LIFE-ITEK KENNEDY ASSASSINATION FILM ANALYSIS

20 November 1967

Itek

ITEK CORPORATION LEXINGTON, MASSACHUSETTS 02173

LIFE-ITEK KENNEDY ASSASSINATION FILM ANALYSIS

20 November 1967

Itek

ITEK CORPORATION LEXINGTON, MASSACHUSETTS 02173

The photographic material used in this analysis is not reproduced in this report since permission for secondary distribution has not been received from the owners of the photographs.

CONTENTS

FIGURES

1. INTRODUCTION

Itek Corporation at the request of Life magazine has, as a public service, conducted certain investigations of the content of selected frame photographs and movie sequences taken on or about the time of the assassination of President John F. Kennedy on November 22, 1963. The photographic materials were supplied by Time Inc., and the studies performed by Itek were defined by Life and were intended to augment those undertaken by staff members of Life magazine.

The movie sequences analyzed did not include the film taken by Orville O. Nix, although collateral information was drawn from Itek's Nix film analysis report where pertinent. The Nix film, property of United Press International, was analyzed by Itek early in 1967 and was reported on in the document "Nix Film Analysis," dated 18 May 1967. ?

1.1 PHOTOGRAPHIC AND REFERENCE MATERIALS

The photographic materials supplied by Time Inc. are as follows:

1. Original 8-millimeter color movie taken by Robert J. E. Hughes. This film is reported to have been exposed approximately 10 minutes before the assassination. The sequence studied shows the Texas School Book Depository building. ?

2. Original 8-millimeter color movie taken by Mr. Bell. The sequence studied also shows the Texas School Book Depository building, but this film was exposed a considerable time after the assassination. The film was employed as a "fixed" data reference (see task D, subtask b).

3. Original size 127 black and white negative taken by Hugh W. Betzner, Jr. This photograph shows the Presidential limousine and background data just prior to the assassination. ?

4. Original 35-millimeter color transparency taken by Philip L. Willis. This picture, referred to as Willis no. 5, was taken just prior to the assassination and generally shows the same scene as Betzner's photograph. ?

5. A 35-millimeter color transparency enlargement of frame 188 from the 8-millimeter movie taken by Abraham Zapruder. The frame shows the Presidential limousine with photographers Willis and Betzner in the background. ?

6. Original 35-millimeter color transparency taken by W. Bond. This frame shows the "grassy knoll" after the assassination. The grassy knoll is located adjacent to Pergola 2 (see Fig. 2-2).

7. A duplicate of a black and white Polaroid print taken by Mary Moorman. This print shows the limousine immediately after point 313 (the frame number on the ? Zapruder film which shows the impact of the fatal bullet) (see Fig. 2-2).

8. A black and white enlarged duplicate of a 35-millimeter color transparency taken by P. L. Willis. This picture, referred to as Willis no. 6, shows the motorcade on Elm Street after the assassination.

? 9. Two original 35-millimeter black and white film strips taken by Thomas Dillard. The strips include narrow angle and wide angle scenes of the Texas School Book Depository immediately after the assassination.

Other materials used in Itek's study included:

? • A copy of the Warren Commission Dealey Plaza map
• Miscellaneous copies and enlargements of the above mentioned photographic materials
? • Selected copies of Warren Commission photographic exhibits.

1.2 STUDY OBJECTIVES

The study consisted of four major tasks, the last of which was divided into subtasks.

1. Task A—Investigate a "facelike" image above the fence and wall at the top of the grassy knoll.

Background. A tonal change resembling the head and neck of a person appears approximately 15 feet north of the southeast corner of the picket fence on the grassy knoll. The same image appears on five different photographic records analyzed. The study was started under the assumption that the "facelike" object might be located immediately behind the wall, between the wall and the fence, or behind the fence.

? 2. Task B— Determine which frame, the Betzner (127 black and white) or the Willis no. 5 (35-millimeter color), was exposed first.

Background. Both Willis and Betzner were located on the southwest corner of Houston Street and Elm Street. The Zapruder frame shows both photographers and ? the Presidential car at approximately the time that they took the pictures being analyzed.

3. Task C—Determine position versus time of the "person" appearing at the south end of the wall (on the grassy knoll) on the Betzner and Willis no. 5 images.

Background. In the Willis and Betzner pictures analyzed in task B a "person" in | dark clothing can be seen at the south end of the wall on the knoll. The "person" can only be seen above the wall, indicating that he is probably on the upper landing of the ? steps between the wall and the fence. The location of this "person" at the time the Presidential car was at point 313 is of interest.

4. Task D—Determine what can be observed and measured at the sixth floor window of the Texas School Book Depository building. This task was divided into subtasks as follows:

   a. Time lapse viewing of Hughes and Bell images under high magnification ?

   b. Stereo viewing of Hughes and Bell images

   c. Three-image photointegration of Hughes and Bell images

   d. Visual integration of Hughes and Bell images

   e. Dodging and low gamma processing of Dillard photographs of Texas School Book Depository building

   f. Improved print of Hughes frame

   g. Photogrammetric analysis of Dillard image. ?

Background. Films of the motorcade when it was still on Houston Street show periodic sequences of the Texas School Book Depository building. Films taken of the building immediately after the assassination provide collateral data. Combinations of these images plus advanced photographic techniques might bring out additional information on occurrences at the sixth floor window and in its immediate vicinity. ?

2. MATERIAL PREPARATION, IMAGE ANALYSIS, AND CONCLUSIONS

2.1 TASK A

Task A involved the investigation of the "facelike" image appearing above the fence and the wall at the top of the grassy knoll. The Moorman photograph shows the image of interest. Fig. 2-1, a photograph taken in 1967, shows the same area for reference purposes. The photographic materials* used in this study (identified by their respective photographers) were Moorman, Bond, Willis no. 5, Willis no. 6, Betzner, and Hughes. The Hughes movie, primarily intended for study of the Texas School Book Depository building, showed in its later sequences the grassy knoll area and therefore was used in task A.

For this task, all but the Moorman and Hughes pictures were enlarged and printed as black and white transparencies to enable direct tonal comparison of the image in question. In all photographic duplication, the materials were processed with low gamma techniques and Itek G-4 chemistry. Appendix A contains a discussion of this procedure and its purpose.

In all but the Betzner picture, the "facelike" image was observed. (In the Betzner picture, the image was obscured by a tree and a road sign.) It was analyzed for tonal and shape similarity in the remaining five records and measured for comparative size and distance from the end of the fence. Measurements of distances confirmed the same location of the image in all five photographs. After corrections for distance variations created by camera perspective angle, the measurements of image location correlated to within 5 to 8 percent.

Conclusions

In the Moorman picture, the "facelike" image could be interpreted as being behind the wall. Two analysis factors refute this observation: (1) The apparent size of the object scaled to known dimensions resulted in a top to bottom head size of 5 inches (obviously too small for an adult human). (2) The remaining frames analyzed show the object only above the picket fence.

*Materials are listed in order of pertinence.

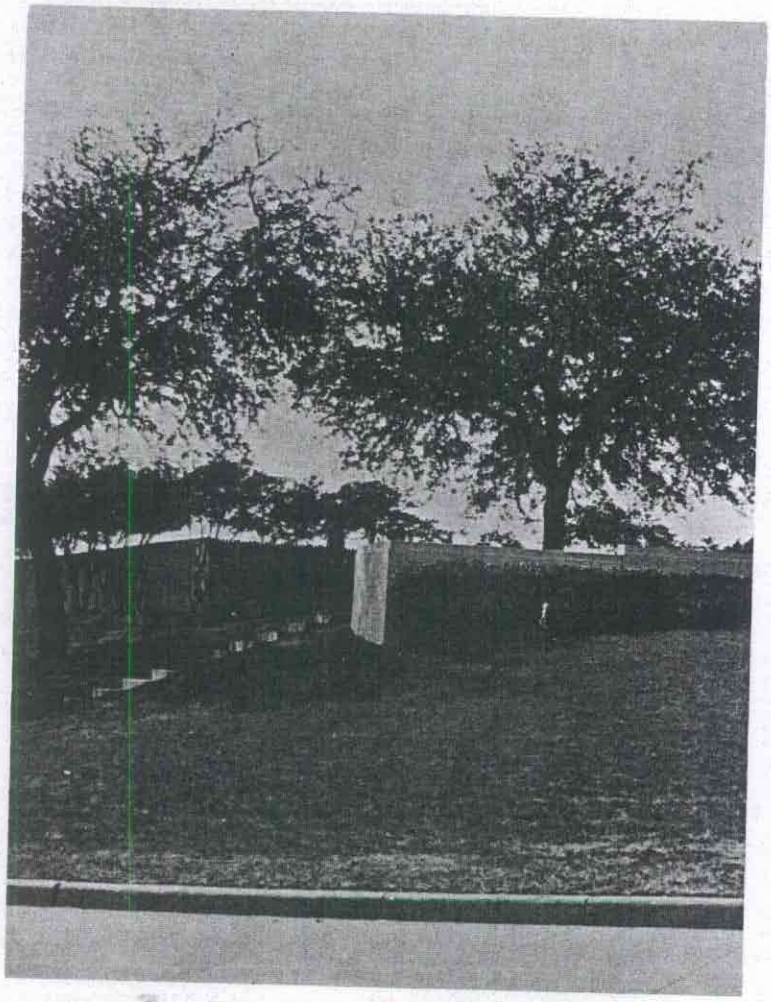


Fig. 2-1 — Ground photograph of grassy knoll

angle ?

The Bond picture clearly shows the object to be a shrub separation with no "body" between the object and the top of the picket fence. Autos in the parking area behind the fence can be seen between the top of the fence and the lower edge of the shrubs at the location of the object.

2.2 TASK B

The objective of task B was to determine which frame, the Betzner (127 black and white) or the Willis no. 5 (35-millimeter color), was exposed first. The materials used in the study were Betzner, Willis no. 5, Zapruder 188, and the Dealey Plaza map.

A duplicate negative of each of the frames under study was produced, using phosphor quench dodging and low gamma processing. Enlarged paper prints were produced to permit graphic resection and feature plotting. (Dodging and low gamma processing are explained in Appendix A.)

Through graphic resection, the photographers' positions, the principal axes of the cameras, and the positions of the Presidential limousine were determined and plotted on a map overlay (see Fig. 2-2). Through photographic analysis the position of the car with respect to lane lines and tree shadow was used to confirm general exposure time sequencing.

?

Conclusions

The location of the Presidential limousine in the resected Betzner picture and in the resected Willis picture showed that Betzner exposed first and Willis exposed when the car was approximately 5 feet farther along Elm Street. Assuming an approximate average vehicle speed of 16.4 feet per second, this would correspond to 0.3 second. The sequencing was verified by location of the car with respect to lane lines and with respect to a tree shadow (tree located approximately 90 feet from the corner of Houston and Elm Streets) barely discernible in the foreground of both pictures.

! on map!

2.3 TASK C

The objective of task C was to determine position versus time of the "person" appearing at the south end of the wall (on the grassy knoll) on the Betzner and Willis no. 5 images.

Because of the chronological sequence of the event being analyzed, collateral information and imagery from the Itek study of the UPI owned Nix film was employed in this task. This film provided key reference data near the assassination point (point 313). Materials used for the study were (1) before point 313, Betzner and Willis no. 5, (2) at point 313, the Moorman film and the Nix study, and (3) after point 313, Willis no. 6, Hughes, Bond, Bell, and the Nix study.

No special photographic operations were required, since materials prepared for the previous tasks were used. Optical screening and viewing equipment was matched to the particular image being analyzed.

Stereophotogrammetric viewing and measurement of the Betzner and Willis no. 5 images verified that the size of the "person" is commensurate with that of an adult human. Scale factors for this conclusion were based on physically measured values

Not W.C.
Not complete
(no TSBD)
But, 1st before 210!
No lane lines (see p6)

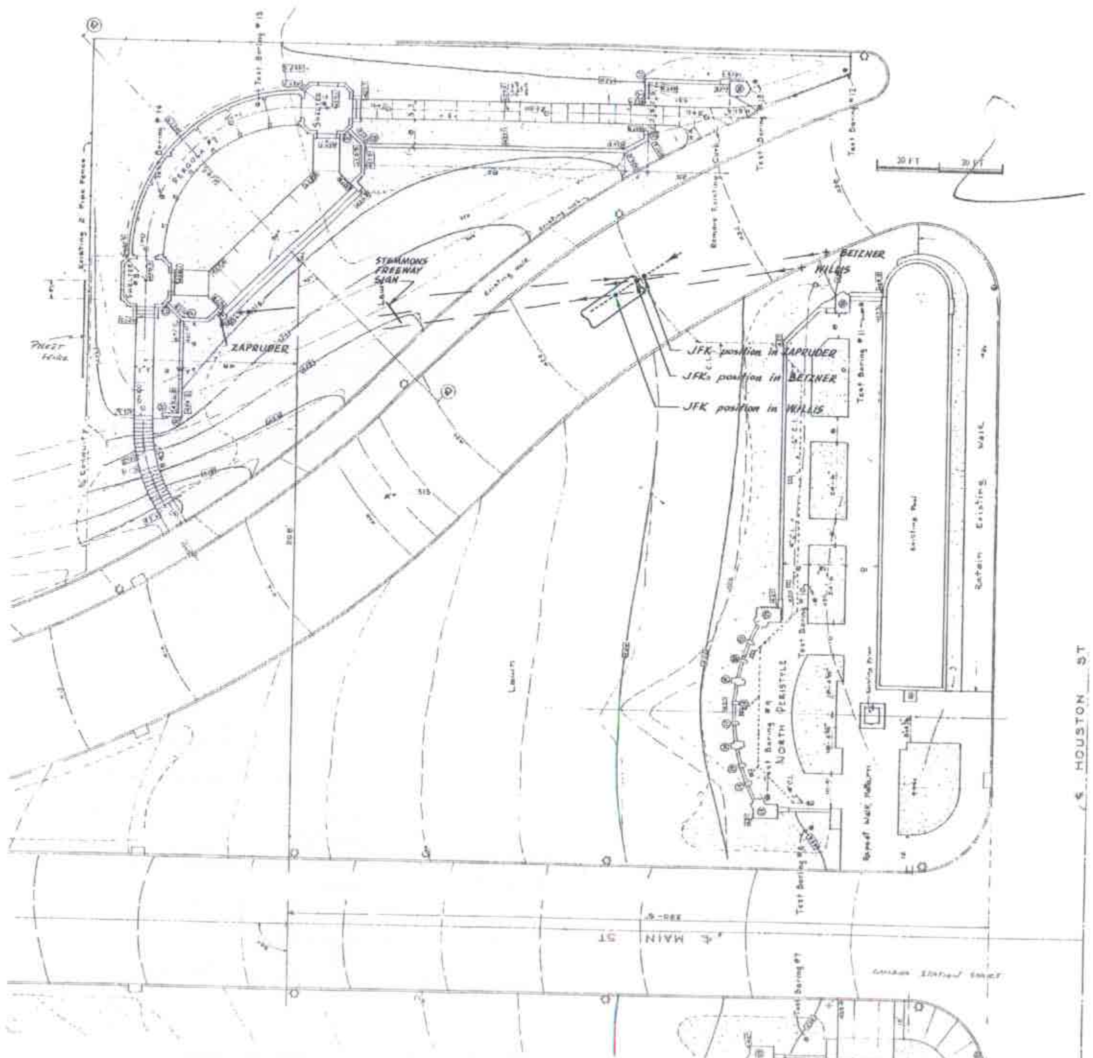


Fig. 2-2 — Map of Dealey Plaza showing photographers' positions and position of limousine in each film of the height of the wall and distance from ground level at the upper landing to the top of the wall at the south end. The stereoscopic base provided by the distance between photographers Betzner and Willis was sufficient to determine that the "person" is immediately behind the wall. The instrument used for stereo viewing and measurement was a Wild ST-3 stereoscope with stereometer.

Analysis of the other imagery was aided by high magnification binocular viewers and film screening devices. The photographic analysis of the location of the "person" was correlated with the relative time interval between exposures.

Conclusions

Measurement of the size of the "person" on the Betzner and Willis no. 5 images verified that it could be an adult person. These photographs were taken when the limousine was approximately 100 feet from point 313. At point 313 the edge of the Moorman picture cuts through the group of persons on the steps, showing only one of the group. The Nix frames immediately after point 313 show a dark clothed man running up the steps away from the motorcade. Films after point 313 provide no clear indication of where the "person" is located.

Photographic evidence indicates that the "person" appearing in the Willis no. 5 and Betzner pictures joined two other persons on the steps by the time the car was at point 313. Since the distance the car traveled was approximately 100 feet between the early pictures at point 313, the "person" would have had from 6 to 7 seconds to walk approximately 20 feet.

2.4 TASK D

The object of task D was to determine what could be observed and measured at the sixth floor window of the Texas School Book Depository building. The photographic materials used in this task were Hughes, Bell, Dillard, and miscellaneous contact prints of pertinent Warren Report pictures.

Both the Hughes and Bell films were contact duplicated using phosphor quench dodging and low gamma processing techniques. The Dillard strip was dodged, duplicated, and processed in the same way.

Selected frames of the Hughes and Bell films were color separated. The procedure and purpose of color separation are explained in Appendix A.

Three successive frames from each of the Hughes and Bell films were integrated (referenced to the sixth floor window) photographically on the Itek ACVP (see Appendix A).

The duplicate films and the Dillard strip were photographically enlarged for some of the analyses.

The image, grain structure, and film base of the Dillard picture (Warren Commission Dillard Exhibit C) were analyzed under very high magnification for possible imperfections.

Subtask a—Time Lapse Viewing of Hughes and Bell Images Under High Magnification. The sixth floor window was repeatedly viewed on the Hughes (before assassination) film. Note was made of the tone and shape of the object(s) and changes thereof appearing in the window. This procedure was repeated on the Bell film.

Subtask b—Stereo Viewing of Hughes and Bell Images. Hughes took his film from a point on Houston Street at road level. Bell took his film from an elevated position adjacent to Houston Street near the Hughes location. The images of the window were brought to the same scale and viewed stereoscopically with a vertical stereo base.

Subtask c—Three-Image Photographic Integration of Hughes and Bell Images. These images were used to repeat subtasks a and b. The resulting imagery was of higher contrast, but no additional information was found.

Subtask d—Visual Integration. This technique was used primarily in the stereo viewing and provided a high resolution stereo view. Two successive frames of the Hughes film were overlayed and placed in one stereo channel, and two successive frames of the Bell film were overlayed and placed in the second stereo channel. A definite improvement in contrast and depth perception resulted.

Subtask e—Dodging and Low Gamma Processing of Dillard Exhibit C. (Closeup of Texas School Book Depository, sixth floor.) Additional information was brought out and analyzed. A pattern of highlight tonal features resembling a face can be observed slightly above and to the right of a box on the windowsill.

Subtask f—Improved Color Print of Highes Film. The new print showed features (boxes, etc.) not visible in the original copy print.

Subtask g—Photogrammetric Analysis of Dillard Exhibit C. After careful photogrammetric analysis, which took into account the photographer's location, camera perspective, scale relations, and window and room dimensions, it was determined that the "facelike" pattern was too small by a factor of two to be a face located along the camera line of sight and still be located in the sixth floor room. The imaged pattern was consistent with patterns on an open box of books located directly behind the point determined to be the assassin's location (see Fig. 2-3).

Conclusions

Subtask a. A rectangular shape with the long dimension vertical can be seen (on both the Hughes and Bell images) slightly to the right of center in the half open, right-hand window of the Texas School Book Depository building. In the Hughes sequence, the shape appears to change in size as the car approaches the corner of Houston and Elm Streets. It seems to decrease in size from left to right and from top to bottom.

Subtask b. The rectangular shape is definitely recessed from the window and would appear to be a stack of boxes. No parallax measurement was made owing to the lack of the necessary numerical data.

Subtasks c and d. The results of these subtasks supported observations in subtasks a and b.

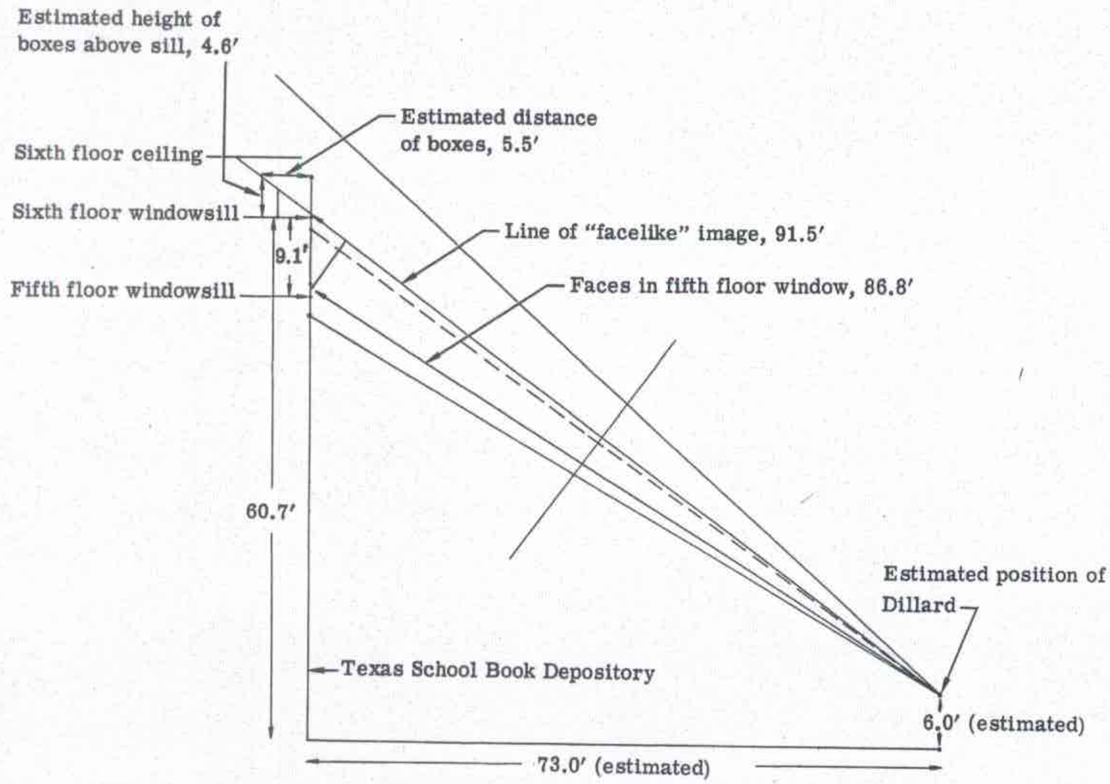


Fig. 2-3 — Geometry of Dillard Exhibit C

Subtask e. Physical analysis of the Dillard film showed a blemish in the base material near the point of the "facelike" pattern. This blemish was considered too small (5 to 6 microns) to cause the pattern.

Subtasks f and g. The results of these subtasks are discussed above.

Appendix A

MATERIAL PREPARATION

PHOSPHOR QUENCH DODGING

This approach entails the use of a quenchable phosphor printing technique by means of which duplicates of very low contrast can be produced from a high contrast original negative while actually increasing the detail contrast, so that details previously difficult to discern with the human eye become more readily discernible.

What in a pictorial photograph is merely a lack of aesthetic quality due to poor contrast becomes a serious matter of information content in specialized photography for photointerpretation. Hence, it was necessary to provide some means of contrast control when producing the prints for analysis. The techniques available for this are:

1. Variable contrast papers
2. Hand dodging
3. Manual dodging printers
4. Unsharp mask techniques
5. Electronic dodging (flying-spot cathode ray)
   - Velocity modulation
   - Intensity modulation
6. Quenchable phosphor dodging
7. Photochromic or phototropic masking films.

The use of various contrast grades of photographic paper effectively compresses the negative tone range to that of the printing paper, but only at the expense of detail contrast, and usually with a notable loss of detail near the ends of the tone range. Masking processes, widely used in the graphic arts field, overcome some of these difficulties. Most important is the difference between contrast control through the use of varying contrast grades of paper as compared to the various other employable techniques, which not only reduce gross contrast but actually improve detail contrast. The obvious difference between the use of varying paper grades and the use of masking of any sort is basically that through the use of the mask, the printing light is modulated. All efficient contrast control systems depend on control of this modulation in one form or another.

The task at hand required that the utmost in image detail and detail contrast be maintained, and in fact enhanced as much as possible. The small 8-millimeter frame dimensions of the Hughes and Bell films eliminated the first four processes immediately. The large number of individual frames, plus the very small detail areas, limited the application of an electronic dodging technique. The photochromic approach, owing to spectral considerations, does not lend itself to printing from color transparencies, and is a slow and awkward process. The only usable technique was quenchable phosphor dodging, a technique for which equipment and experienced personnel were readily available. The phosphor presents dodging increments of extremely small size, and when used properly, this technique can compress the characteristic curve to a very high degree while actually increasing the detail contrast. Also, phosphor quench equipment could reproduce with minimum time and effort the large number of frames required.

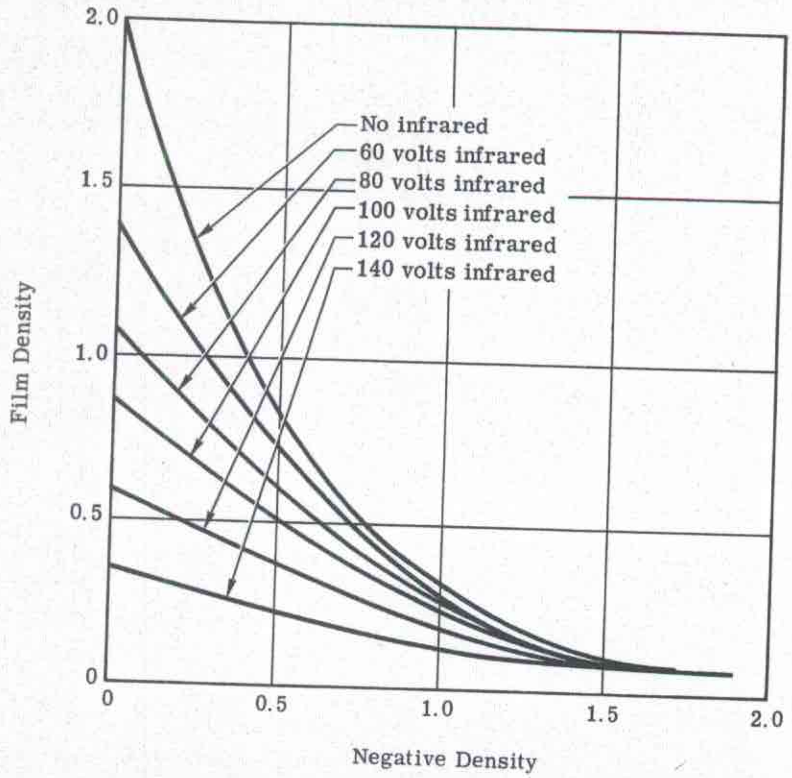
In the contact printing mode, as used in this particular task, the phosphor quench printer consists of an ultraviolet light source which excites a fluorescent screen coated with an infrared quenching type phosphor. The screen emits a blue light to which the photographic emulsion is sensitive. The brightness of this screen is varied by the quenching action of infrared light, the quenching being greatest in areas where the negative is least dense. The screen thus emits a modulated blue light as though an unsharp mask had been inserted between the film and the screen.

The effect of this system is to make all prints, regardless of shadow and highlight variations, appear to have received optimum exposure in every area. As described, the quenchable phosphor printer achieves this by automatically making the exposure brightest under the most dense areas of the negative, and dimmest under the thinnest negative areas. Thus, densities are controlled and printed out in those ranges where the human eye is most sensitive to small gradients, and imagery otherwise hidden in shadow or highlight is made plainly visible in the positives or negatives produced.

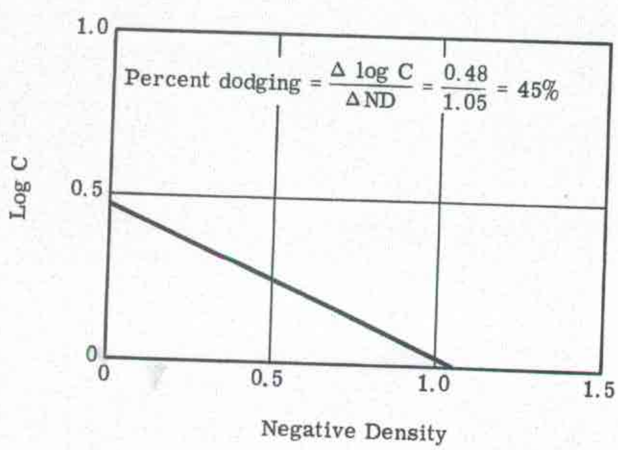
The principal advantage of the quenchable phosphor is that its actual dodging increment is infinitesimal. The dodging area can well be defined as the size of the actual grains that make up the phosphor, proportional to their separation from the negative. This, in effect, means an infinite number of light sources for incremental dodging, with automatic control of the intensity of each minute source by use of the negative as the modulating medium.

Figs. A-1 and A-2 present actual plots displaying the effect on both photographic film and paper as the amount of infrared light applied to the phosphor is varied. The power supply to the ultraviolet lamp was kept constant at 120 volts, maintaining an even level of excitation.

A great deal of contrast control is available through variations in voltage of both the ultraviolet and infrared power sources. The effect of the quenching light can readily be seen in Figs. A-1 and A-2. For example, if a film which produces a maximum density of 2.0 without the application of infrared is exposed to a maximum input of infrared, the density drops to approximately 0.37. This represents a drop in the density scale from approximately 180 to 1 to about 3 to 1. In practice, this much compression

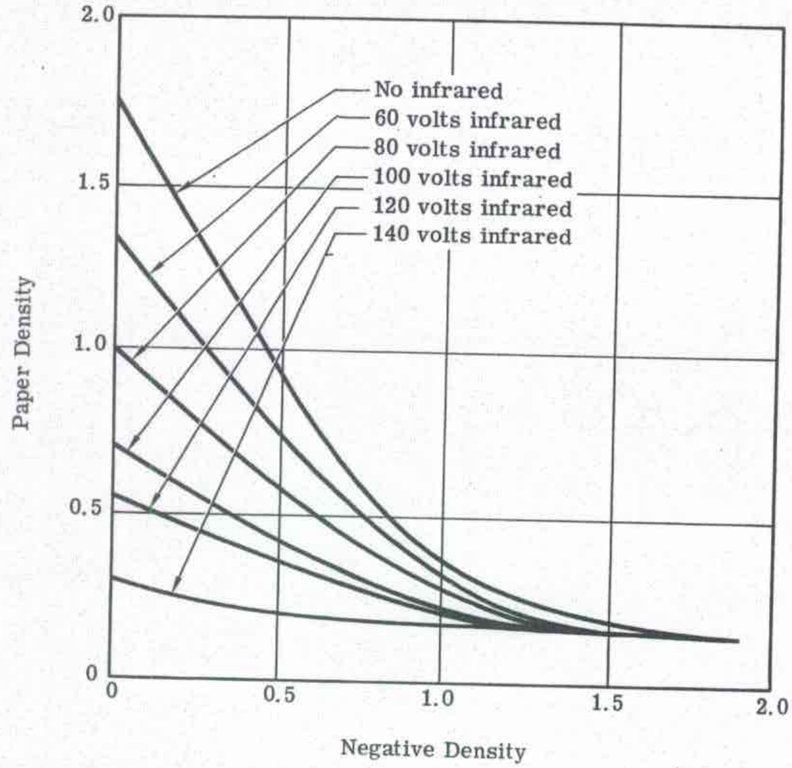


(a) Film density versus negative density

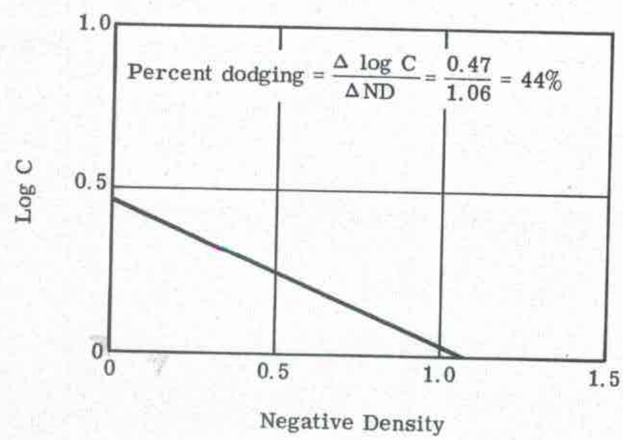


(b) Percent dodging

Fig. A-1 — Infrared phosphor quench on film (exposure time 1.5 seconds; Wratten 2A filter; maximum ultraviolet, three transformers; infrared source four 500-watt Quartzline lamps; ultraviolet source 5 by 7 Aristo Grid FUV lamp)



(a) Paper density versus film density



(b) Percent dodging

Fig. A-2 — Infrared phosphor quench on paper, contact mode (conditions same as in Fig. A-1) is rarely used, but the curves illustrate the ability of the quenchable phosphor technique to produce any desired contrast simply by applying the proper voltage to the infrared source.

In each of the curves, processing was simultaneous for all strips plotted. No effort was made to accentuate the effects of the process. Both film and papers received development as recommended by the manufacturer.

Fig. A-3 is an illustration of an aerial photograph before and after dodging with the phosphor quench technique.

In the task at hand, with a given input (original density scale) of approximately 0.25 to 1.90, or a range of about 140 to 1, the scale of the first-generation negatives from the Hughes and Bell films produced a minimum density of 0.34, and a maximum of 0.64, a difference of 0.30, or a contrast differential of 2 to 1. This compression was in excess of that required for successive generations of printing, and the negatives produced by moderate application of infrared were found most suitable for analysis. These exhibited a contrast difference of about 4 to 1.

Several tests were initiated, working from the original film, to determine optimum exposure and processing, as well as optimum balance between the ultraviolet and the infrared. Several sets of first-generation duplicates were produced, one with a moderate degree of dodging and the other with a maximum amount, printing only for areas of minimal density. For all practical purposes, the moderate dodging produced the optimum imagery for subsequent investigation.

To ensure that the actual image detail being produced through each stage in printing displayed a minimum of loss, resolution test patterns were printed and processed together with the actual imagery. The resolution level obtained with the quenchable phosphor system was approximately 102 lines per millimeter, far in excess of the resolution of the original camera-film combination.

LOW GAMMA PROCESSING

This processing technique expands the visual information in a photograph and enhances information in highlight (bright) and shadow (dark) areas of the image.

The process gamma of Kodachrome film is ordinarily close to 2.5, which produces satisfactory imagery for home viewing but limits its useful exposure latitude. For this task, it obviously was necessary to reproduce and improve image detail in sections of the original photography which were in rather deep shadow. The subsequent generations of printing, from the original, were held to quite low gammas, with none exceeding 1.0. The object was not to truly reproduce any particular tonal scale, but rather to yield the utmost in image detail, based entirely on visual inspection.

Sensitometric curves for the low gamma process are shown in Fig. A-4.

COLOR SEPARATION PRINTING

Color film consists of three layers, each sensitive to a different color. By means of selective filtration, the image content in each of these discrete layers of the original

Fig. A-3 — Illustration of dodged photography

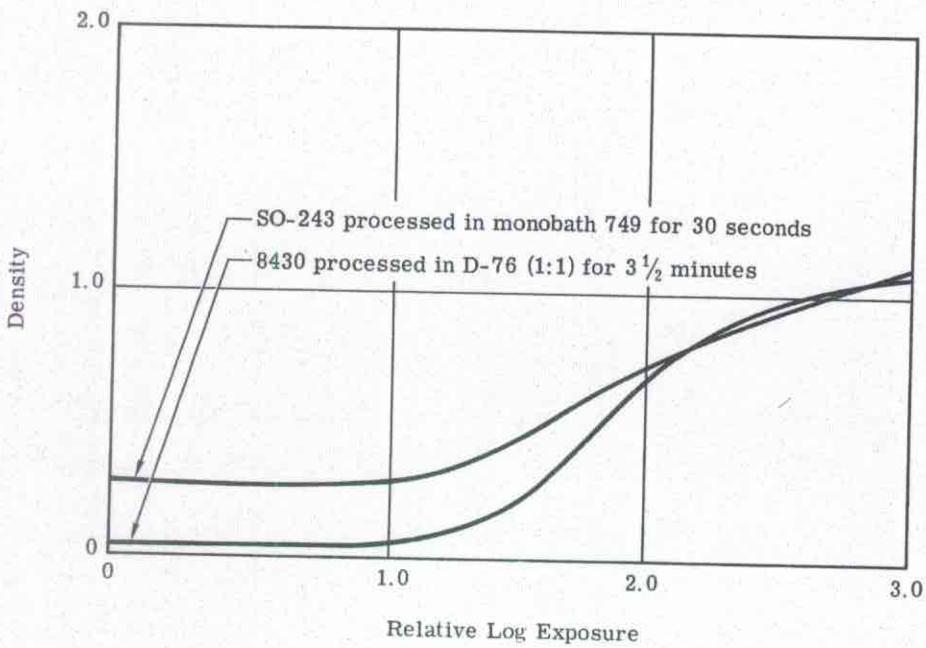


Fig. A-4 — Sensitometric curves for low gamma process color material was separated. Thus each layer became a potential source of information.

Kodachrome film is what is termed a "tripack" film, i.e., it is composed of three superimposed emulsion layers, the top one being dyed yellow, the middle one dyed magenta, and the bottom one (next to the support) dyed cyan (blue-green). The technique of color separation revolves about the ability to produce, by means of selective filtration, black and white film negatives which contain the information inherent in the original color positive. It is important that these separation negatives be in "balance" insofar as density and scale of contrast are concerned. This is ordinarily accomplished through the use of a gray scale at the time of exposure, with variations in processing times employed to achieve a constant gradient.

To produce the records used for analysis, Wratten 29 (red), 61 (green), and 47B (blue) filters were used over the light source. The film used, SO-243, is panchromatic and can "see" these three colors. The exposures were made with the films held in intimate contact by means of a vacuum frame. The films so produced represent records, each complementary to the colors in the original film, i.e., blue-green (cyan), magenta, and yellow.

The first-generation negatives, as printed from the original Kodachrome film, were processed in a special high definition, fine grain developer formulation to a gamma of 1.1. This nearly constant processing gradient eliminated the need for compensation in development to match gradients.

The exposure through the three filters was varied from 0.2 second to 4 minutes and 20 seconds to produce similar density.

Fig. A-5 is a diagram of the color separation printing technique. Fig. A-6 illustrates the color separation spectral sensitivity curves, and Figs. A-7 and A-8 are the color separation exposure curves for two test series.

CHEMISTRY AND FILMS

In each of the techniques applied, the chemistry and film utilized are generally not well known. The first-generation duplicates produced by each of the techniques described were exposed onto SO-243 film, a special high definition aerial film which is fully panchromatic (with extended red sensitivity) and possesses a resolution capability far in excess of the requirements of this particular task. The first-generation negatives, made by means of the phosphor quench system, were processed in an Itek monobath, which in the case of SO-243 film develops to completion in approximately 30 seconds and produces a constant gamma of 0.55. Subsequent printings of these films were made on type 8430 duplicating film, processed to low gammas by conventional methods using such developers as DK-50 and D-76.

IMAGE ENLARGEMENT

Conventional high quality enlarging equipment was used to produce the film and paper positives required for subsequent analysis. The lenses used in each application were Schneider Componons of proper focal length, used entirely with properly assembled

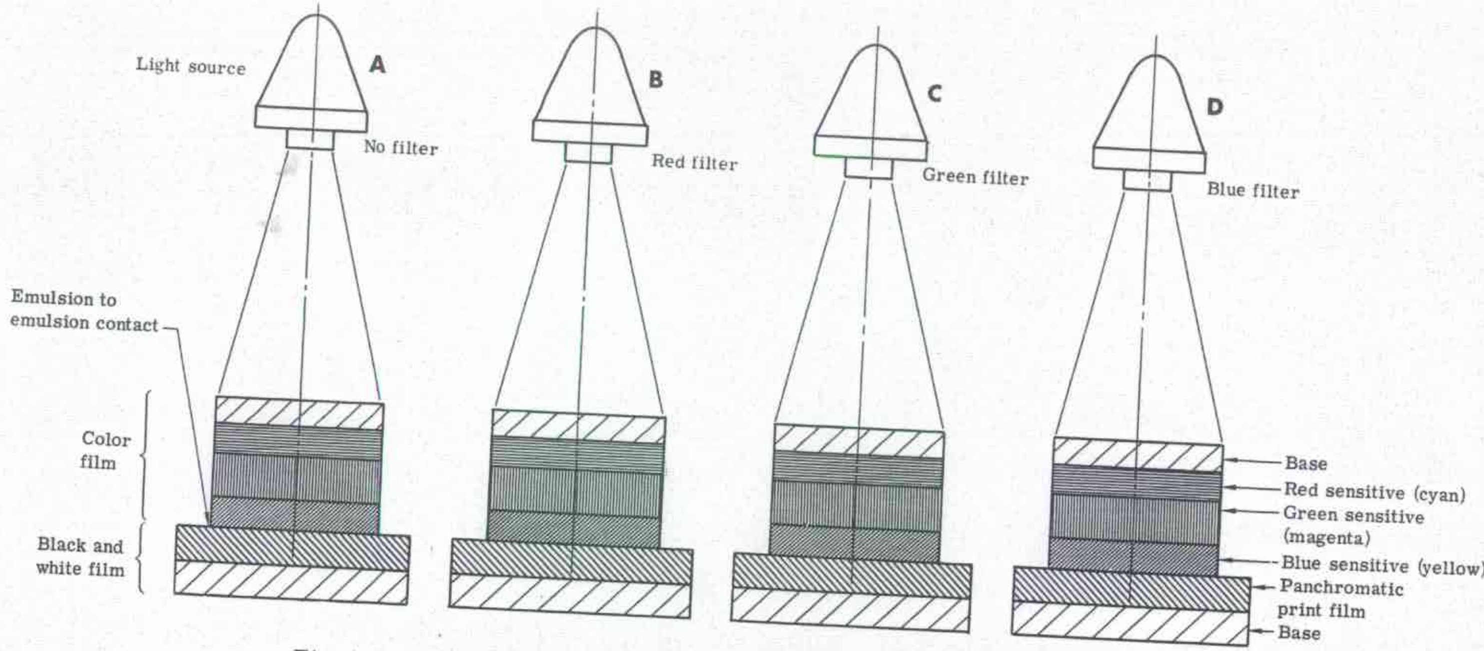


Fig. A-5 — Color separation printing diagram. (A) White light exposure—absorbs no color, transmits full image content in terms of black, white, and grays. (B) Red light exposure—absorbs blue and green, transmits red contributions to image. (C) Green light exposure—absorbs red and blue, transmits green contribution to image. (D) Blue light exposure—absorbs red and green, transmits blue contribution to image.

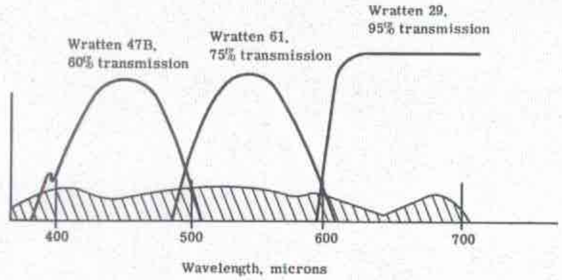


Fig. A-6 — Color separation spectral sensitivity curves with SO-243 film

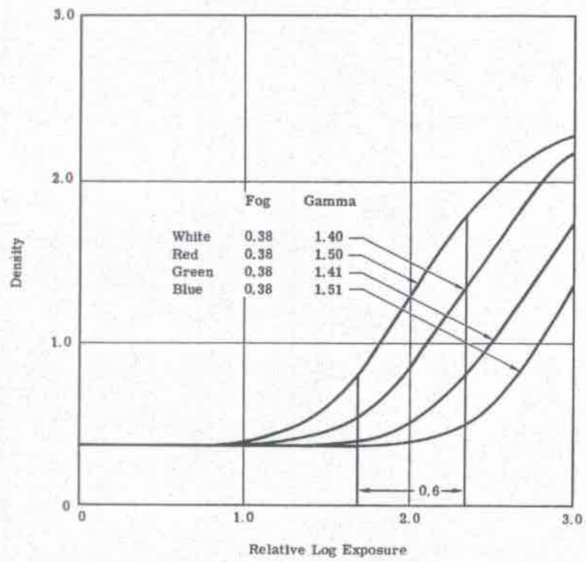


Fig. A-7 — Color separation exposure curves — test 1

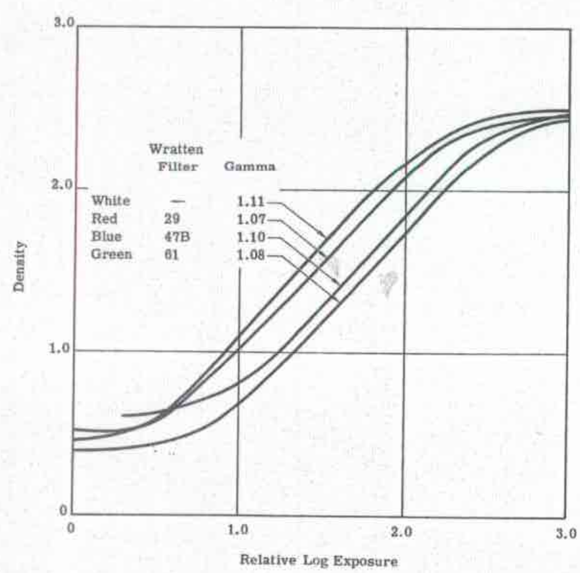


Fig. A-8 — Color separation exposure curves — test 2 condenser systems. Positives were selected on the basis of their appearance and usefulness for image content, owing to the resolution of the original film.

ACVP INTEGRATION

The additive color viewer-printer (ACVP) is a printing device that can integrate four separate films to produce a single print. This integration technique minimizes the grain characteristics and random features of each of the single film inputs, yet accentuates edge characteristics to produce improved imagery. Improved photographs produced by the quenchable phosphor dodging and the color separation techniques described above were printed in this manner.

The practice of superimposing imagery to obtain a higher information output is well established, having been investigated or used by Hickman[1] in 1926, the Lowell Observatory in Arizona in 1927, Blair and Stanton[2] in 1939, Stevens[3] in 1947, Quinn[4] in 1959, and Kohler[5] in 1961.

The purpose of integrating various frames was to determine if a composite of detail, grain pattern, and edges would yield any increase in information content. Such instantaneous superimposition of imagery has the theoretical effect of averaging grain distribution, strengthening edges, and increasing threshold density information.

The instrument used in integrating the frames was the Itek-developed ACVP shown in Fig. A-9. The optical principle of this unit is illustrated in Fig. A-10.

REFERENCES

1. Hickman, K. C. D., J. Soc. Motion Picture Eng., 10, 49 (1926).
2. Blair and Stanton, American Photography, 33, 361 (1939).
3. Stevens, G. W., The Effect of Diffusion of Graininess and Resolution Obtained From Processed Negatives, Photographic Journal, 87B, 74-80 (1947).
4. Quinn, B., Photographic Graininess Reduction by Superimposition, M. A. Thesis, Boston University, 1959.
5. Kohler, R. J., Photographic Image Enhancement Through Superimposition of Multiple Images, Itek Corporation Report, Nov 1961.

Fig. A-9 — Additive color viewer-printer

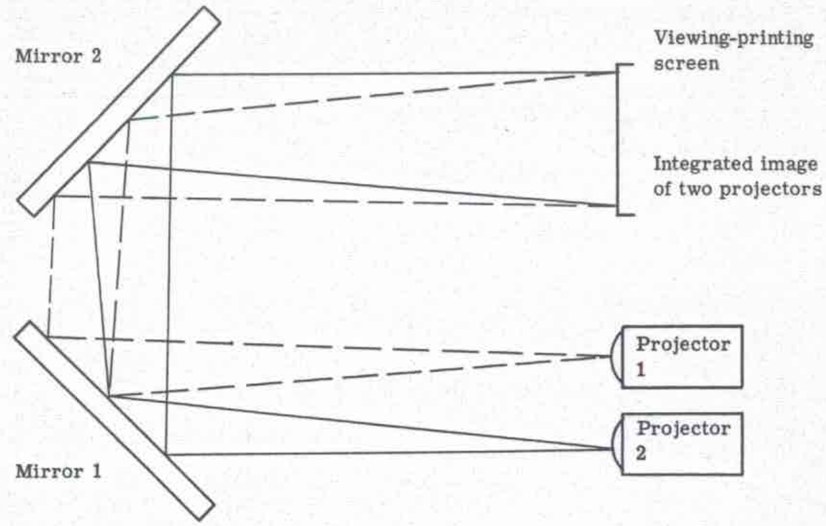


Fig. A-10 — Diagram of integrating optical projection system showing basic geometry (only two projectors are shown for simplicity)