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An Analysis of Offset Process Color Separation Techniques Appropriate for Industrial Arts Programs

Earl B. Marshall

AN ANALYSIS OF OFFSET PROCESS COLOR SEPARATION TECHNIQUES APPROPRIATE FOR INDUSTRIAL ARTS PROGRAMS

by

Earl B. Marshall

Bachelor of Arts, Hastings College, Hastings Nebraska 1937

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Dean of the Graduate School

PREFACE

Printers have always considered process color separation to be too technical and involved for anyone but a specialist. The author was advised by several that offset printing of full-color reproductions from colored copy with average equipment would be futile.

This conception challenged the author to explore the problems related to the commonly used methods of process color separation. Experimentation with Polaroid equipment resulted in a more direct separation procedure.

It is the purpose of this thesis to record, for the use of others, the methods which can be used for successful offset process color separation with average equipment.

The author gives much credit for the completion of this thesis to his wife, Mildred, whose encouragement, sacrifice, and proof-reading skills, made it possible.

We also acknowledge with gratitude, the assistance rendered this work by the Printing Products Division of the 3 M Company, who donated liberal supplies and information on the "Color-Key" proofing process.

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ABSTRACT

The general belief that process color separation is beyond the ability of the average prınter with average equipment was questioned by the author. In this thesis the well known separation processes, direct and indirect, are described; and the difficulties of each are mentioned.

The Polaroid method, a shorter, more direct development of the indirect process, is described and its advantages and disadvantages are listed. The use of Polaroid Type 107 film, Kodak Autoscreen film, and 3 M "Color-Key" proofing is given.

Extensive printing laboratory work was performed by the author and examples of the work are displayed and described in Chapter VI.

It was the opinion of the writer that the numerous steps and the extensive corrective operations of the direct and indirect methods make them unsuitable for the average high school industrial arts printing student.

The Polaroid method eliminates many of the steps of the other systems and with the use of color proofing, provides a process within the ability level of the high school student.

CHAPTER I

THE THEORY OF PROCESS COLOR SEPARATION

Color process printing is the progressive overprinting of primary colors to reproduce the shades and tones of color of the original copy. Separation refers to the extraction of the primary colors from the original for use in this process.

To discuss color reproduction in offset printing, a definition of color and light must be established. Light is a form of radiant energy to which the human eye is sensitive. A narrow region of the visible wavelength contains a full spectrum of color which stimulates areas of the retina in the eye causing sensations of color in the brain.

The colors of the spectrum blend from one color to the next but the colors of violet, blue, green, yellow, orange, and red can be definitely distinguished. There are hundreds of tints and shades of these colors but the printer should use as few of them as possible.

The color of an object depends on its property to reflect and absorb different wavelengths of light. If colored dots of ink are applied to the work in proper proportions, the color of the original copy can be reproduced with some degree of accuracy. Perfect matching of color is

not usually achieved, as printing inks do not perfectly absorb and reflect the existing colors. However the primary colors of red, blue, and yellow can be blended to produce satisfactory color fidelity. Black is often added to sharpen details and to intensify shadow areas.

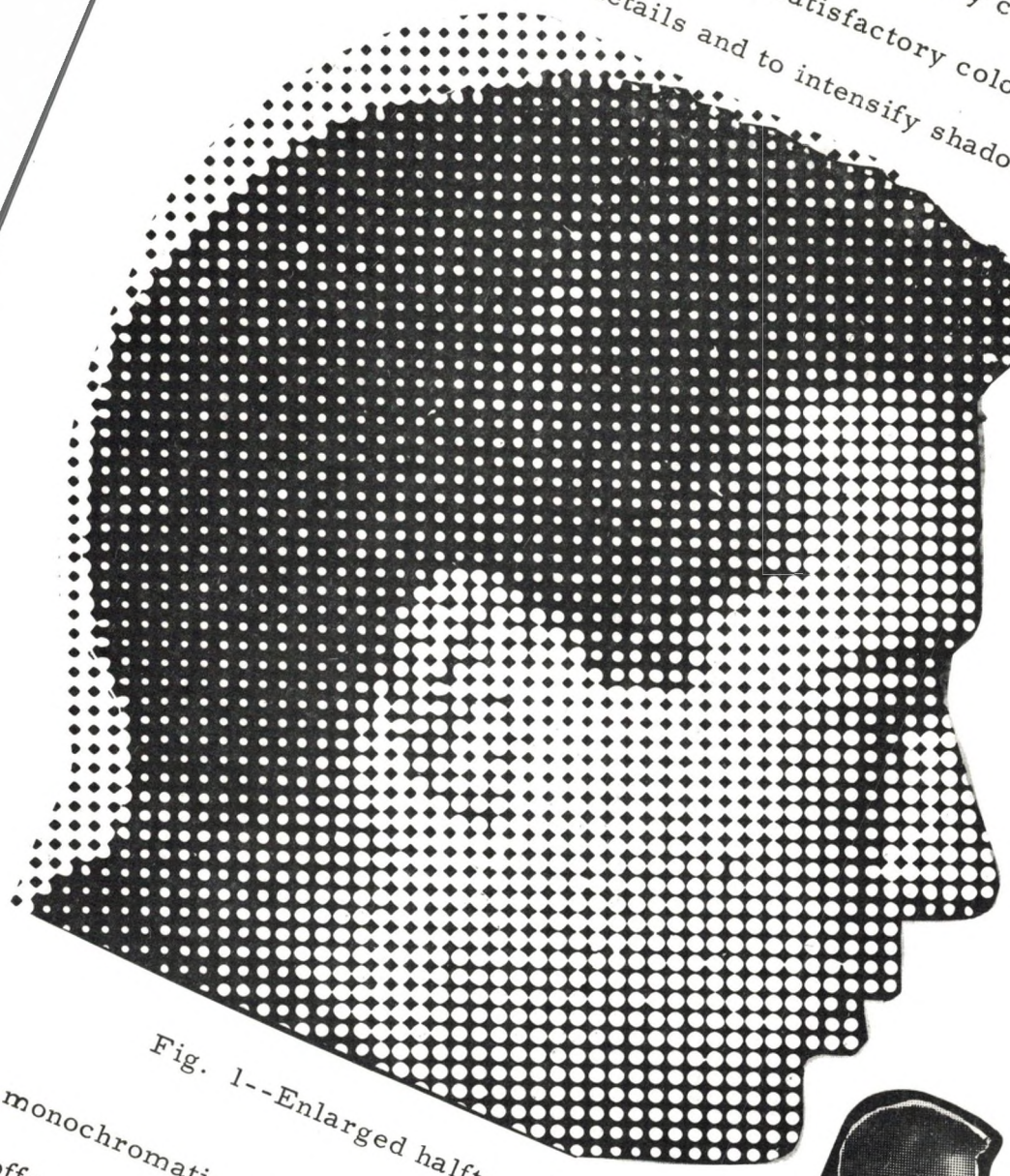

Fig. 1--Enlarged halftone illustration

A monochromatic photograph consists of shades of gray and black. An offset press can produce only solid black images. To represent shades of black and gray, the image is divided into tiny patterns of

solid ink arranged proportionally to represent the densities of blackness in the original copy. In this way the shades of white, gray and black can be approximated by the distribution of black ink in the appropriate proportions. This is known as the halftone process. The enlarged patterns in Fig. 1 illustrate the arrangement and variation of dot patterns which result in visual impressions of black, gray, and white.

If a colored illustration is separated into the primary colors of which it is composed, similar halftone patterns adapted for each color can be consecutively applied to produce a reasonably accurate colored reproduction of the original. This photomechanical process is described in detail in Chapter II. The halftone effect results from passing the image from the copy camera through a screen which divides the image into tiny patterns. The density of the shadow areas will produce nearly solid black with tiny patterns of white, and the highlight areas will be nearly white with tiny patterns of black or color. Color tones result from mixtures of colored dots which blend to give a mental impression of the color of the original copy.

CHAPTER II

THE DIRECT PROCESS

The photomechanical work in process color printing requires the use of a process camera which consists of a lens, copyboard, and image or film board. The lens must be corrected for color fidelity (all colors copy the same size and with equal sharpness over the complete image) and it must be able to enlarge or reduce the image as needed.

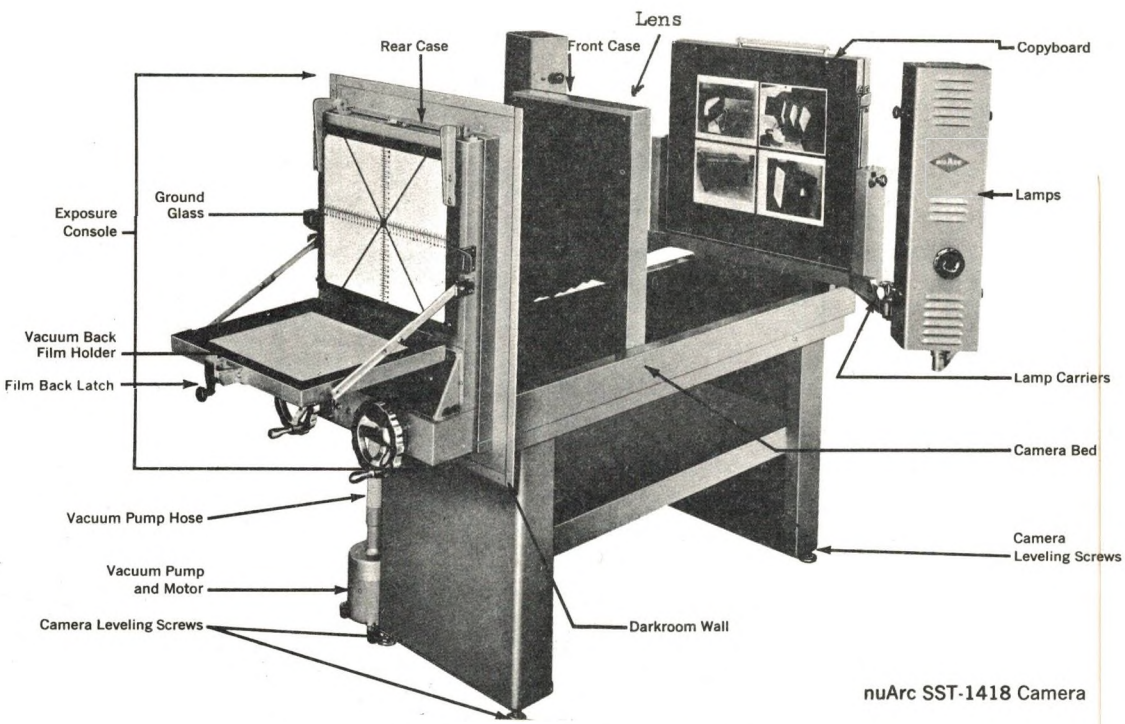

Fig. 2--A process camera

Ranges may be from 15% to 500% of the original copy size. The lens board is mounted rigidly so that it is continuously parallel to the copy and image surfaces. The surface consists of a focusing screen and a film holder. Vacuum forces are often used to hold the film in place during exposure, and the vacuum back and the viewing screen may be combined into one plastic surface. The copy holder is usually glass covered though the vacuum force system may also be used. For precise registration of color application the camera must be a rugged, dependable structure which will produce accurate images at all magnification and reduction settings. Film size may range from 16 x 20 inches to four by six feet. A process camera is shown in Fig. 2--page 4.

The direct process method produces a halftone negative in one operation for each color to be used in the reproduction. The copy is mounted on the copy board of the process camera and the film is placed on the film holder. A colored filter is fitted to the camera lens to exclude the colors not desired, and a halftone screen is placed to pattern the light rays from the lens. The screen should be glass with a ruled grating of fine lines. Gray plastic contact screen is also suitable for this purpose. The magenta contact screen is not used for direct process work as its color would filter out some of the desired color.

To make the halftone negative which controls exposure of the yellow printing plate, a blue filter is used to absorb the reds and blues from the light reflected from the colored copy. The halftone screen

divides the image into proportional intensities of light which print on the negative as highlight and shadow dots. These patterns reproduce the yellow color in the intensities needed for the color reproduction.

In a similar manner, a green filter removes yellow and blue light from the negative which is to print red; and a red filter absorbs red and yellow from the light striking the film for the blue-printing negative. The negative for the black printer is produced by filtering the light through a yellow filter, or by giving 1/3 exposures through each of the red, blue and green filters. Figure 3 illustrates this principle of filtered color control.

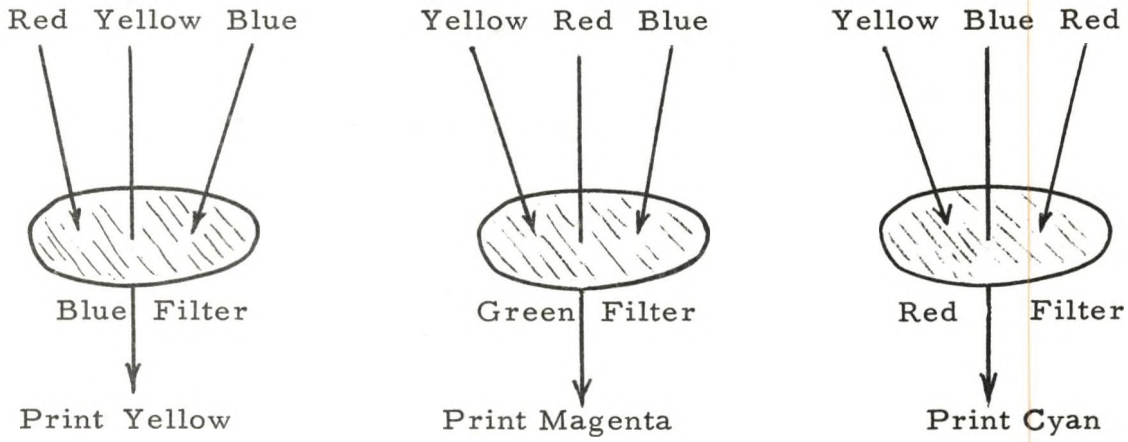

Fig. 3--Effect of color filters as used in the direct process separation method

The direct process is best suited for originals such as paintings, drawings, textiles, color transparencies or color prints. The copy should have high contrast for sharp halftone dot formation.

Some color correction is needed for all successful color

reproduction as the filters do not completely remove the unwanted colors. Correction in the direct process is limited to masking the original to intensify the contrast, or to retouching the halftone negative before the plates are produced. Color masking and correction will be further discussed in Chapter III.

The high-contrast ortho film used for regular lithographic copy work is satisfactory for the yellow, blue, and black halftone negatives; but this film is insensitive to red light and cannot be used for the red printing negative. Panchromatic film, which is sensitive to all colors, may be used for this negative. As pan film produces a low contrast negative, some form of correction will be necessary to get a negative which will make a plate that will print balanced amounts of red.

It was the opinion of the writer that the direct process, while having the advantage of fewer operations, presents too many difficulties and variations to be used successfully in the industrial arts print shop. Since each halftone negative is produced in a single operation, the exposure allowance for film and filter, and the developing time and temperatures are variables which must be controlled simultaneously.

> Beginners are cautioned not to attempt serious color work with flimsy camera equipment and cheap lenses. To do so is only inviting trouble because even the best tricolor filters and photographic material will otherwise not be able to meet the salient requirements of separation negatives-such images must all be exactly the same size and equally sharp,

and their overall density should be more or less uniform in all negatives of the set. [1]

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[1] J. S. Mertle and Gordon L. Monsen, Photomechanics and Printing, Chicago, Mertle Publishing Co., 1957

CHAPTER III

THE INDIRECT PROCESS

Process color separation by the indirect method requires many more steps to produce the halftone negatives, but opportunity for color correction is better and a more accurate color reproduction can be achieved.

The films in this process are made in sets. A set consists of one film for each color to be printed. The first step is to make a set of continuous-tone negatives from the colored copy by use of separation color filters. These negatives are usually lacking in contrast and are quite gray. By contact printing or by projection, (if a different size is required) a set of continuous-tone positives are made from the negatives. The positives are used to make a set of halftone negatives for use in producing the printing plates.

A variation of this method is to make halftone positives and prepare halftone negatives by contact exposure from them. Another variation is to print contact positives from the original continuous-tone negatives, and make halftone negatives by photographing the prints as in any other copy work. The Polaroid method, discussed in Chapter IV,

is related to this variation.

There is no color involved in any of this procedure, except the colors of the original copy. All the negatives are black or shades of black, but they represent the various intensities of color which are to be applied in the final printing process. The first continuous-tone negatives are made with panchromatic film which is sensitive to all colors. The continuous-tone positives would also have to be made on pan film as the high-contrast ortho film will not reproduce tones of gray. The final halftone negatives are made on high-contrast ortho film. If the positives are halftoned, they can be made with ortho film. This process permits correction by etching the dots on the positives to reduce or remove colors from areas in which they are not needed. Some correction may also be made on the negative by application of an opaque color to block light from the areas in which too much color would be applied.

An involved masking procedure is needed to achieve good fidelity of color in this process. A thin photographic mask made with panchromatic film is placed over the colored original to intensify colors and to increase the color contrast. Many masking procedures are used such as making unsharp or diffused masks; using positive or negative masks to preserve highlight or to intensify shadow areas, and making specific masks for each color to be printed.

Due to the number of steps involved and many variable factors in the production of satisfactory halftone negatives, the author does not

recommend this process for use in the industrial arts print shop. Short working periods do not provide time for the continuous application which is necessary for success with this method.

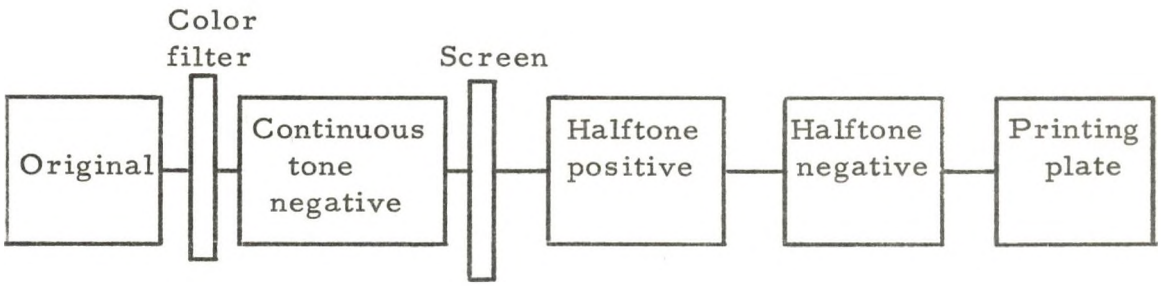

Chart 1--Flow chart of indirect process

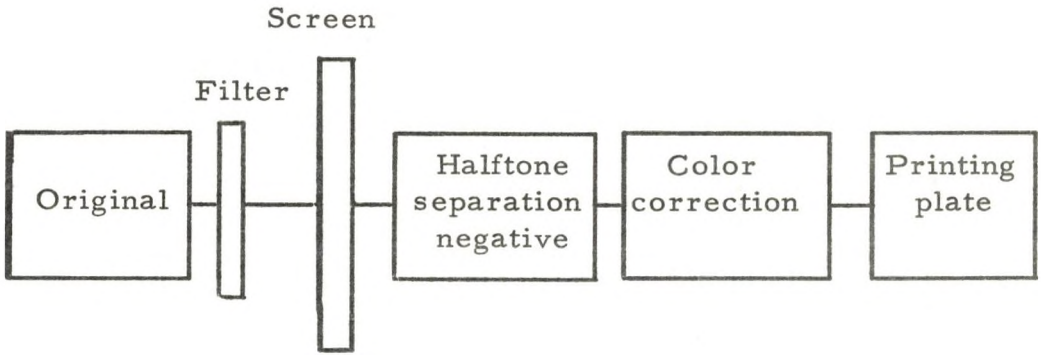

Chart 2--Flow chart of direct process

CHAPTER IV

UTILIZATION OF POLAROID LAND FILM TYPE 107

The Polaroid Automatic 100 Land Camera is uniquely suited to process color separation. It is equipped with an electronic light sensing unit which is coupled to the shutter timer. This device holds the shutter open until sufficient light has collected on the film to properly expose it.

A continuous-tone positive print is made directly with Polaroid Land film. A filter is placed over the lens to separate the colors as in the direct and indirect process. A color filter is also placed over the light sensing lens to provide automatically correct exposures for the amount of light admitted by the color filters. The print is immediately evaluated and a darker or lighter print may be made if necessary. Registration targets and color patches are included in the copy area for later use.

Careful inspection of the resulting continuous-tone positive prints shows that the dark areas represent places where nearly solid application of ink is needed. The near-white or highlight areas have carefully limited dots of ink. Halftone patterns make it possible to blend prime

colors to produce the tones and shades of the colored original. Some color correction can be made at this time by making additional prints with adjustments to alter density and contrast. Reference to the Color Separation Evaluation Chart, (see Chart 3--page 14) aids judgment of the ultimate effectiveness of each print.

The print for yellow is made with a blue filter. It removes cyan, violet, and magenta from the reflected light coming from the copy. The print of these color patches should nearly match a white area if the intensity of the print is correct. The wanted colors are yellow, orange-red, and green. These colors should show dark but should be a little lighter than the three-color (brown) patch. Density allowance is made for the addition of black.

The green filtered print for magenta was made to exclude the unwanted colors of yellow, cyan, and green. These patches in the print should nearly match the white areas. The wanted colors are magenta, primary red, and violet. As in the yellow print, these colors should be nearly as dark as the patch for the tri-color brown.

A red filter is used to remove yellow, magenta, and primary red from the print for cyan. These color patch areas should match the density of the white areas in the Polaroid print. The wanted colors are cyan, violet, and green and should print solid; comparing with each other and with the black on the copy.

A black printer print should eliminate all six colors. This is not

COLOR SEPARATION EVALUATION CHART

Evaluation of Color Separation Polaroid Prints and Negatives by Control Patches

PRINTER	FILTER	WANTED COLORS	UNWANTED COLORS
YELLOW	BLUE	YELLOW, ORANGE-RED, GREEN	CYAN, VIOLET, MAGENTA
MAGENTA	GREEN	MAGENTA, PRIMARY RED, VIOLET	YELLOW, CYAN, GREEN
CYAN	RED	CYAN, VIOLET, GREEN	YELLOW, MAGENTA, PRIMARY RED
BLACK	YELLOW	NONE	ALL

Wanted colors should compare with each other and should be slightly lighter than the brown patch.

Unwanted colors should match a print area which represents white in the original.

Chart 3

possible, but a yellow filter will help intensify the contrast. To restrict the application of black ink a very light print must be made. The color patches should all be tones of light gray and the highlight areas of the copy should be eliminated. An underexposure will give this effect.

The process camera is used to make a halftone negative of each print of the Polaroid set. Careful attention to exposure time and development is essential to control the application of each color. These negatives should have high contrast with transparent open areas and dense black closed areas. A flat negative permits excessive amounts of ink to be applied and the result is a muddy, dull-colored reproduction.

The Polaroid camera reduces the prints to about 50% or less of the original size. This limits the size potential of the final print. However if the process camera can enlarge more than to 200%, this limitation may be minimized.

A Polaroid back may be fitted to a 4 x 5 press camera for larger prints. Since this unit does not have the automatic feature for correct exposure; a light meter, used with the filter, will provide approximate exposure time.

The inexpensive Polaroid cameras are not suitable for process color separation as they do not have the color-corrected lens which is so vital to accurate work. Model numbers below 230 do not accept the close-up attachment.

The halftone negatives are mounted and stripped on goldenrod

layout sheets in preparation for platemaking. Great care must be given to exactly match the register targets. With the punch marks of the masking sheet precisely aligned, the register targets should all match perfectly.

If the lens of the process camera is not color-corrected, or if any adjustment is made in the process camera during the photo-copying procedure, the separation prints may vary in size. If parts of the register marks of the negative are cut out, the negative can be applied to the vacuum back of the camera for accurate comparison with the image of the next print.

CHAPTER V

UTILIZATION OF PRE-SCREENED FILM FOR HALFTONES AND "COLOR-KEY" FOR PROOFING

The Eastman Kodak Company makes Kodalith Autoscreen Ortho film which produces halftone negatives without the use of a contact screen. This film has, effectively, a 133-line screen built into it. This eliminates the need for expensive screens and the many variable steps associated with their use. This film is especially suitable for making halftone negatives from the Polaroid prints as its highlight contrast is higher and the shadow contrast lower than with usual halftone screen methods. Autoscreen film can be also used in a plate camera to produce screened negatives directly. Illustrations in Chapter VI were made this way.

The Printing Products Division of the 3 M Company has developed the "Color-Key" proofing system to give the printer a dependable and an economical method of color proofing from the halftones without inking a press. Positive or negative-acting film, in ink-matching colors, is exposed through the halftone negatives to produce single colored halftone transparencies. These are assembled in register over a white

reflective background to simulate the application of colored inks on white paper. The effect is that of the finished print job.

> It has always been necessary for the color printer to process the plates and pull press proofs to really see what he's got. That's a high priced way to discover - and maybe too late - how many mistakes there are to correct.[2]

It is easy to see, with the overlay system of "Color-Key", which color is excessive or short.

In the indirect process method, positive acting "Color-Key" is used with the halftone positives. Corrections can then be made before the final halftone negatives are produced.

In the direct process and Polaroid methods, the negative acting "Color-Key" is used to proof from the final halftone negatives. During the color printing the "Color-Key" proofs are applied over the first print of colored ink to check the intensity of the printed color. The techniques of the use of "Color-Key" are discussed in detail in Chapter VI.

"Color-Key" is also used to: proof ordinary black print halftones; make transparencies from translucent documents for plate making; apply color to a printing layout to promote the effectiveness of coloration.

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[2]Technical Information Library Series, "Color-Key" Proofing System, Printing Products Division, 3M Company, St. Paul, Minn.

CHAPTER VI

LABORATORY EXPERIMENTS

A partial list of equipment and supplies needed for the Polaroid separation method is given here. A photographic darkroom with standard equipment and an offset printing press are essential.

Other necessary supplies:

Polaroid Land Camera, Model 100 or 230-240-250

Polaroid close-up attachment

Film pack type 107 speed 3000, 8 exposures

Kodak color filters--numbers: 8; K2; 58; 25A; &47. Size 2x2".

Copy holder and camera support fixture

Process camera with lights

Kodak Autoscreen film and Photolith developer

3 M "Color-Key proofing- process colors- negative acting & Stouffer gray scale

The color separation method begins with positive prints made with the Polaroid camera. The close-up attachment was applied and fixtures were made to hold the color filters in place. Centers were removed from lens covers and filters were installed. The color filter

is a thin sheet of colored gelatin. The standard small size is 2 x 2 inches and is large enough to make filters for both the lens and the timing eye. An ink cartridge cover (#-188) fits the eye housing if its length is reduced. Fig. 4 shows the camera mounted on the base with the filters attached to to the lenses. A double lens cover for a twin-lens camera (such as Rolicord) can be adapted to hold both filters in position.

The copy was held between hardboard hinged to a plastic front. A slot was cut in a wooden 2x4 base to fit the closed copyboard. The camera was secured to the other end of the base by a wing-screw through a slot in a sheet metal bracket. This arrangement is essential to the process as exact registration must be maintained between the camera and copy (Fig. 5). A tripod for the camera is not satisfactory as the camera will move when the print is removed.

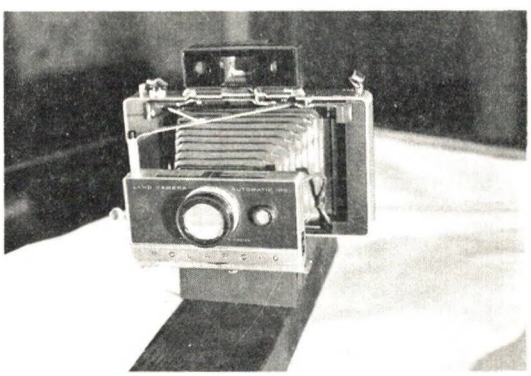


Fig. 4--Mounted camera with filters attached

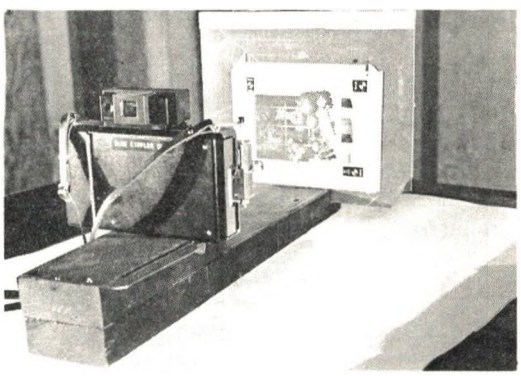


Fig. 5--Camera and copy-board mounted on base

The arc lights of the process camera were used to light the copy. If other light sources are used, the color of the light may influence the colors reflected from the copy, or reflections may appear on the copyboard. Light should strike the copyboard at about 45°. Bright surfaces on the camera, which could reflect on the copy cover, were masked. Background objects were checked to prevent reflecting into the camera.

A trial photograph of simple line copy was made to certify focus and to establish range limits. Some of the copyboard back was included to provide reference points for mounting the colored copy. As the focus was not perfect, a screen was fabricated from an empty film pack for direct focusing. In complete darkness the film pack was removed and placed in a light-safe container. The eye of the camera was covered with black tape to exclude light so that a time exposure for focusing could be made. With the screen in place a good focus was achieved.

The camera was reloaded and re-set for separation shots, and the colored original was placed in the copy back with a strip of color patches and several registration targets. Since color patches should match the colors of the inks to be used, the color patches were made of "Color-Key" material.

Composition of the copy should be given careful attention. Be sure that the texture of the copy is not prominent. Any grain of the copy face should be parallel to the light line in order to reduce copying of the texture. If the texture of the copy shows in the photograph, it will

Fig. 6--The copy

influence the application of color. The targets were at the most extreme range of the photograph to increase the accuracy of registration. The range of the photograph was established to facilitate accurate placement of the copy.

The first separation shot was made with a green filter for the magenta printer. Reference to the evaluation chart, page 14, indicated that the unwanted colors are yellow, cyan, and blue. Inspection of the print showed that it was too dark. The green color patch was too strong

Fig. 7--Print for magenta

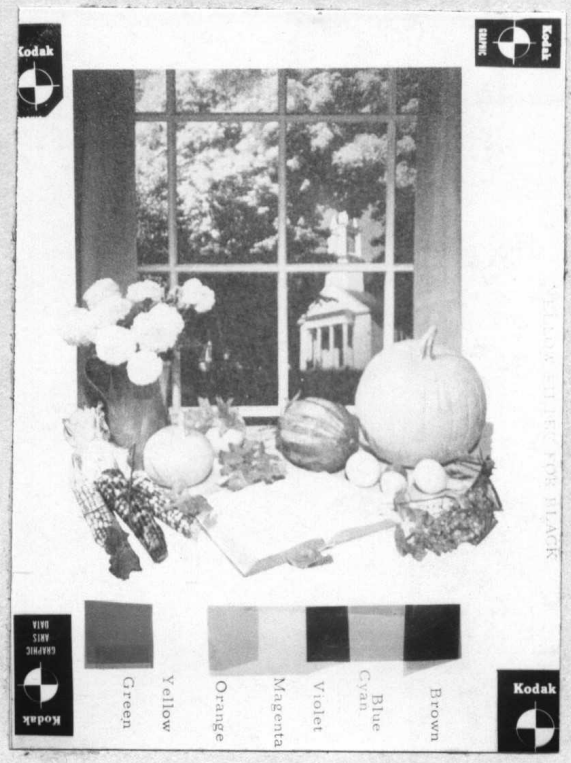


Fig. 8--Print for black

for an unwanted color. The second shot, taken at the maximum lightness setting, was still too dark. An overlay of a blue strip of "Color-Key" was placed over the eye filter to reduce light and increase exposure time. This gave a too-light print so the lens setting was moved toward the darker range to obtain the desired intensity. (See Fig. 7) The best prints for magenta still showed too much green. Areas which are green in the original should be masked or reduced on the halftone negative to prevent printing magenta where green is wanted.

The yellow filter for black should eliminate all color. This is not possible. However a very thin print was made by using the cyan "Color-Key" over-strip on the exposure eye. This very thin print will

make a very dense negative for the black printer. An analysis of this print shows that black will be applied only in the most dense areas and none will be used in highlight areas. The color control patches of yellow, orange, magenta, and cyan have been almost completely eliminated and green, violet, and brown are increasingly gray in that order. If a slightly darker print is desired, the darkness setting of the camera may be used. (See Fig. 8--page 23.)

Examination of the print for cyan, (Fig. 9) shows yellow, orange and magenta removed; and green, violet, and cyan are well defined. The dark areas will print nearly solid cyan and the grey areas will print lighter shades of cyan by dispersal of the halftone dots. The red filter has removed most of the unwanted colors.

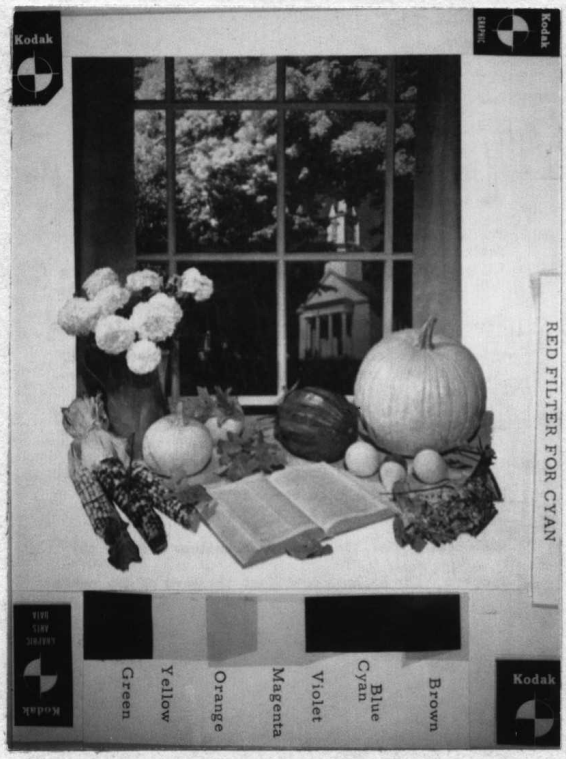


Fig. 9--Print for cyan

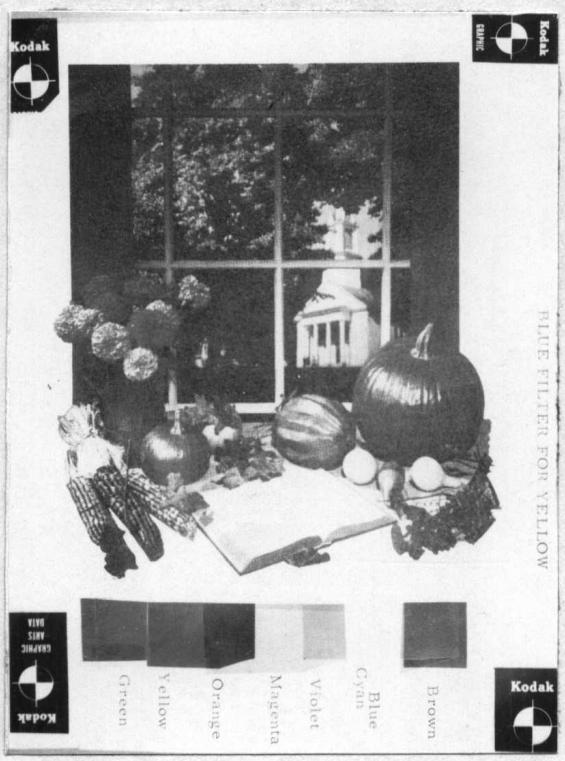


Fig. 10--Print for yellow

The print for yellow, (Fig. 10--page 24) was made with a blue filter. It does not have the contrast of the cyan and magenta prints. However the cyan, violet, and magenta were nearly removed and the wanted colors show well.

Halftone negatives were next made by photographing the Polaroid positive prints in the process camera on Kodak Autoscreen film. This film is pre-screened with 133 lines per inch and the screen pattern is parallel to the edges of the film. Each negative was exposed at a different angle to prevent moire' patterns in the final application of colored inks. A thin sheet of paper, cut to the intended negative size, was used to position the film on the vacuum back of the camera. When the image was made to fit the paper pattern, the film was placed on the pattern. Enough air passes through the paper to provide the vacuum

Halftone Screen Angles

Yellow	90°
Magenta	75°
Cyan	105°
Black	45°

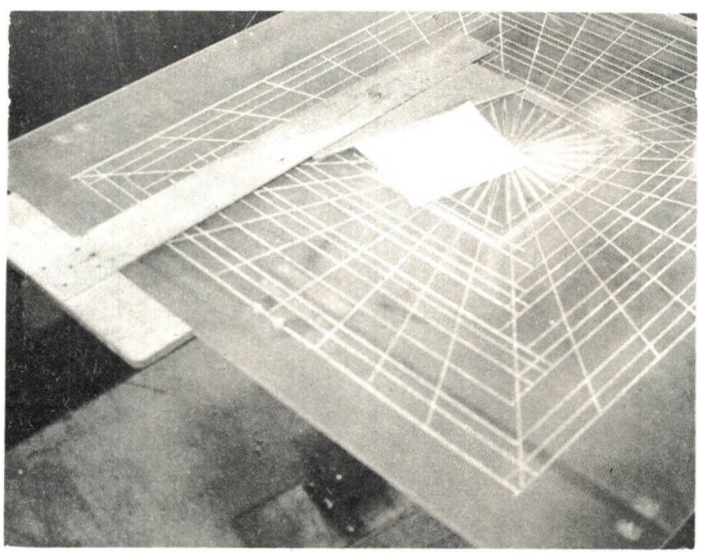


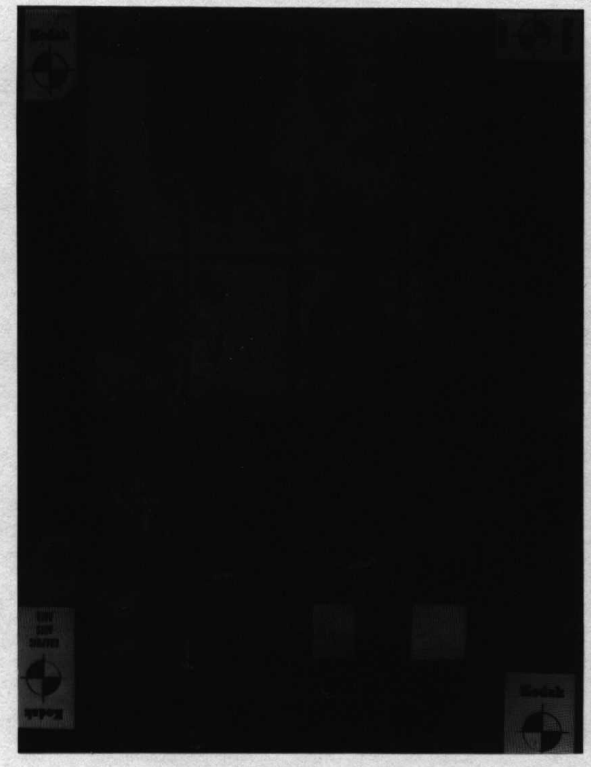
Fig. 11--The vacuum back of the process camera with tee-square and 15° triangle

necessary to hold the film in position. Fig. 11, page 25, shows the arrangement used to position the film. About 30° is needed between screen angles of each color. The set of separation halftone negatives is shown on page 27. The open areas of these negatives permit application of the respective colors. Comparison of the color-patches and the open areas of each negative indicate the method of controlling color.

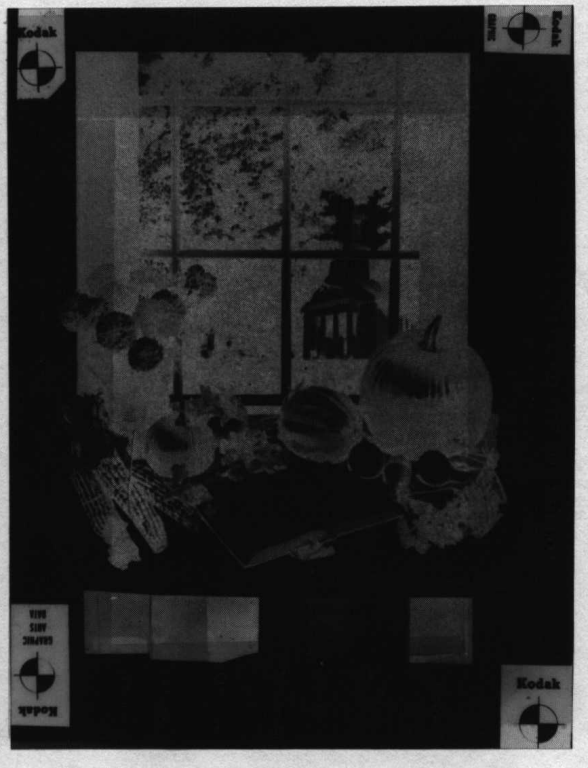
Before making printing plates, a set of "Color - Key" transparencies was made from the halftone negatives to obtain a proof of the result of color printing. These were exposed in a plastic covered frame to an arc light for about one minute. A Stouffer gray scale was used to determine correct exposure time. Registration overlay of these transparencies was made by making cross-cuts on the target lines and the sheets were assembled on two thumb-tacks which passed through the cross-cuts. The individual transparencies are shown on page 28, and the assembled set is on page 29.

Inspection of the assembled "Color-Key" proof will indicate the need for any correction in the negatives. If too much of any color is to be applied, the areas involved can be masked with opaque. If more color is needed, emulsion can be removed from the negative by scraping or by chemical reduction. Farmers reducer can be carefully applied with a brush and washed off when the desired effect is achieved. This method gives a more gradual change of color tone than by hand scraping.

Plate 1--The Halftone Negatives



Black

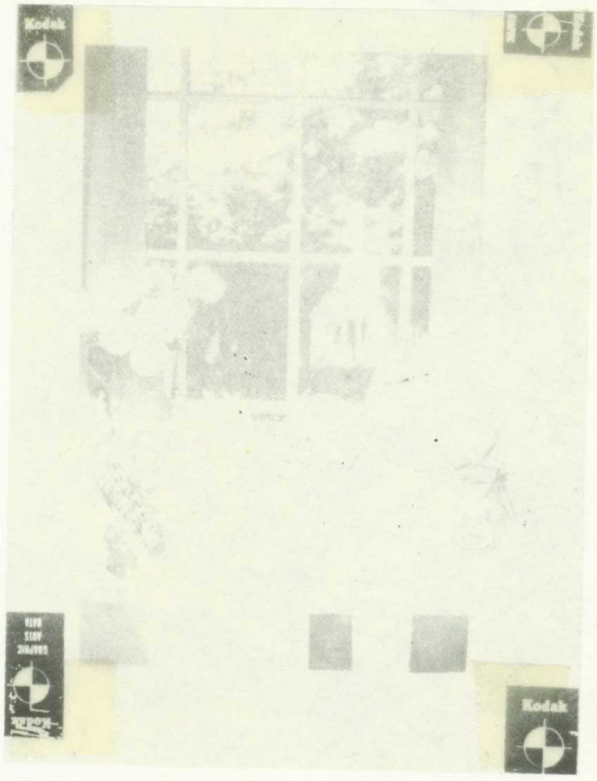


Yellow

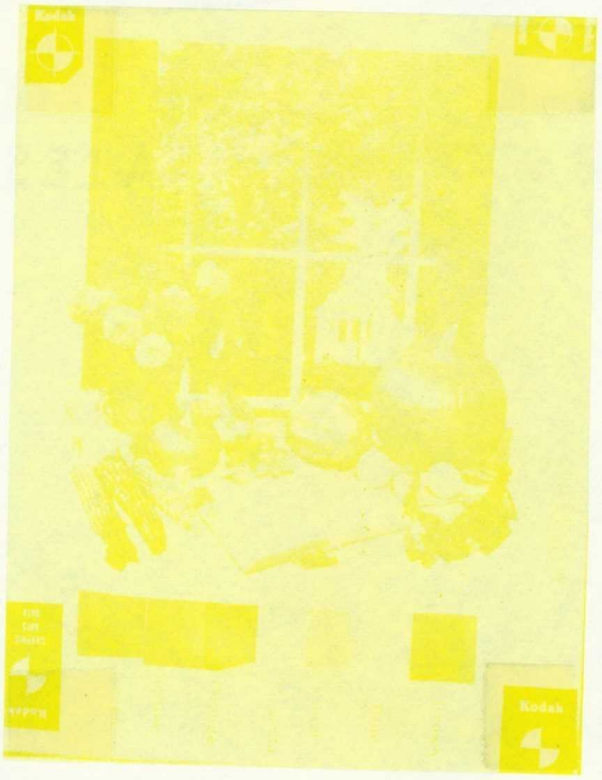
Magenta

Cyan

Plate 2--The "Color-Key" Transparencies



Black



Yellow

Magenta

Cyan

Fig. 12--"Color-Key" Assembly

The "Color-Key" assembly provides proof of the effectiveness of the color separation. The colors have been hinge-mounted so that any combination of colors may be observed. It is evident that more accurate colors are obtained with the black transparency omitted, but the actual printing specimens need the black to deepen shadow areas and to tone otherwise light color shades.

When the proofing and corrections were made, the negatives were attached to masking sheets called goldenrod. These sheets are cross-ruled and precision punched at the edge so that each will register

exactly with another. One of the sharp contrast negatives was mounted on the golden rod, and an opening was cut to expose the desired area. The next negative was lightly taped over the first in exact registration. A goldenrod sheet was placed over this assembly and the punched holes were matched. Double-coated pressure-sensitive tape was placed on the corners of the upper negative and the golden rod sheet was pressed down on it. An opening was then cut in the goldenrod to match the first. In this way the other negatives were cut and stripped. This work was done on a transparent surface lighted from beneath to facilitate matching and cutting the masks. Accuracy of this operation is very critical as the registration of one color over the other is partly controlled by this step.

The plates were prepared for printing by exposing them to photoflood light through the masked and stripped negatives. A printed line crosses the punched holes of the golden rod and the edge of the printing plate was exactly aligned with <u>one edge</u> of the printed line. One top corner of the goldenrod sheet was folded back and the registration lines were matched with the top of the printing plate. In <u>exactly</u> the same way, the other plates were registered and exposed. This is the other of the two precision steps which control the registration of the color printing.

Before the color printing was started, a plentiful supply of stock was cut. All practice and quality sheets must be exactly the same size

so that registration will be constant throughout the operation.

The ink rollers of the press were thoroughly cleaned by repeated applications of wash and conditioner. To absorb any dark ink residue, white ink was distributed over the rollers and was removed. Yellow ink will print dull and muddy unless the rolls are completely clean.

The sequence of color application is not fixed. However many printers begin with yellow and proceed through the darker colors. The changes from yellow to magenta and to cyan and black do not require such complete cleaning as for yellow. However if colors were applied in the reverse order, complete cleaning would be required after each run. Some printers prefer to print yellow after the other three color applications.

This project was printed: yellow, magenta, cyan, and black. When the yellow ink was printing normally, a comparison was made with the yellow "Color-Key". This provided a guide for color intensity. The magenta, cyan, and black "Color-Key" plates were added to the yellow print to determine how the color intensity combined with the colors to be added. When the other colors were printed, the same checking and proofing procedures were performed.

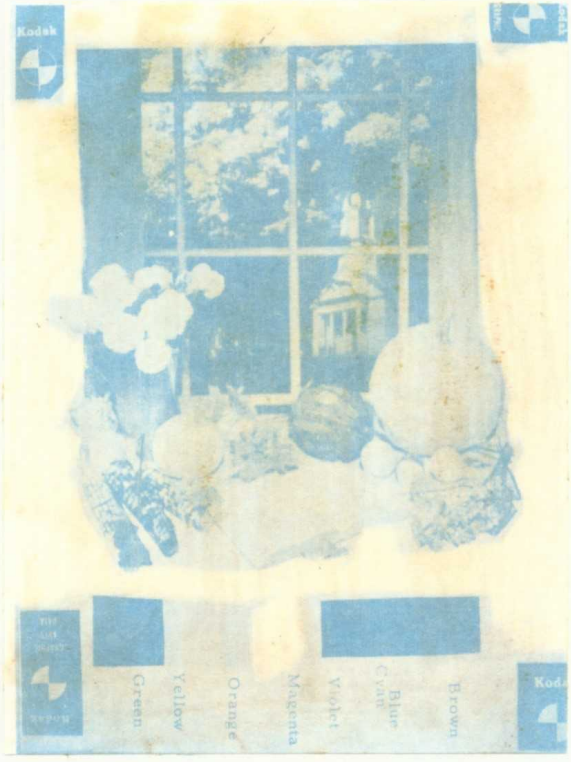
Registration targets were included in the printing for this project for illustrative purposes. A commercial project would have the targets erased from the plate after registration for each color was established.

Plate 3--The Single Color Plates

Black

Yellow

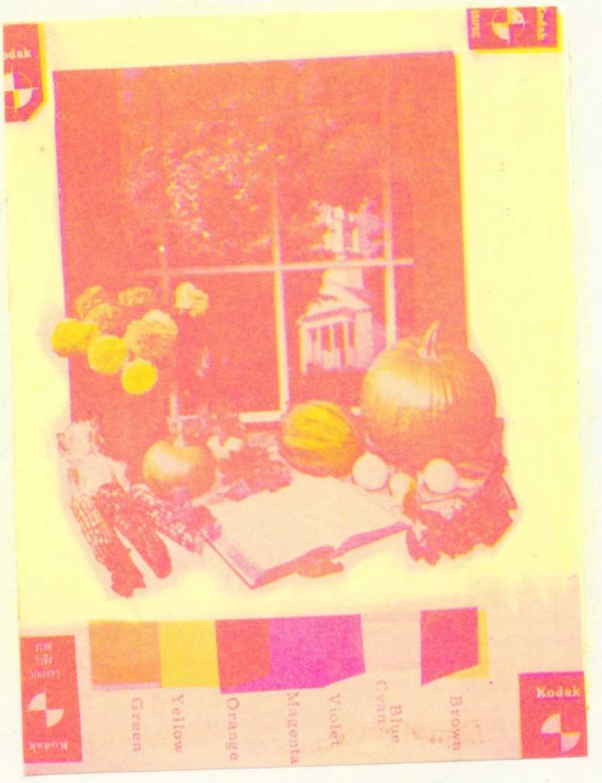
Magenta



Cyan

Plate 4--The Multiple Color Plates

Yellow



Yellow and Magenta

Yellow, Magenta and Cyan

Four Colors

The envelope (Fig. 13) contains extra "Color-Key" transparencies. The reader may register them over the prints on pages 32 and 33 to observe and to evaluate color intensities.

Fig. 13-- "Color-Key" Transparencies

The white border on the copy produced tiny halftone highlight dots on each negative. The dots were printed on the yellow plate but were erased from the other three. This is evident when the plates (p. 32) are inspected. The background of the color patch titles was not disturbed and shows how halftone highlight dots produce grey. If a pure white is desired, the halftone dots should be completely masked or removed.

CHAPTER VII

SUMMARY OF FINDINGS

Process color separation is an involved and technical operation. The ability to reproduce a colored original on an offset press utilizing any process requires much skill and technical knowledge.

The direct process is short, by comparison with other methods, but the many variable qualities in the operation require much skill and experience for success.

The indirect process has many more steps and also includes variables which affect the fidelity of the color reproduction. Only an advanced and experienced student could hope to achieve success with either of these two methods.

The Polaroid method eliminates many of the problems involved in the other processes. The Polaroid positive prints replace the first two steps of the indirect process method and eliminate the need for time-consuming and uncertain masking procedures.

The use of "Color-Key" provides proofing early in the procedure so that corrections and adjustments can be made. Progress proofs during the printing also help insure good color balance.

A dedicated high school student can learn to make process color separations by using the Polaroid method. This system has size limitations but this does not impair its effectiveness for teaching the principles of process separation. Any high school newspaper staff that produces full-color illustrations in their school paper will have a feeling of real achievement.

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