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Optical Measurement Techniques for Blanket Release Characteristics on Web Presses

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OPTICAL MEASUREMENT TECHNIQUES FOR BLANKET RELEASE CHARACTERISTICS ON WEB PRESSES

by

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ABSTRACT

Offset printing involves the transfer of ink from the image areas of the printing plate to the paper through an intermediate blanket. The blanket is usually composed of synthetic fiber materials (e.g. nylon). Blanket-paper-ink characteristics contribute to limits of printing quality and mechanical press operation. Paper and blanket physical surface characteristics and also ink tackiness contribute to adhesion between the paper and blanket. If the adhesion is sufficiently large, the force required to separate the paper from the blanket may cause deterioration of print quality or press operational problems. Deterioration of the printed quality may include picking of coating from the paper surface (leaving holes in the image) or misregistration of succeeding color overlays due to distortion of the paper.

Measurements of blanket release characteristics have been done in the laboratory (Hull) and on sheet-fed presses (Beecroft and Farrell). In both cases, evaluation was done by measuring paper parameters after completion of the printing operation by an indirect method.

This study has led to development of methods for direct measurement of blanket wrap during operation of a high speed web press. A visual technique allows numerical rating of blanket release for objective comparison of blankets or printing parameters. High speed cinematographic techniques allow analysis of the transient characteristics of blanket release.

Samples of data gathered by both techniques are given. Recommendations for further work and standardized blanket test procedures are presented.

INTRODUCTION

Offset printing involves the transfer of ink from the image areas of the printing plate to the paper through an intermediate blanket. The blanket is usually composed of synthetic fiber materials (e.g. nylon). Blanket-paper-ink characteristics contribute to limits of printing quality and mechanical press operation. Paper and blanket physical surface characteristics and also ink tackiness contribute to adhesion between the paper and blanket. If the adhesion is sufficiently large, the force required to separate the paper from the blanket may cause deterioration of print quality or press operational problems. Deterioration of the printed quality may include picking of coating from the paper surface (leaving holes in the image) or misregistration of succeeding color overlays due to distortion of the paper.

Measurements of blanket release characteristics have been done in the laboratory (Hull) and on sheet-fed presses (Beecroft and Farrell). In both cases, evaluation was done by measuring paper parameters after completion of the printing operation. Both methods were indirect. Hull counted blemishes in the inked areas. Beecroft and Farrell measured the distortion in a stack of printed sheets due to curl at the trailing edge of the sheet.

This proposal was to measure the effect of blanket-paper adhesion during press operation by numerically rating the amount of paper deflection from an ideal path or measuring the angular wrapping of the paper around the blanket cylinder. In this test, we were not concerned with the various factors which cause differences in adhesion. For this reason, all parameters were held constant except as necessary to see if differences in wrap were detectable.

The test was conducted on the Goss Commercial 38 web press located in the Graphic Arts Research Center. The press is capable of web speeds over 305 meters per minute (1000 F.P.M.) or 535 impressions per minute. Images are printed on both sides of the paper simultaneously as the web travels between two blanket cylinders. A simplified diagram is shown in Figure 1. This figure represents one printing unit. There are four such units making up the press. The web travels through them in sequence with one color of ink being applied at each unit. All units are operated from a common drive shaft. The resulting action pulls the web through the press. The adhesion of the paper web to the blanket causes the paper to wrap around the blanket cylinder and changes the effective distance between the printing units besides causing possible picking of the paper surface.

There has been some desire expressed to measure the amount of wrapping of the web around the blanket cylinder during press operation. The actual measurement is complicated by the high speed of the web and restrictions on viewing due to the physical configuration of the printing units.

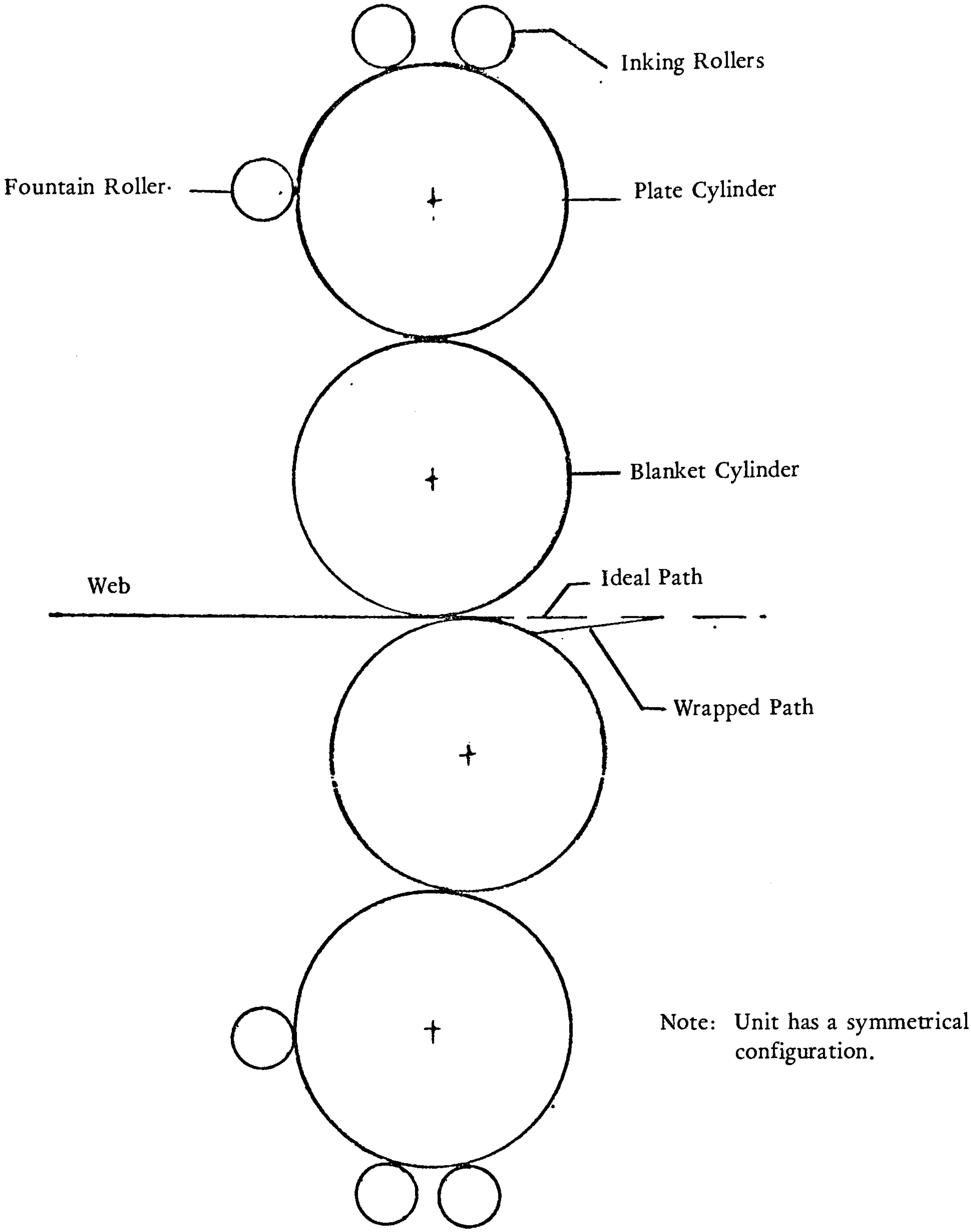


Figure 1. Simplified printing unit with ideal and wrapped web path.

SUMMARY OF WORK

In order to better understand the web deflection and the associated variability, attempts were made to record the wrap release cycle during normal press operation with a high speed cinematographic system. For the first attempt, the web was photographed from its edge with oblique illumination of its upper surface as shown in Figure 2. This technique showed some indication of a cyclic nature for the web release, but numerical data were not obtained. The release point with this system was not sharply defined. The magnification possible made the wrap changes to be measured approach the grain size of the high speed film necessary for this type of work. Physical restrictions due to press configuration prevent closer work with this technique. Optical depth of field considerations prevented usage of a longer focal length lens.

Further study showed that the light transmission of typical stocks used with this web press were greater than 0.1. Measurements and live film tests with a laboratory mock-up showed that sufficient energy was available with a simple high intensity movie light to record the point where the web was released from the blanket. A shadow in the lighted area due to the opacity of the blanket defined the release point. A system was arranged in which the movie light was placed beneath the web and the camera above, as shown in Figure 3, in order to record the blanket release during normal operation. In this system, a reference mark was included, and wrap was measured from the normalized distance of the blanket shadow at the release point to the reference. This was later converted to degrees of wrap.

TABLE I
HIGH SPEED CINEMATOGRAPHY PARAMETERS

Camera: Red Lakes Labs – Hycam
Lens: 50 mm focal length
Exposure: 1/5000 second at f/2.8
Frame Rate: 1000 per second, magnification = 0.14
Film: GAF 2962 high speed reversal film
Illumination: GE 650 watt movie light
Press: 183 meters per minute (600FPM)
Blankets: Reeves No. 714 – 4 ply compressible
Web Stock: Westvaco 60 pound, coated one side
Ink: Sun Chemical Corp., GPI, Cyan R70-6060, Inko Tack 13.6-14.0

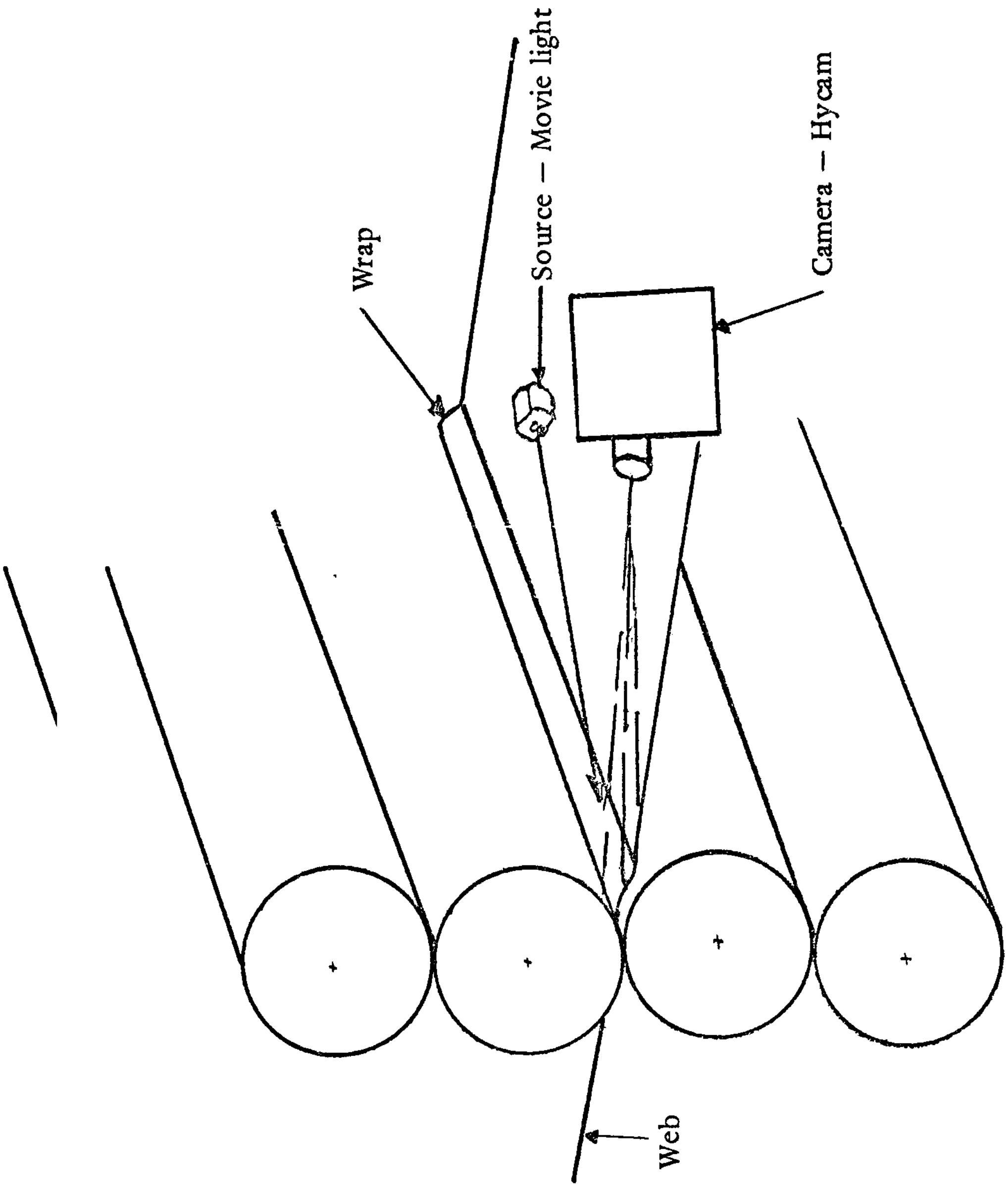


Figure 2. Oblique illumination technique.

Several analysis methods were attempted for the frame by frame evaluation of the resulting film. These included rear projection movie viewers which suffered from low illumination and small image size and a measuring microscope which had such large magnification that information was lost in the film grain. Finally, a variable magnification microfilm reader was chosen for good illumination, convenient image size and the ability to determine location within the roll of film. A schematic of the motion picture frame is shown in Figure 4.

Concurrent with motion picture studies of the blanket release, several non-photographic measurement techniques were investigated. The first systems were based on a range finder type of measurement of the web deflection from a theoretical unwrapped path. The sensitivity requirements for this technique were found to be excessive as a large angular wrap caused a small deflection of the web.

The development of the shadow graph technique for cinematographic recording of the release point led to visual observation of the release point by a similar method in which wrap is apparent to the unaided eye. In order to measure the wrap, some form of calibration was needed. The simplest method involved printing a reference pattern (see Figure 5) on the web and illuminating with a press synchronized stroboscope. The blanket release point is represented by a shadow whose position can be determined from the reference pattern. The illumination/observation arrangement is the same as in Figure 3 except that the observer takes the camera position. In order to provide a permanent record of test results for operational use of this technique, a method was arranged whereby an open flash Polaroid photograph of the release point could be made.

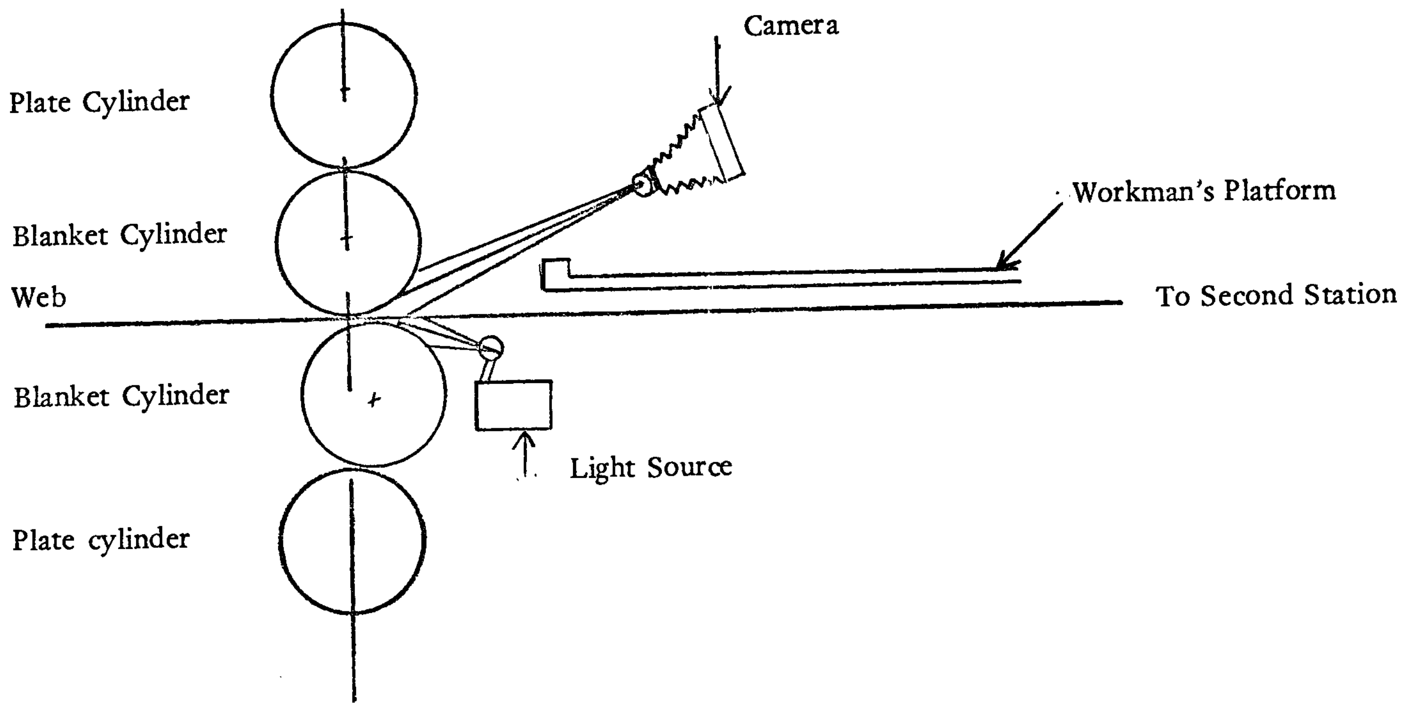


Figure 3. Equipment arrangement for blanket release observation and photography.

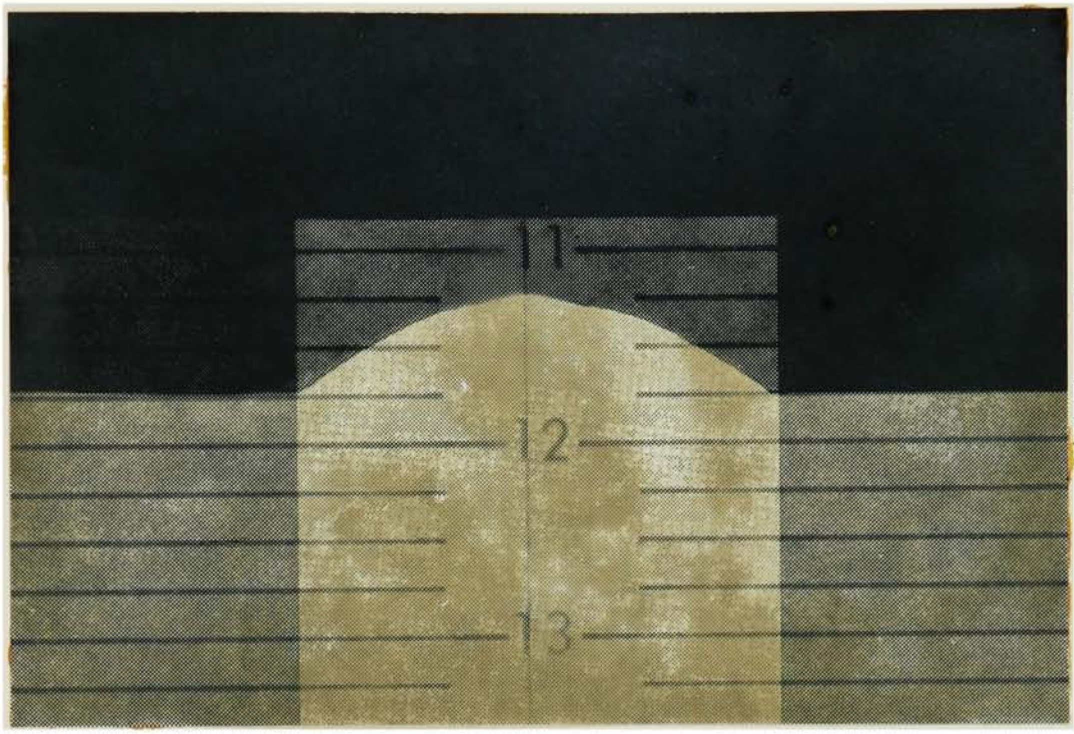


Figure 4. Schematic of motion picture frame.

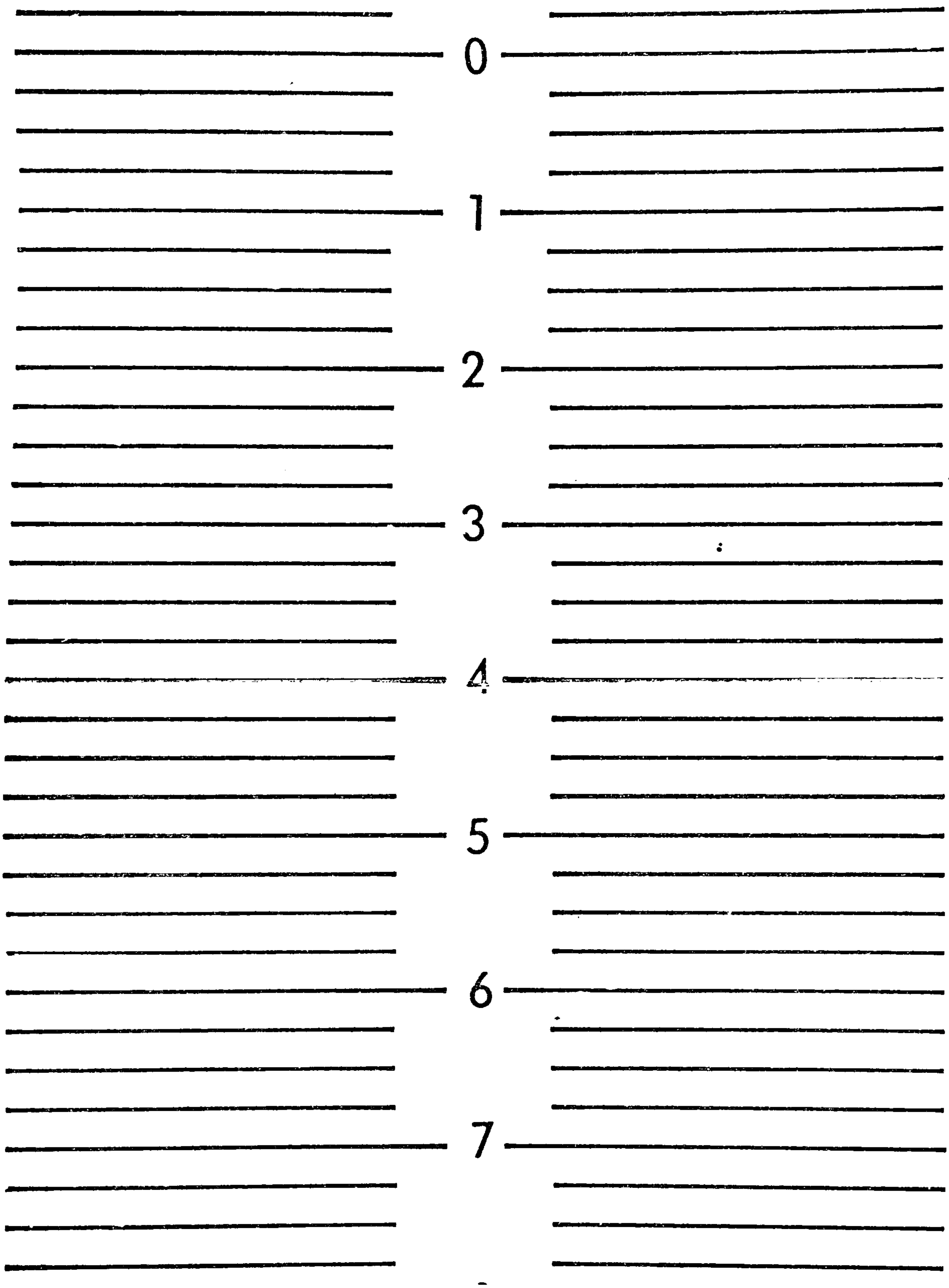


Figure 5. Sample of calibration pattern. This pattern extends through the printed area. The numbers are arbitrary and help in finding the position in the printing cycle.

TABLE II
POLAROID PHOTOGRAPHY OF BLANKET RELEASE

Camera: Crown Graphic with Polaroid 500 back
Lens: 152 mm focal length
Exposure: 1 second
f/11
note: Strobe provided short exposure during shutter open time.
Magnification: 0.31
Film: Polaroid land film type 52
Illumination: GR1531A Strobotac synchronized with press in single flash mode
Press: 183 meters per minute (600 feet per minute)
Blankets: Several by Reeves Rubber Company
Web Stock: Oxford 60 pound – coated on two sides
Ink: Sun Chemical Corp., GPI, Cyan, R70-6060, Inko Tack 13.6-14.0

The physical arrangement is the same as used for high-speed cinematography. The electrical diagram is shown in Figure 6. A simplified system based upon a camera flash is detailed in Appendix II.

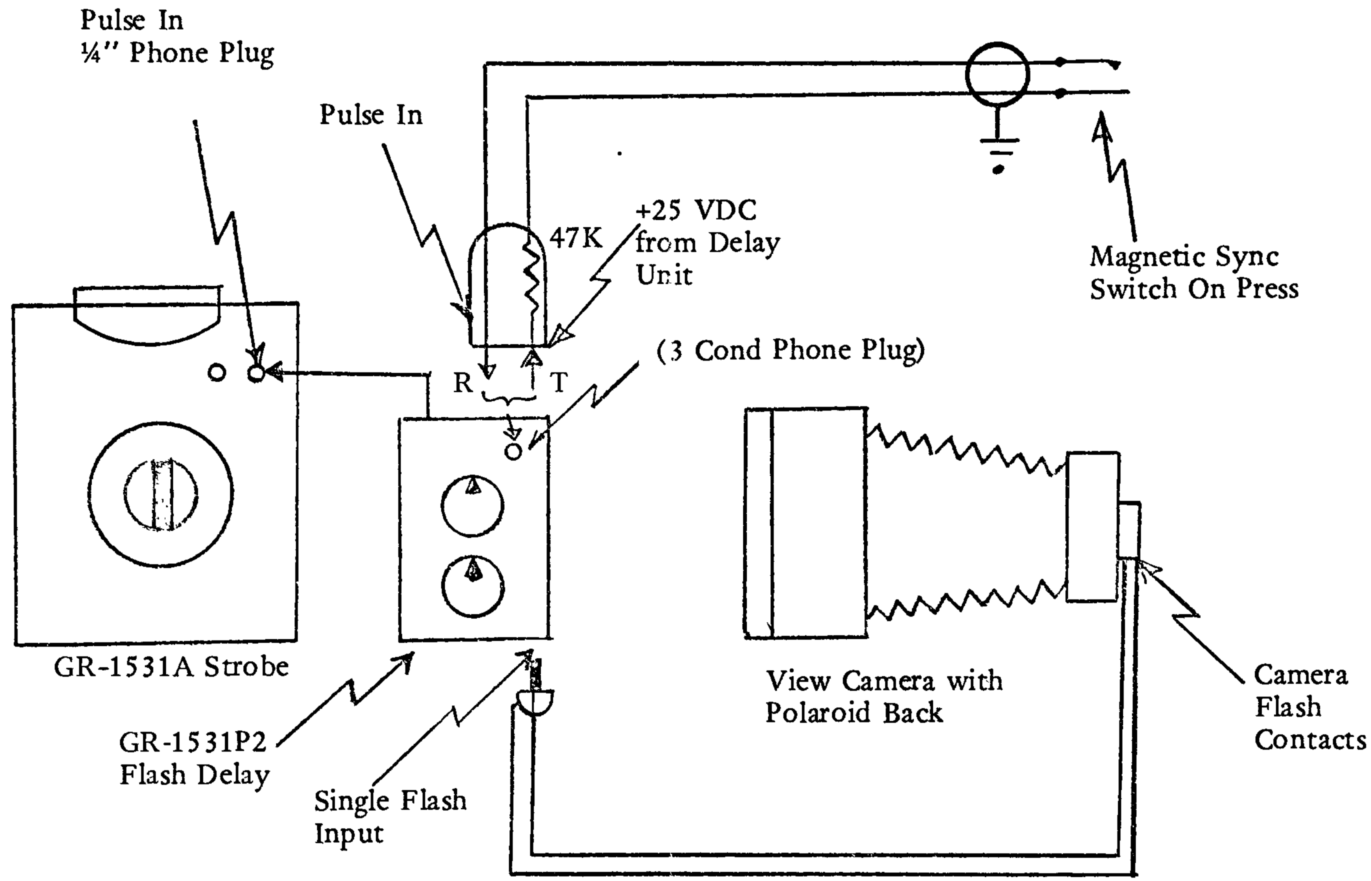


Figure 6. Schematic diagram for single-flash polaroid photography. Camera flash contacts and press sync switch must close to give flash.

RESULTS AND CONCLUSIONS

Techniques for visual and photographic analysis of blanket release were devised and demonstrated. The visual techniques allow numerical rating of blanket release for objective comparison of blankets or printing parameters. High speed cinematographic techniques allow analysis of the transient characteristics of blanket release.

Analysis of high speed motion pictures on a frame-by-frame basis gives results as in Figure 7. This figure gives the mean and range of measured release points from an analysis of five printing cycles. The cycle consists of two major portions, the wrapped area during the actual inking period and a transient during which no ink is applied to the web and the web releases from the blanket.

Physical considerations for an elastic mass with transient stimuli predict periodic oscillations. Statistical analysis of the data in Figure 7 indicates that a change in the mean of less than 1.0 degree of wrap is significant at an alpha of 0.05. Variations greater than 1.0 degree occur in the inking cycle with no apparent change in printing conditions. Therefore, care should be used in single-sample comparison of blankets as differences in the results may occur from the apparent wave motion of the web.

The visual technique and polaroid recording were applied to a series of blankets with results as in Table III.

TABLE III

Blanket	Mean Wrap (degrees)	Standard Deviation	Number of Observations
1	12.80	0.41	4
2	16.08	0.29	4
3	11.50	0.26	4
4	12.60	0.50	4

Table III tabulates results of blanket test with constant printing conditions.

Sample photographs from the test are shown in Appendix I. Statistical analysis of the data in Table III indicates that a change in the mean of 0.85 degrees of wrap is significant at the alpha 0.05 level.

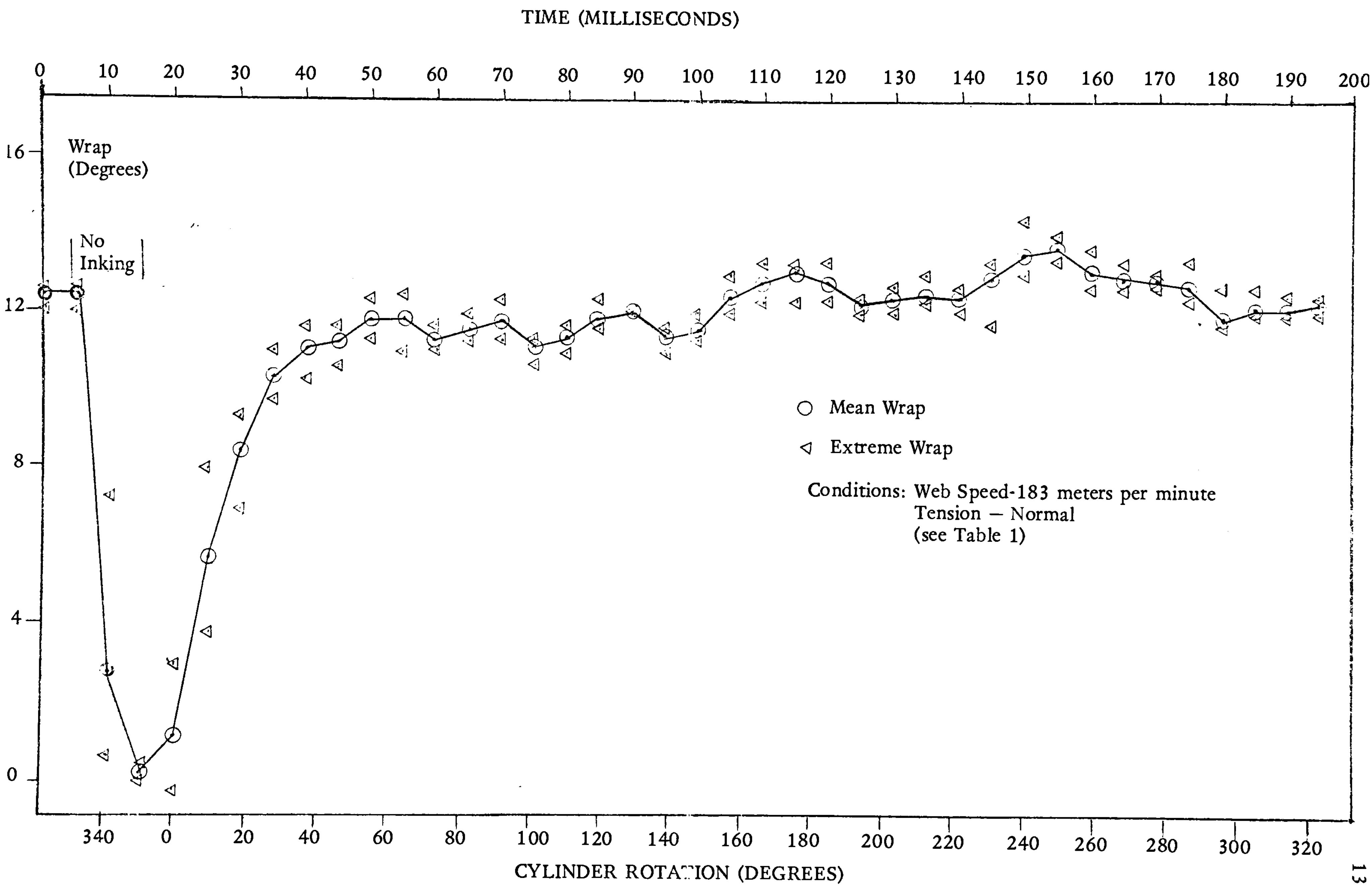


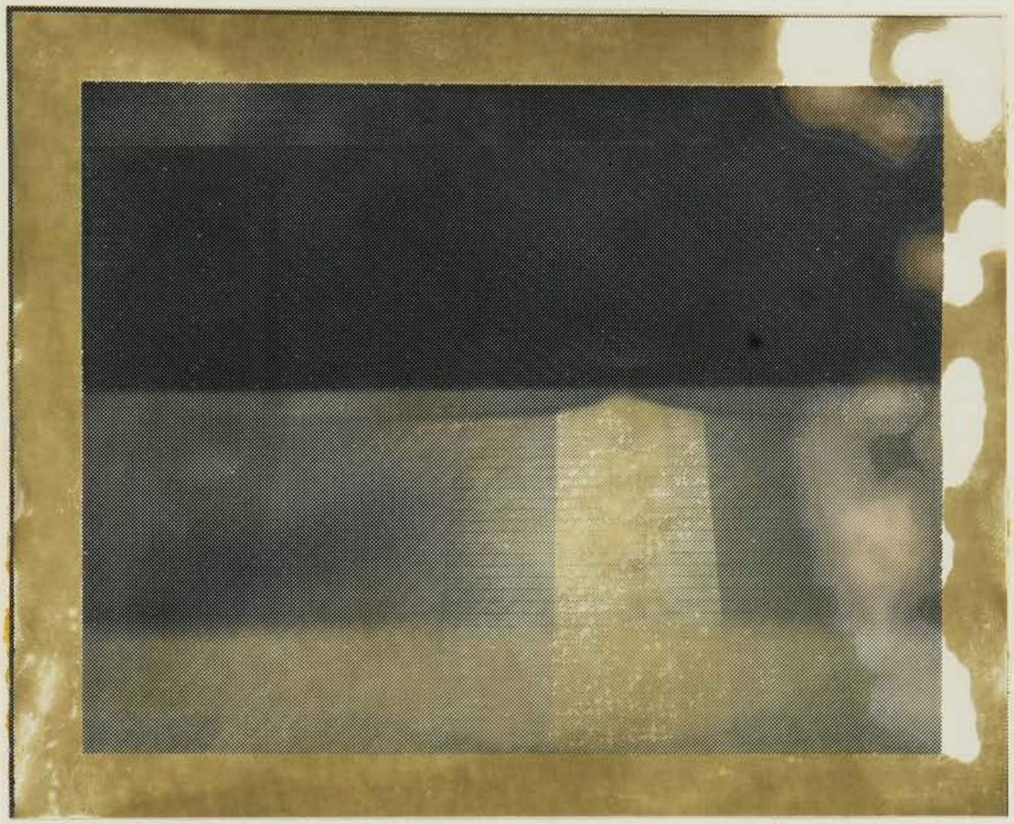
Figure 7. Cinematographic analysis of five printing cycles. Mean and extreme wrap as a function of blanket cylinder rotation.

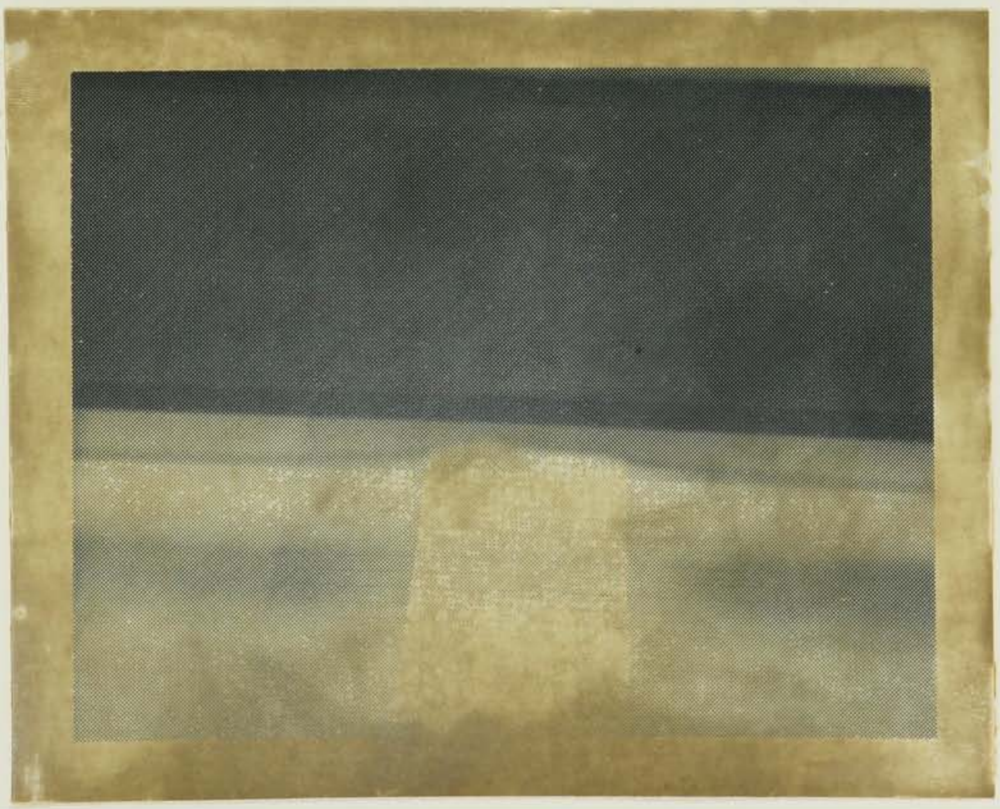
RECOMMENDATIONS FOR FURTHER WORK

Since this method of blanket release analysis has been shown to be effective and sensitive to small changes in wrap, we feel that some work should be done to polish the technqiue. Efforts should be directed towards the nature of the wrap and release. In order to improve the technique, permanent cabling could be done in the subject press to properly suppress electrical noise. Also, a variable sync control which could be operated from the observers position would be useful. Availability of a different focal length lens or a mount which would allow a closer position for the Polaroid camera to give greater magnification and wrap angle resolution is desirable.

Of particular interest in the study of wrap and release is to confirm the existence of a periodic function during the printing cycle. The effects of parameters such as web mass per unit area, web tension, press speed, and ink tack on the period and amplitude of the function would be of importance. Studies of the effect of varying wrap on print quality and press operation should be implemented.

APPENDIX I
SAMPLE PHOTOGRAPHS





APPENDIX II
RECOMMENDATIONS FOR STANDARDIZED PROCEDURE

I. Visual observation or polaroid single sample recording
   A. Materials
      1. Polaroid camera with flash sync contacts and capable of shutter time longer than printing cycle.
      2. Strobe type source of illumination (1 millisecond or less).
      3. Sync mechanism as shown in Figure 8.
      4. Calibration pattern to be printed on test stock.
   B. Procedural Details
      1. Standardize as many parameters as possible to limits of statistical significance.
      2. Arrange equipment as in Figure 3.
      3. Find optimum sync point for strobe. Sync circuits are shown in Figures 6 and 8.
      4. Adjust aperture of camera for proper exposure by strobe with minimum effect of ambient illumination.
      5. System magnification is derived from the known pattern size

$$M = \frac{\text{image size}}{\text{object size}}$$

      6. Wrap is measured in divisions of the pattern from the nip to the release point.
      7. Wrap in degrees is calculated from:

$$W = \left(\frac{360 \text{ degrees}}{2\pi R}\right) \times L \times N$$

W = wrap in degrees
R = cylinder radius
L = length of pattern division
N = number of divisions of wrap

II. Cinematography
   A. Equipment
      1. Camera capable of minimum 100 frames per impression.
      2. Continuous high intensity source.
   B. Procedural Details
      1. Arrange equipment as in Figure 3.
      2. Combination of press speed, camera and film determine parameters such as source intensity, exposure time, image blur, and frame rate.

3. Basics for high-speed photography can be found in the referenced article by Hyzer and other sources.
4. Film can be analyzed frame by frame to measure wrap from a fixed reference point which should be included in the image area.

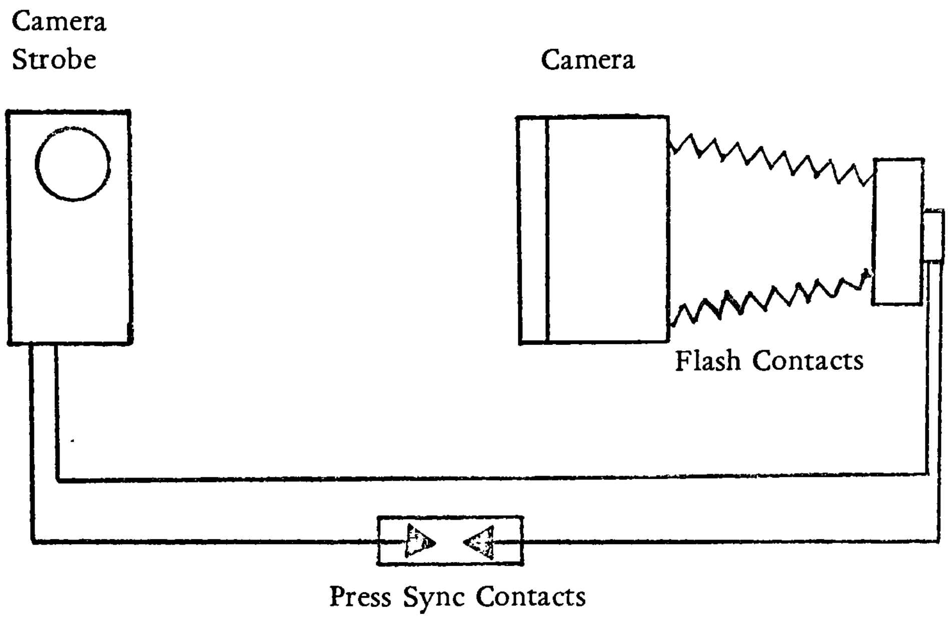


Figure 9. Schematic of simplified single flash system using camera strobe. The long strobe recycle time (normally several seconds) prevents multiple flash.

APPENDIX III
LIST OF SELECTED MATERIALS AND EQUIPMENT

1. Red-Lakes Laboratories – Hycam – high-speed motion picture.
2. GAF 2962 high-speed reversal motion picture film. (Exposure index 400 but rated at 200 due to expected high speed reciprocity failure.)
3. GE 650-watt movie light
4. GR-1531A Stroboscope
5. GR-1531P2 Flash delay unit
6. Gossen Lunasix luminance meter
7. Recordax Motor-Matic microfilm reader
8. Crown Graphic camera with Polaroid No. 500 film holder
9. Polaroid Type 52 film

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