycerine to the mixture.[4] The ink-transfer properties of this roller have never been excelled and many such rollers are in use throughout the country even today.

---

[1] D. J. Coulter, "Printers' Rollers", <u>Proceedings, Institution of the Rubber Industry,</u> December, 1957, p. 117.

[2] Sam'l Bingham's Son Mfg. Co., "Roller News," (advertisement) <u>Printing Production,</u> Vol. 93, No. 9, (June, 1963), p. 6.

[3] Jack Deller, Printers' Rollers, <u>Their Manufacture, Use, and Care,</u> (London: Charles Skilton Ltd., 1959), p. 50.

[4] <u>Ibid.</u>, p. 50.

Since the development of the composition roller, many materials have been introduced into the trade in an attempt to find one that possesses all of the advantages of composition and none of the natural deficiencies, such as poor stability, inadequate strength, and extreme thermoplasticity. Among the materials which have been introduced, some which are still in use are: natural rubber, synthetic rubber, vulcanized oil, and plastic, the latter being mainly of poly-vinyl-chloride. Although some measure of success has been attained with each of these rollers, none has been completely acceptable to the quality-minded printer.

Within the past few years, however, a roller which promises to simulate the outstanding inking properties of the composition roller, while overcoming most of its natural deficiencies, has come into the market.[5] This is the polyurethane roller.

The essential difference between polyurethane and composition is that the latter is thermoplastic whereas polyurethane is chemically cross-linked to give a three-dimensional elastic structure which is not thermoplastic.[6] The fundamental reaction for the formation of a urethane is:[7]

$$\underset{\text{isocyanate}}{RNCO} \quad (+) \quad \underset{\text{hydroxy compound}}{R^{1}OH} \longrightarrow \underset{\text{urethane}}{RNHCOOR^{1}}$$

---

[5] Coulter, op. cit., p. 118.

[6] Loc. cit.

[7] Ibid., p. 119.

The hardness of the polyurethane roller is governed entirely by the proportion of isocyanate used and can be varied to cover the entire range which may be desired by the printer.[8]

The polyurethane roller, when compared with a composition roller, is able to withstand greater temperatures. Under test conditions, the polyurethane roller shows no deterioration after static oven-aging for three months at 150°C, whereas composition melts at 30° to 50°C.[9] This fact is extremely important in that the trend in modern printing machinery is toward higher speeds, hence more friction and higher temperatures.

If the polyurethane roller proves to have a life of from two to three years,[10] which is anticipated, it may prove to be an answer to the search for an ideal roller.

---

[8] *Ibid.*, p. 125

[9] *Loc. cit.*

[10] *Ibid.*, p. 126

CHAPTER II

OBJECT OF THE STUDY

Because the polyurethane roller possesses all of the advantages of the composition roller, and at the same time overcomes most of its natural deficiencies, it would be an ideal roller for the letterpress printer seeking reliable, trouble-free, high-quality ink transfer. Once the roller is in the hands of the printer, however, it is up to him to use it as efficiently as possible. The best possible roller, it must be remembered, is of little value unless it is properly used. Because the roller plays such a critical part in the entire mechanical operation of the printing process, it obviously must be given a great deal of attention.

It is the object of this experiment to determine if there is an ideal setting of roller-to-printing-surface contact at which a polyurethane roller will transfer an optimum amount of ink, and, if there is such a setting, what it might be. It is felt that the knowledge of such a setting would greatly aid the pressman in his quest for high quality plus ease of production. In addition, it is felt that this setting would enable the printer to obtain the maximum amount of transfer which a particular roller can yield. This should be important to the printer, for it would improve the operation of this step in the letterpress printing operation.

CHAPTER III

EQUIPMENT AND MATERIALS USED

Test Unit

This unit consisted of a flat wooden bed with steel bearer rails and a steel transfer carriage for the roller, as shown in Figures I and II. It was designed and built entirely by the author. The test unit was so designed that ink on one plate on the bed of the unit could be transferred to a second plate on the bed by means of a roller positioned in the transfer carriage which traversed the length of the bed and passed over the two plates. The unit had a capacity for testing rollers that were 7.5 inches in length with .499 x 1.25 inch journals on each end and which had diameters ranging from .75 to 4.75 inches. Test plate maximum sizes were 6 x 6 x .918 inches.

The unit was constructed to allow independent plate-to-roller contact regulation on the plates being used in the tests. This contact was varied by changing the amount of packing between the plate and the bed of the unit. As seen in Figure III, rollers could be changed easily by means of the adjustable journal bearing.

It was found, after a brief period of practice, that the author was capable of manually producing the desired transfer-carriage speeds; therefore original plans for a mechanical driving system of limited speed range were discarded. Measurement of the manual speeds was accurately made by employing a Standard Electric

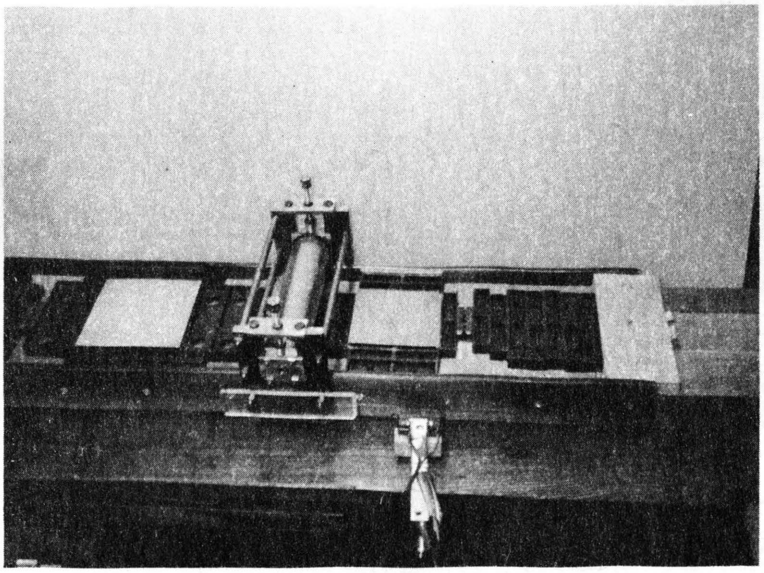

Figure I. View of Test Unit

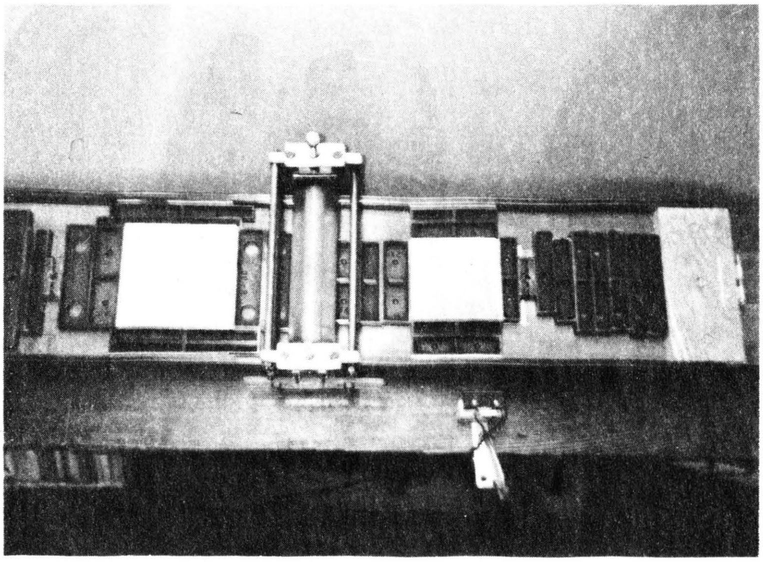

Figure II. Top View of Test Unit

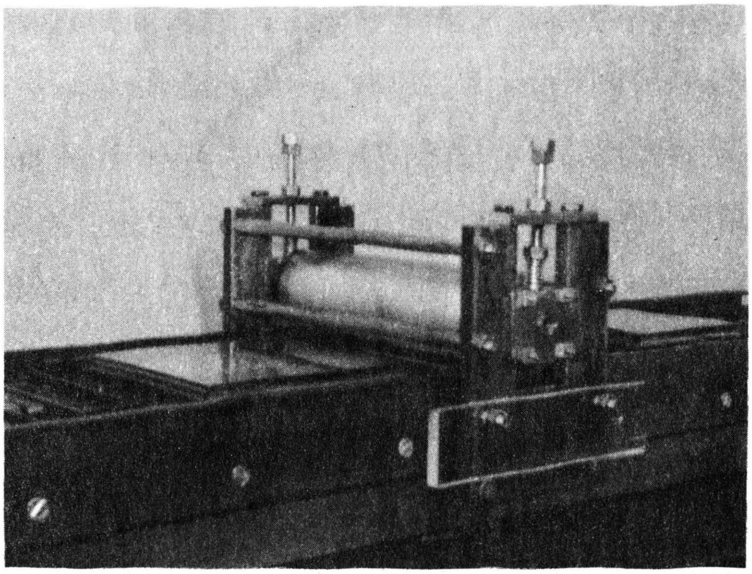

Figure III. View of Adjustable Journal Bearings For Adaptation to Rollers of Various Sizes

Timer. This procedure will be explained in the section on the timer in this chapter. Employing manual speeds for this type of experiments has been validated by Jacqueline M. Fetsko, William C. Walker, and Albert C. Zettlemoyer of the National Printing Ink Research Institute in their paper "Controlled Laboratory Printing Techniques."[11]

Densitometer

All ink film thicknesses were measured by employing a Welch Densichron Type 1 with a linear scale; coupled with the Densichron was a Welch Reflection Unit No. 3832A and a Welch Constant Voltage Transformer No. 3834M.

A reflection densitometer was chosen for measuring the ink film thicknesses because of its adaptability, operation speed, and sensitivity to slight changes in ink film thicknesses. The use of such an instrument for this purpose has been validated by Alden E. Yelmgren of ANPA Research Institute, Inc., in his paper "Technique for Measuring High-Speed Ink Film Transfer".[12] To further validate the use of this instrument, preliminary tests were run to establish the relationship of reflected optical density to

---

[11] Jacqueline M. Fetsko, William C. Walker, and Albert C. Zettlemoyer, "Controlled Laboratory Printing Techniques," *Proceedings of the 6th Annual Meeting of the Technical Association of the Graphic Arts, Inc.*, May, 1954, p. 43.

[12] Alden E. Yelmgren, "Technique for Measuring High-Speed Ink Film Transfer," *Proceedings of the 11th Annual Meeting of the Technical Association of the Graphic Arts, Inc.*, June, 1959, p. 25.

film-thickness curves of each of the inks to be used in the tests. To arrive at each of these curves it was necessary to weigh a blank plexiglass plate (selected because of its uniform reflection) on a balance and to record the weight. The densitometer was then zeroed on the plate with a Welch standard tile as a background. The plate was then inked by hand and the optical density again measured and recorded; it was then reweighed with the ink film on its surface. The difference between this weight and the plate's initial weight was the weight of the ink film. The surface area of the plate was then determined by careful measurement and the specific gravity of each of the inks to be used for the test was calculated (Appendix A). By using these data, the ink film thickness on the plate was easily calculated by applying the following formula (derivation Appendix B):

$$\text{Thickness} = \frac{\text{Weight of Film (mg)}}{\text{Area of Plate (cm}^2\text{) x Specific Gravity}}$$

This operation was repeated with various ink film thicknesses and the resultant data were plotted on a graph. As can be seen in Figure IV, optical density is definitely related to ink film thickness, provided an ink of suitable transparency is used; opaque ink films, however, cannot be measured by this means because the ink film thickness is independent of the optical density.

It is essential that the surface of the plate or object on which the film is to be measured with the densitometer have either a uniform reflectance or that each measurement be taken in exactly

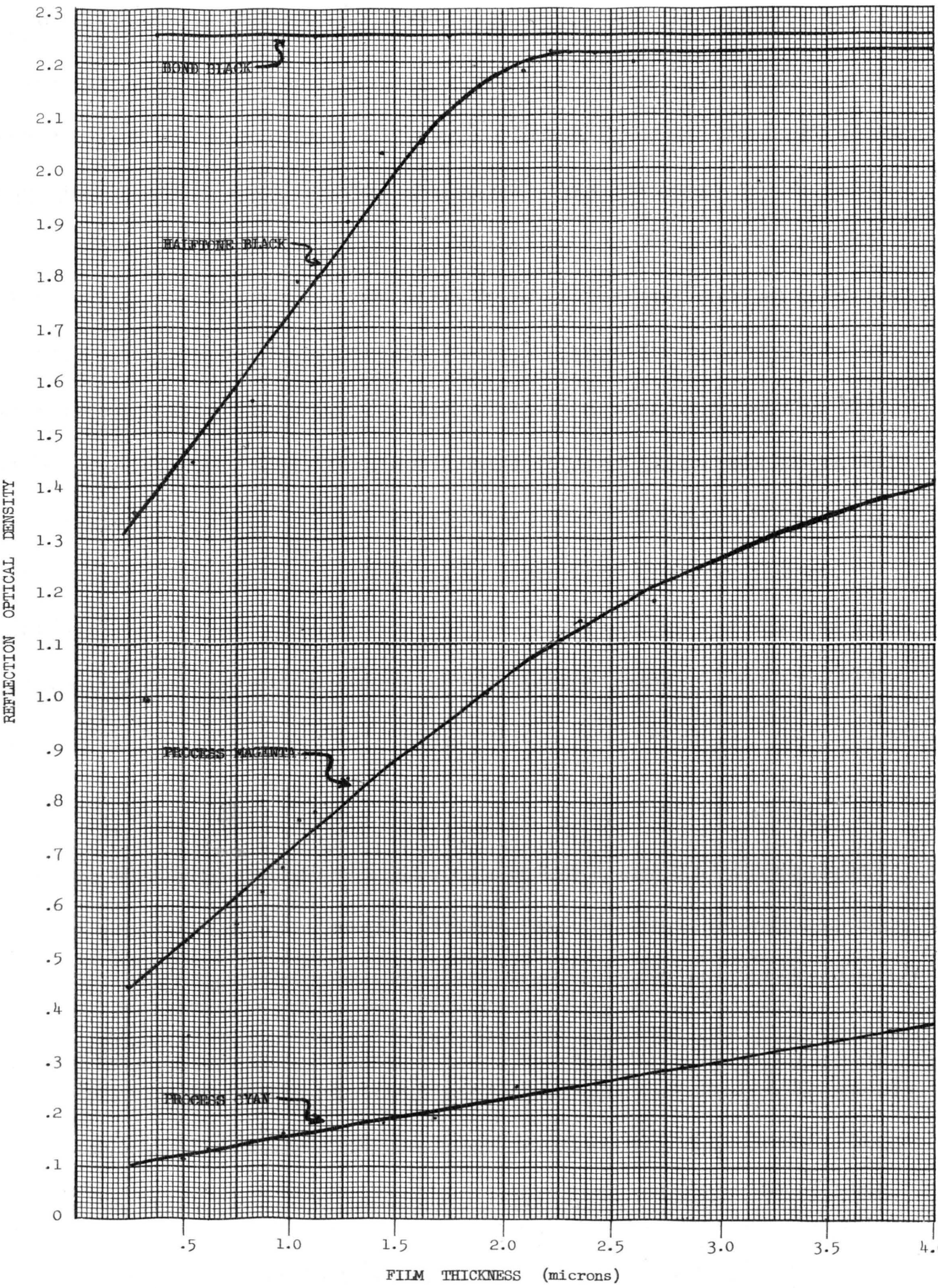

Figure IV. Reflection Versus Ink Film Thickness Curves for Selected Inks the same spot. Failure to meet this requirement will result in erroneous readings. To meet this requirement, the reflection unit was fastened in an arm which, in turn, was hinged to the test unit. This insured that each reading would be taken in exactly the same location. The above arrangement can be seen in Figures V and VI. The hinge pin was removable so that the arm and reflection unit could be transferred and attached in a similar manner to the opposite end of the test unit. This made possible similar readings on the form and supply plates. The distance between the reading points on the two plates was set at exactly twice the circumference of the roller being tested; therefore the points measured on the two plates corresponded to the spot on the roller which picked up the ink film from one plate and deposited it on the other plate.

Timer

All transfer carriage speeds were measured by employing a Standard Electric Timer type S-1. This timer accurately measures elapsed time in increments of .01 seconds. A micro switch was used as the clutch starting switch for the timer and was positioned directly opposite the point at which the transferred ink film thickness would be measured. A piece of plexiglass six inches in length was attached to the transfer carriage so that the switch was closed during the time that the plexiglass passed the point. Having the timer activated in such a manner made it possible to measure accurately the amount of time it took the roller to pass over the point

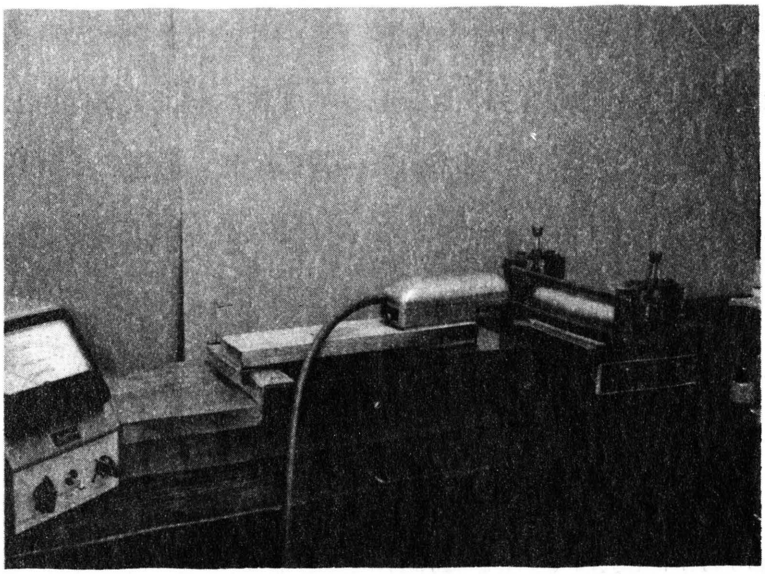

Figure V. Reflection Unit Mounted at Supply Plate End Of Test Unit. Reading Being Taken in Picture

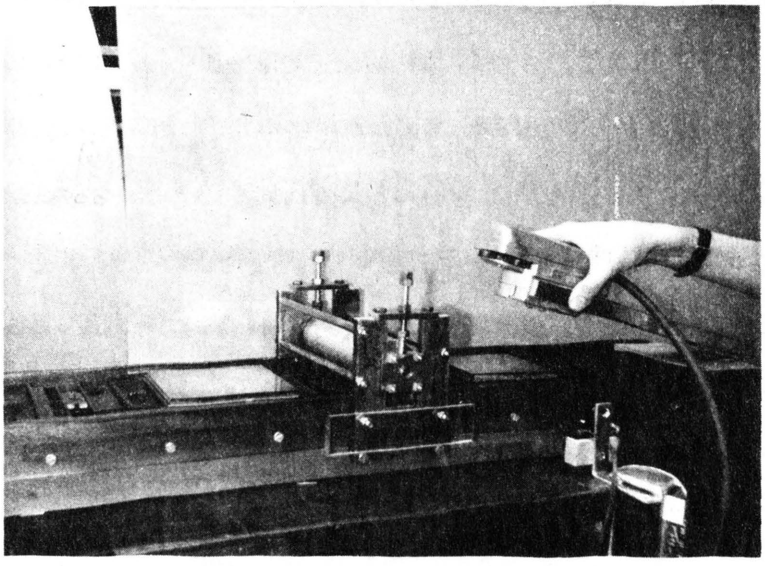

Figure VI. Reflection Unit Mounted at Form Plate End of Test Unit. Reflection Unit Raised Prior to Reading.

where the transferred ink film thickness was to be measured. By applying the following formula the speed in feet per minute is easily determined (derivation Appendix C):

$$\text{Feet per minute} = \frac{60}{\text{Elapsed time (sec.)} \times 2}$$

Roller Setting Gauge

All roller settings employed for the tests were measured by means of a twelve-inch steel rule calibrated in 1/32 of an inch. The measurement of the setting was executed by measuring the plate-to-roller contact image which the inked roller left on a blank plate when it was carefully brought into firm contact with a clean plate, left to rest for several seconds, and removed. The width of this band, which will be referred to as the roller setting, is measured perpendicularly to the axis of the roller and is an accurate measurement of the plate-to-roller contact. This procedure was adopted because it is familiar to the trade and can be performed by any pressman without extensive and elaborate equipment, or explanation. This procedure is also not affected by the hardness of the roller, whereas any pressure readings would be.

Roller Trucks

It is essential that the surface speed of the roller under test be equal to the speed at which the transfer carriage is propelled across the bed of the test unit: failure to meet this requirement results in a slurring action between the roller and the plate. To make certain that this did not occur in these tests, the experimenter equipped the rollers with plexiglass trucks manufactured to the same diameter as the roller. When the periphery of the roller and the truck are identical, no danger of a slur exists. The roller was driven solely by the friction between the roller truck and the bearer rails of the test unit bed.

It is also essential that the diameter of the roller be uniform over its entire length and that its concentricity be perfect. The rollers employed for all of the tests met this requirement to within less then .001 inch.

Materials Used

The plates used on this test unit were of two types, one of steel and the other of Linotype metal. The steel plate was composed of a piece of sheet metal 6 x 6 inches, fastened to a lead block to make a plate 6 x 6 x .918 inches. Steel was selected for this plate because the majority of letterpress equipment in use today has steel ink plates and the experimenter desired to use standard trade conditions whenever possible. The second plate was designed to simulate what might be found in an actual printing form to which a roller would transfer ink. The dimensions of this plate were 5 x 5 x .918 inches.

The inks used for all of the tests were supplied from the stock of the Flint Ink Company. It was arbitrarily assumed that they were representative of the inks manufactured by this firm and used throughout the country. The inks selected were letterpress halftone black, bond black, and the process colors magenta, and cyan. This selection of inks is representative of the types of inks used in everyday job and commercial printing throughout the industry. As can be seen in Figure IV, however, not all of these inks were applicable to the method of ink film measurement employed; several of them were therefore eliminated from the tests. When the film thickness is independent of the reflection optical density, the method of ink film measurement employed cannot be used. This independent relationship occurs with the inks that are either completely opaque or completely transparent at all film thicknesses. As can be seen in Figure IV, the bond black ink could not be used because its film thickness was independent of its reflection optical density. The inks ultimately used in the tests were process magenta, process cyan, and halftone black.

The rollers employed for the tests were supplied by the Sam'l Bingham's Son Mfg. Co., and were made of polyurethane (sold under the trade name of "NuClear"). These rollers were cast on cores especially prepared by the author. The polyurethane material used, according to the manufacturer, was identical to that used in all of the rollers of this type that they manufacture for the trade. The Shore Durometer hardness reading of the polyurethane was 17 and this, according to the manufacturer, is the hardness most frequently used for this type of roller throughout the trade. The roller diameter selected for the tests was two inches: this diameter was chosen because it is used on 12 x 18 Chandler and Price hand and automatic platen presses, 10 x 15 Original Heidelberg automatic platen presses, and Meihle Vertical V-50 automatic cylinder presses. These presses are among the most popular and common platen and cylinder presses in use in the trade.

CHAPTER IV

VARIABLES CONTROLLED

The letterpress printing process, like other processes, is affected by a great many variables which may alter the quality of the finished product. The variables which are of concern in this experiment, however, are only those that affect the transfer of ink from a polyurethane roller to a plate.

In attempting to establish what effect the variable of plate-to-roller contact has on the ink transfer properties of the rollers tested, it was essential that all variables be controlled as closely as possible. In order to accomplish this task it was first necessary to establish what variables exist so that controls over all of them could be built into the experiment. The variables which were expected to have an effect on the results were: one, the ink used; two, the ink film thickness used; three, the speed of the rollers; four, material of which the roller was made; five, diameter of the roller; six, plate-to-roller contact; seven, temperature; eight, humidity; nine, material of which the supply-ink plate was made; ten, material of which the form plate was made; eleven, ink film previously on roller; twelve, number of passes of roller over form plate; thirteen, ink film previously on plate; and fourteen, roller hardness. It is not presently possible to know if all of these variables do affect ink transfer, but without knowledge to the contrary, it is essential to control all potential variables.

As was explained in the section on the Densitometer in Chapter III, control over the ink employed for the tests was accomplished by careful selection of a set of inks.

Control over the ink film thicknesses employed for the tests is an area which required preliminary investigation. It was decided that the film thicknesses to be employed for each of the inks used should be closely related to film thicknesses that might be used on an actual press. To establish what these film thicknesses would be for each of the inks employed in the tests, a sample job was set up on a 10 x 15 Chandler and Price platen press equipped with polyurethane rollers, and the ink was adjusted until it was printing the final sheet at a thickness judged adequate by the author on the basis of his experience in printing. At this point the film thickness on the ink disk of the press was measured with a densitometer and recorded. This procedure was followed on a super-calendered coated sheet of book paper and on a coarse sheet of book paper: these two stock represent the widest range of printing impression possibilities encountered in general job and commercial printing. The two film thicknesses determined for each ink were then employed in the tests as typical of the range of film thicknesses which would be encountered in general letterpress work done with each of the inks.

As explained in the section on the Timer in Chapter III, the speeds employed for all tests were critically measured and controlled. The speeds selected for the tests were chosen because they are typical of speeds which are normally encountered in the course of press operation. The speeds selected for all tests were .10 second, .25 second, and .50 second. These speeds are elapsed times for the roller transfer carriage to make one pass over the form plate. By applying the formula in the section on the Timer in Chapter III it can be seen that these speeds would be equivalent to: 300 feet-per-minute, 120 feet-per-minute, and 60 feet-per-minute. Table 1 shows the corresponding speeds on various presses.

It should be noted that the highest speed approximates, and in some cases exceeds, the maximum speed for some of the presses. The maximum speed of the Meihle Vertical V-50 is 5,000 impressions per hour, 5,000 impressions per hour for the 10 x 15 Original Heidelberg, 2,500 impressions per hour for the 12 x 18 Chandler and Price when it is hand fed, and 3,000 impressions per hour for the 12 x 18 Chandler and Price when it is automatically fed. Normal running speeds for these presses vary up to the maximum depending upon the work being produced, press condition, surrounding conditions, and the pressmen.

Table 1. Press speeds related to the actual test speeds used in the experiment.

Type of Press	Speed		
Test Unit	.10 sec./6"	.25 sec./6"	.50 sec./6"
V-50 Miehle Vertical	4286 iph*	1714 iph	857 iph
10 x 15 Original Heidelberg	5143 iph	2057 iph	1029 iph
12 x 18 Chandler and Price	3600 iph	1440 iph	720 iph

*iph - impressions per hour.

As was previously stated, the roller material employed for all tests was polyurethane.

The variable of roller diameter was controlled during the tests by using only rollers of identical diameter.

The factors of temperature and humidity were controlled throughout the experiment by performing the work in the Printing Laboratory at South Dakota State College. The temperature during all tests was between 73 and 75 degrees Fahrenheit and the relative humidity was between 43 and 44 per cent.

As is explained in the Chapter on Equipment and Materials Used, the materials for the ink-supply and form plates were selected because they are typical of those which are in actual trade use.

The variable of the ink film already on the roller when it was inked for the test was controlled by making sure that the roller was saturated from the amount of ink on the supply plate. This procedure, which will be explained in the chapter on Procedure, was adopted because it is typical of the operation of the letterpress process.

The number of passes of the roller over the form plate was set at two and controlled at that number for each test. This number was selected because it is typical of the operation of most letterpress equipment.

The plate-to-roller contact variable, known as the roller setting, was controlled in accord with the design of each test. Measurement of the setting has previously been explained in the section of the Roller Gauge in Chapter III. The five settings selected for the tests were "bands" of 1/8 inch, 3/16 inch, 1/4 inch, 5/16 inch, and 3/8 inch. These settings were chosen because they are representative of settings in use throughout the country.

The variable of the ink film on the form plate prior to the test passes was controlled throughout the tests at zero. This variable was arbitrarily set at zero because in actual press operation it may vary from zero to a percentage of the film transferred to the surface being printed, thus making it impossible to establish a thickness which is true for all conditions. The ink film remaining on the form after each impression is dependent upon the surface of the material being printed, the speed at which it is being printed, the pressure which is being applied, the ink, and many other variables.

CHAPTER V

TEST PROCEDURE AND DATA

Test Procedure

Prior to the actual tests, five "trial runs" under controlled conditions were made to ascertain whether variations in the results of five identical tests were small enough to make test results valid. These trial tests were performed with magenta letterpress ink of the type used for some of the other tests. The roller-to-plate contact settings were .25 inches on both plates. These trial tests were performed according to the same procedure used for the actual tests. This procedure will be outlined later in this section. The results of these preliminary runs showed a variation in reflection readings of only .01. This variation can be attributed to error in reading the densitometer measurements. The densitometer was equipped with a logarithmic optical density scale, thus making readings at the low end of the scale more accurate than those at the high end. In the trial runs, the initial film thicknesses on the supply plate were set at a film thickness reading of .80, and at this level the scale can only be read with an accuracy of .01, which corresponds with the maximum variation observed. Thus the validity of the procedure and apparatus was shown to be high.

The test procedure consisted of zeroing the reflection densitometer on the blank supply plate mounted on the bed of the test unit. The supply plate was then manually inked by means of a 2.5

inch polyurethane roller which was supplied with an ink film from a glass plate upon which an amount of the ink being employed for the particular test was worked out into an even film. This ink supply was replaced every 15 minutes during the test runs to make certain that a fresh supply was always present. The test roller mounted in the transfer carriage was then passed back and forth over the supply plate until three consecutive readings, each taken after two roller passes, showed no variation. It was then assumed that the roller was saturated. If the three consecutive readings proved to be different from the ink film desired for the test (as specified in the chapter on Variables Controlled) the process was continued or repeated until the readings coincided.

The reflection unit was then transferred to the form side of the test unit and zeroed on the blank form plate. The transfer carriage was then run over and back across the two plates at the desired test speed and another reading was then taken on the form plate to measure the amount of the film transferred. This reading was recorded as the result of that particular test. If there were any variation in speed in excess of an elapsed time tolerance of .01 seconds per pass, the datum was discarded and the test rerun. All readings taken with the densitometer on the inked form plate were made 30 seconds after the transfer carriage passed over the plate. This procedure was followed to eliminate the effect of drying time on the reflection optical density readings.

This established procedure was followed with all of the tests run. The tests were grouped according to ink, and each group was broken down into two series of tests, one for each of the film thicknesses.

Each test series was conducted in the following manner: three tests were conducted, each at one of the three selected speeds, and at one of the specified roller settings. This procedure was then repeated with each of the selected roller settings. This resulted in each series being comprised of 15 different test runs; thus each ink would consist of 30 different test runs.

Test Data

The data from all of the tests furnished the basis for the graphs shown in Figures VII through XII (all data in Appendix D).

One axis of the graphs is calibrated to coincide with the roller settings which were employed for the tests. The other axis is calibrated in reflection optical density. Each of the three lines in each graph represents one of the speeds used for the tests. Line S1 represents a speed with an elapsed roller-passing-point time of .10 seconds, line S2 of .25 seconds, and line S3 of .50 seconds.

The letterpress process magenta and letterpress process cyan inks were each measured through a Welch light blue filter, which was employed to increase the sensitivity of the instrument to smaller changes in film thickness.

Figure VII shows the data from all of the tests run with letterpress process magenta ink at a film thickness reading of .45. The supply plate roller setting for all of these tests was 1/4 inch. These tests were all run under the previously stated controlled test conditions of 73°F and 43% relative humidity.

Figure VIII shows the data from all of the tests run with letterpress process magenta ink at a film thickness reading of .80. All other conditions were identical to those of the tests described in Figure VII.

Figure IX shows the data from all of the tests run with letterpress process cyan ink at a film thickness reading of .25. The supply plate roller setting for all of the tests was 1/4 inch. These tests were all run under the controlled test conditions of 73°F and 43% relative humidity.

Figure X shows the data from all of the tests run with letterpress process cyan ink at a film thickness reading of .35. All other conditions were identical to those of the tests shown in Figure IX.

Figure XI shows the data from all of the tests run with letterpress halftone black ink at a film thickness reading of 1.15. The supply plate roller setting for all of these tests was 1/4 inch. These films were measured without a filter, and they were all run under the controlled test conditions of 73°F and 43% relative humidity.

Figure XII shows the data from all of the tests run with letterpress halftone black ink at a film thickness reading of 1.35. All other conditions were identical to those of the tests shown in Figure XI.

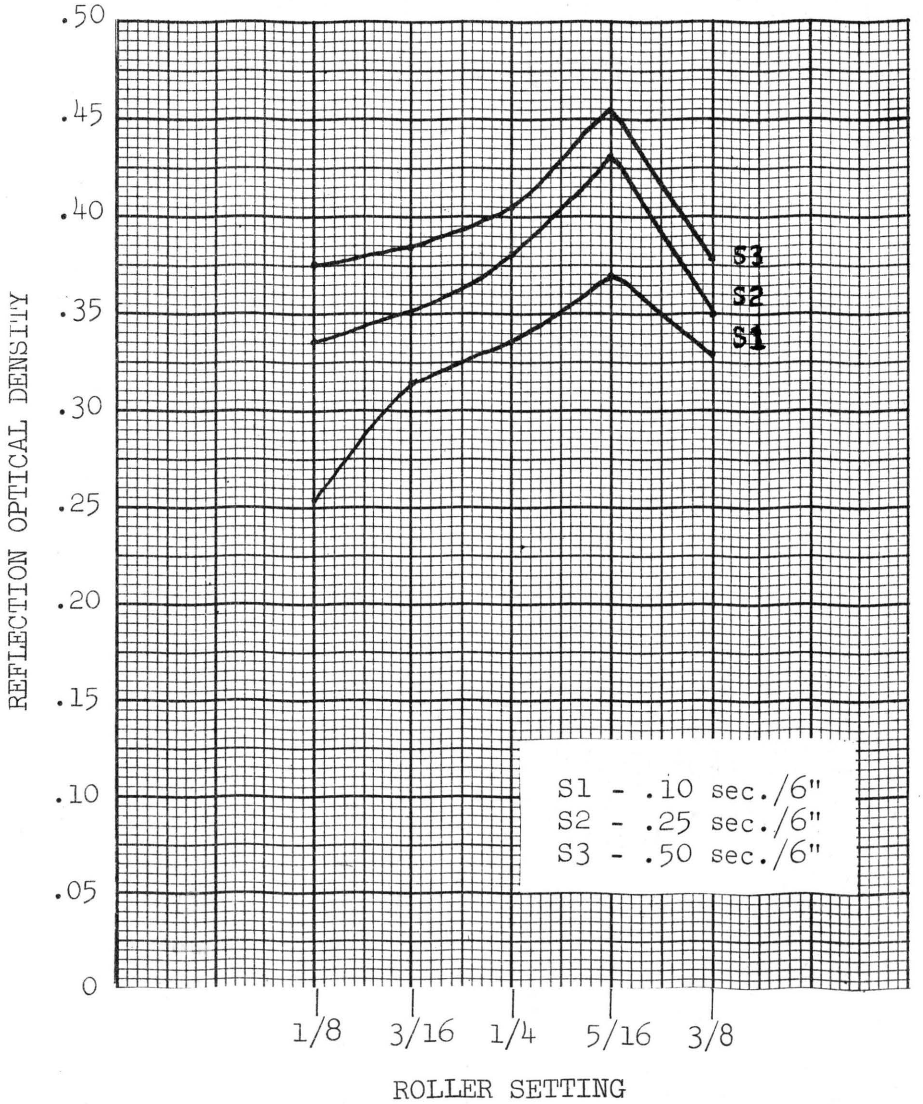

Figure VII. Effect of Roller Setting on Reflection Optical Density Of Thin (.45) Magenta Ink Film Transferred to Form At Selected Speeds

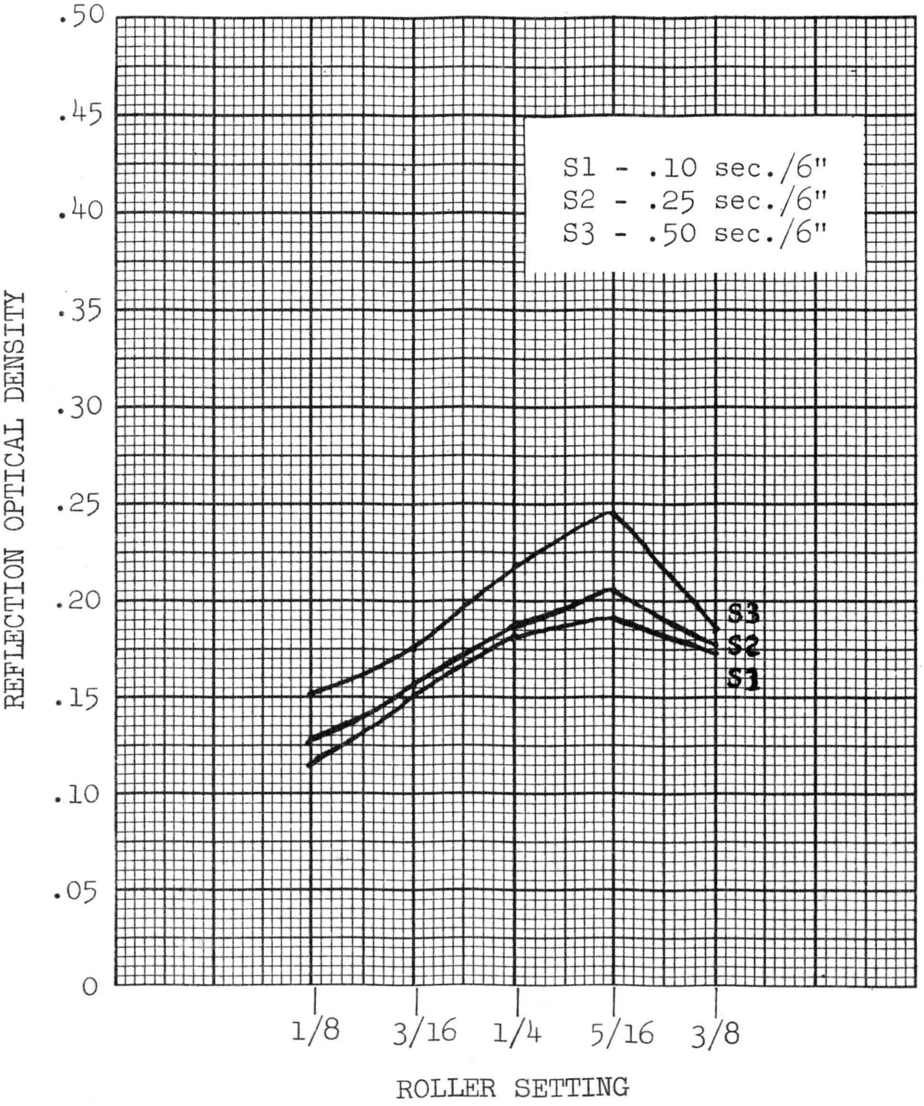

Figure VIII. Effect of Roller Setting on Reflection Optical Density Of Thick (.80) Magenta Ink Film Transferred To Form Plate at Selected Speeds

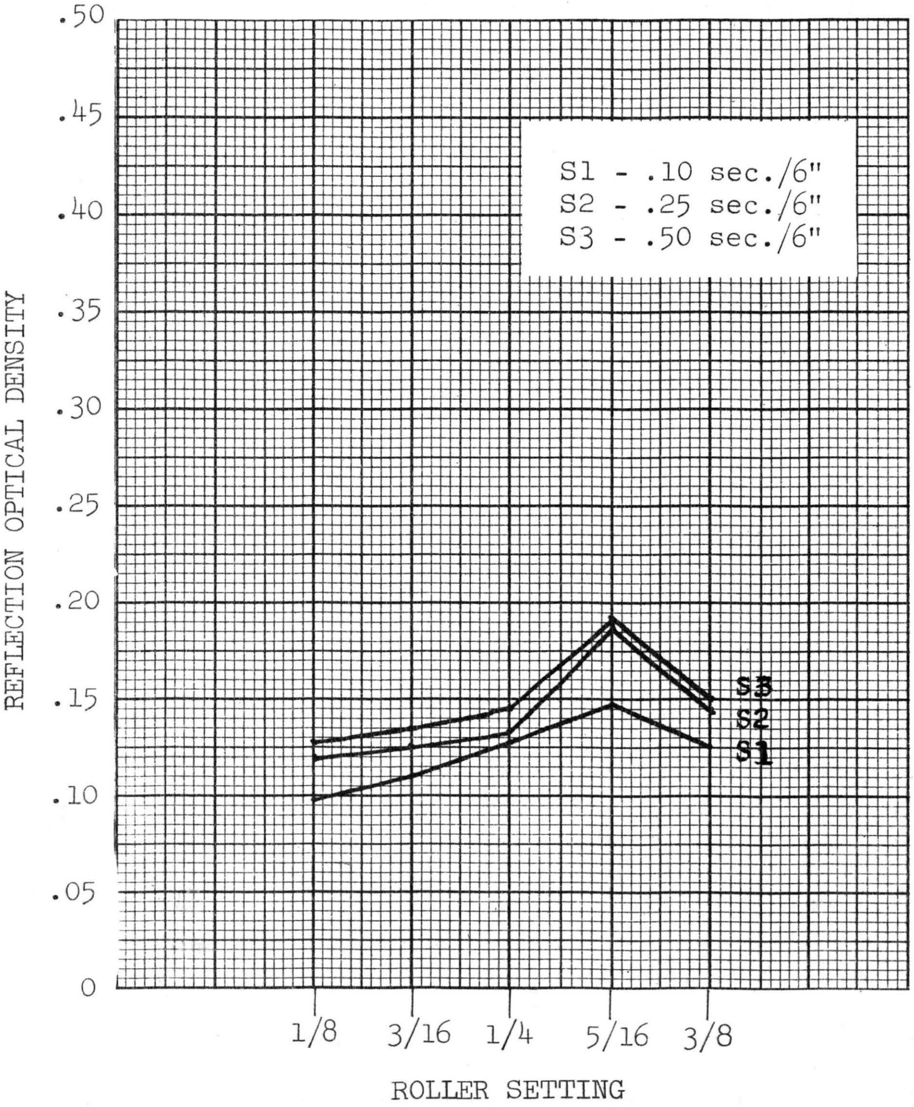

Figure IX. Effect of Roller Setting on Reflection Optical Density
Of Thin (.25) Cyan Ink Film Transferred
To Form Plate at Selected Speeds

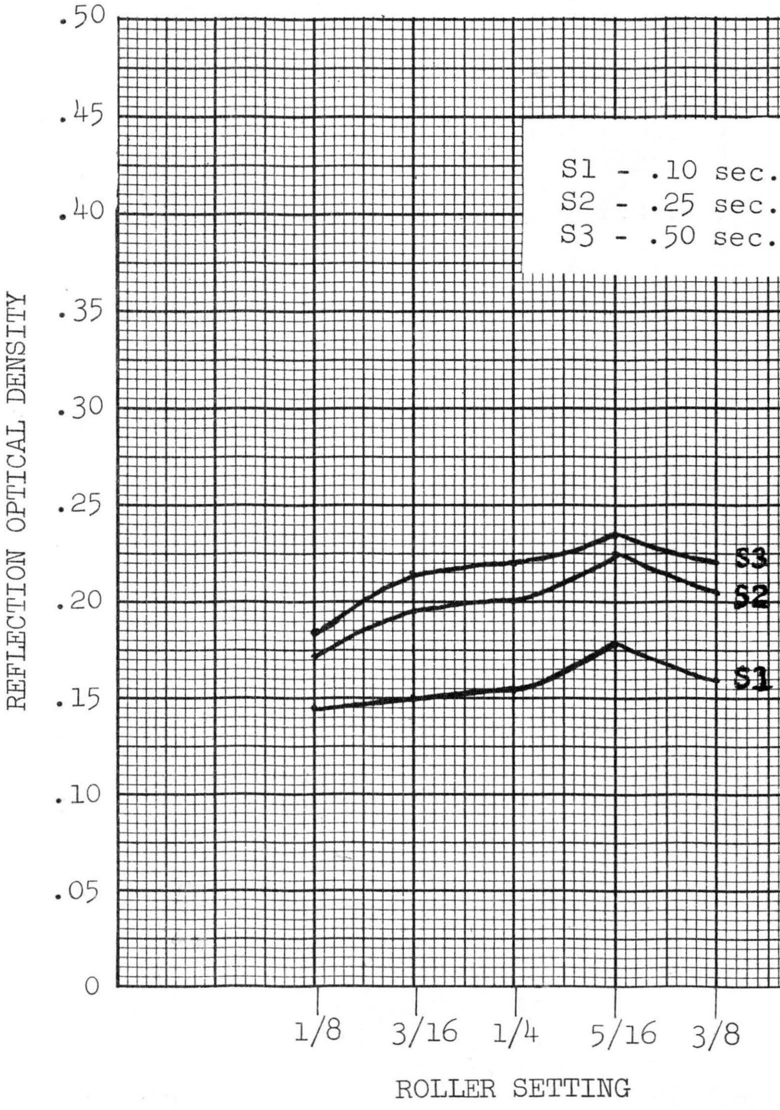

Figure X. Effect of Roller Setting on Reflection Optical Density Of Thick (.35) Cyan Ink Film Transferred To Form Plate at Selected Speeds

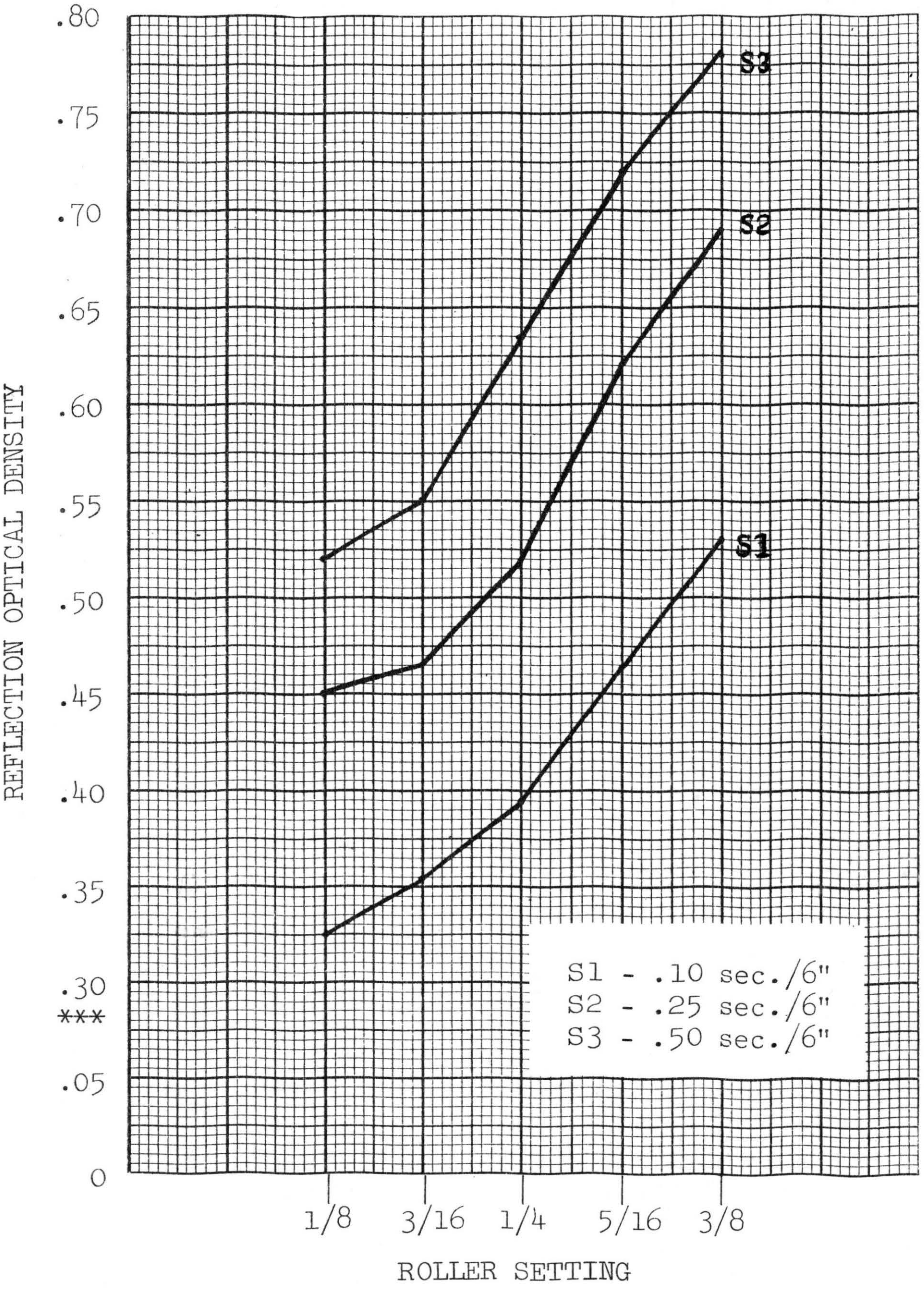

Figure XI. Effect of Roller Setting on Reflection Optical Density Of Thin (1.15) Halftone Black Ink Film Transferred to Form Plate at Selected Speeds

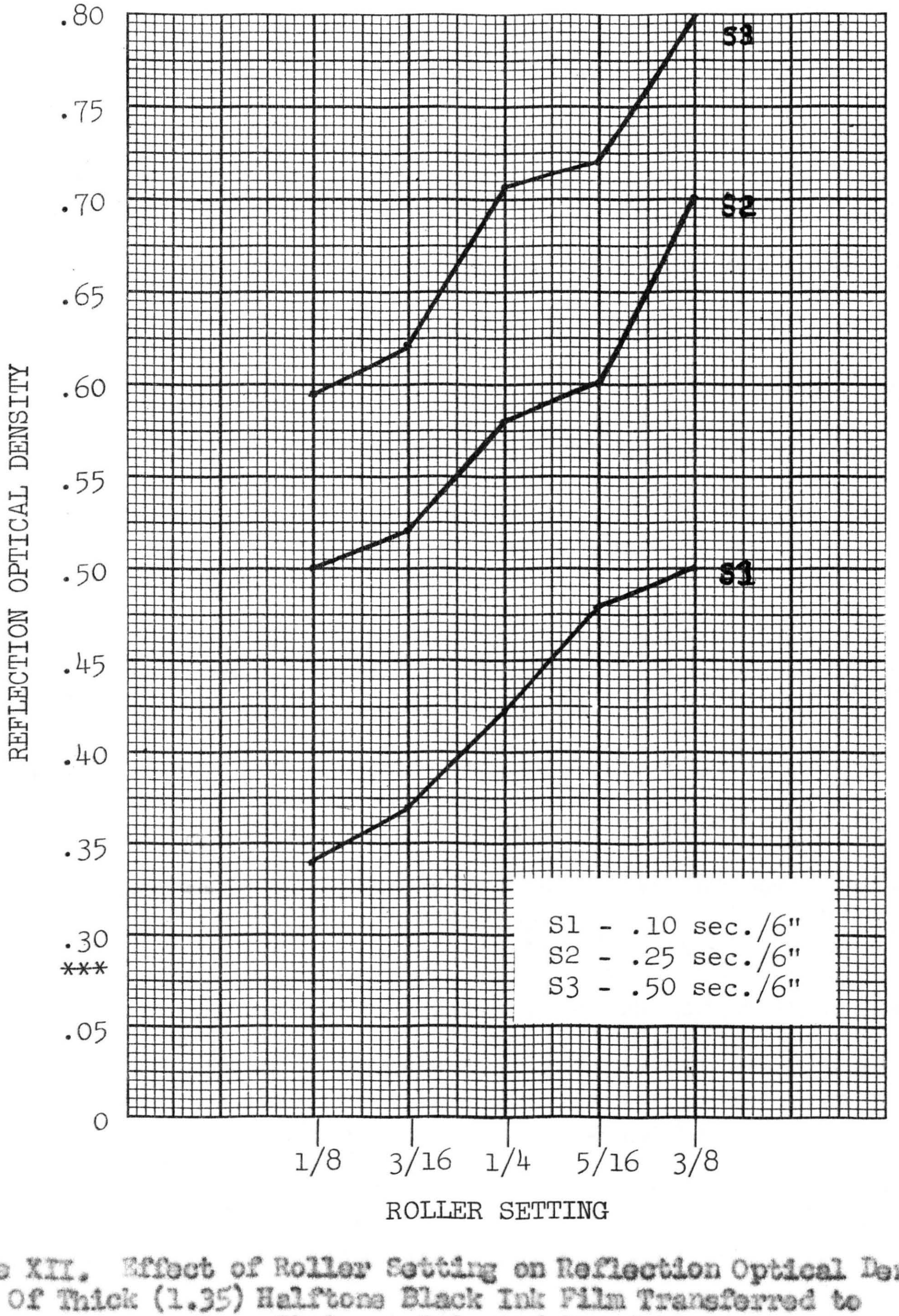

Figure XII. Effect of Roller Setting on Reflection Optical Density Of Thick (1.35) Halftone Black Ink Film Transferred to Form Plate at Selected Speeds

CHAPTER VI

CONCLUSIONS

As can be clearly seen from the peaks on the line graphs in Figures VII through X, there was a setting at which the test roller together with the test magenta and cyan inks performed most efficiently. This point of maximum transfer occurred at exactly the same setting with the process magenta as with the process cyan ink. This setting, as can be seen, was 5/16 inch. This optimum transfer setting remains the same regardless of the roller speed and ink film thickness in this test.

Figures XI and XII, illustrating the findings with letterpress halftone black ink, however, show a variance with the above findings. The test results show that at no point within the selected settings employed did the amount of transfer reach a peak and then drop off. As the setting increased, so did the transfer capabilities of the roller. Regardless of the fact that the halftone black ink performed in this manner, the roller setting found to be capable of producing optimum transfer for the other test inks may also be adopted for this ink. Increased settings which would produce greater transfer from the roller would probably adversely affect the life of the roller. It is not certain, however, that the roller would be damaged and specific tests would have to be performed to prove or disprove this assumption.

By comparison of the results, it can be assumed that the ink transfer capabilities of the polyurethane roller employed in the tests are dependent upon the pressure setting of the roller and the type of ink used. Although the results of these tests indicate that the speed and ink film thickness employed do not affect the optimum transferring point, both film thickness and speed have a marked effect on the amount of ink which a roller is capable of transferring.

It is not possible from the limited tests performed in this experiment to determine if this optimum transfer setting will hold true for other brands and types of ink. Additional extensive tests would have to be performed with other inks, rollers and conditions before any definite statement could be made as to the validity of the results under all conditions.

This experiment has been only a glance at the critical effects of roller settings. The prime importance of this study area in the letterpress printing operation merits much additional study. It is hoped, however, that this experiment has contributed to the body of knowledge on this subject and that the method employed in the experiment may open the door for future studies of this type and may ease the job of future experimenters.

At this time it is impossible to tell whether or not maximum ink transfer from a roller is the most important factor in the printing process or to the printer. It is possible, for example, that the printer may in some cases be more concerned with extending the useful life of a roller. In such cases the lightest possible setting still capable of performing the transfer function might be the solution to his needs. To the author's knowledge, this too has never been investigated. It is further possible that the setting which transfers the optimum amount of ink for a specific roller may have a tendency to "plug" a fine screen. If such were the case, the merit of the optimum ink transfer setting would probably be outweighed by the "plugging" factor. It seems obvious, therefore, that additional study must be performed before broad generalizations regarding roller settings can be made.

CHAPTER VII

APPLICATION OF FINDINGS

Although the optimum transfer setting may not be the sole solution to the transfer question, it can be used as a starting point from which a pressman can work until additional research is performed. Knowledge of the correct roller setting is in itself not enough. Careful and correct application of the setting is essential before the benefits which it is capable of giving may be fully realized. Possessing the best rollers and press plus a knowledge of the best setting are worthless if these factors are not properly combined. It is here that many of the pressman's troubles originate, and the application of a simple systematic procedure might lend a great deal of aid.

It is of prime importance that the pressman start this procedure by thoroughly examining the press upon which he is working to make certain that the roller bearings are in top condition. If it is found that they are worn, they should be replaced. The next step is a careful examination of each roller's measurements. As has been mentioned earlier, it is essential that the roller be the same diameter over its entire length, that the core be perfectly straight, and that the roller be critically concentric over its entire length. These areas can be checked easily with a micrometer and by suspending the roller between two vee blocks, turning it by hand, and having the surface in contact with a dial indicator. Readings taken with the dial indicator at various points along the roller's length will indicate its concentricity within 1/1000 of an inch. If a dial indicator is not accessible, the procedure may be performed on a light table by suspending the roller between two vee blocks. An accurate steel straight edge can be placed parallel to the axis of the roller at the same height above the surface as the center of the roller. This straight edge should then be brought almost into contact with the roller so that a narrow even band of light is projected between the roller and the straight edge as it is viewed from above. The roller may then be rotated and any variation in the width of the light band will indicate that the roller is either out-of-round, eccentric, or has a bent core. The roller should then be carefully checked with a micrometer to make certain that it is not tapered.

If the measurements of all of the rollers have been found acceptable, the next step in the procedure is the careful positioning of the rollers in the press according to the press manufacturer's instructions. This should be done with great care to make certain that the core is not bumped, for bumping could render it worthless. With the rollers correctly positioned in the press, the actual operation of setting may begin. This should be performed according to the press manufacturer's suggestions because of variance from press to press. It should be remembered, however, that the adjustment should be carried out by working from a light setting toward the more heavy desired setting. This procedure will prevent damage to the roller. The setting should be measured by dropping the rollers against the ink plate of the press, if it is equipped with one, and then by measuring the image left by the roller as previously explained. It must be remembered, however, that the press manufacturer may have constructed the press ink plates in excess of .918 inches from the bed. If this is the case, the difference between the ink plate and "type high" must be compensated for in the setting.

In the author's opinion, a better method of obtaining an image of the roller setting is to use one of the roller setting gauges available on the market. Such gauges are constructed of two flat plates of steel separated by a series of wedges. The wedges make it possible for the gauge to expand when one section is moved while the other is held fixed. The gauge is adjusted so that it will expand exactly to type height (.918 inch). By slipping the gauge under the roller while it is in position over the bed of the press, expanding the gauge, leaving it expanded for several seconds, and then releasing it, an accurate picture of the roller setting can be taken. In addition, this device, if large enough, will make it possible to check the settings of a number of rollers at the same time.

It is essential that a measurement be made in at least three places over the length of the roller, two within several inches of the ends of the roller and one in the middle. It is essential that these three readings all agree; if they do not, the setting is incorrect and must be rectified.

It should be obvious that all forms must be made up to type height. If a form is placed on the press with areas that are below type height, the pressman may lower the rollers in order to be able to ink them and this obviously makes any accurate settings worthless.

BIBLIOGRAPHY

Adams, D. N. "An Experimental Study of Ink Film Thicknesses," Proceedings of the 6th Annual Technical Meeting of the Technical Association of the Graphic Arts, Inc., (May, 1954), 194-206.

Anonymous, "Bingham Roller News," (advertisement) Printing Production, Vol. 93, No. 9, (June, 1963), 6.

Blessing, Berwyn M. "Setting and Maintenance of Newspaper Rollers," The American Pressman, Vol. 69, No. 10, (October, 1959), 9-12.

Bradlet, John J. "Study of the Effect of Pressure Between the Fountain Rolls and Bowing or Deflection of These Rolls," Proceedings of the 4th Annual Meeting and Technical Forum of the Flexographic Technical Association, Inc., Chicago, (May, 1962), 75-94.

Brown, James K. "Printing Rollers-What? How? Why?" Reprinted from The American Pressman January and February 1959 issues by the Sam'l Bingham's Son Mfg. Co., 1-10.

Coulter, D. J. "Printers Rollers," Institution of the Rubber Industry, Proceedings, Vol. 5, (October, 1958), 112-128.

Deller, Jack. Printers' Rollers: Their Manufacture, Use, and Care. London: Charles Skilton Ltd., 1959.

Fetsko, Jacqueline M., William C. Walker, and Albert C. Zettlemoyer. "Controlled Laboratory Printing Techniques," Proceedings of the 6th Annual Technical Meeting of the Technical Association for the Graphic Arts, Inc., (May, 1954), 39-47.

Petrycki, John. "Controlling Color on Offset Press with Densitometer," The Inland Printer and American Lithographer, Vol. 150, No. 5, (February, 1963), 52-53.

________, "How to Use the Densitometer" Part II, The Inland Printer and American Lithographer, Vol. 150, No. 6, (March, 1963), 59-61.

Thoma, Paul J. "Roller Setting and Plate Breathing Affect Print Quality," The American Pressman, Vol. 71, No. 11, (November, 1961), 11-16.

Vitt, George A. "Roller Facts for Every Process," The American Pressman, Vol. 73, No. 5, (May, 1963), 8-14.

Yelmgren, Alden E. "Technique for Measuring High-Speed Ink Film Transfer," Proceedings of the 11th Annual Technical Meeting of the Technical Association of the Graphic Arts, Inc., (June, 1959), 21-26.

APPENDIX A

Specific Gravity Calculation

$$\text{Specific Gravity} = \frac{\text{Weight}}{\text{Volume}}$$

1 gram of water is equal to 1 cm^3

$$\text{Specific Gravity} = \frac{\text{Weight of ink}}{\text{Weight of an equal volume of water}}$$

Specific Gravities of selected inks:

Process Cyan = 1.09

Process Magenta = 1.17

Halftone Black = 1.10

Bond Black = 1.12

APPENDIX B

Derivation of ink film thickness formula

$$\text{Specific Gravity} = \frac{\text{Weight}}{\text{Volume}}$$

$$\text{Volume} = \text{Area} \times \text{Thickness}$$

$$\text{Specific Gravity} = \frac{\text{Weight}}{\text{Area} \times \text{Thickness}}$$

$$\text{Thickness (cm)} = \frac{\text{Weight (g)}}{\text{Area (cm}^2\text{)} \times \text{Specific Gravity (g/cm}^3\text{)}}$$

APPENDIX C

Derivation of speed formula

$$\text{Elapsed time on test unit (sec./6 inches)} \times 2 = \text{sec./foot}$$

$$\frac{\text{60 sec./min.}}{\text{seconds/foot}} = \text{Feet/Minute}$$

APPENDIX D

Test Data

Ink Group I

Letterpress Process Magenta (Flintex Process Red 15159)

Temperature 75°F, Relative Humidity 43%

Series 1

Film Thickness .45 Read through Welch light blue filter

Setting (in.)	Speed Over (sec.)	Speed Back (sec.)	Form Plate Reading (optical density)
1/8	.10	.10	.115
1/8	.25	.25	.128
1/8	.50	.50	.152
3/16	.10	.10	.150
3/16	.25	.25	.155
3/16	.50	.50	.175
1/4	.10	.10	.181
1/4	.25	.25	.186
1/4	.50	.50	.218
5/16	.10	.10	.190
5/16	.25	.25	.205
5/16	.50	.50	.245
3/8	.10	.10	.172
3/8	.25	.25	.178
3/8	.50	.50	.185

Series 2

Film Thickness .80 Read through Welch light blue filter

Setting (in.)	Speed Over (sec.)	Speed Back (sec.)	Form Plate Reading (optical density)
1/8	.10	.10	.253
1/8	.25	.25	.335
1/8	.50	.50	.375
3/16	.10	.10	.314
3/16	.25	.25	.350
3/16	.50	.50	.383
1/4	.10	.10	.335
1/4	.25	.25	.381
1/4	.50	.50	.405
5/16	.10	.10	.370
5/16	.25	.25	.430
5/16	.50	.50	.455
3/8	.10	.10	.328
3/8	.25	.25	.350
3/8	.50	.50	.377

Ink Group II

Letterpress Process Cyan (Flintex Process Blue 25217)

Temperature 75°F, Relative Humidity 43%

Series 1

Film Thickness .25 Read through Welch blue light filter

Setting (in.)	Speed Over (sec.)	Speed Back (sec.)	Form Plate Reading (optical density)
1/8	.10	.10	.098
1/8	.25	.25	.120
1/8	.50	.50	.126
3/16	.10	.10	.110
3/16	.25	.25	.125
3/16	.50	.50	.135
1/4	.10	.10	.128
1/4	.25	.25	.133
1/4	.50	.50	.145
5/16	.10	.10	.148
5/16	.25	.25	.189
5/16	.50	.50	.192
3/8	.10	.10	.125
3/8	.25	.25	.145
3/8	.50	.50	.150

Series 2

Film Thickness .35 Read through Welch light blue filter

Setting (in.)	Speed Over (sec.)	Speed Back (sec.)	Form Plate Reading (optical density)
1/8	.10	.10	.145
1/8	.25	.25	.172
1/8	.50	.50	.185
3/16	.10	.10	.150
3/16	.25	.25	.195
3/16	.50	.50	.215
1/4	.10	.10	.154
1/4	.25	.25	.200
1/4	.50	.50	.220
5/16	.10	.10	.178
5/16	.25	.25	.225
5/16	.50	.50	.235
3/8	.10	.10	.160
3/8	.25	.25	.205
3/8	.50	.50	.220

Ink Group III

Letterpress Halftone Black (Flintex H. T. Black CS-225)

Temperature 75°F, Relative Humidity 43%

Series 1

Film Thickness 1.15 Read without a filter

Setting (in.)	Speed Over (sec.)	Speed Back (sec.)	Form Plate Reading (optical density)
1/8	.10	.10	.325
1/8	.25	.25	.450
1/8	.50	.50	.520
3/16	.10	.10	.355
3/16	.25	.25	.465
3/16	.50	.50	.550
1/4	.10	.10	.395
1/4	.25	.25	.520
1/4	.50	.50	.635
5/16	.10	.10	.465
5/16	.25	.25	.620
5/16	.50	.50	.720
3/8	.10	.10	.530
3/8	.25	.25	.690
3/8	.50	.50	.780

Series 2

Film Thickness 1.35 Read without a filter

Setting (in.)	Speed Over (sec.)	Speed Back (sec.)	Form Plate Reading (optical den sity)
1/8	.10	.10	.340
1/8	.25	.25	.500
1/8	.50	.50	.595
3/16	.10	.10	.370
3/16	.25	.25	.520
3/16	.50	.50	.620
1/4	.10	.10	.422
1/4	.25	.25	.580
1/4	.50	.50	.708
5/16	.10	.10	.480
5/16	.25	.25	.600
5/16	.50	.50	.720
3/8	.10	.10	.500
3/8	.25	.25	.700
3/8	.50	.50	.800