4-30-1962

A Preliminary Experiment in the Preparation and Evaluation of Photographic Prints of Unusual Tone Reproduction Characteristics

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A PRELIMINARY EXPERIMENT IN THE PREPARATION AND EVALUATION OF PHOTOGRAPHIC PRINTS OF UNUSUAL TONE REPRODUCTION CHARACTERISTICS

by

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April 30, 1962

Rochester 5, New York
April 30, 1962

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Gentlemen:

Previous work in tone reproduction created a demand on our part to investigate this area more thoroughly. More emphasis was placed on obtaining a variety of curves than on the psychological evaluation.

This paper is written in partial fulfillment of the requirements of Photographic Research, PH-423.

We would like to acknowledge the assistance of Mrs. R. J. Kane in typing the finished copy and to Rochester Institute of Technology and yourselves for your assistance, without which this paper could not have been written.

Sincerely yours,

Robert J. Kane
Irving J. Magin

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ABSTRACT

Using three film types, Super Pan Press type-B, Kodak Commercial and Kodak Gravure (improved), and submitting these films to three levels of development and masking, a variety of tone reproduction curves were obtained. Selected prints, representing a variety of reproduction curves, were viewed by observers to determine preferred curve shapes.

INTRODUCTION

If a comparison is made between the density and density differences of the positive and the log luminance and log luminance differences of the original, a straight line of slope unity indicates objectively perfect tone reproduction.

Deviations from this straight line are commonly obtained in the form of an S-shaped curve. The main limitations being the flare light in the camera and the S-shaped curve of photographic paper.

This investigation is concerned with the variety of curves obtainable using materials and processes somewhat different from those normally used. Such variation is useful in determining the degree of departure which is acceptable to the observer.

THEORY

> The tone reproduction problem has two major aspects, the objective and the subjective or psychological. The former provides direct information about the perfection with which the photographic process has met the requirements for exact objective tone reproduction. The latter involves a comparison of the sensations and the mental impressions produced by the luminances in the various areas of the scene with those produced by the same areas in the illuminated reproduction.[1]

Tone reproduction is the study of the way in which the tones of the original compare with the tones in the finished print. This may not always be desirable for the pictorialist or the commercial photographer whose aim it is to enhance the photograph. "It is evident that the factors which control these aspects of quality are not functions of the photographic processes, but rather of the skill of the photographer in selecting and arranging his subject matter."[2]

The technical requirements on the other hand, require an accurate reproduction of the original. Theoretical perfection in the print would give a straight line at a

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[1] T. H. James, Ph.D., and George C. Higgins, Ph.D., Fundamentals of Photographic Theory (New York, 1960), pp. 235-236.

[2] C. B. Neblette, F.R.P.S., F.P.S.A., Photography Its Material and Processes (New York, 1952), p. 268.

45° angle. "Such a situation is never encountered, and fortunately, appreciable departures from perfection may still give a print of good quality."[3]

If a change in the characteristic curve of the negative material could be obtained, the way in which the densities of the negative reproduce on the print would necessarily change. This change in the negative characteristics would offset the effect of flare in the camera. Development to a gamma of 1.0 is usually used to match the density differences in the negative to the logarithm of the subject brightness ratio. Development beyond this gamma will also cause a change in the shape of the tone reproduction curve. Masking is another way in which the negative and consequently the tone reproduction can be altered.

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[3] C. B. Neblette and H. N. Todd, Elementary Photographic Sensitometry (New York, 1950), p. 92.

DEVELOPMENT VARIATION AND MASKING

Procedure

To insure a variety of negative characteristic curves, three different films were used. Super Pan Press type-B, Kodak Commercial, and Kodak Gravure (improved) were chosen as representing such a variety.

The original used was a print of an outdoor scene and a Kodak grey scale. Two number 2 photofloods were used for illumination at a distance of three feet at 45°. A 4 x 5 graphic view camera was used, equipped with an 8 inch lens, equidistant from the original with the light source. A single exposure was used based upon an incident light reading from an 18% grey card.

Each film was developed in DK-50 (1:1) at 20° C. for normal (0.8 gamma), 1.5 and two times normal. The densities of the developed negatives were then read on a Welch densichron and D log-E curves drawn.

Three masks were prepared for each film varying the development and exposure for each mask. The negatives developed for two times normal were used to prepare the masks. Pan masking film was used, developed in DK-50 (1:1) at 20° C.

Prints were made from negatives and masked negatives on Haloid Varaloid FF (Grade 2) paper.

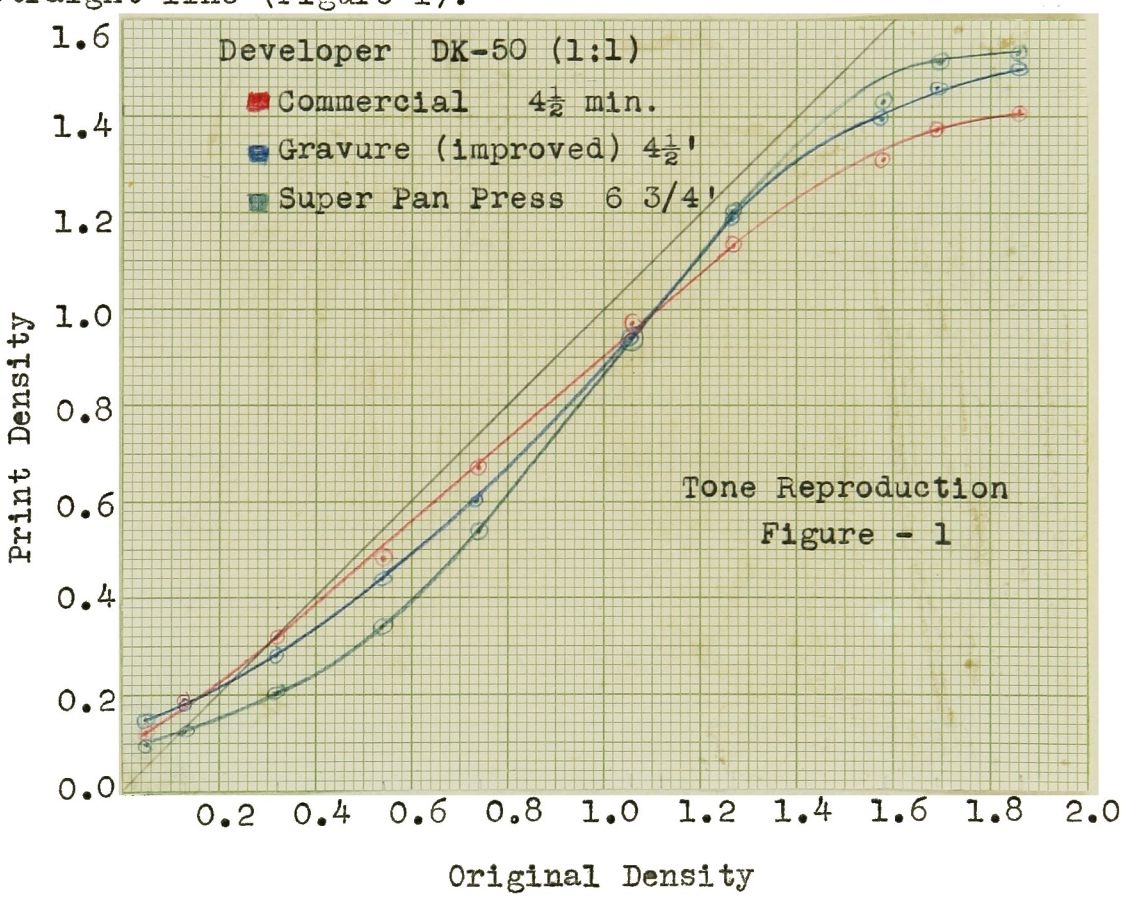
An Omega enlarger with a 161 mm lens and a 4 x 5 glassless negative carrier was used to make the finished prints. The magnification was determined as 1:1 using the original as standard.

Tone reproduction curves were plotted as density of the original grey scale against density of the print grey scale.

Results

As development increased, the gradiant and the length of the straight line portion of the characteristic curve increased. The exposure range was not sufficient to produce the double curve of Kodak Gravure (improved).

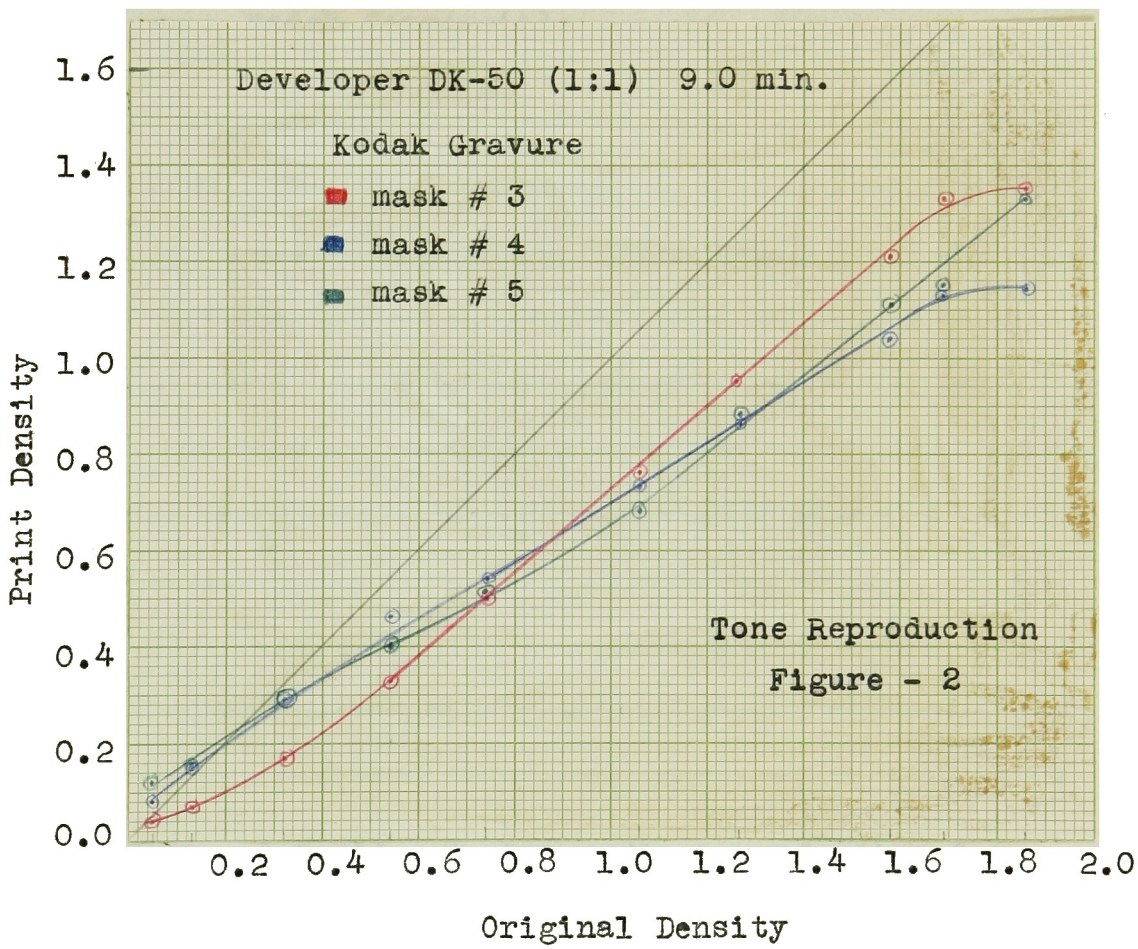
Kodak Commercial film and Kodak Gravure (improved), developed normally, produced tone reproduction curves with no substantial toe or shoulder, the overall curve approaching a straight line (Figure 1).



The reason for this is probably due to the shape of

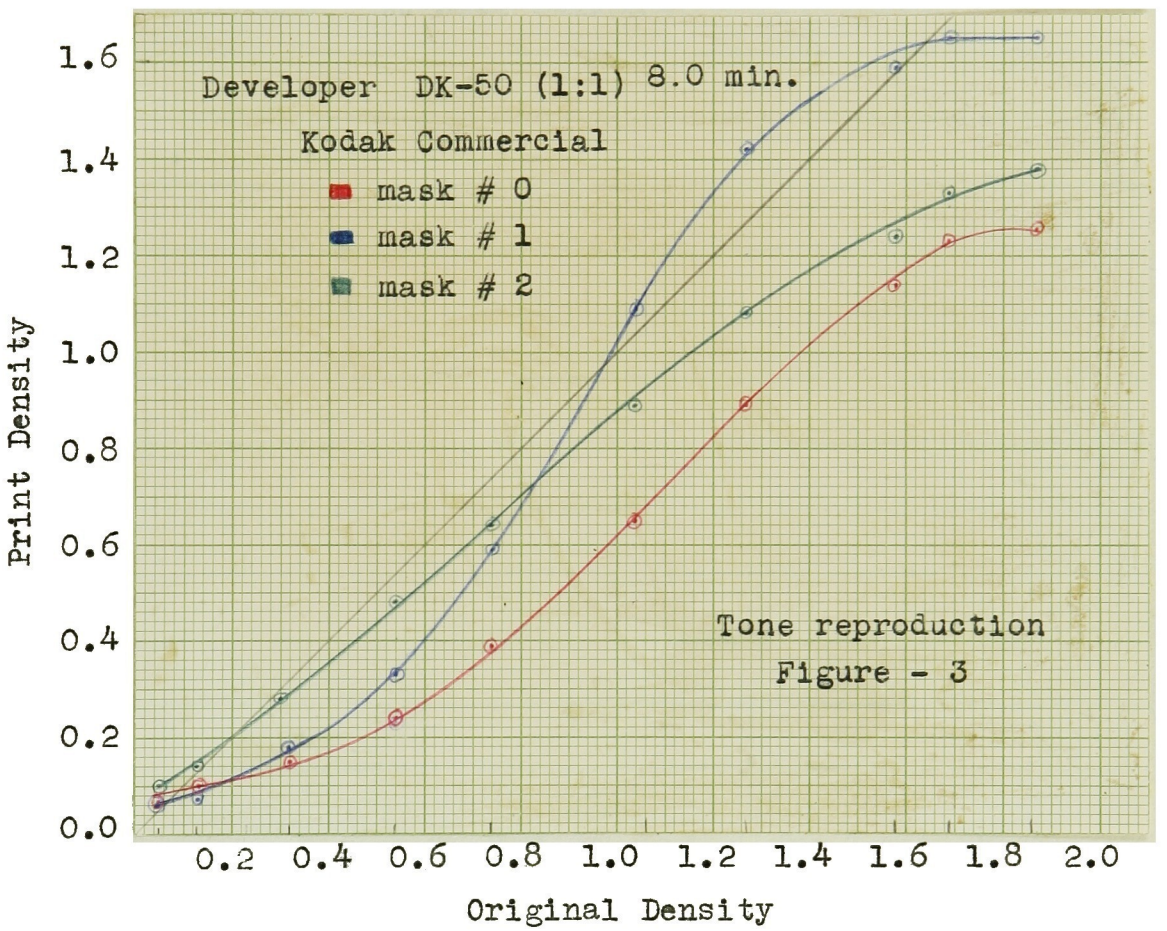
the characteristic curve of these films. Super Pan Press, when printed, gave a reproduction curve closely resembling that which is usually obtained. i.e. S-shaped curve.

The result of masking changed the density of the final print in several ways. Detail increased in the shadows and highlights with the proper combination of film and mask. Kodak Gravure film produced such an effect when used in combination with mask 4 (Figure 2).



Mask 3 produced a similar effect, the average slope being close to unity with good detail in the highlights and shadows. With increased exposure this curve would approach the ideal, intersecting the origin at 0.0.

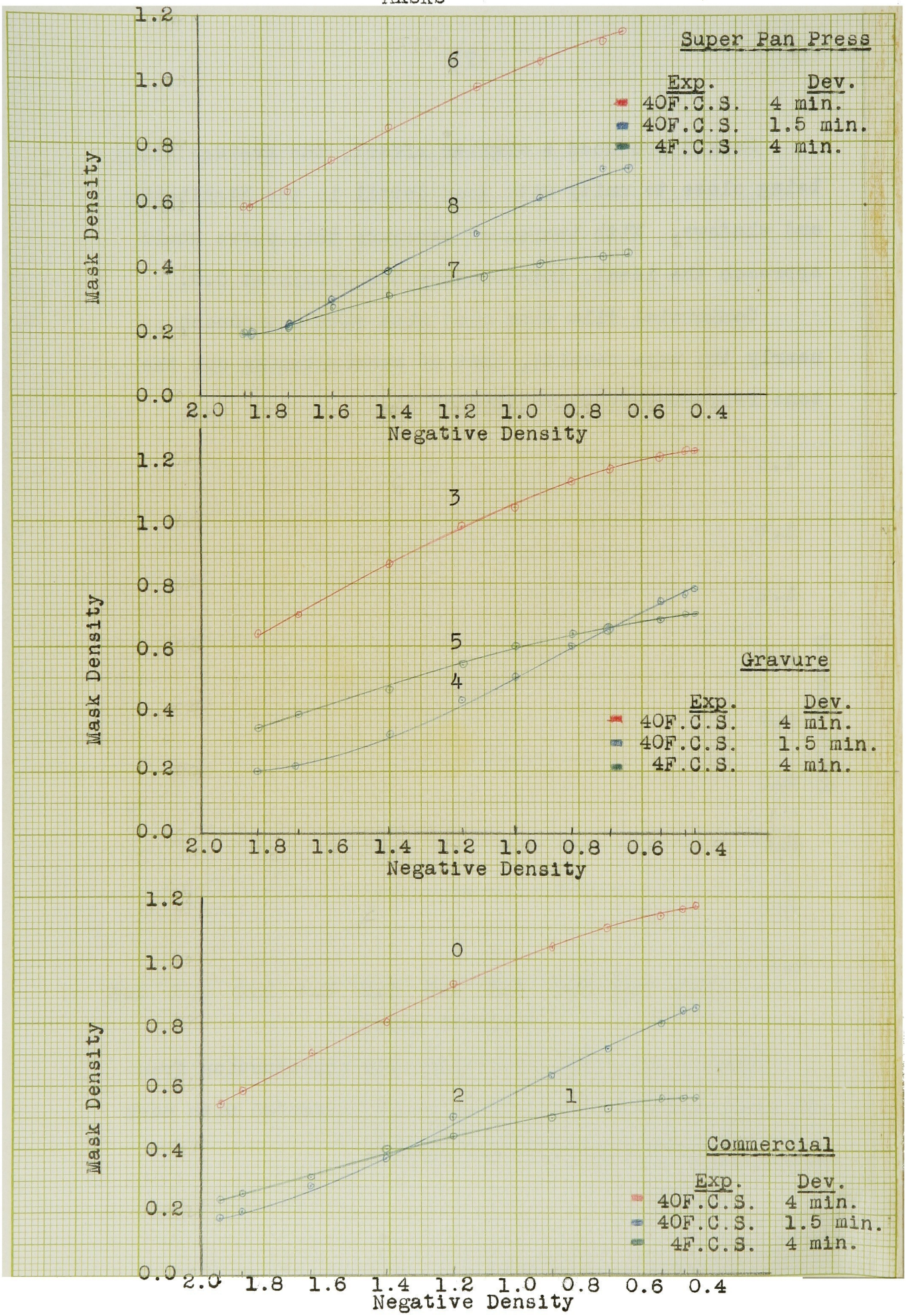
Commercial film when used with mask 2 produced nearly the same results, that of straightening out the tone reproduction curve (Figure 3).



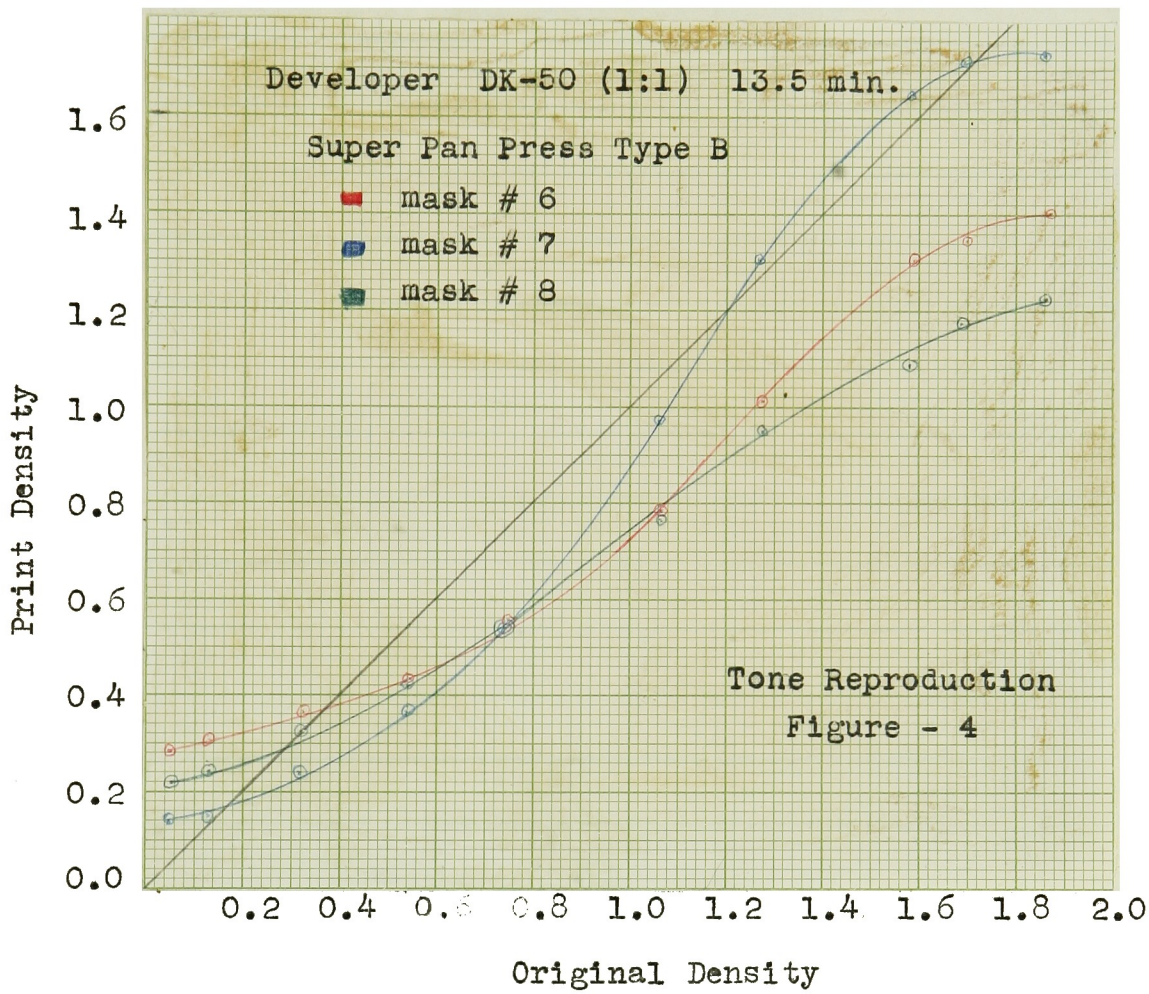
Masks 0 and 1 did not change the reproduction from the usual S-shape, the density range increased with mask 1 and decreased somewhat with mask 0.

MASKS

Figure 5



Masking Super Pan Press Type B did not change the shape of the resulting tone reproduction curve. Mask 8 increased detail in the shadows and highlights and decreased the average slope of the curve, (Figure 4).

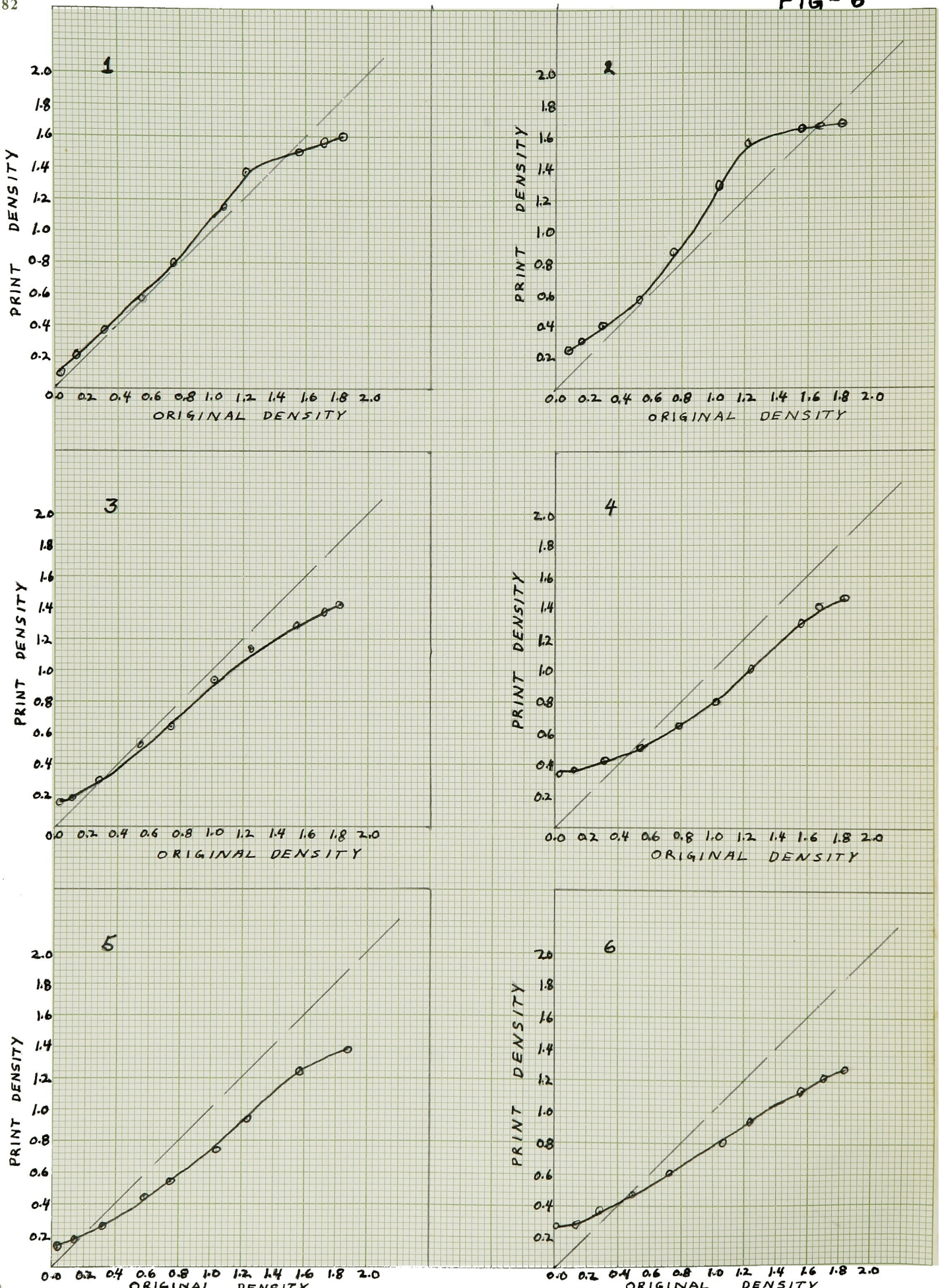


Using three different combinations of exposure and development, three masks were obtained of varying density for each of the three films (Figure 5).

VISUAL JUDGEMENT EXPERIMENT

INVESTIGATION #1

FIG-6



PSYCHOLOGICAL EVALUATION

Procedure

Investigation 1: Twenty-two observers looked at six prints representing six different tone reproduction curves. A standard viewer was used and all six prints were mounted on one grey board and numbered one thru six. Observers were asked to select the three prints they liked best. When the same three prints were selected repeatedly, a second investigation was conducted.

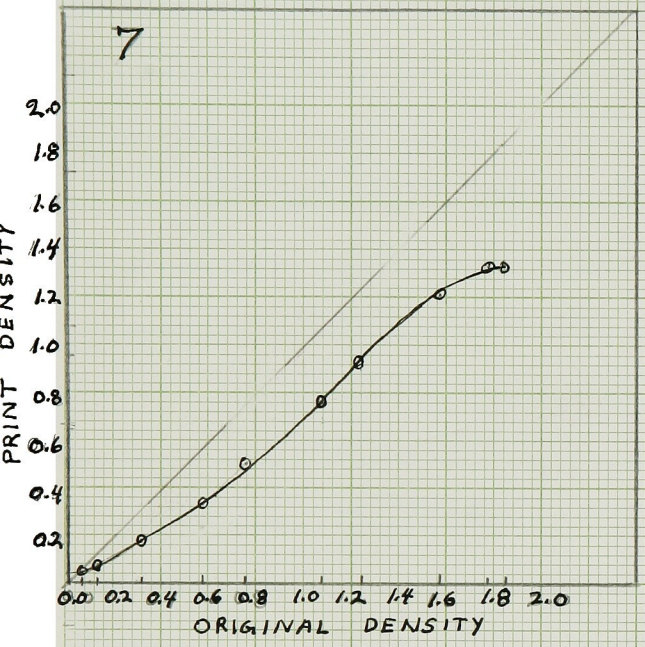
Investigation 2: A total of eight prints were viewed including four prints from investigation 1, and the order rearranged every five observers. The standard viewer was used in this evaluation also. Thirty-one observers were asked to rank the five prints of their choice out of the possible eight. Two prints from investigation 1 were not used because they were too light to be acceptable (curve 5 and 6, Figure 6).

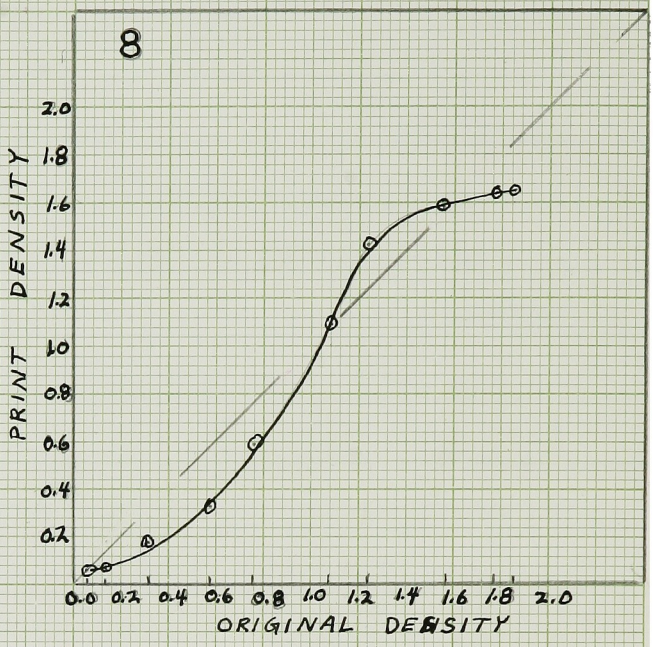
The original was not included in the evaluation. No one observer was allowed to see or hear the results of any other observer, thereby eliminating any bias.

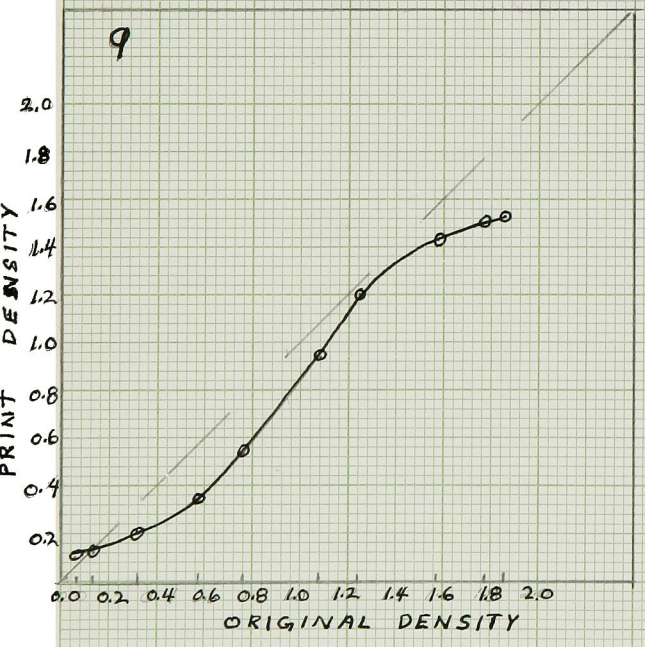
It should be noted here that only students of the department of photography were asked to rank the prints. The observers in both investigations included both science and non-science majors.

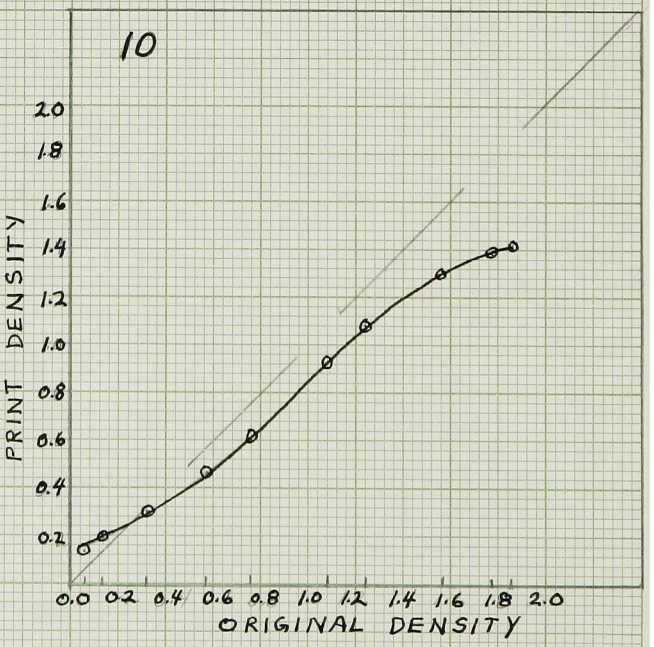
VISUAL JUDGEMENT EXPERIME
INVESTIGATION # 2

FIG - 7









Results

Print numbers correspond to curve numbers (Figures 6 and 7).

Investigation 1: Two prints, 4 and 6, were not selected by any of the observers. Print 2 was picked by all but four observers for third place. Print 1 was selected equally for both first and second place (eleyen observers). Print one received the most votes for first place (eleven observers).

Investigation 2: Print 9 was picked equally for both first and fourth place (nine people). All but two prints were selected by at least one observer for first place, print 9 being selected by the most people for first place (nine people). Print 5 was selected only for fifth place. Print 7 was chosen equally for both first and second place. Prints 2, 3, 7 and 9 were chosen by at least one person for positions one thru five. i.e. Although nine people chose print 9 for first place, nine people also chose it for fourth place, six selecting it for second and third place and one selecting it for fifth place.

HISTOGRAM OF PSYCHOLOGICAL EVALUATION RESULTS

FIGURE 8

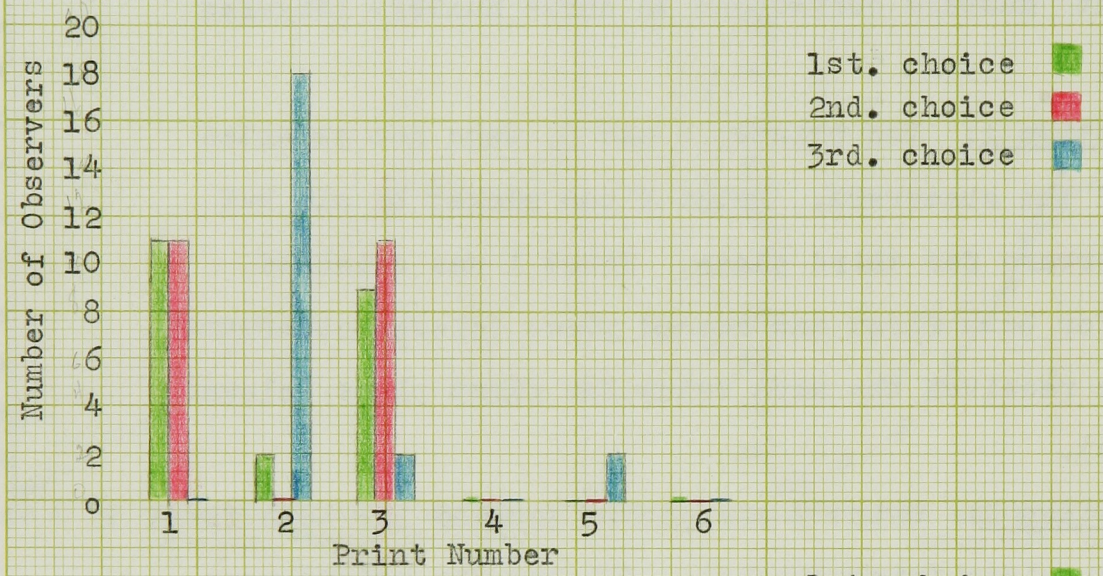


FIGURE 9

CONCLUSION

Development Variation and Masking

Increase in the degree of development did not change the tone reproduction curve significantly from that usually obtained. Masking will change the tone reproduction curve significantly, the change corresponding to the way in which the mask is prepared. Masking the shadow densities of the print results in better detail in this area. In some cases the density may be decreased to the extent that the observer will view the print as not having enough contrast (print 7, Figure 7).

Psychological Evaluation

Out of twenty two observers not one selected prints 4 and 6. These prints were too light to be acceptable. With the choice limited to prints 1, 2, 3 and 5, 5 was next eliminated because it also appeared too light. With the choice narrowed down to only three prints, it became only a matter of arranging the remaining three in order of first, second and third place (Figure 8).

When prints 4 and 6 were eliminated and four other prints added, which were darker, the observers were now placed in the position of having to rank the first five choices out of the possible eight. This became a difficult chore as evidenced by Figure 9. It is interesting to

note that print 9 was selected by the same number of people for first and fourth place. The prints selected for first choice had varying tone reproduction curves. Print 9 which was selected by one more observer than print 7, for first place, had poor detail in the shadows and highlights.

The order in which the prints were arranged seemed significant. Several observers, after selecting print 7 for first place and print 9 for second place, decided the reverse would be a better choice after the order was changed. A print appears to be good if it is placed next to one which is relatively poor in comparison.

It would be difficult to say without statistics, whether an S-shaped reproduction curve is preferred over that which has a straight line curve, but this would seem to be the trend. This could probably be accounted for by the majority of prints, usually made under normal circumstances, having this S-shaped curve. The viewer is inclined to select the print which best approaches that which he is familiar with.

The logical follow-up to this experiment would be a psycho-physical statistical evaluation to determine the most preferred curve shape.

SUMMARY

If a straight line tone reproduction is desired, the combination of Kodak Gravure (improved) film and mask 3 is recommended. Variations in masking will produce variations in the reproduction quality.

There is considerable dissension among observers as to what constitutes a good print. A tone reproduction curve of slope unity intersecting the origin may not be the absolute in perfection, depending upon the use of the photograph. This goal then, straight line reproduction, is not necessarily the ultimate and deviations should not be considered as failures.

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SUPPLEMENT

Sabattier Effect

First exposure determined from reflected reading from 18% reflectance grey card (normal). Each of the three films were exposed and processed according to the following diagram.

Re-exposure (FCS.)

First Dev.Time (Min.)	X	0.4	1.0	4.0
	1	8(A)	5(C)	9(B)
	2.5	1(B)	3(A)	4(C)
	4	6(C)	7(B)	2(A)

A-Super Pan Press
B-Commercial
C-Gravure

Results:

Complete reversal was obtained from position 9-B, Kodak Commercial film developed 1 minute and re-exposed for 4 F.C.S. and then redeveloped for 4 minutes at 20° C. in DK-50 (1:1).

Kodak Etch Bath EB-2

Each of the three films were exposed and processed according to the following design.

Re-exposure (FCS.)

First Dev.Time (Min.)	X	0.5	1.0	4.0
	1	1(A)	4(C)	7(B)
	3	5(C)	9(B)	2(A)
	4	6(B)	8(A)	3(C)

A-Super Pan Press
B-Commercial
C-Gravure

Results:

Complete reversal was obtained from position 1-A, Super Panchro Press Type-B.

Conclusion

Even though complete reversal was obtained, the degree of fogging was too great to allow prints of suitable contrast to be made. An intermediate stage would have to be used, such as a high contrast copy film, to increase the contrast of the positive. To minimize these stages, positive paper was used to print the resultant positives. The following statistical design was used to determine the best working conditions. Only first exposure was found to be significant at the .05 level.

		A_H		A_L		
		B_H	B_L	B_H	B_L	
C_H	D_H	11	14	27	23	75
	D_L	0	16	33	29	78
C_L	D_H	28	30	32	37	127
	D_L	10	15	35	24	84
		49	75	127	113	364

A-first exp.
B-2nd. exp.
C-first dev.
D-2nd. dev.

Gradient - Response variable