Key to Authors
Color Code
Kodak - Black
Swedlund - Red
Ctein - Green
Brokaw - Blue
Pace - Magenta

Table of Contents

DYE TRANSFER TECHNIQUES

Written and edited for Kodak by Frank N. Mc Laughlin with articles by Dennis Brokaw, Ctein, Bob Pace and Charles Swedlund.

Dye Transfer Techniques

Kodak Publication No. E-81

Written and Edited by Frank N. Mc Laughlin

Articles

Making In-Camera Separations, by Charles Swedlund

Matrices from Color Negatives, by Ctein

Large-Format Separations for Dye Transfer Printing, by Dennis Brokaw

Professional Methods for Making Dye Transfer Prints, by Bob Pace

Associate Editor: Joan C. Matochik

Book Design: Dan Marciano

Staff Photographer: Edgar Praus

Cover Photograph: Eliot Porter

Photographic Products Group

Eastman Kodak Company

Rochester, New York 14650

Kodak Publication No. E-81

CAT No. 842 1109

Library of Congress Catalog Card No. 87-071443

ISBN 0-87985-500-2

06-87-00 New Publication

The Kodak materials described in this book are available from photographic and graphic arts dealers normally supplying Kodak products. Other materials may be used, but equivalent results may not be obtained.

FOR YOUR SAFETY

Care is required in handling all chemicals. Photographic chemicals are no exception. For example, it is advisable to wear protective gloves to prevent skin contact with many photographic chemicals. Safe handling information for a particular Kodak chemical can be obtained from the product label and from the Material Safety Sheet (available from Marketing Administrative Services, 343 State Street, Rochester, New York 14650), and Kodak Publications, such as No. J-4, Safe Handling of Photographic Chemicals, and No. J-48, The Prevention of Contact Dermatitis in Photographic Work.

A-2
A-3

DEDICATION

This book is dedicated with love and respect to those two young men from Philadelphia, Louis B. Condax and Robert P. Speck, who in the early 1940s brought the dye transfer process to Kodak and to the world.

IN APPRECIATION

In putting this book together, I have called upon many of my friends in the fields of Commercial and Decorative Photographic Printing for help and inspiration.

Thanks are due, not only to Dennis Brokaw, Ctein, Bob Pace and Charles Swedlund for their words and photographs (and for their patience), and to Harold Boeschenstein, Jr., for his scholarly bibliography, but also to professionals such as Frank Tartaro, Bob DeSantis, Ernie DuSablon and Floyd Lee, who reviewed, suggested and corrected during the manuscript preparation. My appreciation also goes to artist/photographers John Wawrzonek, Jim Bones, Jim Wallace and especially Eliot Porter for inspiration; to writers Mindy Beede and David Doubley for having blazed the trail and for their ideas, to Warren Condit for his enthusiasm for the process and for all his inventions which have made it easier, to M. A. (Morry) Bard for his lifetime of dye experience and his willingness to share, to Joan Matochik for taking the writings of five radically different individuals and organizing them into a single language without changing their thoughts, and to all my friends who have said, "Get that book written so that it can spread the word about this great old method of making the most beautiful color images."

Frank N. Mc Laughlin
Rochester, New York
May 20, 1987

ABOUT THE AUTHORS

Because the dye transfer process is unique and can be accomplished from so many starting points, with so many pathways in the procedure, the working methods of each individual technician can vary greatly. Kodak, as the manufacturer of the photographic materials used in the process, has guidelines for each product application; these are presented first in the content of this book. The four photographers who have contributed articles to this book work with widely divergent techniques to produce equally excellent results. They know that their individual methods of working yield the kind of image that each wants and has struggled to create.

Dennis Brokaw was born in Carmel-by-the-Sea, California, in 1939. He grew up in San Diego studying music theory and orchestration in hopes of becoming a composer. However, after attending the University of San Diego through a journalism scholarship, he took a degree in mathematics and, for a time, worked for the Defense Department as a flight test engineer.

His love of nature and the beauty of the wild West-Coast landscape brought him inspiration for his musical improvisations. In 1962, at the suggestion of his father, he took a camera and a few rolls of color film on a trip through the wilds of Oregon. He had no idea that those snapshots would beckon him to devote the next 20 years to expressing his vision of the world through the photographic color print.

Soon becoming dissatisfied with the results of commercial color prints, Dennis began to search for a printing method that would reproduce the beauty of color and contrast that he saw in the 4 x 5-inch transparencies which he was making. He turned to the dye transfer process, and his eventual success with it has earned him a place among the masters of the medium.

He is co-author with Wesley Mark of The Pacific Shore, has written an article on large-format close-up photography for the KODAK Workshop Series Publication, Close-Up Photography, and has held numerous one-man shows in galleries nationwide. His prints are in many public and private collections. In addition to running his own photographic-file agency (furnishing pictures for everything from encyclopedias to magazine covers), he acts as a color consultant, a teacher and a researcher for articles on color theory.

After exploring the West, Dennis returned in 1973 to Carmel where he settled with his wife, Wendy. When he is not composing pictures, he's composing music at the piano. Those "snapshots" of 20 years ago have, in no small way, helped to find a home, as well, for his love of music, science and art.

Ctein is the name of the only professional photographic laboratory in California that makes dye transfer prints directly from color negatives by means of KODAK Pan Matrix Film. It is also the complete name of the young photographer/scientist that is the proprietor.

Ctein is educated in both the arts and sciences, holding degrees in physics and English from the California Institute of Technology. He has been responsible for print production at the Big Bear Solar Observatory and has worked in the fields of electrophotography and computer peripheral design. As a writer, he has many credits in both electronic and photographic publications and is presently an editor with Darkroom Photography. However, his primary business now is as a photographer and, in particular, a custom color printer.

Over the years, Ctein has worked closely with Kodak and various magazines to promote and advance the dye transfer process. In 1979, he wrote a five-part series for Petersen's Photographic Magazine, providing complete instructions for the novice in making dye transfer prints from color negatives. His article in this book is a revised and expanded version of that series.

In 1983, a dozen of his prints were chosen to be shown in the Kodak exhibit at the photographic trade show of The Professional Photographers of America; in 1985, his work was also shown in the same context in a display celebrating five decades of dye transfer printing.

Ctein's prints are in a number of collections, and his dye transfer renditions of other photographers' color negatives are in exhibits traveling throughout the world.

Ctein continues to work in his laboratory in Daly City, producing fine color prints, advising young color printers and helping field-test new and improved dye transfer products.

Bob Pace was born and raised in Brooklyn, New York, and studied art at the Commercial Art Studios in Manhattan prior to World War II and his enlistment. While in the Army, he became an aerial photographer and lectured to groups of up to 3000 soldiers on the art of camouflage and its photographic detection. Some of his instructors in the service were former photojournalists, and his admiration for these men influenced his career decisions when he returned to civilian life. In the 1940s, he worked in Manhattan in some of the better color photographic advertising studios and professional laboratories; in 1951, he opened his own business, Pace Color Prints, where he made tricolor carbro prints and dye transfer prints. When he decided to open a branch in California in 1958, his studio employed eight technicians and eventually grew to 14. During this time, his studio did work for the largest advertising agencies on both coasts, as well as for the most famous photographers of the golden age of commercial photography.

Bob has always loved to teach and his students populate the dye transfer laboratories across the country. In 1976, he set up dye transfer facilities at California State University at Los Angeles where he taught for one semester, but the full-time job of running a large laboratory precluded his college teaching. The course that Bob initiated is still going strong. Many times Bob invited college photography classes to visit his laboratory; he has explained the dye transfer process to thousands of students.

In 1982, Bob was thinking of retiring when he accepted a position in San Francisco setting-up and managing the Dye Transfer Division of Frog Prince Laboratories, today one of the finest facilities on the West Coast.

In 1984, after more than 40 years in the business, Bob and his wife, Mary, decided to leave the commercial world. They now live in Victorville, California -- but not totally retired. Bob has been writing articles for technical magazines; and he has built a model dye transfer laboratory (which he describes in this book) next to his home, where he still does a few commercial jobs, but concentrates on teaching his art and craft to students who attend short seminars and hands-on workshops in his facilities.

Bob and Mary have gained the affection and respect of an entire industry. Long-distance calls from darkrooms and laboratories around the world interrupt classes, but Bob is always more than eager to talk to his friends and give advice as needed. In a fraternity of technical wizards, he is a master.

Charles Swedlund was born in Chicago, Illinois, and studied at the Institute of Design of the Illinois Institute of Technology, where he earned both B.S. and M.S. degrees. Currently, he is a professor at Southern Illinois State University/Carbondale, where he teaches photography.

Charles has a long and impressive list of publications, including among others, The Making of a Collection, Photographs from the Minneapolis Institute of Arts; Photography, A Handbook of History, Materials and Processes (a massive textbook); and Kwik Print.

His photographs in all mediums have been exhibited in the Billings Art Center, Billings, Montana; the University of Arkansas, Fayetteville, Arkansas; the University of Louisville, Louisville, Kentucky; Penland School of Crafts, Penland, South Carolina; The 1985 Faculty Arts Show at Stone House, Southern Illinois State University/Carbondale, Illinois; The Lay of the Land, 20th Century Landscape Photographs from the Hallmark Collection, Gallery 201, University of Missouri, Kansas City, Missouri; Work by Former Students of Aaron Siskind, Center for Creative Photography, University of Arizona, Tucson, Arizona; Considering Beauty in Photography, The Center for Contemporary Photography, Columbia College, Chicago, Illinois, and many more.

His work is included in collections at the Art Institute of Chicago, Chicago, Illinois; The International Museum of Photography at the George Eastman House, Rochester, New York; The Museum of Modern Art, New York City; The Smithsonian Institute, Washington, D.C.; The National Museum of Canada, Ottawa, Canada; The Minneapolis Museum of Art, Minneapolis, Minnesota; The Illinois State Museum, Springfield, Illinois; The Hallmark Collection and many others.

Charles lives in Carbondale, Illinois, and continues to do for a living what all the contributors to this book do less formally, that is, pass on the love, science and art of photography through teaching.

Frank Mc Laughlin came to professional photography in his early high school years when he became the assistant to the local portrait photographer in the small New Jersey town where he was born. After graduating from school and spending some time in photojournalism and government work during World War II (and recovering from a resulting severe illness), he attended Pratt Institute in Brooklyn, New York, where he received a degree in advertising design, minoring in photography.

Upon graduation, Frank joined the commercial advertising field and spent many years on New York's Madison Avenue, first as a catalog fashion photographer, then in medical and pharmaceutical illustration and, later, in the studio of Nickolas Muray, one of the great color advertising photographers of the industry. His work appeared almost weekly in such magazines as *Life*, *Look*, *The Saturday Evening Post* and *Good Housekeeping*.

It was while at *Muray Associates, Inc.*, that he became fascinated with the technical end of photography and began working first with the tricolor carbro print process and the early transparency materials, then with the dye transfer process. He later worked in Manhattan as sales manager of a professional color processing laboratory, research technician in a large dye transfer laboratory, and before leaving the metropolitan area, as manager of a professional portrait studio and color printing laboratory.

He joined Eastman Kodak Company in 1964 as a technical sales representative trainee but remained in Rochester, teaching color printing, doing product research and, as author/editor, writing publications for the Professional Photographic Division. Among his efforts are the KODAK Publications, No. 0-4, Professional Portrait Techniques; No. 0-16, Professional Photographic Illustration Techniques; No. E-66, early editions of Printing Color Negatives; No. E-96, Printing Color Slides; and both editions of No. 0-22, Photo Decor.

Since 1977, and the retirement of Bob Speck, one of the inventors of the process, Frank also was dye transfer customer relations coordinator; until his retirement in 1986, he was deeply involved in teaching, promoting and improving that beautiful old color printing process.

Frank and his wife, Ginny, remain in their home in Rochester, New York. Frank plans to continue writing and working with the dye transfer process, and hopes finally to get a chance to print some of his own photographs for exhibition.

INTRODUCTION

Welcome to a very different world of color photography. It is a world where YOU are in charge; where you can make decisions regarding not only the color and density of a print, but also the contrast of each individual color and the density of those individual colors. It is a world where you can change the colors of objects in a photograph without changing anything else, or where you can change the entire image to any color that you can think of. Welcome to the world of dye transfer printing.

Because it is essentially a black-and-white photographic printing process (you add the color after the printing is done), you need only know the rules of printing and processing black-and-white films. A knowledge of color relationships comes quickly with the dyeing and transferring of the individual color components. In fact, the dye transfer process is an ideal way to learn the theory of color photography and how it works. AX-1 (A,B,C)

All of this is not to say that the dye transfer process is simple. It isn't. There are many steps in the production of a dye print, and each step must be done precisely to obtain the expected result. However, they are not difficult procedures; they progress in a logical manner. Because each step can be altered, thus changing the end result, standard procedures must be quickly set and only varied after studying their product.

The dye transfer process is not inexpensive. The average finished dye print from an original transparency employs the use of at least 11 sheets of black-and-white film and an average of six sheets of paper. (Working from a color negative is less costly; only three sheets of KODAK Pan Matrix Film 4149 are needed to produce the color image on as many sheets of KODAK Dye Transfer Paper as is necessary to reach a good balance.) The dyes, although long-lasting and capable of producing hundreds of prints per gallon of working solution, are costly and must be replaced periodically. The process is not a toy, but a tool for the serious photographer who wants his images to be seen at their very best.

Dye transfer printing demands few expensive pieces of equipment. Dye prints can be produced from a darkroom equipped to make black-and-white prints with the addition of a few extra trays. However, the process also lends itself to modern processing machines, electronic densitometers and computerized separation scanners. Dye transfer, therefore, can be adapted to simple, hands-on control of the image, as well as sophisticated means of elaborate image manipulation with mechanical, electronic, chemical, optical and other advanced technologies. A carefully masked and retouched dye print makes the best original copy for scanner-separated photomechanical reproduction because no expensive computer retouching is necessary.

The avid interest of its practitioners and their striving to improve the process makes dye transfer a constantly growing and changing method of making color images. As new films and chemicals are introduced to the market, they are evaluated by dye transfer workers and accepted or rejected as components for the process. Workers in the Research Department of Kodak's Professional Photographic Division strive to improve existing products, and a search continues for new products, such as better dyes, and film and paper emulsions. This fifty-year-old process is still evolving and will continue to change and improve until a completely different and better way is found to make the highest quality color images.

History of Early Color Processes

Substractive dyes in one form or another have been used to create color images for hundreds of years. Artists have used palettes limited to three hues and mixed a rainbow of colors from them since the beginnig of painting.

Shortly after the invention of black-and-white photography, the search began for ways to produce color photographic images. Many advances were made in understanding the theory and in 1861, James Clerk Maxwell demonstrated the additive color process by projecting three black-and-white transparencies of an object in separate projector lanterns. In front of each lantern, he placed a transparent container of solution the same color as the filter through which that photograph was taken. The solutions were colored red, green and blue. When the three projected images were superimposed on a screen, the object appeared to be in its original colors.

Later, simplifying this procedure to use a single projector, the three filters were included into a single layer by mixing red, green and blue dyed starch grains into a homogeneous mass and spreading them on the base side of a glass photographic plate. Any clear spaces between starch grains were dusted with carbon black to exclude white light. The layer was lacquered to make it waterproof, and the plate was exposed to a colorful scene through the base. When the plate was developed to a positive, dried and projected, the scene appeared in its original colors. Those little colored starch grains acted as individual filters for both the taking of the picture and its projection. This was Lumier's Autochrome Process.

Another modification of this system, the Finley Process, consisted of a screen of minute red, green and blue lines which was placed over the photographic plate during exposure. After processing to a positive, another identical screen was registered over the black-and-white transparency, producing color and permitting multiple copies to be produced.

Other systems were invented and superseded as time passed and the search for the ultimate in color photography continued at a fast pace.

In the years after World War I, there were several attempts to make colored photographs to be used in the newly important advertising industry. The photomechanical process was capable of reproducing full color in high-quality magazines by means of color separation and red, blue, yellow and black inks. (Actually, the inks were a bluish red [magenta], a greenish blue [cyan] and yellow.) All sorts of color subjects were reproduced: old master paintings; works of the new up-and-coming artists, of which there were many due to this new method of proliferating images, and particularly, thousands of paintings and color drawings of goods for sale. The Madison Avenue advertising industry was in its infancy; all that it needed was a quick-and-easy method of making color photographs of high quality.

The inventors complied. First, there was Color Toning -- the sophisticated relative of the old sepia toning process -- where your portrait was toned a soft brown color as an initial step in oil-coloring or as a finishing step in itself. Color toning laid a basic color into the entire black-and-white print. It actually changed the color of the silver grains in the photograph by treating them with solutions of various metallic salts. (Due to the toxic chemicals used, many color toners died at an early age.) After the basic toning was completed, artists with transparent watercolors and fine brushes or airbrushes completely rendered the subject in the photograph in full color. It was a long, costly procedure to get a beautiful advertisement.

Meanwhile, the artist/photographers had been busy inventing numerous ways of making various types of monochrome prints. There was the Bromoil Process, where a silver bromide print was bleached and the image differentially hardened so that, when the wet paper was tapped with a bristle brush loaded with oily ink, the ink ''took'' only in the areas where the latent gelatin image accepted the ink. The unexposed areas, where the gelatin had been left unhardened, were wet with water and rejected the ink, thus remaining white. Beautiful artistic renderings were possible with the bromoil process, but although many colors of ink were available, only one could be used on each subject and the finished print was still a monochrome.

Other inventions followed until someone discovered that tissue coated with a gelatin and carbon-pigment slurry, sensitized with potassium bichromate, dried and then subjected to an exposure of ultraviolet radiation (sunlight or carbon arc) through a contact negative, produced a differentially hardened image. When washed in warm water, with a little help from some ammonia solution, this image became visible as a beautiful, long-ranged positive print -- the Carbon Print.

This process then evolved into a full-color pigment process where graphic arts separation negatives (red-, green- and blue-filter images) were printed onto sheets of silver bromide paper to produce balanced black-and-white records of the original scene. These "bromides" were combined in a ferricyanide bleach with sheets of cyan, magenta and yellow pigment: red image with cyan pigment; green image with magenta pigment and blue image with yellow pigment. When the bromide paper was stripped off, the pigment tissues washed in hot water, the revealed images transferred to transparent sheets and, finally, the three positive images hand-registered onto a triple-weight paper support; a full-color image of unrivaled beauty and fidelity was achieved. Even today, the Tricolor Carbro Print is regarded by many connoisseurs of photography as still the finest of color print processes, with highlights that have a pearly luster (due to the semimatte finish of the paper base), a lengthened density range (because the heavy thicknesses of pigment and gelatin in the darker densities produce a ferrotyped, glossy surface that allows one to see deeply into the shadows), and a three-dimensional quality created by the actual bas-relief thicknesses of the gelatin/pigment maximum-density areas on the surface of the paper.

Although it took a commercial carbro laboratory several days to produce a single print, and each succeeding print took equally long to make, the tricolor carbro print reigned supreme in the advertising industry until the mid-to-late 1940s when the dye transfer process took over.

Inventors of the Dye Transfer Process

In the year 1935, two young men from Philadelphia, Pennsylvania, arrived in New York City with a new color printing process that they had invented and were sure was going to capture the advertising world. Louis B. Condax, a musican and inventor with a wife and two children, and Robert P. Speck, an unmarried graduate of a business administration college, were ready to take on Madison Avenue. The country was in the depths of the depression and, although their color printing process gained a fair acceptance by the advertising industry, money was hard to come by. Louis and Bob managed to scrape along for several years, commuting to their homes in Philadelphia on weekends and sleeping in cheap hotels or in the laboratory during the week. A-4

At this time in Rochester, New York, the Eastman Kodak Company had recently introduced a color process called the KODAK Wash-Off Relief Process. It consisted of matrix film, receiving paper, powdered dyes and chemicals to develop the film and bleach-harden the image. The following steps included washing the film in hot water to obtain a relief image and then dyeing it the appropriate color. The process produced a beautiful, lifelike color image. Its only problem was that it took almost an hour to transfer each of the colors so it was not commercially efficient.

Bob Speck wrote a letter to Dr. C. E. Kenneth Mees, founder and director of the Kodak Research Laboratories, describing his and Louis' improvement over Wash-Off Relief. After investigating this process, Dr. Mees offered them employment with Eastman Kodak Company. The year was 1942, World War II had started and the advertising industry was at a standstill. Therefore, after some negotiations, Louis and Bob agreed to become Kodak employees, at least until they were drafted.

In November, 1943, Dr. Mees invited Louis Condax and Bob Speck to demonstrate their new dye transfer process methods before an unnamed group in the Kodak auditorium. Within two weeks, requests poured in from the Armed Forces -- they needed color prints. The U. S. Government authorized the two young men to serve their country in Kodak's Research Laboratories.

Shortly after the war in 1945, Louis and Bob realized their goal -- the commercial availability of products for the dye transfer process, a premier quality method for preparing color images for illustration, advertising and display.

Today, the dye transfer process is recognized as the leader in the field of conventional color print processes and is known to be the most versatile and enduring form of color illustration.

The young men from Philadelphia continued to work for Kodak. Louis remained at the Research Laboratories, where he contributed to many of Kodak's products and processes until his retirement in 1966. He continued to be the perennial inventor and gained fame for his rediscovery of an ancient, lost varnish that enhances the tone quality of the violin. He died in 1968.

Bob stayed at the Research Laboratories for a few years, but later he transferred to a product evaluation unit in Kodak's Marketing Division. There he continued to work with photographic products, testing new emulsions, searching for new dyes and constantly promoting his process to the world of photography. He retired in 1977 and died shortly after, in 1979.

To their many friends, Louis and Bob remained "young men" all their lives. Vital, fascinated with everything, interesting in their activities and vastly humorous, they are still remembered with affection by a legion of dye printers across the world.

Users and Uses

After many years of almost proprietory use by the advertising industry, the dye transfer process is gaining popularity in nearly all fields of photographic printing. However, the largest number of dye prints are still used to sell products.

Advertising -- Wherever there is a need for fidelity in color, A-5(A+B) subtle retouching or complicated combining of images, the art director will call for a "dye." Professional dye transfer laboratories are located in the larger cities of the United States, in a few of the advertising centers of Europe and in Japan. Although the largest number of laboratories is in New York, such cities as Chicago, Boston, Detroit, Philadelphia, Los Angeles, San Francisco and Seattle can boast of well-established dye transfer services. The largest laboratory is in Tampa, Florida. New dye departments are opening, usually fostered by full-service photographic laboratories, where business research has determined the need for the highest quality color print.

The fact that the photographic retoucher, who does the final and vital step in the production of an advertisement, finds it easy to make either minute or massive changes on the dye transfer print, and that the work is invisible to the photomechanical separation camera (if done properly), makes the process valuable wherever advertising is produced.

AX-Z (A+B) large

A-X5 A+B ?

The advent of the laser-scanner computer in the printing industry has been viewed by some as bad news for the dye transfer community. However, one separation house has installed a dye laboratory as part of its facilities in order to produce the very best quality input for its scanners and to give them the ability to make necessary changes in the artwork by the most economical means. This may be the way of the future, with professional dye transfer laboratories working not only with the art director and the photographer but in close harmony with the printing industry as well. Only good can result from this because, if the dye laboratory can become translator between the photographer and the printer -- long-time business strangers -- the quality of the final printed image can be vastly improved. That is the goal of all concerned.

Meanwhile, when you see a particularly excellent advertising photograph for hair coloring, food, lipstick, automobiles, jewelry and floor coverings, among many items, you can be almost positive that the original was a dye transfer print. AX4 (A+B)

Photo Art -- When the color negative was introduced in the mid-1950s, the photographic artist was given a present of the colors of nature to play with. Since the beginning of the science, this group had led the way in creating images of beauty and artistry on paper which rivaled the works of the highly respected painter. However, in the circles of the self-styled "true artist," photography was looked down upon as being a mechanical copying medium. This did not stop most painters from using the camera to make study notes from life to paint from (copy) later at the easel. A-6

Now the photographer could produce prints of almost any size that had a superior quality and that were certainly worth framing and displaying. A new source of income was developed by the sale of prints to people who loved the beauty of nature, but could not afford the price of an oil-painted landscape.

As time went by, the color print process was greatly improved and automated to the point of putting a sheet of color print paper into a machine slot and waiting for it to come out finished from another slot. All of the work was done for photographic artists, and there was the rub. They were accustomed to controlling their images completely, from exposure to framing; this new automation took the decisions away. No longer could they change contrast, or add or subtract what they wanted. Those decisions had been made by the photographic manufacturers in order to perfect the process.

Fairly recently, the photographic artists have discovered the dye transfer process. Here, surely, they can control every aspect of the production of their images. They do! Photographic artists have bent and flexed the dye transfer process to meet their personal wishes in every way imaginable, and the process has returned to them the type of images that they sought. From soft, muted colors in a diffuse image, to bright, forceful, ultra-sharp pictures, with every blade of grass in focus, dye transfer prints glow on the walls of galleries and art museums. Yes, the art world is slowly accepting the color work of photographers as a form of true art.

Display -- In the field of point-of-purchase advertising, where images of products are close-at-hand to the customer, manufacturers long ago discovered that such an image had better be the best quality possible or sales would suffer. The multimillion-dollar packaging industry does its best to make sure that the customer is dazzled by product images. Where the actual product is so fragile that it cannot be displayed, such as a plate of ice cream, or not handsome enough to be displayed, such as a bowl of clam chowder, photography comes into play. For national accounts, slick photogravure images are produced and displayed in stores. For local or small-account clients, dye transfer is an economical alternative. Although the first dye print is very expensive, such prints become quite reasonable in lots of 25 or more.

The beauty of the dye transfer image always draws attention to its subject matter. In supermarkets, large, 40 x 60-inch prints of fresh garden produce hanging in the grocery department have proved to increase sales; photographs of well-dressed, prime meats in the butcher department also upgrade the quality of the average purchase. One nationwide, 24-hour convenience chain has smaller dye prints of its sale items hanging along the ceiling line of its stores. Although the fluorescent lights illuminating the store wrack havoc with all types of color photographic and printed matter, the dye transfer prints, overlayed with an ultraviolet (UV) filter material, last as long as they are needed to advertise the specials.

In diverse department store situations, dye prints add color and interest to sales displays; in museums, background photographs are used behind exhibits. In one museum in

A-7

particular, The Museum of Western Expansion under the arch in St. Louis, there are huge dye transfer murals of photographs by landscape photographer David Muench. Some are as large as 16 feet high and 50 feet long in an exhibit extending 500 feet along one wall. These photographs illustrate scenes along the route of the Louis and Clark Expedition of 1804. The use of dye transfer prints was stipulated by the National Park Service because of their color fidelity and long viewing life.

Archival Storage -- The dye transfer print has excellent resistance to fading when exposed to normal tungsten light. It fades under unshielded fluorescent light or sunlight because of the destroying UV rays contained in those sources. However, the dark-keeping qualities of dye prints are unrivaled. Some dye prints have been in dark storage for 50 years and show no deterioration. In accelerated dark-fading tests (with high humidity and temperatures, as well as darkness), dye prints show less than .05 density loss in the equivalent of 500 years.

Archivists are aware of this quality and, when a color photograph is destined for long-time keeping, they specify the dye transfer process. Every month in Washington D.C., one photograph of the President and the First Lady is chosen to be distributed around the world through the U.S. Information Service. The photographs, usually 35 mm transparencies taken by news photographers, are made into 16 x 20-inch dye prints, retouched, then copied onto hundreds of sheets of internegative film. These color negatives are shipped to the U.S. Information Service offices around the world, where color prints are made for local display. This method of distributing such photographs has saved thousands of dollars over the previous method of printing offset lithographs from the photographs and shipping all those hundreds of pounds of printing around the globe. When the laboratory work is done, the dye transfer originals are sent to the National Archives to join the other monthly portraits in storage for America's posterity.

Not only portraits, but many other scenes of national importance, where color is important, are preserved in this manner in the National Archives, along with literally millions of black-and-white prints that date to the days before the War Between the States.

Private files of research scientists and doctors are full of color photographs regarding their special projects. In cases where the importance of the subject has to do with color, of course, dye prints are used. They are more faithful to the subject in the first place, and they remain indefinitely that way in the dark.

Photo Decor -- Since cavemen lived in France and scratched lovely replicas of local animals on the walls, home owners have been decorating their dwellings. In more recent years, we have preferred framed pictures over scratchings, and artists have made

AX-3

a living producing and reproducing many different images for that purpose. The rich had their portraits in oils over the mantle and landscapes or still-lives in the dining room -- all original works of art. Those with less money were satisfied with charcoal sketches and cut-paper silhouettes of family members, and reproductions of famous artists' works.

The era of photography changed that. Soon everybody had small snapshots of their dear ones lined up on every flat surface or hanging in clusters on walls. As sophistication swept the land, the snapshots disappeared into albums, but the need for decoration remained. Large black-and-white photographs of nature scenes became popular. Such scenes are still popular. Today, large color prints are decorating not only the homes of America, but they are also in hotel rooms, restaurants, and the board rooms and reception halls of corporation headquarters everywhere. And today, because many people can afford the best, a large percentage of color photo decor is done in the dye transfer process. The colors are more pure, the detail is in more relief, there is a three-dimensional look not found in other types of color photographs, and with care, they remain so for many, many years. A-8

Landscape photographers, particularly, are profiting from this newest form of decor. They make, or have made (there are excellent dye printing services) limited editions of favorite scenes. This assures the buyer a degree of exclusivity in the piece. Some make limited-edition portfolios of from four to 40 scenes and sell them in velvet-lined cases. Others, who deal exclusively with the corporate world, have their representatives call only on the managers of office decoration departments.

Office decor is not limited to landscapes. Companies, proud of their products and their employees, often have large photographic murals done, using the images made by their industrial photographers. Of course, a copy of the portrait of the founder -- in dye transfer -- still hangs over the president's chair in the board room, where it will preside for generations to come.

Education -- Currently, most universities and colleges, as well as a number of junior colleges and even high schools, have courses in photography as an important part of their curriculum. Of course, color is taught as an advanced study. More and more schools are using the dye transfer process as a bridge between black-and-white and color programs. Since dye transfer is essentially a black-and-white process until the matrices are placed in the dye, students, familiar with that discipline, can produce separation negatives of the proper contrast and density, and from them, make matrices just as if they were making black-and-white prints.

When those students place their matrices in the dyes and make their first transfer, the entirely new world of color bursts upon them. They have no doubts in distinguishing cyan from blue or magenta from red because there are those colors before their eyes, with a brilliance unknown to printers of other color processes. Enthusiasm is boundless. Students actually run from transfer board to dye table in their hurry to make another print. After the initial commotion subsides and reason takes over, evaluating color quality and making corrections are such straightforward processes that the color relationships are easily memorized.

Many experienced teachers of the process, realizing the fascination of the print-rolling aspect, start their dye transfer courses by giving new students matrix sets produced in previous classes and allowing them to roll prints as an introductory exercise. The students quickly learn what qualities are needed in the matrices to produce acceptable prints. They can then go to the more abstract task of making separation negatives because they are better able to relate to the need and ability to control tone scale and color balance.

Students will go on to other color processes, but many return to dye transfer, not for its simplicity, but for its quality and beauty. Those who remain with the newer color systems are more exacting in their work and more critical of their results, because of the quality that touches them in the dye laboratory.

MATERIALS AND PROCESSES

At the beginning of the study of any new process, it is wise to learn exactly what is needed to accomplish the job. Here is a list of materials and equipment that you will need to make dye transfer prints.

Basic Darkroom

A completely light-tight room with provisions for air circulation and an exhaust to the outdoors is essential. Its size should be large enough for two tables to hold printing equipment and a register punch plus a sink long enough to hold four trays big enough for the largest size print that you plan to make. Electrical provisions for a white-light illumination system and a safelight system, as well as numerous outlets for enlargers and other equipment, are required. All electrical outlets should be grounded and those near the sink protected with ground-fault breaker switches. It is a good idea to have the white-light switch positioned at a 5- or 6-foot level on the wall near the entrance door to prevent accidentally turning on the lights by brushing the switch when film is uncovered. Safelight switches can be at a normal level on the wall. Paint walls behind or beside the enlarger or contact-printing locations matte black,

A-9 drawing

and the ceiling and other areas a light color so that safelight illumination can be reflected from them. Areas around the sink should be painted with washable paint to enable you to remove developer and fixer stains.

Basic Transfer Room

A well-lighted room, with a table on one side long enough to hold four trays with ample space for the largest print that you plan to make and a sink on the other side long enough for four trays of the same size, is essential for holding the dye baths and paper conditioner and for treating the matrices in the acid rinses. A third table, next to the rinse sink, is needed for the transfer board, again as big as the largest print contemplated. Space for a print evaluation area with a proper light source and fixtures is needed. An area, possibly the same size as the print viewing space, is necessary for both negative and print retouching. Provisions for air circulation and a good-sized exhaust fan to the outside are required to carry away the steam and moisture from the washing off of the matrices, whether it is done in this room or in the darkroom. It is also imperative to have a dryer for both matrices and prints. Except for the dryer, there are no special electrical needs for this room unless it is going to be used for washing off matrices. In that case, a safelight circuit should be installed. Paint this room a light, relatively neutral color with the area around the print evaluation unit having an 18% gray.

The water supply to either sink must include a plentiful source for hot water between 130°F (54.4°C) and 140°F (60°C) to mix with cold water to use at 120°F (48.9°C), as well as at 68°F (20°C). Thermostatic mixing valves are useful in keeping water temperatures at the proper levels; filters are needed to keep sand, grit and minute waterborn plants and animals out of the process and away from the dyes.

Of course, there are as many darkroom plans as there are darkrooms. Shown here is a simple generic plan from which you can design your own.

Print Evaluation Considerations

The color quality of the viewing light source strongly influences the apparent color balance of the print. Ideally, the evaluation area should be illuminated by light with the same color quality and intensity as that under which the print is to be viewed in its final location. From a practical standpoint, some average condition must be selected.

Several factors are important in specifying light sources for viewing color prints. These are intensity, color temperature and Color Rendering Index (CRI). The intensity of the light source influences the amount of detail that can be seen in the print. For good viewing, a light source should provide an illuminance of 100 $\pm$ 50 footcandles. An illuminance of 50 footcandles should be considered a minimum level. The color temperature of the light source should be 4000 Kelvin (K) $\pm$ 1000K. A color temperature of 3800 to 4000K serves well as an average of various viewing conditions. (Color Temperature -- For visual purposes, the color quality of a light source is evaluated in terms of the color of a perfect radiator, or ''black body,'' heated to a certain temperature. This temperature is expressed in degrees Kelvin (K), obtained by adding 273 to the temperature in degrees Centigrade. When the light source matches the black body in color, it is said to have a color temperature equal to the actual temperature of the black body in the Kelvin scale. The color of light is bluer with higher and yellower with lower color temperatures. Note that color temperature refers only to the visual appearance of a light source and does not necessarily describe its photographic effect.)

The most important characteristic of the light source is its CRI, which is a scale from 0 to 100 used to describe the visual effect of a light source on eight standard pastel colors. These eight colors are viewed under light from the source to be rated and under light from a black-body source of equivalent color temperature. The average difference in the appearance of the colors is used to determine the CRI. The closer the comparison between the two sources, the higher the CRI of the source to be rated. Since the rated light is compared only to a black-body source which best matches it, the CRI readings of two sources of different color temperatures cannot be compared. For good color rendering in the prints being viewed, the CRI of the light source should be 85-100, with a CRI of 90 or higher being desirable.

The quality of light source having a CRI of at least 85 and an equivalent color temperature near 4000K is approximated by fluorescent tubes (in fixtures), such as the WESTINGHOUSE LIVING WHITE, or the DELUXE COOL WHITE Tubes made by several manufacturers. Satisfactory results can also be obtained from a mixture of incandescent and fluorescent light. For each pair of 40-watt DELUXE COOL WHITE Fluorescent Tubes, a 75-watt frosted tungsten bulb can be used.

There is as yet no standard light source for general viewing of photographic color prints. The American National Standards Institute has adopted a light source of 5000K as one part of a set of viewing conditions for color-quality appraisal of <u>transparencies</u>, and is proposing it for proof prints for the graphic arts industry. MACBETH PROOFLITE, DURO TEST OPTIMA and GE CHROMA 50 Fluorescent Tubes, among others, produce 5000K light and are designed for judging prints to be used for graphic arts applications.

For making separation negatives, film processing equipment is no different from any ordinary black-and-white darkroom. You need three trays to hold the sheets of film in the developer, stop bath and fixer, and a film washing tank. A metal tray is convenient for the developer because fine-temperature adjustments can be made quickly to the solution by simply running a stream of hot or cold water on the bottom of the tray, depending upon which way you want the temperature to go. A laboratory-grade thermometer is mandatory. Plastic graduates and measuring columns fill out the list.

Four trays each, for the different sizes of matrix film, are necessary for processing it. Again, a metal tray for the developer, a rinse tray and a fixer tray, as well as another tray for use as a cold-rinse tray during the hot-water wash-off operation, are required. You should also have four more trays corresponding to the various sizes of matrix film to hold the three dyes and the paper conditioner in the dyeing stage of the process. Do not count on the processing trays for this; they will be used for the acid rinses and a final hot-water rinse before returning the matrices to the dyes for further printing. Use the developer tray for the hot-water rinse and wash it thoroughly before use. You will need a total of eight trays. They should be plastic (except for the developer trays) and flat-bottomed; trays with patterned bottoms may leave the pattern in the matrices.

Equipment

Conventional black-and-white photographic printing equipment can be easily converted for dye transfer printing. For example, you can fit ordinary enlargers with pin-register systems and make or purchase register vacuum easels. (The ability to register the image of all three color separation-negative images in exactly the same place on the three matrices, so that they will superimpose without misregister on the final sheet of dye transfer paper, is basically vital to the process. There are a number of systems available for punching film and pin-registering it in enlarger negative carriers, contact-printing frames and printing easels.)

Enlarger light sources of all sorts, if they are suitable for making prints from color negatives, are appropriate. When making color separation negatives, don't use cold light grids that are made for black-and-white printing only. These grids, however, are suitable for making matrices on KODAK Matrix Film 4150. Enlargers made for printing color negatives can be used, without modification, for making dye transfer prints from color negatives utilizing KODAK Pan Matrix Film 4149. The type of enlarger light system used influences the resulting print quality. A semicondenser or so-called ''condensing diffuser'' light source will give less flare, cleaner highlights and snappier detail overall. Total diffusion enlargers are more common in color printing because it is somewhat easier to achieve even illumination with them; they are also used by some professional laboratories to make matrices. Condenser enlargers, such as Durst, Fotar, Omega, Bessler and the old Saltzman, with filter drawers above the negative stage, are excellent choices. The newer, additive light-source enlargers are good if the light sources transmit the proper color. Test such light sources or play it safe by using the recommended KODAK WRATTEN Separation Filters in addition to the built-in dichroic filters.

It is important to have a means of maintaining constant voltage to the light source, such as an automatic voltage stabilizer or an auto-transformer of the proper voltage. Lenses should be color-corrected and of the best quality that you can afford. On-easel color photometers for printing color negatives are useful but not essential for printing matrices. Black-and-white densitometers, for making separations from transparencies with accuracy, can be purchased inexpensively. It is important to have reliable timers attached to your equipment and installed over the sinks in order to time processes properly. Timer dials with luminous faces are a particular help in accurate dark-time processing.

Automatic Tray Rocker -- This is an optional piece of equipment A-10
that makes the proper dyeing of matrices convenient and simple. A-11
In order for the matrices to imbibe the dye solutions fully and (A + B)

evenly, it is necessary for fresh dye to be introduced to the surface of the emulsion on a continual basis during the time the matrices are in the dye baths. If this is not done, the matrix emulsion will draw the dye particles from the still liquid immediately adjacent to its surface, leaving clear water. If the liquid is not agitated in some way at that point, no more dye is drawn into the matrix and, when the matrix is transferred, false densities and mottle will result.

The simple way to agitate the dye baths is to rock the trays by hand, every few minutes, but this takes valuable time. The alternative solution is to make a tray rocker. The construction shown here has been found satisfactory for matrix sizes up to 16 X 20 inches. The rocker should be pivoted in the center as shown; hinging it at the front or rear puts unnecessary strain on the motor. The motion of the rocking should set up a wave action in the liquid that will wash continually over the submerged sheet of film. The rocker table should be made large enough for three dye trays and the paper conditioner tray, which also should be rocked. Placing trays at a slight angle to the direction of rocking will increase the turbulence for more even dyeing of the matrices.

Finally, the equipment list should also include a print roller wide enough to cover the width of the matrix, a hard-rubber squeegee, plastic graduates of the 1-litre and 250-millilitre sizes and columns to measure 1000 mL, 500 mL, 250 mL, 100 mL, 25 mL and 10 mL, as well as squeeze-bottle dispensers for four liquid chemical additives for the acid rinse, and a 3-gallon (11.4 L) bucket (for holding 1% acetic-acid rinse solution). You may find additional small items necessary as you start working, but nothing as important as a triple-beam balance for weighing powdered chemicals in small quantities. An accurate balance is the guardian of quality for the whole process.

Materials for Making Matrices

A-12

Since the making of matrices is essentially a black-and-white process, the materials are few.

KODAK Matrix Film 4150 (ESTAR Thick Base) is used when working with separation negatives to produce a positive-image "printing plate" for each of the three primary color separation-negative images. It is a dimensionally stable, thick-base film with a thick, silver-rich, non-hardened gelatin emulsion. It is blue-light sensitive only and has a soluable yellow dye incorporated in the emulsion to limit the penetration of the image light. It is available in 25-sheet boxes in a number of popular sizes and in 42-inch rolls up to 50 feet long. Some of the sheet dimensions may sound a bit strange, such as 11 1/2 x 15 1/4-inches, or 20 1/2 x 25 1/4-inches. Those extra bits of film in the matrix sizes are to accommodate the space for register punching and a safe-handling area around a full 11 x 14-inch or a 20 x 24-inch printing area. Matrix Film 4150 has an exposure speed approximately that of ordinary black-and-white enlarging paper. It can be handled under a safelight equipped with a KODAK Safelight Filter No. 1 (red) and a 15-watt bulb at a distance of 4 feet (1.2 m). Yellow or orange safelights are not suitable. After processing, there is a thin, positive silver image visible in the film. With considerable experience, you can judge print density from it. However, the only true judgment of proper exposure comes with a transfer.

KODAK Pan Matrix Film 4149 (ESTAR Thick Base) is used when making matrices from color negatives. It is similar to Matrix Film 4150 in manufacture, except that it is panchromatic in sensitivity (sensitive to all colors) and has a speed approximately 10 times faster. That means no safelight can be used and that particular care must be taken to prevent darkroom light leaks and flare from the exposing source. The film has a blue dye and a black pigment incorporated in the emulsion to limit the penetration of the image light. After processing, the positive image has a dark, contrasty, heavy appearance because the black pigment, which is insoluable, adds considerable non-printing density. The only true way to judge print density is to make a transfer. Pan Matrix Film 4149 is available only in 10 x 12-inch and 16 1/2 x 21 1/4-inch sheet sizes at this time. Other sizes and long rolls are available on special order.

KODAK Dye Transfer Paper is a premium-weight, fiber-base, gelatin emulsion-coated, deluxe-grade printing paper. The emulsion contains no silver salts and therefore it is not light-sensitive. It does contain a chemical mordant to which the dye molecules attach themselves during transfer, thus becoming permanently implanted in the emulsion. The emulsion gelatin is hardened and quite tough, permitting extensive retouching, rewetting and handling after transfer. The emulsion is coated on a very heavy, pure white paper stock and care must be taken in handling to prevent cockling or creasing the emulsion at the edges of the sheet. Dye Transfer Paper is available in boxes of 100 sheets in most popular sizes, as well as in the extra-long sizes of the matrix films and in rolls 42 inches wide and 30 feet long. It is available only in F surface.

KODAK WRATTEN Gelatin Filters are needed to separate the primary colors in the original scene, whether it be a transparency, a color negative or from nature herself. Separation negatives are made with KODAK WRATTEN Gelatin Filters No. 29 (red), 61 (green) and 47B (blue). These are sharp-cutting separation filters that divide the visible spectrum into three sharply defined sectors and provide very satisfactory renditions of all colors. Another set of separation filters is used to make matrices from color negatives: KODAK WRATTEN Gelatin Filters No. 29 (red), 99 (green) and 98 (blue). The last two filters pass even narrower bands of color needed by color negatives to render good quality. The No.

98 Filter also provides protection from ultraviolet radiation to which Pan Matrix Film is sensitive.

For making color separations from transparencies, you will need several neutral density filters, such as KODAK WRATTEN Gelatin Filters No. 96 in .20, .60, and 1.00 densities. All of these filters are optically pure and will not distort the image projected through them. However, when they are used under the enlarger lens, their number should be kept to a minimum because any scratches and dust on their surfaces will degrade the quality of the projected image. If possible, place all filters in the enlarger lamphouse, between the light source and the original image. When making contact separations, place the filters between the light source and printing frame.

Matrix Processing Chemicals

A-13

KODAK Tanning Developer A and B is used to develop matrix films. It is an old pyro type formula which chemically hardens the surrounding gelatin as it develops exposed silver halide crystals. The result is a sheet of film with a silver image and a partially hardened gelatin emulsion. Subsequent washing in hot water washes away the unhardened gelatin, revealing a bas-relief gelatin and silver image, thick where much silver was exposed and developed, and thin where little silver was exposed and developed. The developer is used for 2 minutes at 68°F (20°C) as a standard processing time. The normal ratio of the A-to-B components is 1-to-2, but a higher contrast image can be obtained by increasing the ratio and a lower contrast image by lowering the ratio. The official recommendation is for no less than 20 ounces (591 mL) of Tanning Developer A for three 11 1/2 x 15 1/4-inch matrices processed together. Therefore, a mix of 20.28 ounces (600 mL) A to 40.5 ounces (1200 mL) B is the standard developing solution for a set of that size matrices.

When the two developer components are mixed together, oxidation takes place very rapidly. There is a 5-minute safety margin after mixing, so mix them thoroughly by stirring with a thermometer or tilting the tray just before turning out the lights and starting the process. Use the developer solution only once and discard it.

Acid Stop Bath is not essential in processing matrices, but some laboratories use a 1% acetic acid solution instead of a water rinse which is standard.

KODAK FLEXICOLOR Fixer for Process C-41 is the recommended non-hardening fixer for both matrix films. It is relatively inexpensive and comes in liquid form, so it is easily mixed in a 1-to-5 ratio with water. Other fixers, such as KODAK Rapid Fix (without the hardener) or even common hypo rice alone, can be used. Use about 2 quarts (2 L) of fixer solution for 11 x 14-

inch matrices and discard the solution after three sets have been processed. With FLEXICOLOR Fixer, the fixing time is quite short. You can start the wash-off procedure after the last matrix has been in the fixer for 3 minutes. With other fixers, use the rule of fixing for twice the time it takes to clear the film. Always use a plain water rinse (not a stop bath) between the tanning developer and the fixer because some of the final detail is actually developed in that rinse. Keep the rinse time at a constant 30 seconds.

KODAK Paper Conditioner is used to prepare dye transfer paper for receiving dye. It is primarily a surfactant that swells the emulsion and makes the paper soft, but it contains buffering chemicals that bring the emulsion to exactly the proper 6.0 - 6.5 pH (degree of acidity) to accept the dye from the matrix. No more than six sheets of paper at a time should be washed in hot water and interleaved for 1 minute before being transferred to the paper conditioner. This washing will remove any paper dust or gelatin particles that may be accompanying the paper, and will wash away some of the acidity from the paper mordant which, unless removed, will quickly change the pH of the conditioner bath. The paper sheets should stay in the conditioner bath for 15 to 20 minutes and agitated regularly before the first one is drained, positioned on the transfer board and squeegeed down. The other sheets can stay in the conditioner for several hours without damage. As the paper is used, wash and add single sheets to maintain a supply of conditioned paper.

One gallon of KODAK Paper Conditioner will treat many sheets of paper. Eventually, it will evaporate and become syrupy, and may contain bits of foreign material which can stick to the paper and be carried over to the transfer board to become an unwelcomed addition to a print. It will also change in pH from the acid brought into it by a large quantity of paper, and transfer time will be extended. It is wise to discard it when it begins to "sheet" off the bottom of the paper as you are draining it in preparation to transfer. KODAK Paper Conditioner comes concentrated in bottles to make 1 gallon of working solution and cubitainers to make 5 gallons of working solution. Use distilled or deionized water for dilution.

KODAK Film and Paper Dyes and Dye Buffers -- Cyan, Magenta and Yellow -- These are the heart of the dye transfer process, for it is from these three dyes that all the colors of the rainbow are possible. The dyes are actually acid fabric dyes, selected after many trials to be the best possible combination of subtractive colors available. The dyes are not toxic -- in fact, one is a food coloring -- but they are concentrated, so take care not to ingest them or get them into your eyes. They wash off easily from your skin and clothing with soap and water. Although they are the best available, the dyes are not perfect in their rendition of color. Each of the dyes absorbs some portion of this spectrum that it should freely reflect. KODAK Film and Paper Dye, Cyan, is a long-lasting dye that acts as though it contains some magenta and a little yellow. KODAK Film and Paper

Dye, Magenta, is a long-lasting dye that acts as though it contains slightly too much yellow. KODAK Film and Paper Dye, Yellow, although almost perfect in its absorption of blue light, is not as long-lasting as the others, particularly when subjected to ultraviolet radiation. However, with proper masking of separation negatives (color negatives are already masked with undeveloped color-coupler masks), highest quality color prints can be made containing all the colors of nature.

KODAK Film and Paper Dyes and Dye Buffers come in a 1-gallon balanced kit of three colors and in 25-gallon individual color units. The dyes are concentrated and must be mixed with buffer and water before use. Since each individual dye batch is carefully balanced to a contrast and density standard by means of minute changes in the buffer formula, do not attempt to mix the buffer solution from one batch number with dye from another batch number. Use distilled or deionized water for diluting the dyes. Follow carefully the mixing and replenishment instructions, and one set will last for many months and produce numerous prints.

Dyes can be stored in stoppered glass or plastic bottles. Before each use the dyes should be filtered through a 3-micron chemical filter to eliminate any spores or microscopic plant life that may have found a home in the liquid. The dyes are slightly acetic in pH and, like vinegar, make a healthy medium for many microorganisms.

Other chemicals that you will need are: acetic acid (purchase glacial acetic acid, 99.5% and dilute it to the strengths that you need); sodium acetate; and CALGON Sequestering Agent (from your grocery's soap department). These are used in modifying the dye image during the transferring operation.

Materials for Making Color Separations

A-14

The steps in making color separation negatives from a transparency may seem complicated; however, taken one-at-a-time, they are logical.

There are several different types of masking films needed to produce the final, full-tone negatives:

KODALITH Pan Film 2568 (ESTAR Base) is an extremely high-contrast, fast panchromatic film on a dimensionally stable, 0.004-inch (0.10 mm) base. In separation-making, it is used to produce color-corrected highlight masks. These masks are actually high-contrast separations in themselves because they are used to protect the highlight areas of the scene from being degraded or fogged with light during the making of the matrices. They also compensate for the tone scale problem caused by the flat <u>toe</u> portion of the matrix film. They are registered with the transparency when making the principal masks (pre-masking), or they are registered with the separation negatives when making the matrices (post-masking). Three balanced highlight masks are made through KODAK WRATTEN Gelatin Filters No. 29 (red), 61 (green) and 47B (blue). KODAK WRATTEN Gelatin Filters No. 98 (neutral density) of a 1.20 value are added to the red filter and one of a .60 value to the green filter in order to correct for their differences in filter factor with the dense blue filter and to make the three exposure times relatively the same length.

KODALITH Ortho Film 2556, Type 3 (ESTAR Base) is also an extremely high-contrast film that is orthochromatic in sensitivity (not sensitive to red light). It is used to make white-light highlight masks, when tricolor masks are not necessary or when an extra "specular" or very high-contrast mask is needed to protect the tiny direct reflections from the light source. This is the mask that will preserve the sparkle of the water in a beach scene. Since the film is not sensitive to red light, you can process it under a safelight with a KODAK Safelight Filter No. 1 (red) and a 15-watt bulb at no closer than 4 feet (1.2 m), and watch the highlight image develop to the density that you need. A specular highlight mask is usually used as a post-mask.

KODAK Pan Masking Film 4570 is a very special type of film. It is designed specifically as a masking film, and as such, is not only panchromatic, but also has a slightly diffuse base that is not protected with an antihalation backing; it has a degree of flare built into it. The purpose of a mask is to hold back colored light, not to form an image. A properly made principal mask produced on KODAK Pan Masking Film 4570 appears to be a series of rather flat, unsharp densities, conforming to the general outlines of the original image. There is noticeable flare in areas where moderate differences in density meet, and nowhere is there sharp detail. When placed with an original transparency while making separation negatives, the principal mask holds back a portion of the enlarger light in certain areas, causing a change in density relationships in the negative. The crisp detail is carried through the mask by the transparency, while the flare in the mask actually helps make that image appear sharper by increasing the density difference between adjacent image areas where it overlaps.

KODAK SUPER-XX Pan Film 4142 (ESTAR Thick Base) is a moderately high-speed, panchromatic film on a dimensionally stable 0.007-inch (0.18 mm) base. It is the primary recommendation for making separation negatives because it has a remarkably long straightline portion to its characteristic curve, and will reproduce density differences as they appear in a scene, from bright highlight to deep shadow, without distortion. It is a film particularly suited for tray-processing (which is the best way to process separations) and it takes retouching well. Although it is a daylight-balanced film and its blue-speed-to-tungsten-light is slow, it tolerates the long developing times necessary to bring up the blue-separation contrast.

KODAK Separation Negative Film 4131, Type 1, is a fine-grain, moderately fast panchromatic film on the same dimensionally stable ESTAR Base. It is designed for machine processing and is used extensively by large dye transfer laboratories where high production demands automation. Although the characteristic curve of this film is a modified "S" shape, care with tricolor exposures make it a satisfactory separation material. Its fine grain also makes it attractive when large prints are needed.

Chemicals for Processing Separations

A-15

KODAK Developer D-11 is a high-contrast developer recommended for processing highlight masks made on KODALITH Pan Film 2568 or KODALITH Ortho Film 2556. The developer should be used full-strength for 2 1/2 to 3 1/2 minutes at 68°F (20°C). The developer is supplied in powder form.

KODALITH Developer is a very high-contrast developer which produces only a maximum-density image where sufficient exposure has taken place on KODALITH-type Films. It is an ideal developer for making the tiny, bright, star-like highlights needed for specular highlight masks. Develop the KODALITH Ortho Film, Type 3, for 2 1/2 minutes at 68°F (20°C). The developer is supplied in powder form in A and B components which must be mixed separately and combined in a 1-to-2 proportion just before using.

KODAK HC-110 Developer is a general-purpose developer for black-and-white films. It is primarily suggested for processing both principal masks and separation negatives. The developer is supplied as a thick concentrated liquid, which must first be diluted to a stock solution before being further diluted to a working solution. Although this may seem like an extra step, it is convenient to have a long-lasting (up to six months) supply of stock developer available. Simply dilute to the strength needed when you are ready to process; this is a great time saver. Process principal masks on KODAK Pan Masking Film 4570 in KODAK HC-110 Developer, Dilution F (a developer-to-water ratio of 1-to-79). Make a litre of working developer solution by mixing 50 mL stock solution with 950 mL of water at 68° F (20°C). Develop the films, with constant agitation for 3 minutes. Process separation negatives on KODAK SUPER-XX Pan Film 4142 in KODAK HC-110 Developer, Dilution B (a developer-to-water ratio of 1-to-15). Make a litre of working developer solution by mixing 250 mL stock solution with 750 mL of water at 68° F (20°C). (This dilution may change, depending upon the contrast required by your enlarger.) Typical processing times for separation negatives are: red-filter negative, 4 1/4 minutes; green-filter negative, 4 minutes; and blue-filter negative, 8 minutes.

KODAK Developer DK-50 is a secondary recommendation for processing principal masks and separation negatives. It is a medium-contrast developer, supplied in powder form. Masks on KODAK Pan Masking Film 4570 should be processed in a dilution of

1-to-4 of the stock solution; separation negatives on KODAK SUPER-XX Pan Film should be processed in the undiluted stock solution.

KODAK Rapid Fixer works well with these films as does KODAK Fixer or KODAK Fixing Bath F-5. KODAK Rapid Fixer works in 2 to 4 minutes; the others take 5 to 10 minutes to completely fix film.

KODAK Indicator Stop Bath or a dilute solution of acetic acid should always be used between the developer and the fixing bath when processing separation films, unlike processing matrix films, when a water rinse is used. A stop bath will arrest the developing action exactly when you want it stopped. You will find that using a stop bath will provide much more consistency in separation densities.

KODAK PHOTO-FLO Solution, diluted as recommended, should always be used as the final rinse when making color separation negatives. It is a surfactant that will prevent water spots and streaks, and promote even drying of the various films. Use every help that you can find to eliminate conditions that may cause misregister in separation sets. Do not use KODAK PHOTO-FLO Solution with Matrix Films.

A Word About Cleanliness

When a number of photographic films are processed and brought together to be printed, as they are in the dye transfer process, it is almost impossible to prevent specks and spots from appearing in the final print. Fortunately, dye prints are easily retouched, using the same dyes that made the color image. However, it is a tedious job and anything that you can do to reduce the task is well worth the effort.

Three important tools are the broom, the vacuum cleaner and the sponge-mop. Use them daily to remove the constantly raining-down of dust from the building, lint from clothing, dirt tracked-in on your shoes, and foreign material, seemingly, from everywhere. Remove it all, before it gets into your pictures.

Do not smoke in the darkroom or in the transfer room because tobacco smoke coats lenses and glass plates, thereby cutting down sharpness; the ashes will be drawn into the enlarger by the blower (or by convection) and make a snowstorm of spots. Also, smoking is an easy way to introduce photographic chemicals into your body, from your fingers-to-the-cigarette-to-your-lips, where they may do considerable harm. Do not eat in the laboratory for the same reason. Take time for lunch and rest breaks away from the chemicals; it is important for your health!

Wet-mop the floors weekly. Clean all trays, sinks, table-tops and transfer boards once a month with a sodium hypochlorite bleach, such as CLOROX, SUNYSOL, or 101 Bleach, to kill bacteria and prevent mold spores from growing and getting into the dyes. If possible, purchase an electronic dust precipitator, such as those used for sickrooms or for alleviating allergies; it will not only remove dust and smoke from small, unair-conditioned areas but also get rid of the mold spores that migrate through the air and infiltrate the dyes. These spores grow colonies of gelatinous matter that transfer to the matrices and make blots on the prints. Anything that will help to keep the laboratory clean is worth having.

BASIC DYE TRANSFER PRINTING TECHNIQUES

A-16

Because the dye transfer process evolved from earlier, well-used processes, namely, the tricolor carbro process and the KODAK Wash-off Relief Process, many of the old methods of working have carried on into the newer system. Operating techniques for dye transfer are not as clearly defined as they are for more modern color processes, such as the various color paper printing and processing systems, which are rigid and unyielding in their time and temperature demands. For the last 40 years, technicians around the world have been making beautiful dye prints -- not one of them doing it in exactly the same way as anyone else.

In the articles that follow in this book, you may find statements by one author that seem to contradict those of another. Who is to say who is right or wrong? If the print looks good, the printer did the work correctly. Color balance, density and contrast are subject to individual taste and judgement. There is really only one who can set parameters -- the manufacturer of the products that go to make up the process. And Kodak, as the manufacturer, can only set the parameters for the performance of the products, not for the manner in which they are employed. This chapter presents the procedures recommended by Kodak for making color separation negatives, matrices and dye prints, using Kodak products in the manner for which they were made.

Making Dye Transfer Prints

Starting Points -- This process can begin with a positive color transparency, a color negative or internegative, or black-and-white separation negatives made directly in a camera. The versatility to translate color information from various types of originals into a uniform finished product is one of the attractions of the dye transfer process. The finished color product can be either reflection images on paper or transparent ones on film base; the result can be in almost any size and quantity, and of the highest quality.

If the starting point is a positive transparency, color separation negatives are made on a suitable panchromatic sheet film such as KODAK SUPER-XX Pan Film 4142 (ESTAR Thick Base) by exposures through red, green and blue (tricolor) filters. These separations can be either contact size or enlargements from the original. Then three matrices on KODAK Matrix Film 4150 (ESTAR Thick Base) are made from the separation negatives by white-light exposures.

Direct color separation negatives can be produced successively in a camera through red, green and blue filters, if the scene is a still life. Three matrices are then made from those separations.

An original color negative or a color internegative is, in effect, a set of color separation negatives in the form of dye images on one sheet of film. Three matrices therefore can be exposed directly from the negative through tricolor filters onto KODAK Pan Matrix Film 4149 (ESTAR Thick Base).

Regardless of the starting point, the actual matrix processing and printing procedures are substantially the same. After exposure through the base side, the matrix films are developed in a tanning developer, fixed in a non-hardening fixer, washed in hot water to remove the untanned gelatin in the unexposed areas, and dried. The images that remain are silver/gelatin reliefs, in which the thickness of the gelatin varies with the degree of silver exposure. The matrices -- which are, in effect, red-, green- and blue-record separation positives -- are soaked in solutions of cyan, magenta and yellow dye, respectively. Each matrix takes up dye in proportion to the thickness of the gelatin. When the three dye images are transferred, one at a time and in register, onto a sheet of KODAK Dye Transfer Paper, a color print is produced.

BASIC SEPARATION NEGATIVE TECHNIQUE

A color transparency is only an approximation, although generally a satisfactory and pleasing one, of the original subject. In the entire photographic reproduction system, the greatest loss in fidelity takes place in this first step of recording the subject on film. When the transparency is reproduced, there is further loss in image quality because of deficiencies of the dyes in the photographic process. The reproduction becomes an "approximation of an approximation" and is frequently neither satisfactory nor pleasing, particularly when the original subject and the print are compared. A more accurate reproduction can be obtained by making some corrections for these deficiencies. This correction procedure, known as <u>masking</u>, is an additional step in the reproduction process, but the resulting improvements more than justify the extra effort involved.

Reproduction Errors -- Reproductions of many color transparencies can be made without masking by means of the dye transfer process, but departures from accurate color rendering will always be present. Photographs in which blues and greens predominate will appear dark and desaturated; reds and warm colors will appear light and desaturated. A-17 (A-K) Series (small)

Another important error in reproduction is caused by the fact that photographic films do not respond equally to all light levels. Less change in density occurs at both very high and very low levels of light than at intermediate levels. All films do not respond to light in the same manner. The curve that desribes the response of a film to varying amounts of light, as through a silver step tablet, is called a <u>characteristic curve</u> and is plotted on a standard graph (See page 00). In most transparencies, the diffuse highlights fall somewhere on the flat lower (toe) portion of its characteristic curve and their contrast is therefore lower than that of the middletones. When a separation negative is made from a transparency, the highlights may fall on the flatter maximum-density (shoulder) portion of that film's characteristic curve, which is again of lower contrast than that of the middletones. To further compound the error, the final photographic step of the process is to print the separation negatives onto KODAK Matrix Film 4150, which has a decided ''S''-shaped characteristic curve, flatter on both the toe and shoulder. This means that both image highlights and shadows print with less contrast than do the middletones.

Highlight Masking

With subjects that contain important highlight areas and, indeed, most photographers highlight their subjects, it is usually necessary to correct this multiple low-contrast error by introducing highlight masks to the printing system. These are negative masks that are very underexposed so that only the detail of the very lightest tones of the image are recorded. There are two methods of making highlight masks. In the first method, the highlight masks are made before the color-correction or principal masks and are incorporated into them by exposing the highlight masks in register with the transparency when the principal masks are made. These are called highlight pre-masks because they are used before the separation negatives are made. The second method consists of making rather weaker highlight masks and placing them in register with the separation negatives when the matrices are made. These are called highlight post-masks.

Because it is necessary to monitor the density and contrast of the various film components that go to make up a set of separation negatives, a standard density scale image should be placed with the original transparency when it is prepared for separating. Such a density scale is the KODAK Photographic Step Tablet. It is available in sizes to fit alongside any transparency.

KODALITH Pan Film 2568 (ESTAR Base) -- In order to correct the low contrast of the important highlight areas, a very high-contrast film is needed. Because each of the layers of the transparency has highlights in different areas depending on the color of the object depicted, those highlight areas should be color-corrected, and the film should be panchromatic. (In the past, a single highlight mask was made on KODALITH Ortho Film 2556, Type 3, and used to make both principal masks or on all three separation negatives. However, the degradation of color in the highlights led to the use of three highlight masks on panchromatic film.) KODALITH Pan Film 2568 is an ideal film for the situation. When processed in relatively high-contrast KODAK

Developer D-11, full strength, for 2 1/2 to 3 1/2 minutes at 68° F (20°C), it produces a characteristic curve that is very steep but has gradation in the high upper middletones and more than compensates for the loss of contrast in the toe of the transparency image. After development, highlight masks should be rinsed in an acetic stop bath, such as KODAK Indicator Stop Bath, fixed in a fixer such as KODAK Rapid Fixer, for 5 minutes, washed for 20 minutes in running water at 68°F (20°C), rinsed in KODAK PHOTO-FLO Solution, and dried without heat. It is important to treat these films gently when drying (no more than 110°F [43.3°C]) because extreme heat may change their dimensions and destroy register in subsequent steps.

When making separation highlight masks through KODAK WRATTEN Filters No. 29 (red), 61 (green) and 47B (blue), add WRATTEN Neutral Density Filters No. 96 of a 1.20 value (two .60 filters) to the red filter and a .60 value to the green filter to compensate for the high filter factor of the blue filter. Adding neutral density filters makes the three exposures relatively equal, thus preventing any reciprocity failure effects between the masks. At a light level of 3 footcandles at _f_/4.5 at the exposing plane and stopped down to _f_/22 + a 1.00 neutral density filter (the recommended exposure conditions), an average exposure for all three masks should be about 20 seconds. This depends upon the individual components of the exposing system -- light source, filters, lens and enlarger head (if any) -- the emulsion characteristics of the film and the condition of the developer.

Maximum densities should be about .40 for pre-masks and belowl.00 for post-masks. Again, this may vary, depending upon the contrast and flare qualities of the enlarger used to make the matrices. The masks should be balanced to each other to within a .10 density.

KODALITH Ortho Film 2556, Type 3 -- There is another type of highlight mask that is used regularly in laboratories where highest quality is the goal -- specular masks, which are used to pull out the tiny specular reflections in a scene. These are the sparkles in the water, the glittering in the crystal or any highlight that is a direct reflection of the light source. When properly made, it will effectively prevent any exposure from occurring in that part of the matrix and render the specular highlights paper-white in the print. Since no color is rendered in specular reflections, usually color correction is not necessary and an ortho film can be used. Only one mask is needed and it is used on all three separations as a postmask. The mask is developed in KODALITH Developer for 2 1/2 minutes at 68°F (20°C). A KODAK Safelight Filter No. 1 (red) with a 15-watt bulb (in a suitable fixture) can be used during processing. With a little experience, it is possible visually to determine the proper density of the specular highlights as the film develops. The masks should be rinsed, fixed, washed and dried in the same manner as other high-contrast films.

The characteristic curve shape of KODALITH Ortho Film developed properly in KODALITH Developer is nearly vertical; there are almost no gray tones at all, only complete black and absolute clear.

Because of the high-contrast characteristics of KODALITH Films, proper exposure is difficult to achieve. The only way to find the exact exposure time is to make tests with a standard set-up and a silver step tablet.

Using Pin-Register Equipment -- Pin-register equipment is necessary for the following masking and separation procedures. Such equipment need not be complicated or expensive. (Homemade pin-register systems are described later in this book.) If possible, punch film for register with the emulsion up; this will prevent the emulsion from being scratched by dirt or objects on the register punch board. Be sure that the edge of the film is completely in the throat of the punch, against the edge-guide and tightly against the back-stop. Activate the punch with one complete stroke of the lever; never punch twice. Make identifying corner cuts after punching the film. Place the punched film on the register board or printing frames by pressing it carefully onto the pins, making sure that it is fully against the base by pressing with your fingernails on each side of the pins. Enlargers, equipped with pin-register equipment and carefully braced against movement, provide the means to produce perfectly registered prints without problems.

Masks and separation negatives are marked for identification by cutting off a small portion of the corners of the films. Cut no corners on the films exposed to light from a red filter, cut one corner -- the one next to the film-code notches -- on the films exposed to light from a green filter and cut two corners -- the code-notch corner and the one nearest it -- on films exposed to light from a blue filter. (Some laboratories use modified train conductor ticket punches to put notches into the sides or end of the film.)

A-16x (A+B)

Arrangement for Exposure (Contact Masks with ''Built-in Highlight Masks) -- The highlight mask should be in sharp focus. If the mask is to be the same size as the transparency, the masking film and the original (include a silver step tablet) should be positioned with their emulsions in direct, intimate contact. Use a contact-printing frame, such as the KODAK Register Printing Frame, or other method to hold the films immobile and in register directly under the light source. Simply, a small register vacuum easel will work satisfactorily with a sheet of clear, photographic-quality glass hinged to it with black masking tape so that the glass holds the masking film flat to the register easel and can be raised to remove the transparency and exposed film. Usually no vacuum is necessary. Place the film in the contact equipment for the base side of the transparency to face the exposing light and make the exposure.

Enlarged Masks -- Place the transparency and a silver step tablet in the enlarger negative carrier, emulsion down and masked to prevent fog from stray light. Focus the image on a sheet of white film the same thickness as the separation film that you are going to use. (This can be made by painting a sheet of waste film with white latex paint.) Use a good quality magnifying grain focuser and be sure to include the image of the step tablet. Remove the focusing sheet, lock the enlarger tightly and brace it so that there is no possibility of movement. Fasten the vacuum register easel securely in place. (The integrity of this enlarger-to-easel register must be maintained until after the separation negatives are made.) Place a sheet of separation film that has been exposed to light, processed to maximum density, dried and punched for register, on the vacuum easel pins, emulsion up. (This spacer-sheet will put the masking film at the proper image-to-easel position for placing it on the separation-negative or principal mask films in subsequent steps.) Finally, punch and place a sheet of highlight masking film on the pins. Turn on the vacuum or close the glass register gate and make the exposure. Store each film after exposure in a light-tight carrying box and securely close the lid.

This preoccupation with the highlight portion of dye transfer prints may seem excessive, but it isn't, particularly for the commercial laboratory person who is making advertising illustrations. The purpose of such illustrations is to draw the attention of the readers of magazines and newspapers to a product. The first thing that the scanning eye of the average reader notices is the lighter, brighter portions of a picture. If there is interesting color and detail, the eye pauses and investigates further, initially scanning the highlights, then the middletones and finally the shadow areas. If the picture is provocative enough, the reader will finally evidence enough interest to read the caption and text of the advertisement. Highlight detail is vital to advertisers and, to a lesser degree, every maker of photographic images, for we all want the viewer to pause and study our photographs.

Principal Masking

Theoretically, it is possible to correct completely for all the shifts in hue, changes in brightness, and distortions of the tone scale which occur in the printing process if a sufficient number of masks are used. Practically, the mechanical problems of registration and maintaining definition, as well as the progressively smaller improvement gained with each successive mask employed, impose an effective limit on the use of multiple masks. Usually two types of masks are employed: highlight masks, to protect the detail of the lightest areas of the transparency, and color-correction or principal masks, to (1) correct the brightness and saturation of all colors, (2) correct the greater darkening of blues and greens relative to reds, (3) correct the darkening of greens relative to blues, (4) improve the saturation of yellows, and (5) correct the shifts in hue of greens toward blue, of blues toward purple, and of reds toward an orange-red.

These corrections are needed because color saturation, generally, suffers when a transparency, which can transmit a very high range of values, is reduced to a print, which can reflect a more limited range of values. When the contrast has been reduced, either through development or masking so detail can be retained in a scale of neutrals, the visual appearance of both neutrals and colored areas is dull. We accept the neutrals as being duller but not the colors. Through masking, we can remove ''black formers'' or complementary colors, ie. cyan from reds, magenta from greens and yellow from blues. At the same time, we can print more of the ''hue formers'', ie. cyan and yellow into green areas, magenta and yellow into red areas and cyan and magenta into blue areas. In other words, relative to the neutral scale, color areas are printed with less ''black former'' and more ''hue former.'' Colors are printed with a higher contrast than neutrals.

Even if the purity and depth, or saturation, of color were not a problem, color shift due to the limitations of the preferred dyes would still have to be recognized and corrected. The problems are as follows: (1) The function of the cyan dye is to control how much red light we see. It is cyan (blue-green) because it absorbs red. Ideally, it should only absorb red;

unfortunately, instead of freely transmitting or reflecting all of the incident blue and green, the cyan absorbs some of each and not in equal amounts -- more green than blue. This results in the cyan being spectrally and visually bluish. So, when cyan is used in the print in the forming of blues and greens, those colors appear darker than ideal, as though magenta (the black former green) and yellow (the black former of blues) were present. Since the unwanted absorptions are unequal -- more green than blue -- colors formed with this cyan will shift toward blue. Greens will appear bluer -- lacking in yellow, while blues will appear more purple-blue or lacking in green -- synonymous with saying too much magenta.

(2) The function of the magenta dye is to control how much green light we see. Unfortunately, it also absorbs some red and blue which it should not, and does so unequally -- more blue than red. The dye acts as though it contains some cyan (the black-former for reds) and yellow (the black-former for blues). This causes the reds to appear a little darker than we would like to see. It also adds to the problem of the blues being darker. Notice that we have an unwanted loss of blue light by the absorption of both cyan and magenta dyes. Since the unwanted absorptions are unequal, this again results in a hue shift. The magenta dye does not absorb red as much as the cyan dye absorbs green, so in the formation of blues -- using cyan plus magenta -- the blues will appear minus green and plus red, as if there were too much magenta in them.

In the forming of reds by combining magenta and yellow, the absorption of blue by magenta is a function that should be reserved for the yellow dye. This will make reds shift toward the yellow. They are minus blue, another way of saying they are plus yellow.

(3) The yellow dye is nearly perfect, compared to the other two. There is some unwanted absorption of green, which should be a function of the magenta dye. This causes areas printed with this yellow to appear minus green, or plus magenta. A saturated yellow will be somewhat orange, usually the least of our problems, and can be corrected when needed. More importantly, the purity of the yellow makes it appear much brighter than the other colors formed and is improved by visually increasing the saturation -- by printing more yellow in the yellow areas.

How do we use this knowledge in masking? We would need a multitude of masks to correct individually for tone scale and color reproduction errors fully. Some reasonable compromise is necessary because the mechanical problems of registration and maintaining definition impose effective limits on the use of multiple masks.

Correcting for Unwanted Cyan-Dye Absorption -- Absorption of the cyan dye in the green and blue regions is directly proportional to its absorption in the red region. If a contact print of a transparency is made on panchromatic film with a red filter over the exposing source, the black-and-white densities in the resulting negative are a record of the cyan dye. The contrast of this record can be adjusted so that it is approximately equal to the contrast of the unwanted cyan-dye image in the blue and green regions. If this negative mask is then registered with the color transparency and viewed or photographed through a green filter, the image of the cyan dye is cancelled out, leaving only the image of the magenta dye.

Correcting for Unwanted Blue Absorption -- Magenta colors in an original transparency shift toward red in a reproduction, while yellow colors suffer a marked loss of saturation and a slight shift toward orange. These changes occur even though a red-light mask is used on the transparency when the reproduction is made. Instead of making individual masks of the unwanted absorptions of the magenta and cyan dyes alone in the blue region (a procedure which would involve several register steps), you can create a compromise correction by using a green-light mask. This mask is a combined record of the magenta, cyan and yellow images. (It is developed to the same gamma as the red-light mask; otherwise the separation negatives would have to be developed to different gammas.) This green-light mask is then registered with the transparency to correct partially for the unwanted absorption of the magenta and cyan densities in the blue region. The correction is a compromise because the densities of the cyan and magenta dyes do not bear the same relationship to each other in the blue region as they do in the green.

Masking for Color Correction

This type of mask is a negative made on a continuous-tone film, exposed to the original transparency by filtered light, and processed to a low contrast. It can be either a contact mask or an enlarged mask.

Effect of a Single Mask -- With some transparencies, one mask will give acceptable results. However, considerably better results can always be obtained with two masks.

The primary function of a single mask is to correct relative brightness and saturation errors. The effect with prints made to normal contrast is to increase the saturation of all colors and to lighten the reproduction of colors complementary to the filter used in exposing the mask. For example, a magenta filter absorbs green light and thus allows less exposure of the mask through the greens in the picture than it does through the other colors. When the mask is registered with the transparency, the greens are effectively lightened in relationship to the other colors. Similarly, a mask exposed with a red filter, which absorbs both blue and green light, actually lightens the blues and the greens.

Effect of Two Masks -- Regardless of the color of light employed to expose it, a single mask used to modify all three separation negatives can accomplish no hue-shift correction. With two masks, however, it is possible to correct not only the relative brightness and saturation errors, but also the most serious hue-shift errors.

Because KODACHROME Films for Process K-14 have different spectral characteristics from EKTACHROME Films, different color masking filters should be used. Use the accompanying chart to choose the proper filters for the type of original color transparency film that you are using.

Exposing Light	Filter No.	Time
White	96 (totaling 1.20 density)	100 sec
Magenta	33	100 sec
Red	29	100 sec
Green	61	150 sec

For Process K-14 Films

Red	24	50 sec
Green	61	150 sec

KODAK Pan Masking Film 4570 -- This film is designed specifically for the preparation of masks for color transparencies and yields fine-grain images which are approximately neutral in tone, even at low contrast. In order to facilitate register of the mask on the original, the emulsion is coated on a thin ESTAR Base. It does not have an antihalation coating on the base side, and a degree of diffusion is introduced into the base material. The resulting internal flare produces an unsharp image that helps with registration, but its most important effect is to increase apparent sharpness in the final image by causing a slight edge-effect at density boundaries. Thus, it is possible to produce dye transfer prints that appear sharper than the original transparencies. (In some instances, where contact masks are greatly enlarged when making separation negatives of subjects that have sharp differences in density and color, such as a silver airplane in a blue sky, the flare introduced by the Pan Masking Film may cause a dark halo to surround the subject. In this case, either use another sharp film for masking or make enlarged masks as well as separations to reduce the degree of mask magnification.)

Single Mask Procedure -- If the greatest accuracy of color and tone reproduction is not required in the final print, prepare a single mask from the transparency by exposing KODAK Pan Masking Film through a magenta filter, such as the KODAK WRATTEN Filter No. 33. Use a light source with a color temperature of 3200K. The effect of this filter is to lighten the reproduction of greens. If lighter blues are also desired, use a red filter, such as the KODAK WRATTEN Filter No. 29.

Arrangement for Exposure (Contact Masks) -- Principal mask images should be diffuse and almost devoid of detail because they act as neutral density areas to prevent some of the light from selected portions of the original image from printing in the separation negatives. Although KODAK Pan Masking Film contains a degree of built-in diffusion, it is necessary to provide an additional amount when making contact principal masks. This can be accomplished by placing the masking film with its emulsion to the base side of the transparency and placing a sheet of KODAK Diffusion Sheet (0.003-in) between them. Consider the matte side of the diffusion sheet as the emulsion side. All three sheets should be facing the exposing light source. Even more diffusion is needed when making separation negatives in contact with larger than 4 x 5-inch transparencies. One or more sheets of cleared film base, such as that of KODAK Matrix Film 4150, can be added to the diffusion sheet.

Use the same printing equipment for making principal masks as for making highlight masks.

Enlarged Masks -- There is enough flare in any optical printing system and diffusion in the masking film so that auxiliary diffusion is not usually necessary when exposing Pan Masking Film for making enlarged principal masks. Maintain the spacer-sheet of black film on the register pins, punch and place a sheet of Pan Masking Film on the pins, emulsion up, turn on the vacuum or close the glass register gate, and make the exposure. After exposure, place each film in a light-tight carrying box and securely close the lid.

Processing -- Develop the masks for 3 minutes at 68°F (20°C) with continuous agitation in a tray of fresh KODAK HC-110 Developer, diluted 1 part stock solution to 19 parts of water (Dilution F), or in a tray of KODAK Developer DK-50, diluted 1:4. Rinse the films in an acetic stop bath and fix them in a fixer, such as KODAK Rapid Fixer, at the film dilution for 5 minutes; wash them for 10 minutes in running water at 68°F (20°C), treat them in KODAK PHOTO-FLO Solution and dry them without heat.

The density range should be approximately 1/4 to 1/3 the density range of the transparency, primarily depending on the degree of color correction and contrast reduction desired. To obtain more or less correction, increase or decrease the development time. The resulting masks should be very low in contrast, have very little detail in the subject, and be very diffused.

Newton's Rings -- The close contact between the smooth base sides of films and the smooth glass of contact-printing frames or negative carriers sometimes produce an interference pattern in the image called Newton's Rings. They appear as multiple, irregular, plus-and-minus density lines in film images and are usually most easily seen on red-filter highlight masks or separation negatives. However, they can be on other films in a less apparent state which will not show up until the print is finished. There are several ways to solve this problem. The easiest is to be sure that the sandwich of films -- transparency and masks, or negative and masks -- are of equal dimensions and close to the same size as the glass sheets in the printer or negative carrier, and that the pressure of the glass on the sandwich is as light as possible. Any unevenness in the layers of film cause different amounts of stress in areas of film-to-glass contact and makes Newton's Rings. Vacuum contact-printing frames should be set for as little vacuum as possible and spring-metal contact frame locks should be very soft because excess pressure only agravates the situation. Only pressure enough to bring the films into solid contact is necessary. Any small particles of dirt will create Newton's Rings, so cleanliness is vital. Another cause is humidity between the sheets of film and the glass, due to inadequate drying of the film during processing or damp conditions in the darkroom.

As a final resort, use a fine powder, such as OXY-DRY Offset Powder or ATF Powder (available from graphic arts dealers and used to help separate paper sheets in printing presses) to coat very lightly the base sides of films. Spray a tiny amount into the air from a small rubber syringe and, as the powder falls, pass the film through the cloud. The powder must be applied each time that films are inserted into the print frame or negative carrier. Getting an even distribution requires practice, and care should be used to avoid inhaling the powder.

An alternative method for the control of Newton's Rings is to spray the glass surface with a fine mist of gum arabic solution. Prepare a solution by adding 1/2 ounce of 14% gum arabic to 4 ounces of water. Apply the mixture with an atomizing spray bottle to the clean glass on the side that comes into contact with the film. Work in a dust-free atmosphere. Avoid spraying large droplets, which may reproduce in the photographic image, by holding the glass above the spray cloud so that only the lighter mist will hit the glass. Once the gum arabic is dry, glass can be handled with normal care and can be cleaned with a dry cloth. When it becomes necessary to wash the glass to remove fingerprints, smudges, grease or similar foreign matter, use water or window cleaning solution and reapply the gum arabic solution. Gum arabic may be purchased from drug stores, chemical supply houses, candy supply dealers and graphic arts supply houses.

Measuring Footcandles on the Easel -- As a starting point for most exposure recommendations in this book, the light measurement of 3 footcandles is given. The problem, then, for the reader is to measure the amount of light produced by his or her own enlarger light source. Using a light meter is the most direct way. Meters which are designed to read the brightness (luminance) of a surface or the amount of incident light (illuminance) in an area are calibrated to match as closely as possible the spectral response of the human eye. On the other hand, most exposure meters, including the built-in type of 35 mm cameras, which are designed to give information for the exposure of photographic films, are calibrated for the wide range of situations in which photographs are exposed. Unless modified, they do not perform well at very low levels of illumination.

In the absence of a properly calibrated light meter, you can estimate to within a stop of exposure the luminance or illuminance values of a darkroom light source by using an exposure meter and an 18% neutral test card and by following this table. Set the meter for 1/30 of a second and a film speed of ASA 400. Hold the meter close enough to the gray card so that it "sees" only the card and not some brighter or darker background. Convert the meter reading to the appropriate *f*-number and consult the table for the desired value of luminance or illuminance.

	LUMINANCE		ILLUMINANCE	
f-number	cd/ft2	Footlamberts	Footcandles	Lux
1.0	0.08	0.26	1.5	16
1.4	0.17	0.52	3.0	32
2.0	0.33	1.05	6.0	63
2.8	0.67	2.1	12.0	125

4.0	1.34	4.2	23.0	250
5.6	2.67	8.4	47.0	500
8.0	5.35	17.0	93.0	1000
11.0	10.7	34.0	190.0	2000
16.0	21.4	67.0	375.0	4000
22.0	43.0	135.0	750.0	8000

Making Separation Negatives

The final step in making separations is to combine the images of the principal masks, with or without the highlight masks built into them, and the transparency into carefully balanced and properly exposed black-and-white silver negative films. These separation negatives should contain all of the image information in the transparency in contrast and in densities that can be easily printed onto matrix film. The separation negatives should be processed for archival keeping, for they will store the color of your images indefinitely without changing.

Orientation of the Principal Masks -- If the matrices are to be exposed by enlarging the separation negatives, register the principal masks on the base side of the transparency, then place the emulsion side of the transparency so that it faces the emulsion side of the separation negative film and expose either by contact or enlarging (See diagram on page 00).

If the matrices are to be exposed by contact, register the masks on the emulsion side of the transparency, then place the transparency so that its base side faces the emulsion side of the separation negative film and so that the emulsion sides of all three films face the light source. The separation negatives can be exposed by contact or enlarging. Prints made by this method are not as sharp as those produced by the first method. Using a point-light source will improve the sharpness.

Arrangement for Exposure (Contact Separations) -- Use the same equipment for making separation negatives as for creating the masks. Arrange the transparency and the separation film, emulsion-to-emulsion, with the principal mask emulsion facing and in register with the base side of the transparency. Place the three films so that the base side of the principal mask faces the light source.

Enlarged Separations -- Remove the black spacer-sheet of separation film from the register pins and replace it with an unexposed sheet of separation film, emulsion-side toward the exposing light. Then place the principal mask on top with the emulsion toward the light (See diagram on page 00). Close the glass register gate and make the exposure.

KODAK SUPER-XX Pan Film 4142 -- The film that is first choice in making separation negatives is KODAK SUPER-XX Pan Film 4142. It is panchromatically balanced and has an extremely long straight-line portion to its characteristic curve. This means that, although exact contrast balance in a set of separation negatives is still important, the exposure has a fairly wide latitude. The long straight-line portion of the curve will accommodate exposure differences without causing highlight or shadow detail to be recorded on either the shoulder or toe of the curve and create off-color in the print. When separation negatives on SUPER-XX Film have varying highlight densities, for instance, it is only necessary to compensate for the difference when exposing the matrices. The film is excellent for tray processing and is tolerant of rough handling.

KODAK Separation Negative Film 4143, Type 1 -- Another good film for making separation negatives is KODAK Separation Negative Film 4143, Type 1. This film is equally panchromatic and is designed for machine-processing, although it can be processed carefully in a tray and has a modified "S"-shaped characteristic curve. Both contrast and exposure must be precisely balanced in a set of separations for the highlights and shadow areas to print properly. Many people use Separation Negative Film 4143, Type 1, because of its fine-grain characteristics when making negatives for extremely large prints.

Exposure -- The following is a guide for making exposure tests to prepare separations from transparencies. Begin with using the information to adjust your equipment and determine exact exposure data for your own system. Remember, contrast and color balance are personal choices, influenced by the characteristics of your enlarger and method of processing. The only true test of your system is a finished dye transfer print.

Adjust an enlarger, equipped with a tungsten bulb, to give 3 footcandles of illumination at the exposure plane (measured without filters) with the lens set at *f*/4.5. These exposure suggestions are for average transparencies; use 1/2 stop more exposure for low-key subjects, 1/2 stop less for high-key originals. A density of 2.8 in the transparency should, in a properly exposed negative, reproduce with a density ranging between 0.35 and 0.40.

Color of Exposing Light	KODAK WRATTEN Filter No.	Use Mask Made KODAK WRATTEN Filter No.	Exposure Time At *f*/8
Red	29	29	25 sec
Green	61	29	15 sec
Blue	47B	61	30 sec
For Process K-14 Films			
Red	24	61	8 sec
Green	61	24	15 sec

Blue	47B	61	30 sec

After exposure, place each film in a light-tight carrying box and securely close the top.

Making Direct Separation Negatives

Making separations from still-life subjects and copies of color photographs and artwork is a viable part of dye transfer printing. Since photographs of three-dimensional subjects are not copies of other photographs, much of the color-correction is not necessary but contrast masking is still needed. Good negatives can be made with a sheet-film camera and the same tricolor filters used for making separations from transparencies. Copies of color photographs and artwork are photographed in the same manner and postmasked from the processed separations. Contrast control and color correction for the printing dyes are possible by using the same films and techniques as for transparencies. Since film for sheet-film cameras does not always lie in the same plane in different holders, you should use only one holder, unloading and reloading it in total darkness between changes of filters. The camera should be firmly braced and weighted to eliminate movement during or between exposures.

A paper reflection scale of neutral gray steps, such as the KODAK Gray Scale included in the KODAK Color Separation Guides, No. Q-13 (Small) or No. Q-14 (Large), should be placed in the scene or at the edge of the flat copy and included in the negatives.

Exposure -- When KODAK SUPER-XX Pan Film 4142 is used in a conventional camera to make separation negatives directly from the subject, typical exposure conditions with 450 footcandles of tungsten illumination (3200K) on the subject are shown below.

Color of Filter	KODAK WRATTEN Filter No.	Camera Lens Opening	Exposure Time
Red	29	*f*/16	15 sec
Green	61	*f*/16	12 sec
Blue	47B	*f*/16	20 sec

Processing

A-18

Develop the first separation tests at the times given below. Adjust the times to obtain the desired density range and a balanced contrast (gamma) of the three separation negatives. From normal subjects, a density range of about 1.2 is desirable.

The gamma of the unmasked separation set should be about .90 (see page 00).

In the processing room, arrange three trays slightly larger than the films to be processed. (Don't use large trays to process small films; the unnecessarily large liquid surface will both oxidize the developer quickly and cause rapid cooling of all solution temperatures due to evaporation). Use a stop bath after the developer, followed by the fixer. Also use a volume of liquid to fill the trays to about 3/4-inch in depth. Be sure to use the developer only once and discard it. The stop bath and fixer may be used for processing several sets of separations or until the film takes longer than 30 seconds to clear in KODAK Rapid Fixer or longer than 1 minute to clear in other fixers.

Bring the chemicals to the proper temperature of 68°F (20°C). (It is wise to tray-process separation negatives in a surrounding tempering bath, such as a water jacket or larger tray, containing a volume of water at the proper temperature in order to maintain the processing solutions at the desired temperature during the entire processing cycle). Set the processing timer to the longest developing time. Turn out the lights and remove the separation films from the light-tight carrying box. Arrange them in order of longest to shortest developing times, identifying them by means of their clipped corners. The normal sequence is blue-filter separation, then red-filter separation and, finally, green-filter separation. Place the films where they will not be splashed by the processing solutions. Start the timer and immediately immerse the first film in the developer, emulsion down, then flip it emulsion up, then emulsion down. This action will remove any air bells clinging to the film surface. Continue constant agitation until time for the second film to be introduced to the developer solution. Wait until 5 seconds after the exact starting time for the second film, then immerse it in the same manner as the first film. Finally, immerse the third film 10 seconds after its exact starting time and go through the introduction procedure. When all films are in the developer, start a constant, interleaving agitation action by removing the bottom sheet of film from the tray and putting it on top, rocking the tray at the same time. The films should all be emulsion down during the interleaving agitation. After each cycle of three films, remove the films from the developer from a side of the tray 90° to the previous one to prevent developing streaks. Five seconds before the timer reaches zero, remove the sheet of film that was started first from the developer and drain it for 5 seconds. Transfer it to the stop bath and agitate it with one hand while you remove the second sheet in order, drain it for 5 seconds and transfer it to the stop bath. Continue with the last sheet in the same manner. This procedure will insure that all sheets of film receive the proper length of developing. Interleave the films in the stop bath for one cycle and place them in the fixer, draining and agitating as in the developer-to-stop bath procedure. Fix the films for the time recommended for the type of fixer that you are using, then wash them for at least 20 minutes in running water at 65 to 70°F (18.5 to 24°C) and hang them, in the same orientation, to dry in a dust-free place without heat.

Since separation negatives are permanent records of the color and shape of a photographic subject, they should be processed for archival storage and preservation. The Kodak Publication No. F-40, Conservation of Photographs, provides details of proper techniques for the care of valuable images.

Dye Transfer Process	KODAK Developer*	Development Times (Minutes) Red	Green	Blue	Approx. Gamma
Color separation negatives directly from subject or masked color transparency with unmasked step tablet.†	HC-110 (Dil. A)	4 1/2	4 1/2	7	0.90
Color Separation negatives from transparencies	HC-110 (Dil. B)	4 1/2	4 1/2	7	0.70

and step tab-
lets that are
unmasked or
transparencies
and step tab-
lets that are
masked.

---

*Tray development at 68°F (20°C) with continuous agitation.

†Using tungsten illumination as light source.

PRACTICAL DENSITOMETRY

Successful mastery of any photographic process depends upon having a small knowledge of the scientific facts that make it work. Because the dye transfer process -- particularly the separation-negative portion -- effectively reduces a color image to its basic components, alters them and then reassembles them in a new color form, basic familiarity with the laws of densitometry will help considerably in understanding the way changes are effected. This chapter is intended to acquaint you with the basic principals of plotting and interpreting densitometric data. It will tell you how to make density readings with a densitometer and how to make the proper changes in exposure and processing of films to balance the resulting density curves.

The Language -- Densitometry is part of a larger science called sensitometry, which can be called the determination of the photographic characteristics of light-sensitive emulsions. Densitometry is the practical, density-measurement part of that science. It deals with light-measuring instruments called densitometers, which are used to gather data that will let us determine the photographic characteristics of a film or paper. A transmission densitometer is used to measure the amount of light that passes through a film. A reflection densitometer measures the light that reflects from the face of a print.

A19

Some of the terms of the science are: Density, which, in the sense that we will use it, relates to the amount of developed silver (or dye) in any area of a negative, color transparency, color negative or print. It is a measure of the "light-stopping power" of that area. Density is the logarithm to the bas 10 of the opacity or reciprocal of the transmission. The figures used to express density -- those on the scale of the densitometer -- are derived by this formula: TRANSMISSION = the amount of light that gets through a given area divided by the total amount of light that strikes that area. Transmission is symbolized by the letter "T" and is expressed as a percent. A transmission of 85% (T = 85%) means that 85% of the light that hits any specific part of a negative or transparency gets through.

Opacity is the opposite of transmission. Stated algebraically O = 1/T. In the example above (T = 85%), the opacity (O) is 1/0.85 or 1.176. OPACITY = the total amount of light that hits a given area divided by the amount of light that gets through.

Density relates directly to opacity; it is the logarithm to the base 10 of the opacity. D = log O (or D = log I/T).

The density in any part of a negative depends on the exposure which that part of the film received and the amount of development given to it. In any negative, the density changes that we see are because the individual areas received different amounts of exposure. With any given degree of development, the density anywhere in the negative depends on the exposure at that point.

To get a diagram of the density/exposure relationship, read the densities of a silver step tablet with a transmission densitometer and plot them against the logarithms of the exposures used to produce them (See graph). The resulting curved line is called an H & D Curve (after Hurter and Driffield, the men who devised it), or a D-log E Curve. We will call it the Characteristic Curve of the particular type of film used because it actually describes the photographic characteristics of that film.

A-20
A-21
A-22

Densities falling on the toe (A-B) and the shoulder (C-D) portions of the curve are not directly proportional to the logarithm exposures. B-C is the straight-line portion of the curve; the density in the film increases proportionately with the logarithm of the exposure.

The slope of the straight line (tangent of the angle between the line and the log E scale) is gamma. Generally, the longer you develop any film, the higher the gamma, until it reaches a limit. The higher the gamma, the greater the contrast of the negative due to development. Other factors which combine to make the total -- or printing -- contrast are subject contrast, lighting ratio, flare in the optical systems of camera and enlarger, and even fog from safelights and light leaks in the darkroom. When we talk about gamma, we are referring to development contrast only.

Remember that, in the straight-line portion of the characteristic curve, the density of the film increases an equal amount for each logarithm exposure increase; therefore, there is good tone separation in those areas of the picture that are composed of straight-line densities. In the toe and shoulder regions of the curve, equal logarithm exposure differences don't produce equal density differences, so the tones in the shadow and highlight areas of the picture are compressed, the tone separation is much less than in the straight-line portion, and there is less contrast.

The highlights of a negative should not fall on the shoulder of the film's characteristic curve anymore than is necessary. If too much of the highlight detail falls on the shoulder due to overexposure, it will be lost in tone compression. A high-contrast auxiliary negative, containing exagerated tone separation, can be added to the negative in the form of a highlight mask which will restore the missing detail.

Part of the shadow densities normally fall on the toe portion of the curve, giving the black, detail-less shadows in the image. However, if too much of the toe is used for image density due to underexposure, the shadow tone separation will be poor. A medium-to-low-contrast positive auxiliary mask can be made from an overexposed negative and added to the printing negative. This will raise some of the densities of the shadow areas out of the toe region and onto the straight-line portion of the curve, thus permitting the shadow area to be printed legibly.

In the case of gross overexposure or underexposure, the resulting prints will be flat (low in contrast), with important tones in either the highlights or shadows lost to extremely little separation. If we expose and develop our negatives so that as few densities as possible fall on the toe or shoulder, the resulting prints will be good. The choice of a film that has a long straight-line portion to its characteristic curve provides a better chance to accomplish this task.

Judging Negative Exposure -- After your transmission densitometer has had its daily calibration, read the density of the clear, unexposed edge of the film and record the reading as the base-plus-fog density. Next read the density of the shadow area -- the lightest part of the image that has detail -- the shadow density. Subtract the first reading from the second. If the difference is less than 0.05, the negative is too underexposed to print. Remake the negative with more exposure. The difference between the base-plus-fog density and the shadow density should not be less than 0.05 or more than 0.25.

Negative Density Range -- Read the highest diffuse density in the darkest area of the negative, that is, the area where there are the highest highlight tones with printable detail. Read the density in the shadow area where you want detail to print. Subtract the shadow density from the highlight density; the difference is the density range. For example:

Highlight density=	1.18
Shadow density=	(-)0.13

Density Range=	1.05

In most photographs, there are objects that reflect brightly the image of the light source. Such reflections are called specular reflections and contain no detail. They should print as white, since they are the densest portions of the negative.

(Sometimes it is necessary to put a very high-contrast highlight mask, a specular mask, on these areas to preserve them.) Do not include specular highlights in the area measured for the density range.

Recording a Characteristic Curve -- Use a KODAK Photographic Step Tablet No. 2 or No. 3 as the original subject. This is a piece of photographic film containing a series of 21 densities running from about 0.05 (base-plus-fog density) to about 3.05. Each step differs from the preceding step by a density difference of about 0.15. Read the densities of the step tablet and record them. This "calibrates" the step tablet for your purposes. However, you can assume that the steps are actually 0.15; any minor deviations will not matter in making comparisons.

Make a contact print of the step tablet using your enlarger as a light source. Adjust the magnification to get 3 footcandles of illumination at the exposure plane with the lens set at *f*/4.5. Reset the lens to *f*/16 and use an exposure time of 10 seconds. Use a contact-printing frame with a black backboard, or back up the film with black paper to prevent flare. Use the film that you plan to utilize for making separation negatives. Process the exposed film for the normal time suggested in the instructions, or use your own data. Dry the film and read the image of the densest step of the original (lightest in the negative) on a transmission densitometer. It should read about 0.10 in a properly exposed negative. Remake the test until you get close.

Using KODAK Curve-Plotting Graph Paper or ordinary graph paper, plot the density readings (See chart). It is a good idea to make a number of tests, using your normal procedure, until you have made a few plots. You will then know if you have to modify your routine or not. Write the density readings beside the densities of the original step tablet, but backward. That is, start with the heaviest densities of your test scale, and write them opposite the lightest densities of the original step tablet, as shown below.

Step No.	Original Density	Density of Test
1	0.08	2.19
2	0.26	2.12
3	0.41	2.02
4	0.57	1.93
5	0.73	1.82
6	0.86	1.73
7	1.01	1.63
		and so on

KODAK Curve-Plotting Graph Paper -- This specially designed graph paper is designed to provide a quick and easy way of plotting step-tablet and gray-scale images made on black-and-white and color films. The semitransparent paper stock enables you to superimpose two or more sheets for easy direct comparison. The vertical lines marked 1 through 21 along the bottom of the graph represent the 21 steps of the KODAK Photographic Step Tablet No. 2 or No. 3. Plot the density of each step in the step-tablet image on the vertical line corresponding to the step number marked on Line A. With a KODAK Photographic Step Tablet No. 1A (an 11-step tablet), use only the odd-numbered lines marked on Line B. Consider the starting point at the far right (Step No. 1) as zero and proceed to the left. The smallest unit division is 0.02. Step No. 2 is 0.15, No.3 is 0.30, etc. The scale is set up from right to left to represent increasing exposure from left to right; the least exposure comes through the highest densities of the step tablet.

The horizontal axis of this graph is called the abscissa and the vertical axis, upon which the density increases in 0.02 units, is the ordinate. The KODAK Gray Scale included in No. Q-14, KODAK Color Separation Guides, has 20 steps; image densities are plotted on the vertical lines above the increments along Line C. The 10 density values printed on Line D represent the steps of a KODAK Gray Scale (included in KODAK Color Separation Guides), a 10-step reflection scale that can be placed in scenes for sensitometric measurements when direct, in-camera separations are made. Plot the density of each step in the gray-scale image (from negatives containing the gray scale) along vertical lines drawn from these points. The eight density values printed on

Line E represent the gray scales in No. R-28, KODAK Professional Photoguide and No. R-19, KODAK Color DATAGUIDE.

You can order No. E-64, KODAK Curve-Plotting Graph Paper, in envelopes containing 25 sheets from your photographic dealer.

Plotting the Characteristic Curve -- If you use KODAK Curve-Plotting Graph Paper, plot the densities in the test scale above the 21 points in Line A on the abscissa that represents the steps of the tablet. If you use regular graph paper, start the abscissa scale at the right with 0.0 and then plot the densities of the test scale above the actual densities of the original step tablet. In either case, the shape of the resulting curve will be the same.

For example, if Step No. 1 has a density of 2.19, make a dot at that density level on the vertical line over the figure "1" on the KODAK Graph Paper or right over the density of original Step No. 1 (which is 0.08) on the abscissa of the regular graph paper. Step No. 2 plots at the 2.12 density level over figure "2" on the KODAK Paper or over 0.26 on the regular paper, and so on. When you have plotted all the steps, you should have a line of dots like Graph A.

Now, draw a smooth curve through the average of the points. Don't try to connect each individual dot to the next one because they never line up perfectly. Your first curve should look like Graph B.

Gamma -- To figure gamma, pick any point on the straight-line protion of the curve and count to the right 30 small units (0.6 on the lower axis). Now count the small units up to the curve (on the vertical axis). Perhaps there are 27 of them. Then GAMMA = the vertical distance divided by the horizontal distance: 27/30 = 0.90, as shown in Graph C.

When you make a characteristic curve of a film by contact and then use the same film to make an enlarged characteristic curve, you will find that the curve from the enlarged image of the step tablet will not coincide with the contact curve. It will not be as straight in the straight line and it will not have as low a minimum density. The reason is the flare that is inherent in any enlarging system. Flare can be reduced by using super-coated lenses and by reducing reflections in the enlarger head and bellows but it cannot be eliminated. However, it can be compensated for in the processing of the film.

Gamma can be controlled by development. Longer developing times or higher solution temperatures will increase gamma; shorter development times and lower temperatures will lower gamma -- within limits. This makes it possible to take three identical sheets of film exposed through red, green and blue filters that have different filter factors and different resulting contrasts, and process them to exactly the same gamma by using three different developing times. Thus, making balanced sets of separation negatives is possible.

The characteristic curves of the KODAK Films used in making separation negatives, as well as the curves for KODAK Matrix Film 4150 and KODAK Pan Matrix Film 4149, are reproduced here along with sensitometric data for each. Study will show why masks are needed to combine these films to produce a relatively even density response from highlights to shadows in the print.

Interpretating Gray Scales in Separation Negatives -- A color-balanced set of separation negatives should have the same contrast, as well as approximately equal densities, in corresponding steps of the step tablet. In order to evaluate the results, the densities of the steps in the three step tablets should be read, plotted and compared. A-23 A-24

This section describes the evaluation of separation negatives made from a transparency, but the same principles apply to direct separation negatives.

After the desired densities and contrasts have been obtained consistently in exposing and processing tests, dispense with the plotting of each step; instead determine the density ranges from corresponding steps in the three negatives that most closely match those of the diffuse highlights and shadow densities in the red-filter negative. This will save considerable time in producing routine separation sets. However, a step tablet should always be included with every transparency that you separate. Use the small-size KODAK Photographic Step Tablet, No. 1A, with 35 mm and 2 1/4-inch transparencies by enlargement, the No. 2 Tablet for 4 x 5 and 5 x 7-inch films and the No. 3 Tablet, or part of it, for 8 x 10-inch transparencies, when making contact separations. The readings that you will get from silver step tablet images that are enlarged will differ from the readings from contact images. Light passing through an enlarged step tablet will be scattered by the silver grains by a phenomenon known as the Callier Effect. (The Callier ''Q'' Factor for photographic silver is 1.40; for dye in gelatin it is 1.00. That means that silver images scatter light 40% more than do dye images). Enlarging of the image permits this effect to broaden in the image of the silver step sale by 40% over the dye image. Select image areas for obtaining absolute density values (such as those used for determining exposure) and the external scale values for comparing the red, green and blue separations for relative density and contrast.

Plotting Densities from a Transmission Step Tablet -- Follow the instructions in the section on Plotting the Characteristic Curve on page 00 to record the densities of each of the three separation negatives. Use a separate sheet of KODAK Curve-Plotting Graph Paper for each negative; and use red, green and blue pencils for drawing the curves of the appropriate negatives.

A French Curve, which can be purchased at art supply stores, is a valuable aid in connecting the density dots on the graph.

Interpreting the Curves -- The curves of a perfectly balanced set of separation negatives are not only alike in shape and slope, but superimposed (See the graph on page 00). If the curves are parallel but do not coincide, the development times were correct but the three exposure times were not properly balanced. If the curves are not parallel, the development times were incorrect (See the graph on page 00). If the density range of the transparency recorded in each of the separations is the same, compensation for a slight fault in coincidence can be made by adjusting the matrix exposures. However, if the lateral displacement is greater than 0.15 in either direction, the separations should be remade with the proper exposure corrections.

The exposure corrections can be found from the chart shown here. If the densities of the transparencies are satisfactorily recorded on the straight-line portion of one of the negatives, its exposure need not be changed. The exposure for each of the other negatives can be corrected by measuring the distance, in terms of the units on the horizontal (log exposure) scale, that each of the curves needs to be moved either to the right or left. For example, if two curves are superimposed and the third is displaced to the right by a density difference of 0.3, the exposing time for this negative should be multiplied by 2. The A-25 distance that the curves need to be shifted in order to bring the reproductions of a fairly neutral shadow density of the transparency to the recommended minimum density of 0.4 in the negatives is measured along the horizontal scale.

Determining the Density Range -- Once a set of well-balanced A-26
color separation negatives has been obtained, determine the A-27
density range of the negatives. From the two points on the A-28
horizontal scale corresponding to the highlight and shadow A-29
densities in the original transparency, draw lines vertically A-30
until they intersect the curves of the separation negatives. At A-31 A-32
these points, extend the lines horizontally to the left to the vertical (density) scale. The difference between these values, which is the density range of the negatives, should be about 1.2 for a transparency with a long brightness range. In the dye transfer process, however, compensation for separation-negative density ranges as low as 0.9 or as high as 1.8 can be introduced by altering the composition of the matrix film developer.

MAKING MATRICES

Matrix exposures are made through the base of KODAK Matrix Film 4150 from color separation negatives. (Making matrices from color negatives on KODAK Pan Matrix Film 4149 will be discussed later). Organize the separation negatives so that each matrix image will appear in its correct left-to-right position when seen through the base of the film. The dye images will then be oriented correctly when they are transferred to paper. After each matrix is exposed, it should be identified by the clipped-corner system to prevent mistakes in later operations.

Using KODAK Matrix Film 4150

This film is designed specifically for preparing dye transfer matrices from color separation negatives. The emulsion side is toward you when you hold the film with the code notch at the top of the upper right-hand corner. To facilitate exposure through the base, KODAK Matrix Film has a clear backing. Since exposures are made through black-and-white negatives, the emulsion is primarily blue-sensitive. The yellow dye that is incorporated in the emulsion makes the film quite visible under the light of the KODAK Safelight Filter No. 1, which is recommended for use during handling and processing. After the film is developed in a tanning developer and fixed in a non-hardening fixer, it is washed in hot water, the dye dissolves out and the unexposed portions of the emulsion wash away, leaving a gelatin relief image with a rather faint silver optical image.

Contrast Control -- A degree of contrast control is possible when exposing KODAK Matrix Film by changing the quality of the exposing light source. For example, a condenser-type enlarger will tend to give higher contrast; a cold-light (fluorescent) diffusion-type enlarger will give a lower contrast. A KODAK WRATTEN Filter No. 35 (violet) over a tungsten light source will give less contrast than white light, whereas a WRATTEN Filter No. 6 (yellow) will increase the contrast. The amounts of change depend upon the type of enlarger and the condition of the enlarger bulb, and you must make tests with your equipment to use these controls. Filters should be positioned in the enlarger head above the negative carrier, if possible. If they must be placed below the lens, be sure that they are clean and held flat and parallel to the lens board.

Temperature and Humidity -- Keep unopened boxes of matrix film in a cool place, preferably in a refrigerator, for short periods of storage. Store boxes of matrix film for relatively long periods in a freezer to prevent any change in the sensitometric characteristics. Remove boxes from a freezer 12 hours, and those stored in a refrigerator 3 hours, before opening them for use.

Prolonged exposure of matrix film to humidity higher than that under which the film was packaged (50% RH) may lead to changes in photographic quality. To minimize such changes, open the foil envelope in which the film is packed by tearing off as little of the longer tab of foil as possible, then remove the required number of sheets of film, press out as much air as possible from the envelope and make a double fold in the remaining foil tab. Replace the package in the triple-section box and return it to a refrigerator. Do not put opened boxes of film in a freezer because ice crystals may form in the emulsion from invading humidity.

Under low-humidity conditions, handle matrix film carefully to avoid static marks. Static can usually be minimized by using a small humidifier in the darkroom in winter months or whenever the humidity is reduced. Do not pull single sheets from the foil envelope containing the film; rather, remove the entire quantity of film and peel single sheets from the top of the stack. Always replace the extra, unusable sheet of film (with the clipped corner) that protects the emulsion side of the films from abrasion, and the cardboard protector sheets before replacing the film in the foil envelope. (In every box of film, you will find a quantity of yellow interleaving folders. Use them to store the processed matrix sets. Place one folder within another, thus making a multiple page form with three spaces to hold the matrices safely).

Always handle sheets of matrix film carefully. If the film is bent sharply, kink marks (crescent-shaped plus-density marks) may be formed in the area. Handle the film only by the edges to prevent finger marks and in such a way that each matrix of a set receives as nearly identical treatment as possible during exposure, processing, drying and printing.

Exposing

Matrices by Enlargement -- It is most convenient to have a pin-register system built into the enlarger and use a register vacuum easel to hold the matrix film. However, matrices can be made, unpunched, by placing each of the separation negatives, in turn, in the same position in the negative carrier. This will help prevent misregister and color wedging, and provide the maximum useful picture area in the finished print. Organize the negatives so that the image on the easel is in the normal right-to-left position. Tape an oversize sheet of thin white paper to the easel. Trace on the paper a few key lines and points from the projected image of the lead negative. Secure the easel in place. The next negative can then be positioned by moving the negative carrier until the image falls approximately on the marks.

When placing the matrix film on the easel for exposure, cover the white paper with a sheet of black paper to prevent flare in the matrix. Remember to place the matrix film on the easel with the emulsion down. Mask the film so that there will be unexposed strips about 1/2-inch on three sides and about 1 1/4-inch on one end of the matrix so it can be handled and punched outside of the image area. Use a clean piece of glass to hold the film flat during exposure.

If your equipment includes a pin-registered enlarger and a register vacuum easel, no tracing is necessary. Simply place the separation negatives on the pins of the negative carrier in the proper orientation, place the negative carrier in the enlarger and secure the register lock. Punch the matrix film before you place it on the pins of the vacuum register easel (emulsion down), turn on the vacuum and make the exposure. Your separation set will be in register if nothing is moved during or between exposures.

Matrices by Contact -- Use an enlarger, a modified safelight lamp or a point-light source to expose contact matrices. Maximum sharpness in the matrix is obtained by using a small light source at a considerable distance from the printing frame. Mask the matrix to provide a "safe edge" around the four sides of about 1/2-inch on three sides and 1 1/4-inch on the end to be punched. Orient the separation negatives in the printing frame so that the image appears correctly when viewed through the glass. The KODAK

Register Printing Frame can be used if the separation negatives have been exposed on the same pin system.

Effects of Exposure on Print Quality -- A correctly exposed and processed matrix, when dyed and the dye transferred to paper, shows a just-perceptible transfer of color in the highlights. The exposure given to the cyan printer (exposed to the red-filter separation negative) is usually used to establish the overall density of the print. When a set of dyes is properly balanced, whites, grays and blacks in the picture will reproduce as neutrals in the print when all three matrices have equal densities in those areas. A slight adjustment of color balance can be made at the transfer stage, but the first objective is equal densities in neutral areas of all three matrices. Compensation for any density differences among the separation negatives must therefore be made in exposing the individual matrices. Personal preferences to warm or cool neutrals can be satisfied by slightly adjusting the yellow printer exposure.

Determining Matrix Exposure -- Make a test exposure from each new set of separation negatives, as follows: Expose a diffuse highlight area of the subject from the red-filter negative onto KODAK Matrix Film and process the film through the wash-off step. With your fingernail, scratch the emulsion in the white highlight area in the test strip. View the test strip against a dark background by oblique transmitted light. The unscratched area should be just perceptibly darker than the scratched area.

Alternatively, dye the test strip in cyan dye and transfer it to KODAK Dye Transfer Paper, as outlined on page 00. View the print through the red filter with which you made the separation negative. The cyan image from a correctly exposed matrix will look like a properly exposed black-and-white print of flesh and other warm colors. Compare the image of the print to the transparency through the red filter; they should look similar, allowing for the difference of density range between a reflected-light image and a transmitted-light image.

With the proper exposure known for the red-filter separation negative, determine the exposures for the green- and blue-filter negatives by using a transmission densitometer and calculating the difference in highlight densities in logarithm exposure times, using an electronic calculator or the graph on page 00.

You can utilize an on-easel photometer (color analyzer) to record the highlight densities and exposure times of a perfect set of matrices and use the information to make very close first-tests on future sets of separation negatives. Use the white (no filter) channel for reading diffuse highlight areas or the second or third steps from maximum density of the step-tablet image on the easel. A-33

Registering Matrix Films

Unless matrices have been exposed in register, they will have to be registered visually after they have been processed, dyed and dried. To save time, the matrices can be dyed directly after the last step in the processing and then dried. It is very important to use freshly filtered dyes, otherwise foreign particles may become permanently embedded in the soft gelatin relief image. When they have been dried once, the relief images are somewhat more resistant to physical damage. Carry out the first four steps in the transferring routine on page 00, then hang the matrices to dry, taking care to hang them in the same orientation.

Using the KODAK Register Punch -- Mount the KODAK Register Punch beside the screen of a horizontal illuminator so that the illuminator surface will support each matrix at the level of the mouth of the punch. Use an illuminator that does not get hot because heat can damage the matrix images, and be certain that the matrices are thoroughly dry before you start to register them. Use cotton gloves to handle the matrices, and be certain that the surface of the illuminator is clean.

First, superimpose the three dye images approximately in register, and make sure the matrices coincide to about 1/8-inch along the edge that is to be punched. If they do not, trim one or two of the matrices as required.

Start by placing the cyan (the red-filter negative) matrix, emulsion side up, as far into the throat of the punch as possible, then pull it back a fraction of an inch. Tape the cyan matrix in that position, and punch it. Without moving the cyan matrix, carefully superimpose the magenta (green-filter negative) matrix on it and, with the aid of a magnifying glass, check the register in three widely spaced points. Use small highlights as guides and look for edges of cyan or magenta dye. When such edges become blue (the combination of cyan and magenta), register is good. Secure the matrix with tape that does not overlap the cyan matrix tape, and punch and remove the magenta matrix. Finally, register the yellow (blue-filter negative) matrix over the cyan matrix in the same manner, looking this time for yellow and cyan edges to change to green, indicating good register. Remove both matrices and prepare to make full transfers. The three matrices should not be punched simultaneously for fear of damaging the register punch.

Using KODAK Pan Matrix Film 4149

A-34

This film is designed to make dye transfer prints from color negatives and internegatives. It has a fast, panchromatic emulsion and must be handled and processed in total darkness. The insoluable black pigment that acts as a limiting factor for the exposing light makes the film difficult to see during the exposure to the color negative, and the duration of the exposure must be gauged in some other way than by watching the easel. The pigment remains in the image portion of the processed matrix giving it a very contrasty and heavily-exposed appearance. KODAK Pan Matrix Film is punched during manufacture to fit the KODAK Register-Pin System on the KODAK Register Printing Frame and on the KODAK Vacuum Register Board (no longer manufactured), so register is automatic.

Expose the matrices with the emulsion side of the color negative facing the base side of the Pan Matrix Film. The matrix images appear in their correct left-to-right positions when seen through the base of the matrix film, and the dye images are correctly oriented on the paper print.

This film is particularly susceptible to damage by heat and humidity because of its thick, fast, unhardened emulsion. Keep sealed boxes of Pan Matrix Film in a freezer, and return opened boxes to a refrigerator after removing the film needed for the printing session; reseal the foil envelope with a double fold. Film that has been damaged exhibits a thick, black, rubbery skin of fogged surface emulsion in the maximum-density parts of the developed image that will not wash away with normal treatment in the hot-water wash step. Such areas can be removed by carefully loosening the puckery skin with a retouching brush and washing it away with a gentle stream of hot water. Work under the surface of the hot-water bath and do not allow the emulsion to dry before all the unwanted emulsion is removed.

The matrices of a set include one made through each of the following filters: KODAK WRATTEN Filters No. 29 (red), No. 99 (green) and No. 98 (blue). A WRATTEN Filter No. 47B (blue) can be substituted for the WRATTEN Filter No. 98, if the exposure time proves to be too long.

A tungsten light source of 3200K can be used for exposing the film. All stray light should be masked to prevent fog and a safe-edge provided by masking all sides of the matrix to allow handling without touching the image area. After exposure, the matrices should be identified by the clipped-corner method and processed immediately.

Pan Matrices by Enlargement -- Any type enlarger with a tungsten bulb can be used to expose Pan Matrix Film. Enlargers designed for printing color negatives work well; the cyan, magenta and yellow filters incorporated in the enlarger head can be used in conjunction with the red, green and blue separation filters to modify exposure times (see page 00). Check the enlarger head and support thoroughly for rigidity. Any movement of the enlarger during or between exposures will cause misregister. Avoid jarring the enlarger head when changing the filters. An opaque mask must be used around the negative to prevent white light from getting past the image area and fogging the matrices.

A practical way for composing the image on the vacuum register board is to place a sheet of white paper that is larger than the widest vacuum channel on the pins. Draw a light pencil line along the location of each vacuum channel; then compose the image within the proper channel. The paper can be kept and reused for each succeeding set of matrices.

Keep the picture margin 1/2 inch or more away from the register pins; otherwise, difficulty may arise during transfer of the dye images. When the transfer board has been positioned properly for the negative to be printed, clamp or tape it securely to the enlarger baseboard to prevent movement between exposures.

Pan Matrices by Contact -- Attach a strip of film containing register perforations to the negative so that it can be positioned identically with three sheets of KODAK Pan Matrix film in the contact-printing mechanism. The strip of film can come from a discarded matrix or, if a KODAK Register Punch is available, it can be used to punch a discarded strip of some other type of film. The perforated strip should be wide enough to bring the edge of the negative at least 1/2 inch away from the pins in the contact printer. After attaching the punched strip of film to the negative, fasten an opaque mask to the base side of the negative to prevent the edge of the matrix film from being exposed; this provides a safe-edge for handling outside of the image area. If the register punch is used to make the perforated strip, punch both the register strip and the opaque mask simultaneously.

Use the KODAK Register Print Frame to expose matrices by contact, or use a vacuum register board with a sheet of clean cover glass to maintain contact between the negative and the matrix film. The vacuum channels are useless because two sheets of film cannot be brought into close contact with vacuum on the surface of the board.

Orient the negative with its emulsion side facing the base side of the matrix film and its base side facing the exposing light source. Use an enlarger or point-light source to expose three sheets of Pan Matrix Film through KODAK WRATTEN Filters, No. 29 (red), No. 99 (green) and No. 98 (blue).

Determining Exposures for Pan Matrix Film -- A correctly exposed matrix will show, after processing, a just-perceptible density in the diffuse white highlights of the subject. Find the exposure necessary to produce this density by making a trial exposure through the red separation filter, as described below.

Tungsten enlargers vary considerably in light output, normally ranging from less than 1 footcandle up to more than 10 footcandles in intensity. Use the following chart as a guide for making matrices of normal contrast from average color negatives having adequate shadow detail. The data is for an incandescent-light enlarger with no color-correction filters in the light beam.

Footcandles (at the exposure plane)	Exposure Time in Seconds*		
	WRATTEN Filter No. 29 (red)	WRATTEN Filter No.99 (green)	WRATTEN Filter No. 98 (blue)
1/2	52	52	96
1	26	26	48
2	13	13	24
4	6.5	6.5	12
6	4.3	4.3	8
8	3.2	3.2	6
10	2.5	2.5	4.7

*Avoid exposure times of less than 10 seconds by using either smaller aperture settings or by adding KODAK WRATTEN Neutral Density Filters to the light beam.

The red-filter exposure found by trial determines the overall density of the final print. A preview of that density is possible by transferring the cyan (red-filter) matrix to paper and viewing the cyan dye densities through a red filter; the dye transferred from a well-exposed matrix will have the tones of a good black-and-white print, with detail in both highlights and shadows.

The color balance of the print depends upon the relative exposures received by the three matrices. A balanced set of matrices shows equal densities in areas that correspond to neutrals (white, gray and black) in the subject originally photographed.

As a general rule, the color quality of the light source should be adjusted if the longest exposure time is appreciably more than twice the shortest. For instance, if the red and green exposure times are approximately equal and the blue exposure time is four times as long as either, add a KODAK Color-Compensating Filter CC30B (blue) over the lens (or add 30 magenta and 30 cyan to a color-printing enlarger head). Since the added filtration will approximately double the red and green exposure times without appreciably affecting the blue exposure time, the three times will be brought closer together. They will remain within the desired tolerance if the lens is opened (1 stop in this example) to restore the red and green times to their original length. If possible, adjust the enlarger to give exposure times which are under 30 seconds and preferably between 10 and 20 seconds.

Gray Scale -- A KODAK Gray Card, No. R-27, a KODAK Paper Gray Scale or the gray scale found in the KODAK Color DATAGUIDE, No. R-19, will be helpful in printing if it is included in the original scene when the color negatives are exposed. You need not include such a test image in each negative; a separate negative can be made which will be a reference for other negatives produced under the same exposure and processing conditions. Make at least one test exposure under each exposure situation and develop at least one test image in each processing batch.

If a test image is not available, expose the matrices by trial-and-error, using the times that made your last good print. If you compensate for any enlarger magnification changes, the chances are that the matrix-set balance will be close to neutral.

Master Negative -- For the first negative to be printed, make a master negative of a scene that is "normal" in contrast, lighting and exposure, and containing a KODAK Gray Card or a gray scale. Before printing other negatives, establish the printing relationship between your master negative and the emulsion number of the Pan Matrix Film that you are using. Then you can calculate the printing times for future negatives from density readings made with an on-easel photometer, analyzer or densitometer. Use this same master negative to check changes of matrix emulsions, new batches of dye, new enlarger bulbs or any other variable in your printing system.

Testing New Emulsions -- Use this procedure to zero-in your enlarger for the first time and to evaluate each new emulsion number of KODAK Pan Matrix Film.

1. Make a mask. Use black paper, completely exposed and processed film or any other opaque material to cover adequately the projected negative image on the vacuum easel. Mark the area of a diffuse highlight and the area of the gray card and/or the gray scale on the mask. Cut out these areas, reposition the mask and tape it to one side of the easel so that it can be folded back.

2. Tape the diffuse-highlight area. With the mask folded back, place a piece of tape on the vacuum board alongside the projected diffuse-highlight area so that the tape can be used as a guide to positioning a matrix test strip. The location should include the projected gray-card area, as well (or, if there is too much distance between the two, use another piece of tape and a second test exposure).

3. Make the red-filter exposure. Clip or punch an identification mark on one end of the matrix test strip to identify the first exposure and place the clipped end under the mask in the area of the diffuse highlight with the emulsion down. With the red filter over the lens, the first exposure might be 15 seconds at *f*/8 for a 2X enlargement. If the gray card image was not

included in the first exposure, move the test strip and make another 15-second exposure.

4. Make the green- and blue-filter exposures. With the test strip in a light-tight drawer or safe-box, replace the red filter with the green filter. Now, with the lights out, place the test strip under the gray-card mask aperture so that the image will fall adjacent to the red exposure on the strip. Make a 15-second exposure. Repeat this procedure using the blue filter and give a 25-second exposure.

5. Process the test strip. It should show three exposed areas, easily identifiable by their positions in relation to the clipped end. If the green- or blue-filter areas are lighter or darker than the red-filter area, the time of exposure for the two must be lengthened or shortened until all three areas have the same density. Then you can determine the overall density level by scratching the diffuse-highlight area with your fingernail and placing the test strip on the bottom of a white tray; the unscratched area should be noticeably darker than the scratched area.

On-Easel Exposure Determination with a Photometer -- Once the matrix exposures from the master negative have been established, you can determine times for exposing other color negatives on Pan Matrix Film of the same emulsion number with an on-easel photometer having suitable response to red, green and blue light.

1. With the master negative in the enlarger and the lens and magnification at the same settings as for the test strip, and the photometer probe on either the gray-card or a flesh-tone area, adjust the photometer potentiometers so that the exposure times through the red, green and blue filters are recorded in the memory banks of the respective channels and are indicated on the meter scale or digital readout display.

2. Place the new negative in the enlarger and compose the image on the vacuum easel. Place the photometer probe on either the gray-card or a flesh-tone area and, with the red filter in place, adjust the lens opening so that the meter scale reads the same exposure time on the red channel as for the master negative; then read the green and blue times directly through their respective channels. Be sure to make the readings with the proper separation filters in place.

Off-Easel Exposure Determination with an Electronic Transmission Densitometer -- You can use an electronic transmission densitometer outside of the printing room to determine matrix exposures for new negatives, when the master negative times are known, if the same emulsion of Pan Matrix Film is used.

1. Read and record the red, green and blue densities of the gray-card or a flesh-tone area in the master negative.

2. Read and record the red, green and blue densities of a gray-card or flesh-tone area in the new negative.

3. Using a calculator with a logarithmic scale or the chart on page 00, compute the difference in the exposures of the red, green and blue filters for the new negative.

When a flesh tone is used instead of a gray card to read densities, both of the above exposure determination methods tend to reproduce all flesh tones alike, regardless of individual variations in skin tone or in the light falling on the orginal scene. Similarly, all images of gray cards tend to be printed alike, regardless of the position of the card relative to the main light illuminating the scene. Usually, however, these minor failures in color balance can be corrected during the transferring of the matrices by using wash-back controls.

When you put a new emulsion number of KODAK Pan Matrix Film into use, make a new set of trial exposures with the master negative. Use the previous exposure times as a guide for the first test. When you have established new red, green and blue exposure times, use them as a standard for determining exposures for future negatives.

PROCESSING MATRICES

A-35
A-U (series)

Most of the instructions in this section are the same for both KODAK Matrix Film 4150 and KODAK Pan Matrix Film 4149. However, note the following differences:

1. Matrix Film can be handled under a red safelight (KODAK No. 1); Pan Matrix Film must be handled in total darkness.
2. Presoaking is mandatory before development with Pan Matrix Film, but optional with Matrix Film.
3. Filters can be used with Matrix Film as a means to supplement the contrast control that is available through adjustment of developer composition. This is not possible with Pan Matrix Film.

Preparations -- After exposing a set of matrices and making the identifying corner cuts, store the films in a dark drawer or three-part safebox while you prepare to process them. Be sure that the dark drawer or safebox is truly dark and safe, with no light leaks, broken corners or pin holes. Process the films as soon as possible after exposure to prevent shifting of the latent image density.

During processing, the matrices are placed in the tray with the emulsion down. Only the yellow (blue-filter) matrix is clipped in both top corners and can be identified easily. Use it as the lead matrix through the processing baths and follow it with the magenta (green-filter) matrix and the cyan (red-filter) matrix, in that order. That will leave a matrix on top which is easily identified because it has no clipped corners.

Using KODAK Tanning Developers A and B

The developer recommended for processing matrix films has two chemical components, Solution A (developer and tanning agent) and Solution B (accelerator). Mix the stock solutions from prepared packets of KODAK Tanning Developer A and B, which are sold separately in powder form.

KODAK Tanning Developer A consists of two containers of powdered chemicals marked Part 1 and Part 2. Mix them in that order in the specified quantity of hot water at 125°F (51.6°C). Completely dissolve the powder of Part 1 before adding Part 2. Continue mixing until the solution is clear. Tanning A Developer normally has a clear to slightly yellowish-brown color when mixed. If the color is decidedly dark brown, the developing agent has become oxidized and the solution should not be used. Store Tanning Developer A in clean, brown glass bottles, tightly stoppered. Fill the bottles completely to the stopper with the solution to eliminate air. Solutions thus stored will remain usable from four to six weeks. Developer in partially filled, stoppered bottles will last for less than a week. When the solution becomes the color of coffee, discard it.

Tanning Developer A is very alkaline in nature and can cause allergenic skin reactions. Wear rubber gloves and eye protection when mixing and using the Developer. It also causes stubborn stains on clothing in combination with fixer. Wear a protective smock and rubber apron during mixing and processing.

KODAK Tanning Developer B consists of a single chemical powder. Mix it in the specified quantity of hot water at 130°F (54.4°C) until the solution is clear. Store Tanning Developer B in stoppered glass or plastic containers for as long as necessary at room temperatures above 55°F (12.7°C). Colder temperatures will cause the chemical to precipitate. To restore precipitated Tanning Developer B, remove the stopper and place the container upright in hot water and stir until the crystals have returned to solution.

Contrast Control -- If properly balanced, most separation-negative sets and most normal color negatives will produce prints of suitable contrast when the matrices are developed at the "normal" developer ratio. The actual contrast level chosen for developing a given set of matrices will depend on the subject and lighting range, the personal preferences of the operator and the character of the printing equipment.

The preferred method of contrast control is to develop all matrices to normal contrast; then, if necessary, adjust the contrast of the print by varying the degree of acidity of the dye baths (See page 00). However, a practical range of matrix film contrast can also be obtained by varying the relative volumes of Solution A and Solution B. Increase contrast by raising the volume of B relative to the volume of A. In the table below, five grades of contrast are given at levels similar to the different printing grades of black-and-white paper. The grades are on the use of the normal dye contrast recommended for KODAK Dye Transfer Dyes. Intermediate contrast grades can be found by interpolating the table.

Matrix Film Contrast Ranges

Degree of Contrast Desired	Negative Plus Hightlith Mask Density	Parts by Volume		Exposure Adjustment*
		Sol. A	Sol. B	
KODAK Matrix Film 4150				
Very low	1.8	1 part	1 part	130%
Low	1.6	1 part	1 1/2 parts	115%
Normal	1.2	1 part	2 parts	100%
High	1.1	1 part	3 parts	90%
Very high	0.9	1 part	4 1/2 parts	80%

KODAK Pan Matrix Film 4149†

Normal	1.2	1 part	2 parts	100%
High	0.9	1 part	4 parts	70%

*Assuming normal exposure at 1.2 development to be 100%.

†Processing adjustments for reducing contrast are not recommended for Pan Matrix Film.

This contrast control table is based on the use of a tungsten lamp in a diffusion enlarger. Other types of light or optical systems may require adjustment to align the equipment with the table. For KODAK Matrix Film 4150 only, a KODAK WRATTEN Filter No. 35 (violet) over a white light source will give less contrast by about one step in the table. A KODAK WRATTEN Filter No. 6 (yellow) will increase the contrast by about the same amount. The approximate increase of exposure is 4 times for the No. 35 filter and 5.5 times for the No. 6 filter.

Fixer -- Because exposed and developed Matrix Film has a subject image on it that consists of developed silver and tanned gelatin, as well as considerable undeveloped silver halide and untanned gelatin, it is necessary to fix the film in a fixer that will stop the developing action without hardening the untanned gelatin (so it can be washed away in the subsequent hot water rinses). Several fixers are suitable: KODAK FLEXICOLOR Fixer and

Replenisher, mixed at the working dilution, is the first choice. However, KODAK Rapid Fixer, mixed without the hardener at the film dilution, or a simple hypo fixer formula, such as KODAK Fixing Bath F-24, will do as well. Use enough fixer solution to fill the tray to the depth of 1 inch and discard it after use.

Quantities -- For three 11 1/2 x 15 1/4-inch matrices processed together in a 12 x 16-inch tray, use no less than:

Developer*	2 quarts (1.9 L)
Water Rinse	2 quarts (1.9 L)
KODAK FLEXICOLOR Fixer and Replenisher	2 quarts (1.9 L)

*Composed of the required parts by volume of Developer A and Developer B (see table below). Do not use less than 20 ounces (591 mL) of Developer A for three 11 1/2 x 15 1/4-inch matrices at any contrast level. To process individual 11 1/2 x 15 1/4-inch matrices, use approximately one-third of the above volumes.

For other film sizes and test strips, maintain the above ratio of developer to film area as far as possible. Never fill the developer tray to less than one-quarter the depth of the tray.

Processing Equipment -- Place three clean trays, large enough to just accommodate the matrix film, in the sink side by side. Do not use trays any larger than necessary; the amount of chemicals needed to fill them to a working level is more than necessary to process the film, and the larger expanse of liquid surface will cause rapid evaporation and temperature change. If you have a metal tray (stainless steel or enameled steel), use it in the left-hand position to hold the developer. (Metal conducts heat more readily than plastic; delicate temperature adjustments can be made quickly by momentarily running hot or cold water against the side of a metal tray and rocking the developer solution.) If the temperature in the darkroom differs appreciably from 68°F (20°C), provide a water jacket of this temperature for the developer tray. Plastic trays are satisfactory for the water rinse and the fixing bath, which do not have to be so precise in temperature. Do not use trays that have ribs or other reinforcements in the bottom. Anything other than a smooth bottom will cause plus-density marks in the matrix images that will reproduce in the print. An adequate supply of hot water is vital to the success of the process. The water must be hot enough to deliver 120°F (37.7°C) at the faucet and adequate to fill a tray at least four times within a half-hour period.

Utilize a timer with a sweep second hand (and phosphorescent numerals, if you are processing Pan Matrix Film) to time the process; read the solution temperatures with a reliable and repeatable thermometer. Wear rubber gloves for mixing the developer and while handling the film during processing. However, the film becomes extremely slippery during the hot water wash, so rubber gloves with finger grips are necessary at this point in the process or use bare hands.

Prepare a place to hang the wet, processed matrices to dry. Wire lines strung at a comfortable height above the processing sink, with stainless steel clips attached to them, will work nicely if production is not heavy. For high-production laboratories, drying rooms with heaters, dehumidifiers and air circulation are necessary.

Processing Procedure -- Processing matrix films is not difficult, yet it is an exacting operation in the sense that the steps must be carefully standardized if repeatable results are expected. All details of the procedure should be carried out as instructed; no variations, based on past experience with other films, should be introduced.

Interleaving Agitation -- Immediately after settling the third matrix, emulsion down, in any solution, lift the edges of the top two matrices slightly, pull the bottom or lead matrix out, place it on top and rock the tray to immerse it completely. Follow with the second and third matrices, handling them in exactly the same manner. After each set of interleavings, lift the films from the adjacent side of the tray to prevent repeated developing streaks. Interleave the matrices continuously in this manner throughout the entire process, adjusting the rate so that, at the end of each processing step (through fixing), the lead matrix is on the bottom.

It is important to develop a smooth, reproducible and moderately rapid interleaving technique, and to give special attention to the interleaving operation during the first few seconds in each processing bath. Take special care to prevent the adherence of one matrix to another by rocking the tray to maintain a layer of liquid between them. The emulsion is very soft and must be handled carefully throughout the process.

The lead matrix should be the first matrix in all of the processing steps, and the other two matrices should be given the same treatment as the first in every way possible.

Handle the matrices emulsion down through all of the processing steps except the final hot water wash-off and chill operations. During these last two steps, handle the matrices singly, emulsion side up.

Fill the right-hand tray with fixer to one-quarter its depth and fill the center tray to overflowing with clean water, both at a temperature of 68°F (20°C).

Place the required amounts of Solution A and Solution B in separate containers, one of which is large enough to hold the total volume of developer to be used. Bring the temperature of both containers of liquid to slightly above 68°F (20°C). (When the two components of Tanning Developer are combined, the temperature will fall slightly, according to volume.) When combined, the components begin to oxidize immediately, therefore as little time as possible should elapse between mixing the A and the B and starting the developing cycle. The left-hand tray will be used for the developer.

Just before turning out the room lights, mix together the developer components in the larger container. Stir the mixture briefly and pour it into the left-hand tray. Check the temperature and, if necessary readjust it to 68°F (20°C) by quickly running hot or cold water onto the outside of the tray while rocking the solution. Set the timer for the process cycle, turn out the lights and begin the process.

Presoaking -- Use the same water bath for both presoaking and rinsing. Soak the matrices for 1 minute prior to development, using the same immersion and interleaving techniques as recommended for the other steps. Presoaking is recommended for Pan Matrix Film, but should be used with Matrix Film 4150 only to minimize non-uniformity of results until proficiency is gained in processing three matrices at one time. If matrices are handled individually through the processing steps, it is not necessary. If presoaking is used with Matrix Film 4150, there is some loss of contrast, which can be compensated for by slightly increasing the volume of Tanning Developer B relative to Tanning Developer A.

1. Develop the film by immersing the three matrices in the developer in succession, in 5- or 10-second intervals. Start with the lead matrix and immerse it emulsion down in the developer solution. Immediately flip it over, emulsion up, then immediately flip it over again so that the emulsion is down. The flipping action will release any trapped air between the film and the solution surface, as well as dislodge any bubbles adhering to the emulsion. It will take you a few seconds to accomplish this. Rock the tray by lifting one side an inch or two and letting it fall again to bring a quantity of solution over the film surface; repeat the entire procedure with the second matrix. Follow with the third matrix, keeping the interval between immersion times the same. Maintain this spacing of matrix handling throughout the process. At this point, begin the interleaving agitation described above.

Note: For maximum uniformity of development, it may be desirable to process large-size matrices individually, emulsion side up. For individual development, use tray-tilt agitation.

2. Rinse the matrices at the end of the development time by placing them in the center tray containing clean water at 68° F (20°C). Transfer the matrices from the developer to the rinse in the same order and at the same time interval as was

used to immerse them in the developer. Drain each matrix for 5 seconds before immersing it in the rinse, flip the films as before and interleave through two cycles. This should take about 30 seconds. Withdraw the lead matrix, which should be on the bottom, drain it for 5 seconds and immerse it in the fixer; follow it with the other two, using the same transfer order and time interval.

Note: Do not drain pan matrices when transferring them from solution to solution because it may cause developing streaks. Quickly lift each matrix in turn from the developer and immediately immerse it in the next solution, then follow with the flipping action.

3. Fix the matrices by agitating them for 2 minutes in the right-hand tray containing the non-hardening fixer. Use the same interleaving procedure as in the developer. Turn on the room light after 1 minute. The matrices can remain in the fixer until they are given the hot water wash treatment. However, do not store the matrices in the fixer longer than 15 minutes. From this step on, handle the matrices individually, emulsion up.

Tray-Tilt Agitation -- The agitation used for processing individual matrices and throughout the the hot water washes is similar to that recommended for black-and-white processing of single sheets of film. Raise the left side of the tray about 2 inches above the bench top; lower it smoothly and then immediately raise the lower or near end similarly. Next, raise and lower the right side and then again the near side. These four operations constitute an "agitation cycle," which requires a total time of about 8 seconds.

IMPORTANT: The emulsion is extremely soft at this stage and should never be touched or have direct streams of water running onto it. Direct-spray devices, even those which appear to be gentle, have been found to be harmful, washing away highlight portions of the gelatin relief image. Do not use them.

4. Wash off the untanned gelatin emulsion from the matrices by placing two trays (you can use the rinse tray and a spare tray, saving the developer tray for the chill rinse) side by side. Fill one tray to about half capacity with water at no less than 120°F (49°C) and place the lead matrix in it, emulsion up. Be sure that the matrix is completely submerged in the hot water. Give the tray moderately vigorous tray-tilt agitation for 1 minute (strong enough that water is spilled from the edges). This treatment removes the bulk of the untanned gelatin and also the backing layer, which in Matrix Film 4150 appears brown after development. The initial wash-off of Pan Matrix Film 4149 removes most of the untanned gelatin containing the black pigment and the blue-appearing backing, as well as any fogged surface emulsion, which comes off in long strings and patches of black gelatin.

While agitating the matrix in the first tray of hot water, fill the second tray with hot water, again at 120°F (49°C). At the end of the 1-minute period, place the lead matrix in the second tray, empty the first tray and quickly rinse it, wiping the edges of the tray to remove any loose particles of gelatin that otherwise may become attached to the next matrix. Then start refilling the first tray with hot water and give the matrix a 30-second rinse with tray-tilt agitation. At the end of the 30-second period, remove the matrix from the water and wipe the edges and punched holes carefully with your fingernails to remove any loose gelatin "whiskers" left from cutting the raw emulsion edges during manufacture.

When the edges of the film have been cleaned, place the matrix in the refilled first tray again for a third 30-second rinse identical to the previous one. Complete the wash-off with an additional 30-second rinse using a fresh volume of hot water at 120°F (49°C). Use a minimum of four hot-water rinses to complete the wash-off procedure and as many more as is necessary, with old film or film that may have a chemical fog, to be sure that all non-image gelatin has been removed.

5. Chill the emulsion of the lead matrix by immersing it in a third tray (the developer tray) about a third to a half of its capacity with clean water at 68°F (20°C). During the following 30 seconds, lift the matrix out of the water and drain it three times to remove any surface residue which may be present. Then

immediately hang it up to dry. Do not treat the matrix with a wetting agent.

Follow with the second and third matrices, treating each in exactly the same manner as the first.

Keep the matrix wash procedure consistent from beginning to end with standard time, temperatures and technique.

6. Dry the matrices in a dust-free area. Suspend them from two clips attached to the top corners in such a way that the orientation of the image in each matrix is the same. Larger matrices may show a tendency to curl, which can be minimized by attaching lightly weighted clips to the lower corners. Drying can be expedited by removing water droplets from the base side only with a clean, damp viscose sponge or a KODAK Photo Chamois, and by circulating warm, dust-free air. Be sure to treat all the matrices in the same manner. Do not touch the relief images.

This tray-tilt agitation process takes approximately 15 minutes to complete.

An Alternative Method of Processing Matrix Films

Although KODAK Matrix Films are designed to be processed by KODAK Tanning Developer A and B, there is another system of processing which has an advantage, particularly for workers inexperienced in film processing. The process is not new; in fact, it is the predecessor of tanning developer which was used in the long-discontinued KODAK Wash-Off Relief Process called bleach-hardening. The advantage is in the developing step, which is done with an ordinary film developer at much longer times than with Tanning Developer A and B. The result for inexperienced workers is processed matrix film with very little chance of uneven development and with much more repeatability. The only disadvantage is that the process takes much longer to complete. There are differences in the sensitometric results which can be compensated for in exposing and developing. Different developers can be used at different concentrations and for different lengths of time, resulting in considerable control of image density and contrast. Successful experiments have been made with developing matrix films in color processing tubes, with the bleach-hardening step done in a tray.

Processing Procedure -- There is no difference in processing procedure between KODAK Matrix Film 4150 and KODAK Pan Matrix Film 4149 except the safelight recommendations. Use the same immersion and interleaving techniques as for Tanning Developer.

1. Develop the matrices in a continuous-tone developer such as KODAK HC-110 Developer (Liquid), KODAK Developer DK-50 or

others for a nominal 5 minutes at 68°F (20°C). (Determine exact developing times and developer concentrations by making tests. Successful tests have been made using KODAK HC-110 Developer, Dilution C [1 part of stock solution to 4 parts of water] for 5 minutes at the above temperature.)

2. Stop the action of the developer by immersing the matrices in a bath of 1% acetic acid for 1 minute.

3. Wash the matrices in running water for 5 minutes at a temperature not higher than 68°F (20°C). Use a tray with a hose attached to the edge to introduce a flow of fresh water. The flow of water will not interfere with the interleaving agitation if you tilt the tray and spill some water as you move each matrix from the bottom to the top.

4. Bleach the matrices completely (about 4 minutes) in KODAK Bleaching Solution R-10a (See page 00) at 68°F (20°C). Turn on the room lights at the end of this step.

Beginning with Step 5, and in all succeeding steps, the matrices must be handled separately, emulsion up and with extreme care. Three trays may be used simultaneously for each step or the bleached matrices can be returned to the wash water after Step 4, then carried individually through the succeeding steps.

5. Wash off the unbleached, unhardened gelatin in four changes of hot water at 120°F (49°C) (as in Tanning Developing Step No. 4).

6. Fix the films in KODAK Fixing Bath F-5 for 5 minutes. If you desire to remove the brown stain, leave the film in the fixing bath for about 20 minutes. (Stain does not interfere with dyeing or transfer, but it may affect judgment of color balance.)

7. Wash the matrices in running water for 5 minutes.

8. Dry the matrices, using the same precautions as for tanning development.

This process takes a minimum of 29 minutes to complete, if you use separate trays for the wash-off and final washing steps; it will take 57 minutes to complete, if you use one tray for those steps and treat the matrices singly.

MAKING PRINTS

The instructions for making color prints by transferring dye from matrices to paper are the same for both KODAK Matrix Film 4150 and KODAK Pan Matrix Film 4149. The instructions for the actual transfer operation are based on the use of KODAK Dye Transfer Paper and a pin register transfer board compatible with the KODAK Register Punch.

How it Works

The dyes used in the dye transfer process are acid fabric dyes and food colors that have been chosen very carefully in regard to their hues and transfer characteristics. In spite of the hundreds of dye formulas available, there are only a few dyes that are even close to the proper colors and will transfer quickly from one gelatin layer to another.

A Matter of pH -- The pH Scale is a measure of the acidity or alkalinity of a solution, with the number "7" indicating neutral. The numbers on the scale rise with increasing alkalinity and descend with added acidity.

The dyes in the dye transfer process have the ability to be imbibed (absorbed) by gelatin that has a higher pH factor than the material in which the dyes are residing. Thus, the generic name for this family of color processes is dye imbibition.

The three dyes that make up a set of KODAK Film and Paper Dyes and Dye Buffers have relatively low nominal pH factors. The normal cyan dye has a pH of 4.35 to 4.36, the normal magenta dye has a pH of 4.78, and the normal yellow dye has a pH of 3.97. One percent acetic acid has a pH of 2.97 and 28% acetic acid has a pH of 2.08. KODAK Paper Conditioner, when mixed to a working solution, has a pH of 6.0 to 6.5. (Paper conditioner is used to prepare KODAK Dye Transfer Paper for receiving the dyes.) With this difference in pH values, conditions are correct to move the dye images from the gelatin relief image of the matrices to the gelatin emulsion of the paper.

The main purpose of the 1% acetic rinses is to remove all the surface dye from the matrix and to prevent bleeding of the dyes from the gelatin relief image. The acid rinse bath should be as low a concentration as possible because the rate of transfer of dye is retarded by an excess of acid. This fact gives us another control: By adding minute quantities of a stronger acid solution (28% acetic acid) to the first acid rinse and putting some working dye solution into the bath, more dye is accepted by the gelatin relief image; by adding minute quantities of an alkaline chemical solution (5% sodium acetate) to the first acid rinse, the pH of the bath is raised slightly and some of the image dye washes away. In the first case, the dye image becomes relatively darker; in the second case, the dye image becomes relatively lighter, as compared to the other two dye images. Add equal amounts of either of these control chemicals to the first rinses of all three matrices of a set, and the resulting print is relatively the same color -- but lighter or darker, producing a good, repeatable and rather extensive density and color balance control. By varying the amount of control in the first rinses of a set, you can shift the color balance.

The second 1% acid rinse always remains at that concentration to return the matrix to the optimum transfer pH. It primarily acts as a holding bath for the matrix until the paper is ready to receive it.

The quantity of acid added to the dyes governs the absorption by the matrix, therefore the contrast. The buffer, which is supplied with the dye concentrates, is added with a specified amount of distilled water to the concentrates to make a working dye solution. (A buffer is a chemical substance that is capable of maintaining a pH balance in a solution by neutralizing, within limits, additional acids or alkalines.) In manufacture, the amount of acid added to the buffer is changed according to the pH condition of each individual dye concentrate as one of the tools used to match the contrast of that batch to a balanced standard. In this way, the three balanced dyes will make a neutral image of a silver step tablet and very close simulate reproduce the colors of all densities of a scene. This, of course, provides another control: Add acid in the form of a few millilitres of 28% acetic acid to a dye and you increase its basic contrast; add an alkaline solution, such as 10% KODAK Triethanolamine Solution, to the dye and you decrease its basic contrast. (Triethanolamine is used rather than sodium acetate because it will continue to hold the dye solution at a given pH longer; it makes a better buffer.)

You should not mix a buffer solution from one batch number with the dye concentrate of another batch number.

KODAK Dye Transfer Paper has a gelatin emulsion incorporating a mordant which chemically locks the dye molecules in place, once they have been transferred, thereby preventing them from migrating to other areas when the paper has dried. Highly alkaline solutions can overcome this mordant; using such solutions will bleach the dyes, thus providing a method of retouching dye transfer prints.

With all of these process controls available, a problem in dye transfer printing is one of choice. The worker must decide which controls to employ and which to ignore.

Preparation

Mixing Solutions -- Some of the chemicals for the dye transfer process are available in prepared form. Follow carefully the mixing directions on the containers. Always use distilled or demineralized water in making the working dye baths. If the tap water is unusually high in mineral content, use distilled water for the first acid rinse bath and paper conditioner as well. When tap water is used in the first acid rinse, white highlights may show a tint of color. If this occurs, it often can be eliminated by adding .34 to 1.35 ounces (10 to 40 mL) of KODAK Matrix Highlight Reducer R-18 per gallon (3.78 L) of 1% acetic acid rinse. Depending on the hardness of the water, it may be necessary to use much larger quantities. Do not use Matrix Highlight Reducer or any other additive in the second acid rinse.

One Percent Acetic Acid -- Since 1% acetic acid is used for both the first and second rinses, you should prepare an adequate quantity before you start transferring. To prepare a solution of approximately 1% acetic acid, add 1 part of KODAK Glacial Acetic Acid to 100 parts of water or 1 part of KODAK 28% Acetic Acid to 28 parts of water. Use 1 1/4 ounces (40 mL) of glacial acetic acid per gallon (3.78 L) of water or 4 1/2 ounces (140 mL) of 28% acetic acid per gallon (3.78 L) of water. Pour the acid into the water, not water into acid. Concentrated acetic acid will cause chemical burns if splashed on skin or in eyes. Wear rubber gloves and an apron plus safety glasses. (One percent acetic acid is harmless for it is 1/5 the acidity of vinegar but it will sting eyes or cuts. In this case, flush with cool water.) Keep a large open container of acid rinse solution near the sink and dip out the solution with a plastic graduate as you rinse the matrices; dump the tray, rinse it with clean water and refill with fresh rinse.

Using KODAK Paper Conditioner

KODAK Paper Conditioner is utilized to soften and expand the emulsion of KODAK Dye Transfer Paper and to bring it to the proper pH to receive dye. The concentrate should be mixed with three times its volume of water to make a working solution. Before placing paper in the conditioner, wash each sheet in a bath of warm water at approximately 100°F (37.7°C) for about 1 minute to remove any loose gelatin specks or paper dust and to wash away any of the highly acetic mordant that may be present on the paper's surface. Interleave not more than 6 sheets of paper at a time in the running wash before draining each sheet separately and placing it, emulsion up, in the conditioner bath. Immediately interleave the stack of paper a few times and agitate the tray periodically to keep the surface of the top sheet submerged. (The paper conditioner tray should be included with the dye trays on an automatic tray rocker, if one is available.) Allow the paper to condition for 20 minutes before starting the first transfer and add sheets to the conditioning bath as printing progresses, washing and draining each one before placing it in the tray on the bottom. Paper can remain in the conditionetioner can be used until it begins to thicken to the consistency of maple syrup and run from the draining paper in sheets rather than in a stream. Filter the conditioner occasionally to remove solids, such as paper dust and gelatin fragments; rer indefinitely. However, remove any remaining sheets at the end of the day, squeegee off the conditioner and hang the paper to dry. It can be placed directly in the conditioner for the next transfer session.

Paper condiplace it if you have any doubts about its purity.

Using KODAK Film and Paper Dyes and Dye Buffers

Mix only the amount of working dye solution needed for dyeing the size of matrix film that you are using. Only 33.8 ounces (1 L) of working solution will satisfactorily dye matrices up to 16 1/2 x 21 1/4-inches in size in a tray that is continuously rocking. More solution is needed if the tray is still or to minimize color variations from print to print. The surface of the matrix must be either completely submerged in dye solution or continuously washed with it. To be able to absorb the maximum amount of dye particles into the emulsion relief image, fresh dye solution must be constantly introduced to the surface of the matrix. A continuously rocked cyan or yellow matrix will absorb its maximum amount of dye in 5 minutes; the magenta takes 10 minutes. An occasionally agitated cyan or yellow matrix will take 10 or more minutes to attain maximum absorption; the magenta matrix will take even longer.

Mix the dye by first measuring the required amount of water into the mixing vessel, then add the dye concentrate and mix it with the water before putting the buffer solution in it. This procedure will protect the dye concentrate from being overacidified by the buffer, which would happen if you added the two concentrates together and then added the water. When mixing, be sure to use each dye with its own buffer. The dye buffers are not interchangeable.

Expand dry matrices individually in a bath of warm water at 100°F (37.7°C) for at least 1 minute before putting them into the dye baths. Always handle the matrices with the emulsion side up. Wash newly transferred matrices in the same manner before returning them to their respective dye baths.

Filtering and Storage -- To remove foreign particles that may have accumulated, filter the dye working solutions each day before use. For best results, utilize a fine mesh filter paper, such as the WHATMAN No. 3 or J. GREEN No. 798, which will remove particles that are 3 microns or larger in size. These filters will remove airborn mold spores, waterborn fungi and other biological growth which find the acid environment of these organic dyes an ideal growing medium. Use a filtering mechanism with a suction action to speed the filtering process.

Do not leave the dye baths and paper conditioner trays uncovered in the trays for any longer than necessary, since evaporation will change their chemical composition and airborn contaminants will invade the solutions. Put clear plastic covers on the trays and remove them only long enough to insert or remove the matrices and paper. Store the working dye solutions in clean, stoppered glass bottles every night. Do not use bottles that have previously stored strong alkaline or acid solutions.

Changing Dye Contrasts -- To make normal contrast dye solutions, follow the directions given on the bottle labels or in the instructions. (Make small quantities of normal dye solutions by mixing 1 part of dye concentrate with 18 parts of water and add 1 part of buffer solution.) The following levels of contrast are roughly equal to the change in one grade of black-and-white paper.

A-36X (A+B)

High Contrast -- Add to each quart (946 mL) of normal working solution the following amount of 28% (by volume) acetic acid:

Cyan	Magenta	Yellow
21 mL	12 mL	47 mL

Low Contrast -- Add to each quart (946 mL) of normal working solution the following quantities of 10% (by volume) solution of Triethanolamine*:

Cyan	Magenta	Yellow
13 mL	10 mL	17 mL

*KODAK Triethanolamine, Chemical 1599, or equivalent grade. KODAK Laboratory Chemicals are available through laboratory supply houses.

Caution: In concentrated form (10% or higher), triethanolamine is a skin irritant. Use a polyethylene squeeze bottle to dispense the 10% solution into a graduate. Do not pipette triethanolamine by mouth or allow the concentrated chemical to come into contact with your skin or eyes.

Intermediate Contrasts -- Use quantities of triethanolamine or 28% acetic acid in proportion to the maximum low- and high-contrast quantities given above.

Replenishing Dye Solutions -- When more than four 8 x 10-inch prints (or the equivalent print area in other sizes) are made, replenish the dye solutions to provide uniformity of color balance in successive prints. Add dye concentrate to each of the working dye baths in the average amounts in the following table. Use a different graduated 5 mL pipette or a carefully cleaned 10 mL cylinder for adding each dye.

Dye Replenishment Table

Size of Matrix (in Inches)	Number of Matrices Dyed in 1 Quart (946	Approximate Amount of Dye Concentrate*

	mL) of Dye Solution Before Replenishing	Added per Quart (946mL) of Dye Solution
8 x 10	4	2 mL
11 1/2 x 15 1/4	2	2 mL
16 1/2 x 21 1/4	2	4 mL

*Film and Paper Dye without addition of Buffer.

With the replenishment table, it may be necessary to make slight changes in the quantities of dye concentrate added, depending on the color and density characteristics of the original picture. For example, if the color yellow predominates in the picture, the yellow concentrate may have to be increased slightly; if the color blue predominates, both cyan and magenta concentrates may have to be increased. A dark, high-contrast image will deplete the dye baths more than a high-key picture will; more of all concentrates will have to be added. If in doubt about the exact quantity of concentrate to add, err on the high side, rather than the low side.

Adjusting Dyes to Produce a Good Neutral Scale -- After mixing fresh dye baths and bringing them to the desired contrast level, slight adjustments may be required to produce a satisfactory neutral balance. Do this by raising or lowering the contrast of appropriate individual dyes until the contrasts of all three produce an image of a step-tablet matrix that is neutral from highlight to shadow, within reason. (The human eye is an excellent comparer of neutral densities. Slight tints of green in the middletones of a step-tablet image are common, and since they seldom never are visible in an actual colorful picture image, it is not necessary to fine-tune the neutral balance to eliminate completely such minor deviations.) Use the table below to determine what additions of acid are needed under different circumstances. To test the dye scale, put a single matrix successively in each of the dyes to transfer the image in register or use three identically exposed and processed matrices in the normal manner. The quantity of each of the chemicals needed in any given case will depend on circumstances. Until you have gained some experience in estimating the effect of a known amount of acid or triethanolamine, keep the quantities small. Ten percent of the given amounts in the paragraphs regarding high- and low-contrast is a good starting point, except where the overall contrast is to be maintained (Column 3). In that case, begin with 5% of the amount of the appropriate chemical.

Keep acidity adjustments to a minimum and do not use them to convert overall contrasts back to normal, once they have been changed. If high-, normal-, and low-contrast dyes are needed, mix separate sets and keep them available.

Acidity Adjustment Table

If the High-Density Portion of the Scale is	For a Slight Increase in Overall Contrast	For No Change in Overall Contrast	For a Slight Decrease in Overall Contrast
Cyan	Add acid to magenta and yellow.	Add acid to magenta and yellow, and triethanolamine to cyan.	Add triethanolamine to cyan.
Magenta	Add acid to cyan and yellow.	Add acid to cyan and yellow, and triethanolamine to magenta.	Add triethanolamine to magenta.
Yellow	Add acid to cyan and magenta.	Add acid to cyan and magenta, and triethanolamine to yellow.	Add triethanolamine to yellow.

Red	Add acid to cyan.	Add acid to cyan, and triethanol-amine to magenta and yellow.	Add triethan-olamine to magenta and yellow.
Green	Add acid to magenta.	Add acid to magenta, and triethanol-amine to cyan and yellow.	Add triethan-olamine to cyan and yellow.
Blue	Add acid to yellow.	Add acid to yellow, and triethanol-amine to cyan and magenta.	Add triethan-olamine to cyan and magenta.

Dyeing and Transferring

The conventional order of dyeing and transferring matrices is cyan matrix first, then magenta and finally yellow. Some laboratories, however, transfer the matrices in this order: magenta, cyan and yellow. They feel that transferring magenta first eliminates an apparent decrease in the amount of magenta dye transferred between the first and subsequent prints. Tests have proved, however, that there is little sensitometrical difference between prints made with any one of the three matrices leading the transferring order.

Uneven wetting may cause permanent damage to the matrix films. Handle the matrices emulsion side up and singly in the trays; be sure that they are completely immersed in the liquid. When removing matrices from any solution, drain them until droplets begin to form at the drain point on the corner of the matrix. Standardize this procedure so that carryover of liquid from one bath to the next is consistent.

Sequence of Steps

A-37 (A-?)

1. Measure out first acid rinse and add required control chemicals.
2. Remove cyan matrix from dye; drain into dye tray until drops form on bottom edge of matrix.
3. Place cyan matrix in first acid rinse, emulsion up, and start timing (usually 1 minute); agitate continuously.
4. Lift and drain cyan matrix until drops form and place in second acid rinse (holding bath); do not agitate.
5. Remove one sheet of paper from paper conditioner, drain until drops form, and place it on transfer board, emulsion up 1/16-inch below register pins and squeegee.

6. Rinse hands in used first acid rinse (or in a graduate containing clean 1% acetic acid).
7. Remove cyan matrix from second acid rinse, engage register holes on transfer board pins, and roll into contact, emulsion down. Do not allow image area to touch paper before rolling it into place. Maintain for 5 minutes.
8. Dump dirty first acid rinse and rinse tray with clean water.
9. Time cyan transfer for 3 minutes before starting next step.
10. Measure out first acid rinse for magenta matrix and add required control materials. A-38 (A-E)
11. Remove magenta matrix from dye and drain as before.
12. Place magenta matrix in first acid rinse; time and agitate as for cyan matrix.
13. Drain and place magenta matrix in second acid rinse; do not agitate.
14. With aid of roller, peel back cyan matrix and place in warm water wash.
15. Rinse hands in 1% acetic acid briefly, then pick up magenta matrix, drain and roll into place on paper. Maintain for 5 minutes or more depending upon density of the image.
16. Remove cyan matrix from wash after 1 minute, drain and return to cyan dye.
17. Dump dirty rinse; rinse tray with clean water.
18. Measure out first acid rinse for yellow matrix and add required control chemicals.
19. Remove yellow matrix from dye, drain and place in first acid rinse.

20. Time rinse, usually for 1 minute, while agitating continuously.

21. Drain yellow matrix and place in second acid rinse; do not agitate.

22. Peel back magenta matrix with the aid of the roller and place in a warm water wash.

23. Rinse hands briefly in 1% acetic acid and pick up yellow matrix from second acid rinse drain and roll into position on paper.

24. Remove magenta matrix from wash after 1 minute, drain and return to magenta dye.

25. After about 4 minutes, peel back yellow matrix with aid of roller and place in warm water.

26. Squeegee excess liquid from surface of print and proceed to dry.

27. Remove yellow matrix from wash after 1 minute and return to yellow dye.

28. Replenish dyes, add paper to paper conditioner tray, rinse out first acid rinse tray with clean water, and prepare for further transfers.

Rapid Drying of Dye Transfer Prints -- KODAK Dye Transfer Paper has a hardened gelatin coating which, unlike color papers can withstand fairly rough treatment and higher drying temperatures. For extra-fast drying of test dye prints, wipe the print with a clean cloth towel as it lies on the transfer board after the last transfer. Then place it emulsion down on a sheet of blotter paper and wipe the base side. Place it in your dry mounting press. Put the clean felt pad from the press on top of the image-side and close the platen. With the press temperature between 175 and 225°F (79.5 and 107°C), you can dry a dye transfer print in less than a minute by steaming out the moisture. After 45 seconds or longer, remove both the print and the felt pad from the press and peel them apart. Hold the print in the air for several seconds to cool, then place it on a tabletop, image up, and with the flat of your hand, rub away any lint from the felt pad that may be adhering to the surface. Put the damp felt pad on the top of the hot press to evaporate the moisture in preparation for the next print.

WARNING: Do not use this method to dry color prints made on KODAK EKTACOLOR or EKTACHROME Papers, other multilayer products or papers with a soft emulsion.

Subsequent Procedures -- Make additional prints by repeating the dyeing and transfer procedure as many times as necessary. In most cases, you can make improvements in print quality by using the control techniques described in the following section.

Quantity printing can be accomplished by using 5-minute dyeing and transferring times and setting up two transfer boards; one operator can can print two subjects simultaneously. The number of satisfactory prints that can be made from one set of matrices depends almost entirely on the care with which they are handled during the process. Keep the solutions clean and avoid physical damage to the relief images; as many as 100 prints or more can be made from a set of matrices. Store matrix sets by washing each matrix for 1 minute in running water at 100°F (37.7°C) and hanging it up to dry. The best place to keep them is in the box in which the film was originally packed. Place each matrix in a separate fold of interleaving paper. Store printing data with the matrices so that information about dye contrast and control solutions used in the first acid rinse is readily available if printing is resumed.

When you reprint a set of matrices that has been stored for a long period of time, simply soak the matrices separately in a bath of warm water at 100°F (37.7°C) for 3 minutes before placing them in the dye baths. Be sure to keep the emulsion surface immersed completely during the soaking so that the emulsion swells equally overall.

Controlling Color Balance

Usually some change in the first print is desirable either to correct for small errors in exposure or processing, or to satisfy personal preference as to print quality. Briefly, overall density can be reduced by adding a sodium acetate solution to the first acid rinse, or it can be raised slightly by adding acetic acid plus a little dye. Density in the highlights can be diminished by adding KODAK Matrix Highlight Reducer.

Reducing Print Density -- One of the most useful controls in the dye transfer process is the addition of sodium acetate to the first acid rinse of one, two or all three matrices. Equal treatment of all three matrices results in a lighter print. However, suppose that a print shows an overall magenta cast. The density of the magenta dye image can be reduced by adding a 5% solution of sodium acetate only to the first acid rinse bath used with the magenta matrix. Add 1 to 10 mL of the 5% sodium acetate solution per 5 ounces (150 mL) of standard rinse solution. Dye the magenta matrix in the usual manner. When lifting the matrix from the dye bath, be sure to drain it until the dye solution begins to run off in droplets before putting it into the acid rinse containing the sodium acetate. Agitate the dyed matrix for 1 minute (use the tray-tilt method of agitation), then put it in the second acid rinse. Use more sodium acetate solution or a longer time to lower the density further.

In this example, only the rinse for the magenta matrix should contain sodium acetate. Depending on the direction in which the print is off-balance, it may be necessary to add sodium acetate to the first acid rinse used with two of the matrices, perhaps with a difference in the concentration of the additive or the length of treatment.

You can remove rather large amounts of dye from matrices with sodium acetate solution. However, there is a serious decline in photographic quality if you attempt to salvage a definitely overexposed or unbalanced set of matrices by this method.

Mix the sodium acetate solution often and in small quantities to insure consistent results.

Reducing Density in Highlights -- When the print is properly balanced but the highlights are tinted, add 1 to 10 mL of KODAK Matrix Highlight Reducer R-18 per 5 ounces (150 mL) of the first acid rinse used with the matrix carrying the color that tints the highlights. Agitate the matrix for 1 minute in the first acid rinse before putting it in the second acid rinse. If necessary, you can use both sodium acetate solution and highlight reducer in the same acid rinse bath, and vary either the concentration of the highlight reducer or the time of the rinse to accomplish both a lighter image and clean highlights.

Changing Contrast -- As stated in the section, Using KODAK Film and Paper Dyes and Dye Buffers, the preferred method of contrast control is adjusting the degree of acidity of the dye baths. However, contrast can also be increased slightly by adding acetic acid to the first acid rinse bath. Add 3 to 10 mL of 28% acetic acid per 5 ounces (150 mL) of the first acid rinse bath. When removing the matrix from the dye bath, transfer it directly without draining to the tray containing the rinse with the extra acid in order to carry over a little dye into the rinse so that the rinse becomes, in effect, a second dye bath. Alternatively, add a specific amount of dye to the first rinse. Agitate the matrix for 1 to 5 minutes in this bath, depending on the increase needed in the contrast, and transfer it to the second acid rinse. As in reducing contrast, you may have to modify the first acid rinse baths used with one, two or all three of the matrices.

Assuming that the calculations involved in making a set of matrices were correct within 5 or 10%, the use of extra acid usually provides adequate correction. If a greater contrast change is needed for one or more of the dye images, dye the matrix in a modified dye bath prepared as described in the section on Using KODAK Film and Paper Dyes and Dye Buffers.

When you are making many prints, maintain the dye baths by using the replenishment chart on page 00 and prepare sufficient quantities of first acid rinse solution containing the necessary adjustment chemicals to complete the run, thus avoiding the repeated measuring of small amounts of additive during each transfer.

Special Procedures

Extra Rinse Treatments -- Sometimes a print shows a gradual shift in color from one side of the image to the other. This effect, known as "wedging," is usually the result of non-uniform processing. An even color balance across the image can sometimes be restored by additional rinsing of one or more matrices in an auxiliary 1% acid rinse containing sodium acetate and KODAK Matrix Highlight Reducer R-18. For example, if one side of the print is too yellow, give the corresponding side of the yellow matrix an extra rinsing in the auxiliary rinse bath after completing the normal first acid rinse. The time of the extra rinse treatment can be varied across the film by gradually dipping the matrix in and withdrawing it. Stop the action of the extra rinse at any time by placing the matrix in the second acid rinse bath.

When a print shows good color balance but has an excess of one color in a localized area, the chances are that one of the matrices or negatives did not receive full development in that area. Again, the correction is to rinse some of the dye held by the corresponding matrix. Very carefully apply the rinse solution locally with a camel's-hair brush, or use the rinse solution in a washing bottle of the type sold by scientific supply houses for use in chemical laboratories.

Extra Transfers -- Instead of removing dye by an extra rinse treatment, it is sometimes advantageous to put additional dye into the picture. The contrast of any of the dye images can be increased greatly by a second transfer from one of the matrices. However, it is seldom desirable to transfer a second image of full strength. You can adjust the amount of dye carried by the matrix by using <u>one</u> of the following procedures:

1. Redye the matrix briefly. A dyeing time in the range of 10 to 30 seconds is usually satisfactory.

2. Redye the matrix completely, but rinse it afterward in water to remove the dye from all areas except deep shadows. Then rinse the matrix briefly in the second acid rinse.

3. Instead of redying the matrix, return it to the used first acid rinse bath to which you have added 10 to 15mL of 28% acetic acid per 5 ounces (150 mL) of rinse solution. The rinse bath already contains dye carried over from the dye bath; if necessary, add a few additional millilitres of dye solution. Agitate the matrix in the dye bath for 3 to 4 minutes.

When additional color is required only in certain areas, the following procedure may be beneficial: After the first transfer, clean the matrix as usual, but do not return it to the dye bath. Instead, use a soft brush of a suitable size and carefully put dye solution on the matrix in the areas where it is needed. Depending on the amount of additional color necessary, use either a diluted dye solution or the working dye solution. In either case, follow the dye application by the usual first and second acid rinses before transferring the additional dye to the print. (Take great care in using the brush on the soft relief image of the matrix emulsion.)

MAKING IN-CAMERA SEPARATION NEGATIVES

by Charles Swedlund

My interest with in-camera color separation began while I was recreating and exploring J.C. Maxwell's demonstration on color perception (See page 00). This experience introduced me to the purity and intensity of photographic color that is possible when color separation is done directly from the scene rather than indirectly from a color transparency. I became fascinated with the objective and non-objective color relationships as a result of changes that may occur in the scene between the separate exposures and the factual rendition of the colors of stationary objects. Later I explored the soft focus, centrally oriented imagery made possible by using a 98¢ magnifying lens on the camera. In addition to the unique, exciting images produced, I am also intrigued with the process of color separation. It ''magically'' helps me to produce high-quality color photographs with regular black-and-white film, ordinary film-processing procedures and simple equipment. Therefore, I think of in-camera separation as a principle rather than a technique that enables each person to design his or her own personal system which is influenced by the individual's equipment and desired imagery.

The majority of my photographs were done with a 4 x 5- or 8 x 10-inch camera. I generally use sheet-film cameras since each sheet can be processed individually, but I have also used roll-film cameras (even inexpensive ones like the DIANA Camera). When a roll-film camera is utilized, the resulting colors are somewhat softer; there is compromise in factual depictions because some control is lost when the separation negatives cannot be developed individually.

Initially, I used KODAK TRI-X Film, 8 x 10-inch, for my work with in-camera color separations but I soon changed to KODAK SUPER-XX Pan Film because of its ability to obtain enough contrast in the blue color separation negative. (Since KODAK SUPER-XX Pan Film is not available in roll-film size, I still select TRI-X Film when using a roll-film camera.) I purchase my film in sizable quantities with the same emulsion number and store it under refrigeration to maintain consistency and reduce the need for testing. Having a number of film holders from the same manufacturer helps to minimize registration problems; a label on each side of the holder identifies the color and the set of which it is a record.

At first, I used the KODAK WRATTAN Filters, No. 25, 59 and 47, but shortly changed to the No. 29, 61 and 47B series. To avoid confusion, I expose them alphabetically by color -- blue, green and red. Each filter requires additional exposure over the normal meter reading, which is expressed by the filter factor number. However, converting the factor into an ''*f*-stop more light'' number is very convenient. The filter factor (or *f*-stop more light) will vary with the type of film, the quality of illumination and the color of the filter. The following chart, shows the filter factors translated to *f*-stops more light for SUPER-XX Film exposed to daylight.

KODAK SUPER-XX Pan Film, Daylight Illumination

WRATTEN Filter No.	Filter Factor	*F*-Stops More Light
47B (blue)	8	3
61 (green)	12	3 2/3
29 (red)	25	4 1/2-5 (or approx. 4 2/3)

The film being exposed with the blue filter will need three *f*-stops more light than the meter indicates. The imagery of this negative will have more depth of field than the red negative because of the two *f*-stop difference. This variance may prevent perfect registration. If the shutter speeds are used instead of the aperture, there may be a difference in the recording of motion between the three negatives. In addition to these problems, it is often difficult to set the aperture at 1/3 increments especially at *f*/22 or *f*/32.

To overcome these problems, I use neutral density filters with the color separation filters to even out the exposure differences between them. Every .10 density reduces the light by 1/3 of an *f*-stop. Since the red filter requires the greatest exposure increase, I add neutral density filters to the blue and green to make them equal to the red. For instance, the blue filter would need a .30 and a .20 neutral density filter, and the green filter would need a .60 neutral density filter to equal the red. This ''balanced'' set of filters makes the exposure simple and more consistent. The 4 2/3 *f*-stops more light number is then used to convert the film manufacturer's suggested ASA into an ASA number that reflects the exposure increase of the filters. In the above example, the ASA for SUPER-XX Pan Film ''effectively changes'' from 200 to 8.

Manufacturers Suggested ASA =	200
1 *f*-stop more light changes it to	100
2 *f*-stop more light changes it to	50
3 *f*-stop more light changes it to	25
4 *f*-stop more light changes it to	12
2/3 *f*-stop more light changes it to	8

Using the ''balanced'' set of filters and the adjusted ASA enables the exposures to be determined easily and made without time-consuming calculation. These figures have worked well for me, but variations may be necessary due to your own supplies, equipment or manner of processing.

Each time I begin working with a new batch of film, I make tests. My test card consists of a gray scale (No. Q-14, KODAK Color Separation Guide and Gray Scale) to measure and compare minimum and maximum density, density range and gamma; a gray card (R-27, KODAK Gray Card) to see easily slight variations in color balance; and samples of different colors such as those on the Separation Guide. I use daylight for my exposures; otherwise separate tests would have to be made with each type of light source. When conducting daylight tests, choose a bright sunny, cloudless day from 10 a.m. to 2 p.m. These conditions present the purest white light, the best contrast and the most consistent intensity. As a time-saving device, I use a copy stand because it eliminates the number of possible variables that may occur when setting up the camera each time. The size of the individual areas on the negative will be large enough to be read accurately with the densitometer. It is important to remember that exposure from these tests will be different than when photographing a regular scene due to the exposure increase for bellows extension; however, that exposure increase may be easily calculated and compensated for. Because these tests require organization to keep track of the extensive information, I place an identification number in the test area and keep a thorough notebook to prevent confusion.

I find it best to start with the blue record when beginning S-2 the tests for in-camera color separations exposed with daylight. The blue record requires the longest development time and has the lowest density range. I have never been able to get the blue beyond a 1.2 density range. Usually it is around 1.1. As a result, I use a developer such as KODAK HC-110 Developer at the A dilution at 75°F (23.9°C) to obtain more contrast. This extra amount of contrast helps when I want to photograph on a cloudy, flat day, as the subsequent drop in contrast will not fall below the tolerances of the process. I tend to use 75°F (23.9°C) rather than 68°F (20°C) because I develop the majority of my film in the summer when 75°F (23.9°C) is easier to maintain.

The first things to examine in the test are the minimum and maximum densities of the blue record. The film is underexposed if the shadow area density is below .30; a density of .50 indicates overexposure. Ideally, the density of the shadows should be in the .30s. I vary the neutral density filters in the ''balanced'' set of filters to alter the exposure. The final filter pack may differ from the manufacturer's suggestions. This variance is normal due to the difference in film, equipment and developing technique. The highlight density is basically controlled with development. Usually my blue record density is around 1.40 to 1.50. Subtracting the .30 minimum density from this number gives me a 1.1 to 1.2 density range. Upon plotting a curve, I determine the gamma. Once exposure and development times are established for the blue filter, I continue to make tests for the green and red filters to bring them all into balance. The three colors are then plotted on graph paper to examine their characteristics and relationships. Ideally, all three curves will be in perfect superimposition, but this perfect set is difficult to achieve when made outdoors. If there is a problem, the three color separations must be retested as a set.

I prefer the one-shot method for developing, but often use a replenisher for economical reasons when I have a lot of film to be developed in a short period of time. All of my film is processed in trays with a water jacket (a larger tray) to help maintain the proper temperature. I like to develop each set of separation negatives as a batch, rather than individually, in order to save time. In recent tests, I have found that the blue color separation negative requires 12 minutes to develop, the green 5 minutes, and the red 6 1/2 minutes. I stagger the insertion of the film into the developer rather than its removal so that the films can be fixed, rinsed, neutralized and washed together.

The registration system that I devised not only works well, but is very inexpensive. I use an ACCO Model 10X or 110 Paper Punch (available in office supply stores), graphic arts plate pins, a modified contact-printing frame and a sheet of 1/4-inch plate glass for a transfer board. The paper punch makes two 1/4-inch holes with 2 3/4-inch centers, which is ideal for 4 x 5-, 5 x 7-, and 8 x 10-inch film. The six 1/4-inch plate pins should be the type that have a flat broad surface on which the pins sit. Two pins are used to register negatives or matrices on the light table, two are for the registered contact-printing frame, and two S-3 are used on the transfer board. The contact-printing frame must be the next size larger than your film size, and holes must be drilled through its back to accommodate the pins. To set up the contact-printing frame for registration, punch a strip of film, insert two register pins in the holes for spacing, place it on the glass of the printing frame, and tape the pins securely to the glass. In the same manner, align and tape two pins each to the light table and the piece of 1/4-inch plate glass which is larger than your print size. Coat the tape on the transfer board (glass) with waterproof varnish or lacquer to help make it waterproof. After awhile, the register pins may rust and will have to be replaced, but wiping them dry after each use helps to prevent this problem.

The method of registering the color separation negatives depends on whether they are going to be contact-printed or enlarged. Most of my prints are made contact from 8 x 10-inch negatives, which makes my method direct, fast and simple. If enlargements are desired, easel registration followed by registering dried, dyed matrices is required. The image occupies the entire area of my 8 x 10-inch film which necessitates attaching a registration strip to it. The added dimension of the registration strip does not present any problem because the matrix film is 10 x 12 inches. The registration strip also insures that there is enough space between the registration pins and the image to allow placing the roller when transferring.

I prepare 1 1/2 x 8-inch registration strips from old film. It is better to have film than paper because the holes do not enlarge with use. After punching the strips, I place one strip over the pins on the light table, then I put the green color separation negative (emulsion down) next to the registration strip and tape them together, using plastic tape -- not masking tape. Another registration strip goes over the first one, and I register the second color separation negative with the one below it by comparing areas of the image that could not move during the exposure. A magnifier is often helpful. When the two are registered, I tape the top color separation negative to the top registration strip, carefully remove it from the pins and similarly register the third separation negative. When all of the negatives are placed on the pins, their image edges do not usually align perfectly, thus looking sloppy in the final print. This can be eliminated by making a mask of GOLDENROD or BASE-LINE Paper -- a yellow and translucent paper that blocks out light with ortho-sensitive photographic materials. It is commonly used by printers in preparing copy for printing. Punch a sheet of this paper, which is larger than the image area on the negatives, and place it on the pins over the three registered negatives. Since it is translucent, you will be able to see the images below. With a ruler, triangle and fine-point felt-tip pen, draw the desired image area. Remove the GOLDENROD Sheet, place it on a sheet of glass and use a mat knife or razor and a straightedge to cut out the window area. Place this sheet with each color separation negative when exposing the matrices to produce clean, white borders in the resulting dye transfer prints.

The exposure may be facilitated with a point-light source. Tests will be needed to determine which light intensity setting and/or neutral density filters will be appropriate. Another method is to use an enlarger for a light source. With this method, a negative carrier, without a negative, is placed in the enlarger. Make sure that the focal length of the lens correlates to the format size of the negative carrier. Raise or lower the enlarger head until the projected area of light is just larger than the contact-printing frame. Focus the enlarger so that the edges of the projected area are sharp. Close down the lens two or three _f_/stops, and make a series of tests to determine the proper exposure for the setup. Measure the distance from the lens to the baseboard and make careful notations of the information so that the enlarger can be used in exactly the same configuration the next time it is needed as a light source for making contact matrices.

MATRICES FROM COLOR NEGATIVES

by Ctein

C-1 (large)

The dye transfer process is similar to the mechanical press process used to reproduce the color illustrations in this book. Both processes lay down a color image as a series of single color prints, transferred one at a time, in register, to blank white paper.

The dye transfer process uses three subtractive primary color, transparent, water-soluble dyes to create a full-color picture, while mechanical printing uses four colors (three primaries plus black) of semitransparent oil-based inks. The mechanical ink image is carried on the surface of a halftone-screened metal or plastic plate. In dye transfer printing, each dye image is absorbed into and carried by a continuous tone gelatin layer on a plastic film base, called a matrix.

The matrix gelatin layer is actually a relief image -- the thickness of the gelatin at any point is proportional to the optical density (darkness) of the image at that point. The relief image is produced photographically as outlined in the following steps:

1) A sheet of matrix film is exposed through the transparent base to a negative containing the separation image. Matrix emulsion is heavily loaded with light-absorbing dye. The

brighter the light at any point, the deeper it penetrates the emulsion. The exposed silver halide crystals that result are not distributed uniformly throughout the bulk of the emulsion, but are concentrated in a layer close to the base of the film.

2) The exposed film is processed in a tanning developer, such as pyro developer. The gelatin of an unprocessed matrix is unhardened -- if the film is immersed in hot water, the emulsion will melt away completely. Pyro developer hardens or ''tans'' gelatin adjacent to developing silver halide crystals. Since unexposed regions of the emulsion are not hardened, a relief image layer of hardened emulsion is created within the volume of the unhardened emulsion.

3) The developed and fixed film is washed in hot water, melting away all unexposed portions of the emulsion. The remaining gelatin image is proportional in thickness to the original exposure.

4) The finished matrix is soaked in an acid-fixing dye of the appropriate color. Gelatin will absorb such dye in an acidic solution and release it later when put in contact with a neutral or basic environment. The amount of dye that a given thickness of gelatin on a matrix absorbs is controlled by the acidity and chemistry of the dye in which the matrix is immersed. Under consistent conditions, the amount of dye carried by the gelatin C-1a

is proportional to the thickness of the layer and therefore to the original exposure.

5) When the dyed matrix is squeegeed into contact with a sheet of receiving paper, the dye migrates from the film to the paper where a mordant in the paper emulsion locks the dye molecules into the print.

More light means a greater thickness of gelatin, more dye absorbed by the matrix and as a result, a darker print; therefore, the dye transfer process is a negative-to-positive process. KODAK Matrix Film 4150, which is only blue-light sensitive, can be used to make dye prints from black-and-white separation negatives that may be originals shot in-camera or intermediate negatives made from a color transparency.

Color Negatives vs Transparencies

The dye transfer process is particularly well-suited to producing prints from color negatives. Current color negative materials consist of three superimposed, color dye-separation negatives. Since dye transfer is a negative-to-positive process, one can produce a set of dye transfer matrices directly from the original negative without having to make intermediate separations.

Color negative materials currently provide both sharpness and fine grain structure comparable to that of transparency films. Negative materials have an integral color-correction mask and are able to record an extremely long scale of exposure values. This permits making excellent negative dye prints, equally as fine as those made from transparencies.

One might even argue that, in theory, dye prints from negatives should be superior to those from transparencies, since no intermediate images (which must always lose some information) are involved. On the other hand, the transparency masking and separation contrast are completely controlled by the printer. This extra degree of control should, in theory, allow more accurate and precise rendition of transparencies (I suppose that a dedicated printer could do additional color-correction masking with negatives. This would add a considerable amount of work and complexity, so it is not normally done).

However in practice, the quality of a dye print is almost always limited more by the skills of the photographer and printer, not by the materials that they use. Dye transfer is such a flexible and controllable process that fully evoking its excellence is not easy.

Some situations will favor one medium over the other. Transparencies provide a visual reference that is extremely important when several people are involved in the production and use of a print. This can make transparency prints preferable for commercial and advertising work, especially when the original film can be shot under carefully controlled conditions.

The negative's ability to record a longer exposure range may make it preferable when the situation is less well-controlled. High luminance ranges or unusual light characteristics, such as mixed lighting or extreme color temperature, are more easily and accurately handled by negative films. Neither recording medium is the winner in all situations.

My personal choice has always been negatives. I am more ''print-oriented'' than ''projector-oriented.'' A great deal of my best work has come from unusual lighting conditions; I like to photograph what I see, which rarely conforms to the precise specifications of any available films. I do all my own printing and have produced excellent work with transparency films, but I am much more comfortable with negatives. In the end, it is always a subjective decision.

Dye transfer is the best method of producing prints from my negatives because dye prints provide the most accurate and purest color that one can get in a color negative print. The process gives a degree of control over the final print that lets me convey, in the print, what I visualized when the negative was exposed.

Benefits -- Dye transfer prints are the only generally available negative prints which are truly permanent against dark-fading and staining (print deterioration that even occurs in prints of other types that are protected from the light). Accelerated fade tests indicate a life, at room temperature, of several hundred years before noticeable change occurs. They are also the only generally available color prints still on fiber-base paper, which is the only material whose stability has been documented for a long period of time in actual use. I don't feel that I am being unreasonable as an artist when I hope that some of my work will outlive me.

It is particularly important for would-be dye transfer printers who have experience with other color processes, such as KODAK Process EP-2, to realize that their knowledge about the principles of color enlarging will be useful for dye transfer work. However, the procedures and general approach are totally different as is the attitude which they must have towards their work and the process.

Getting a properly exposed piece of print paper is the goal of most color processes. Color print development is so standardized and well-defined that machine processing will produce as good, if not better, results than hand processing, regardless of the skill of the printer.

Ansel Adams has remarked that a negative is much like a musical score, with the print as the interpretation and playing of that score by an artist. This holds true for dye transfer printing. Making a good set of matrices is half or less of the work; it is only the score that you play to make a print. Properly interpreting those matrices, by controlling the way in which they absorb and carry dye to the final print, is where the real skill and flexibility lie. In terms of the ''attitude'' that you must take towards your work, dye transfer has more in common with other fine-art processes, such as stone lithography or etched-metal plate printing, than it does with ordinary photographic printing. It is very much a hands-on process; any experience that you have with those other processes will be most valuable.

To work successfully in dye transfer, you must understand why you do what you do. Dye transfer is not, and never will be, a ''cookbook'' process. This sort of intimate acquaintance with and appreciation of a printing process is always desirable; in the case of dye transfer, it is absolutely essential.

If you do not approach dye transfer printing with the appropriate attitude, you will find it a frustrating and unpleasant process; previous experience with how things proceed will be in conflict with how matters <u>are</u> progressing. If, on the other hand, you accept the process on its own terms and acquire the intellectual and emotional understandings which I have hinted at, you will find dye transfer printmaking to be an enjoyable, satisfying and even pleasant way to pass many hours. This process can inspire love (and hatred) that no tray of developer ever will.

Using KODAK Pan Matrix Film 4149

C-2

Dye transfer prints can also be made from color negatives on KODAK Pan Matrix Film 4149, which is sensitive to all colors of light. In this case, the separate color dye layers of the color negative function directly as separation images, and no intermediate negatives are needed. Pan Matrix Film can be exposed directly through red, green and blue color separation filters. These filters allow the printer to separate directly the three color dye images in a color negative. The red separation filter freely transmits both magenta and yellow light, while absorbing cyan light. Since the cyan dye layer of the negative passes only cyan light, it appears opaque (black). A sheet of Pan Matrix Film, exposed via red light, records only the cyan dye image, not the magenta or yellow ones. This film, when processed, will be used to print the cyan dye in the final print.

Similarly, the green filter passes cyan and yellow light while isolating the magenta dye layer. The blue filter isolates the yellow dye layer, producing the yellow-printing matrix. In practice, these filters don't do a perfect job. The green filter, for example, ''sees'' a little of the cyan and yellow dye layers, but the results are good.

Unprocessed Pan Matrix Film is blue-black in color in order to absorb all colors of light equally. The separation filters do not transmit a great deal of light, so the film is extremely sensitive and must be handled in total darkness. Light leaks which would not fog ordinary color papers will fog Pan Matrix Film.

Registration

Pan Matrix Film comes prepunched with a set of registration holes. Since the dye images in the negative are already in register, one can easily expose a registered set of matrices on an exposure easel equipped with appropriate register pins. When these matrices are used to transfer dye for a final print, the three dye images will automatically be laid down in register if the transfer easel is equipped with a similar set of pins. This simplifies dye transfer work considerably.

The exposure easel should be a vacuum easel to make sure that the matrix film is held flat and cannot shift or curl during the exposure. It should be heavy enough so that it cannot be moved accidentally when the film is changed between exposures.

The transfer easel does not need to provide a vacuum; surface tension holds the wet receiving paper flat and the matrix to the paper. The easel does not have to be particularly heavy either as long as it is waterproof and extremely flat (to within a few thousandths of an inch). If the easel is not flat, the matrix and paper will not make uniform contact when rolled together, and you will get poor transfers of dye. If the easel is not waterproof, it will absorb liquid during the print transfers and will promptly become un-flat!

Pan Matrix Film comes punched with special ''ob-round'' registration holes (round holes with flattened sides). These holes match the pins of KODAK Transfer Easels as well as registration pins and easels produced by Condit Manufacturing Company. It is both easy and economical to construct your own register easels using CONDIT Pins. These pins come set into a thin strip of stainless steel, spaced to fit the film's prepunched holes.

As an alternative, you can punch your own holes, using a heavy duty paper punch and have registration pins made to match your punch. Both approaches have their merits.

CONDIT Pin-Strip Easels -- Condit Pin-Strips are inexpensive and prealigned. It is easy to construct several easels with identical registration characteristics, so one can build separate C-3 C-4 C-5 easels for exposure and transfer, thus simplifying easel construction greatly.

There are some disadvantages in using CONDIT Pin-Strip Easels. You need two frames instead of one. If you wish to use both 10 x 12- and 16 1/2 x 21 1/4-inch Pan Matrix Film, you will need to buy two different sizes of pin-strips; the two film sizes have different hole spacings. If you don't buy either a KODAK or CONDIT Film Punch, you cannot punch film to fit the easels. You cannot cut large film to size to make several small prints, nor can you save a set of misregistered matrices by repunching them.

Custom Pin Easels -- With custom pin easels, you can use a single easel for film exposure and print transfer with any size film. You can repunch misaligned matrices, saving the time and expense of remaking a set. You also have an easel and punch for use with other darkroom processes that require registration techniques.

However, without special alignment tools, it is very difficult to set the pin spacing to perfectly match your punch. This means that you cannot be sure that a set of matrices will align the same way on two different easels; you must build a combination exposure and transfer easel. This is a much more laborious construction project. It is not for the novice; anyone can build CONDIT Pin Easels.

I have both kinds of easels, although most of the time, I make my exposures and transfers on the CONDIT Pin Easels. I recommend that the beginner use CONDIT Pin Easels for more assured, successful construction and application of these designs.

CONDIT Pin Easel Construction

When building a CONDIT Pin Easel, the exposure easel should be a few inches larger than your matrix size. With 10 x 12-inch film, a 12 x 14-inch easel is appropriate (See the illustration on this page). You will need the following materials:

1. 12 x 14-inch sheet of tempered MASONITE Hardboard, 1/4-inch or thicker

2. 12 x 14-inch sheet of 1/2-inch plywood

3. 4 1/2 feet of 1 x 2-inch clear pine lumber

4. 6-inch length of 1 1/4-inch metal or plastic tube to fit vacuum cleaner hose

5. 20 3/4 x 4-inch wood screws -- 10 round-head and 10 flat-head

6. Silicone rubber sealant

7. 1 short (6 1/2 inches) CONDIT Pin-Strip with high pins

8. Flat black spray enamel

You will also need a sanding block, medium sandpaper, a saw, a screwdriver and a drill with a 1/8-inch bit.

Cut the lumber into six pieces of the proper lengths. Drill 1/8-inch holes in the plywood and the MASONITE Hardboard Sheet for the screws, and drill vacuum holes in the hardboard. Mount the 1 x 2-inch lumber pieces on the plywood base with the flat-head screws. Run a bead of sealant along all the inside joints of the frame to make them airtight. Lay a thick layer of sealant into the slot left for the vacuum tube, and press the tube into place. Let the assembly sit for a couple of hours until the sealant sets.

Lay a thin bead of sealant along the top of the sides of the frame. Place the hardboard on the frame and screw it down lightly. Don't tighten it too much; just let the sealant fill any gaps or irregularities to avoid warping the hardboard. Fill in the gaps around the vacuum tube with sealant and set the frame aside to dry. Put a strip of masking tape on the hardboard where the pin-strip will be, and spray the entire frame with flat black enamel. When the enamel is dry, remove the tape. The flat black surface will scuff easily, but it will cut out any unwanted scattering of light which is vitally important. Spread a <u>thin</u>

layer of sealant on the unpainted area of the hardboard and press the pin-strip into place. You can slide it about slightly to position it exactly.

An exposure easel for the 16 1/2 x 21 1/4-inch film is constructed in exactly the same manner -- just use more materials. The dimensions for such a frame are given in the accompanying illustration. The large easel requires a <u>long</u> (9-inches) high pin-strip instead of a short one. It is also possible to build a dual easel which can handle both sizes of film. Make a large easel about two inches longer than the design shown here. Fix a short pin-strip to one end and a long pin-strip to the other; the extra length insures that the short strip doesn't intrude into the area where the large matrix film lies. When using small-size film, cover the extra vacuum holes with masking tape. C-6

The transfer easel is extremely simple to build and it can be used with 11 x 14-inch paper. Purchase the following supplies: C-7 C-8

1. 13 x 16-inch sheet of plate glass, at least 1/4-inch thick

2. 3 feet of 1 x 2-inch clear pine

3. Silicone rubber sealant

4. 1 short CONDIT Pin-Strip with low pins

5. Polyurethane spray lacquer

You will also need some medium sandpaper and a saw.

Lightly sand the edges of the glass to remove dangerously sharp edges and corners. The glass will serve as the transfer surface, so the heavier it is the better. Quarter-inch glass is unlikely to break under normal use.

Cut the wood into one-foot lengths and sand it free of splinters. Spray it with several heavy coats of lacquer. Don't skimp, if the wood absorbs moisture, it will swell and warp or even break the glass. Give the lacquer 24 hours to dry, and spray the wood a second time, just to make sure.

Lay the lumber on a flat table, spaced 5-inches apart. Run a thick bead of sealant along the length of each piece. Carefully lay the glass down on top of the wood and sealant. Don't press the glass down; let the weight of the glass squeeze the sealant into a cushion between the glass and the wood. Let the easel sit this way for several hours without touching it. If you must move the easel before 24 hours have passed, set it down again carefully, with the wood on top, so as not to disturb the position of the pieces.

After the sealant cures, attach the pin-strip to one end with silicone rubber; this does not chemically bond to either glass or stainless steel. If you should break an easel or want to rebuild one at some future date, you can remove the pin-strips and reuse them.

On this page, you can see the dimensions for a large print easel, suitable for 20 x 24-inch paper. Use the long, low pin- C-9
strip with this design. As before, you can build a dual easel by making the frame 2 inches longer and affixing a short strip to one end and a long strip to the other.

Custom Pin Easel Construction

If you wish to build a register easel for your own punch, plan on building a single easel to handle both exposures and transfers. This requires more skill than building CONDIT Pin frames. Many C-16
appropriate designs are possible, so I will not give detailed plans with specific dimensions. If you do not feel confident to work out your own design from the following guidelines, you C-10
probably should not tackle this project.

First, you must select a suitable punch. Paper punches are not intended for punching heavy ESTAR-Base Film; don't assume that any punch will do the job. Try out a punch before buying it; a well-stocked office supply store usually has several different models of two- and three-hole punches.

Try out the punch by punching several sets of holes in a sheet of matrix film. A good punch will produce clean round identical holes every time. If there are any rough edges or flash in the holes, the punch will not produce regular enough results for critical registration work. The punch should have a broad, flat shelf to support the film, and the punch arm should be long enough for you to punch the film easily and smoothly.

Your registration pins should be made of stainless steel to prevent corrosion. ALLEN Head Screws make ideal stock from which pins can be cut. Your local metal-working shop can provide screws whose heads are slightly larger than your punch holes and turn the screws to size on a lathe. Provide the machinist with a punched sheet of matrix film, with the holes numbered to keep things straight. The pins should fit the holes snugly, but they should not be so tight that they have to be forced into the film holes.

Have two sets of pins made -- one as a spare set. Be sure the machinist tags them with numbers so you can match them to the appropriate punch holes. The illustration on this page shows a finished set of pins and a pin clip. Also, purchase an ALLEN Key to fit the screw socket.

Your pin set will be mounted in a thin support strip. Rigid plastic, such as PLEXIGLAS Sheets, or varnished wood is suitable. The strip should be thinner than the length of the threaded stem of the pin. You will want to purchase a stainless steel washer whose hole is larger than the pin diameter and a stainless steel nut for each pin.

If you wish to use spring clamps to help secure the matrix film to the pins, you can make a set from ordinary suitcase latches (available at hardware stores). Simply file or grind out the inside of the latch arm. These clamps are optional.

Wood or ferrous materials used in construction must be protected from moisture and acid. Wood should be given several coats of a high-quality grade of polyurethane lacquer, after the wood has been cut to size and drilled for screws or vacuum. Make sure you lacquer the inside of all the holes. Metal, with the exception of the register pins, should also be lacquered. Because the spring steel in your film clamps will rust, pack the interior of the clamp with moly or lithium axle grease, after the clamp is mounted. All screws should be brass or stainless steel. C-15

Mark the approximate locations of the pins on your support strip, using the punched film as a template. This will not precisely locate the pins; therefore, drill holes that are slightly larger than the screw threads but smaller than the heads. Later you will adjust the pin positions precisely. C-12

After lacquering the support, if necessary, insert the pins through the support holes and screw on the nuts finger-tight. C-13

Make sure the right pin is in the right position. Press a sheet of punched matrix film onto the pins. The film should be supported so that it lies flat.

Check the film between the pins very carefully. It should not be stretched nor show any signs of buckling. This is the critical assembly; pins which are incorrectly spaced will put a strain on the film so that it will neither lie flat on the easel nor always align in the same position. You should use the ALLEN Key to shift each pin as necessary, until you are satisfied that all the pins are aligned. When this is done, tighten the pin nuts, holding the pin motionless with the ALLEN Key. If you attempt to turn the pins to tighten them, you will instead shift them from their desired positions. C-14

Remove the sheet of film from the pin-strip and try pressing it back into place. It should go on easily without any sign of alignment problems. The fit will be firm, but not strained. If this is not the case, repeat the alignment procedure until everything is okay.

Be patient. You only have to do this once. When the alignment is as good as you can make it, cement a washer to the support around each pin. A super glue will work well for this. If you are using film clips, mount them now. In a properly mounted clip, the arm of the latch rests on the washer in front of the pin. Set the finished pin assembly aside for now.

The frame of the easel is similar in design to that for the CONDIT Pin-Strip exposure easel. Every component of this frame must be waterproof, as previously mentioned. The top of the frame should have an overhanging edge to which the pin-strip will be attached. The top must be of some material into which you can drill holes, but it must be extremely flat and also must be waterproof. Wood, MASONITE Hardboard and other similar materials are totally unsuitable. I suggest a very heavy sheet of PLEXIGLAS (at least 3/8-inch) or a composite, such as a FORMICA Countertop. The former is more expensive and difficult to work with; the latter requires very careful selection for flatness as well as good waterproofing. C-17

You can check flatness by standing a heavy metal ruler on its edge on the surface. If the ruler rocks slightly, then the center is bowed up; if there is a slight gap under the ruler, it is bowed down. Check several different directions. None should show a gap thicker than a 3 x 5-inch file card. If you must get a piece with a slight bow, make sure it bows in only one direction because matrix film cannot conform to a double curvature. Otherwise, you will not get good transfers.

Drill a series of vacuum holes in the easel top. Holes don't have to be large -- 1/16-inch will do. Arrange them so as to provide uniform suction out to the edges of any sizes of film which you plan to use.

The general dimensions of the CONDIT Frame can be used as a guide for your custom easel frame; adapt them to your specific design. Cut, drill and assemble the frame without any caulking or sealant to make sure everything fits. Then dissasemble it and seal all surfaces, inside and out, with several lacquer coats. Be sure to get the drilled holes. Use flat-head, countersunk screws on all surfaces, so that you can caulk them over to seal out moisture. Once all the components have been waterproofed, you can reassemble them, caulking all joints to make the frame air- and water-tight. Do not mount the top of the easel to the frame at this time. C-18 C19

The custom pin-strip must be rigidly mounted to one edge of the top. The idea is to have the easel surface level with the film support washers, enabling the matrix film to lie flat without any strain. To avoid interfering with the film, the mounting plate must attach to the bottom of the pin-strip and the easel top. If, at some future time, you wish to rebuild your frame, you can detach the intact pin-strip and move it to a new frame without having to rebuild and align it. C-20

The illustrations here show the completed pin-strip and mount-assembly which I built, attached to the underside of the easel top. Notice that the edges have been sealed with caulking compound, and a layer of compound has been spread between the mount plate and the easel top. Countersunk screws have been used C-21 on top of the pin-strip assembly and sealed over with several coats of lacquer.

The only remaining steps are to seal off all the screw heads and paint the easel with waterproof, flat black enamel. The edges of the film clamps are also sealed to help prevent moisture from seeping into the clamp. When you paint your easel, be careful to protect the pin-strip, since paint will increase the pin diameter and keep the punched matrices from fitting. Before using the finished frame, pack the clamps with axle grease. Periodically check the packing. Otherwise, your frame should not need any maintenance.

Preparing The Negative

C-59

Choose as ordinary a negative as you can for your first dye transfer print. It should have a full range of tones, a variety of colors and moderate contrast. I suggest that you get or make a conventional color print of that negative as a guide and for comparison purposes. You may use a print on KODAK EKTACOLOR Paper, but I prefer a print on KODAK EKTAFLEX Print Material -- its color rendition and exposure range are a much closer match to those of a dye print made with KODAK Pan Matrix Film. In the following examples, I will be referring to a test print on EKTAFLEX Print Material.

The exposure easel will not mask off the edges of the matrix film the way a conventional paper easel masks off a print. If you want to crop your image, you can do so by trimming the finished prints and remounting them, or you can mask the negative or matrix film when you make the matrices. I recommend this approach; it leaves clean borders on the matrices, making them much easier to handle, and provides prints with big white borders.

C-22
C-23

A suitable mask for the negative can be made from ordinary sheet film. Any heavy-based film will do, black-and-white or color. Outdated film is perfect. Develop the film for several minutes under room light in a tray of KODAK DEKTOL Developer. Fix and wash the film; you will have completely opaque plastic sheets from which masks may be cut.

Carefully measure the dimensions of that portion of the negative which you wish to enlarge. Cut a window of the appropriate size in a sheet of the masking material, using a sharp hobby knife. If you cut through the film from the emulsion side, you will get a very clean, crisp edge to the mask. Blacken the edges of the cut-out window with black drafting ink. This keeps the clear film base from scattering light around the border of the mask. Sandwich the finished mask with the negative in your enlarger when exposing the matrices.

You will need to cut a new mask every time that you wish to enlarge a different size region of a negative, but after a while, you will build up a file of such masks. Thereafter, it is little work to select the appropriate mask and sandwich it with your negative.

As an alternative, you can mask the negative directly with opaque tape. Adhesive-backed metal tape, found in hardware or electronic stores, or thin, silvered MYLAR Tape, such as SCOTCH Brand No. 850, is most suitable, since it does not stretch and can be cut to give a clean, straight edge. This method requires a light table for best results. Tape your negative to the table, and carefully mark the edges of the film to indicate the limits of the region that you wish to enlarge. You can use either a fine pen or make small scratches with the tip of a hobby knife.

Cut a strip of tape, using a metal straightedge and a fresh knife blade, to make a clean, dirt- and knick-free edge. Hold the strip taut and carefully lay it on the negative base. When you have lined it up with your guide marks, press it down lightly. Cut and lay the other three strips in the same fashion. When all the strips are positioned, burnish them down firmly to make sure corners and edges are well attached. This method is preferable to using small masks as it produces sharper borders. It is also difficult to cut a small sheet film mask (under 3/4 x 1 1/6 inches or 2 x 3 cm) with any precision. Tape-masking does require more negative handling, though, and in the long run, it means more work.

A third masking method is useful when making enlargements of any size negative. A sheet of film, the size of your matrix film, can be cut to make a mask with the dimensions of your final print. Old, discarded matrices work well, since they are punched to fit your register easel. Take a sheet of film and fit it to your easel. Using a marking pen, indicate on the film the approximate dimensions of the enlarged image. Use these marks to lay out a precisely rectangular outline, and cut the film with a hobby knife. Spray paint the finished mask with black paint on both sides.

This mask is used with each sheet of matrix film, which means that it must be pressed onto the register pins before you expose each matrix. This technique produces extremely sharp borders, but it requires more work and additional steps to keep track of when exposing a set of matrices. Of course, you will need a mask for each size print that you want to make. Nonetheless, this technique is a useful one, and is my preferred masking method.

In any case, once you have settled on your mask, prepare your negative for the enlarger. You cannot clean your film too thoroughly. Any speck of dust or scratch will be faithfully reproduced in your matrices and thereafter in print after print after print! A minute spent now to clean the film will save you hours of spotting in the future. Frequently, I spend as much as an hour preparing a negative to my satisfaction, sandwiching it with a mask and getting the enlarger set up and focused exactly as I want it to be. This is time well spent. I rely on KODAK Film Cleaner, a good camel-hair brush, compressed air and occasional rewashing of a recalcitrant negative.

Test Prints

C-24

There is no need to make full-sized test prints. I always determine exposure and color balance for a contact print or very small enlargement before making a full-size set of matrices. I find that this is more reliable than making a test strip of a small portion of a large image.

C-25

My test prints are between 2 x 2 1/3 inches (5 x 6 cm) and 4 x 4 3/4 inches (10 x 12 cm) in size. Small prints make it difficult to expose and print the test strips, while larger images unnecessarily waste valuable matrix film. If you are working with medium- or large-format negatives, you can contact-print them. Smaller negatives should be enlarged to the recommended size.

The test procedures are identical for both enlarged (projected) and contact test prints, with the exception of exposure times. When contact printing, I set the enlarger to the height that I will be using for my full-size exposures. This produces test exposure times very close to those required for the final matrices (there are slight differences between contact printing and projection printing times).

Small-enlargement tests produce different exposure times than full-size enlargements. When the tests are done, one figures a correction factor by which to multiply the test times. It is not difficult.

In the test example on page 00, I used the enlargement method, although my negative is large enough to contact-print (my normal method). This technique demonstrates how to figure the exposure correction.

Determining Exposure and Color Balance

There are two ways for determining exposure and color balance. If you have an enlarger equipped with a color filtration head, you can use the filters to help control exposure times for the three matrices. With a black-and-white enlarger, you control density and color balance solely by adjusting the exposure times of one or more matrices.

Tricolor Method -- Each approach has its merits. The ''tricolor'' approach, utilizing black-and-white enlargers, is very straightforward in concept. If you want to change a print's density, multiply all matrix exposure times by the same factor. If you want to shift color, alter the three times unequally. When you use color-balancing aids, such as the KODAK Color Print Viewing Filter Kit, it is necessary to do a bit of computation to convert the common KODAK Color Compensating (CC) Filter values into exposure factors for the matrices.

Color Compensating Filters -- In white-light printing of color negatives to make prints on KODAK EKTACOLOR Paper, the color of the light is controlled by placing filters of various hues in the light beam of the enlarger. These filters act as densities to their respective complementary colors in the enlarger light source, thus modifying it to the specific requirements of the color negative being printed. Either KODAK Color Printing (CP) or KODAK Color Compensating (CC) Filters can be used for this purpose. CP Filters are utilized in the enlarger between the light source and the negative -- not in the image-forming area. They are made of acetate and will affect the definition. CC Filters, on the other hand, are made of gelatin, like the separation filter, and can be used anywhere in the system. They are also put in front of the camera lens to correct color balance in exposing transparency films and have existed much longer than CP Filters. When dichroic filter-equipped enlargers came on the market, they were calibrated in ''CC'' units, denoting the densities in percentages of log-exposure to their complementary colors. For instance, a CC10Y Filter is yellow in color and is of a .10 log density to its complementary color, blue. Common practice is to evaluate color-balance corrections in a print in ''CC'' units throughout the photographic industry.

Color Head Method -- The ''color head'' approach is more complex in theory. Matrix exposure times are always kept equal; they are changed equally when one wishes to alter print density. The enlarger's built-in cyan, magenta and yellow filters are used to control color balance. Each filter subtracts one of the primary colors (red, green or blue) from the white light, which changes the intensity of the light passing through the matching separation filter. Hence, the exposure of that matrix is altered, even though the printing time remains the same (exposure equals intensity multiplied by time). For example, if 30 CC of yellow filter is added to the enlarger head, the amount of yellow light is <u>not</u> increased, rather the amount of blue light is decreased. The light is made ''yellower'' by subtracting blue light from the beam. Since the blue filter only passes blue light, that matrix receives less exposure.

There are several advantages of employing this approach. It is quite analogous to the ways most amateurs and professionals make conventional color prints. Skills developed for regular color printing can be applied to the matrix exposure. In addition, all three exposure times remain the same, so any reciprocity-failure effects from very long or short exposures influence the three matrices equally. Such effects may manifest themselves as a slight difference in contrast, but all three matrices will be changed equally; there will be no color shift or color crossover. I have used exposure times as long as 12 minutes for each matrix with no problems whatsoever. This is well beyond the permissible times when the matrices do not receive the same exposure times.

The major disadvantage of the color head approach is that exposure times are generally a little longer. Also, a fair amount of computation may be involved to translate matrix exposures to filtration factors.

Nonetheless, I prefer the color head approach. I have a very bright enlarger, I like being able to use tools such as viewing filters, and I am not bothered by doing the math. In this section, I will calculate exposures using both approaches, so you may see how it is done, although all my tests will be made with the color head approach.

Your exposure times will depend on which separation filters you use. I recommend the following set of KODAK WRATTEN Filters: No. 29 (red), 99 (green) and 47B (blue). Kodak recommends a No. 98 (blue) which is equivalent to the No. 47B plus a 2B Ultraviolet (UV) Absorbing Filter. The No. 98 filter will require about 25% longer exposure times (or about 10 CC yellow subtracted from your filter head). Almost all color heads are already equipped with UV filters, but this filter may be preferable with black-and-white enlargers.

In a pinch, you may substitute No. 25 (red) and 61 (green) filters. The No. 25 (red) will slightly reduce exposure times, but will do a slightly poorer job of isolating the cyan dye image. The differences are almost negligible in most cases. The No. 61 (green) filter is not effective at cutting out unwanted cyan and yellow dye absorptions, but it will usually produce acceptable results. It will cut the green light exposure by at least a factor of two; in some cases, this may be desirable.

If you are using a black-and-white enlarger, I can't provide a precise exposure recommendation but only some very rough estimates; there are too many varieties of enlargers. As a guess, try figuring your red light exposure on KODAK Pan Matrix Film at 5 to 10 times the exposure that you would use to make a normal black-and-white print of the same size from an average black-and-white negative. The green light exposure will be about the same; the blue light exposure will be 2 to 3 times longer.

If you work with a tungsten-halogen enlarger, use a red light exposure equal to 1.5 times the exposure used to make prints on color paper of the same size. This is your starting point whether or not you are using the color head approach.

This recommendation, and any others that follow, apply only to prints on paper made with exposure times of less than 30 seconds. Conventional color materials show reciprocity shifts that can alter color balance and density significantly. Pan Matrix Film exhibits much less shift; it loses about 1 stop of film speed with a 10-minute exposure.

The required filter pack for a tungsten-halogen enlarger is often very small, but it depends on your choice of separation filters and negative film as well as the specific image. Start off with a OM+OY+OC pack for your first exposure tests, which really means equal exposure times for all three matrices with either color-balancing approach. Of the matrices which I have made in recent years, many required filter packs of less than 30 CC in the strongest color. That would correspond to a 1-stop exposure difference between matrices for the tricolor method.

You can use the printing data from the test print to derive a good estimate for your Pan Matrix Film exposures. The corrections will vary from one batch of either material to the next, so the following correction factor is only a starting guide. If you are using the color head method, subtract 45 CC of the red from your test filter pack and use a matrix exposure equal to 1.5 times the test exposure.

Even if you are planning to use the tricolor approach, you can still convert test printing data to matrix exposures by utilizing TABLE I on page 00, plus a bit of thought. Table I relates exposure changes to color filtration and print color changes. For instance, let's suppose that a test print suggests an exposure time of 25 seconds, with a filter pack of 5M+10C. Here is how to convert that to no-filters (tricolor) exposure. We have 5 CC of magenta filtration. Magenta filters out only green light, so this says the intensity of the green exposure has been reduced by 5 CC. According to our table, adding 5 CC of filtration is equivalent to dropping the exposure to 0.9 times normal. Therefore, 25 seconds plus 5 CC is the same as 25 seconds times 0.9 or 22 1/2 seconds.

By similar reasoning, we conclude that the red light exposure has been reduced by 10 CC or 0.8 times, making our new red light exposure 25 x 0.8 or 20 seconds. Our blue light exposure does not change at all because there is no yellow filter for which to correct. Our final set of times is: red, 20 seconds; green, 22 1/2 seconds; and blue, 25 seconds. Notice that all the times have decreased or remained the same, which is what you would expect when you remove light-absorbing filters from the enlarger.

If you own a color analyzer, you can program it with color head filter and exposure time information for your matrix film, much as you would for a conventional color print. Any analyzer is suitable. Since they are all programmed slightly differently, I will not describe procedures in detail. The only change from your usual procedures is to make each color channel reading through a complementary separation filter. For example, insert the No. 29 (red) filter into the enlarger when setting (and later measuring with) the cyan channel. Similarly, make your magenta and yellow channel adjustments through your green and blue separation filters.

As with conventional color printing, the analyzer will only give you an approximation of the correct exposure data, but it will usually be good enough to let you bypass all but one exposure test. Since the tests can take an hour or more, a color analyzer will save you a considerable amount of time, once you have enough dye transfer printing experience to be able to calibrate your analyzer.

You will have to re-adjust your analyzer each time you start using a different emulsion number of Pan Matrix Film. Fortunately, you will find that this will be only a modest change in the analyzer program. In any case, none of this is useful until you make at least one correct print, so I have developed the following procedures which I used for many years, until I finally got around to buying an analyzer. I still use them when I am starting without any color reference in the negative to give me an idea of what the correct exposure data will be.

Exposing Test Matrices

The accompanying photograph shows an image of my standard negative, a 2 1/4 x 2 3/4-inch (5 1/2 x 7 cm) KODAK EKTACOLOR Film, Type S Negative, taken by daylight and masked with KODAK Pan Masking Film to produce a contrast acceptable for conventional color materials. On my enlarger, the print data was 19 1/2 seconds at *f*/16 with a 56M+45Y filter pack. The print is 7 1/2 x 9 1/2-inches (19 x 24 cm). The area of the negative printed was 2 x 2 1/2-inches (5.3 x 6.6 cm).

My test prints will be 4 x 5 inches (10 x 12 1/2 cm). The following formula will provide exposure corrections for different size prints:

> If the original image is A in length, and
> the final image is B in length, and
> the negative is n in length, then the exposure
> Correction Factor = $\frac{(B + n)^2}{(A + n)^2}$

This is equivalent to the standard correction formula based on magnifications: $(M+1)^2/(m+1)^2$, but it eliminates having to compute the magnifications.

In my case the correction is:

Correction = $(12.5 + 6.6)^2/(24 + 6.6)^2$ = 365/936 = 0.4

My basic exposure time is 1 1/2 times the proof print time or 29 seconds. Multiplied by the correction, I get about 10 seconds at f/16 or 20 seconds at f/22. The latter is better, since it allows more accurate timing of the test strips. Purists may argue that my earlier remarks indicate that the precise printing data should be 23 seconds at f/22 with a filter pack of 11M. I am making this first print with uncallibrated materials so that kind of precision is not warranted. I am almost certain that the filter pack will be near zero; it is more convenient and less confusing to start out with round numbers like 20 seconds and no filters. Nonetheless, whatever the exposure time, this is our starting point.

Remove a sheet of Pan Matrix Film from its original package in total darkness and cut it into equal small rectangles on a paper cutter. If your cutter does not have an adjustable guide bar, put a couple of pieces of masking tape on the easel to indicate where to place the film. Hold the film down with a piece of paper, with the emulsion side up. This avoids fingerprints and scratch marks on the emulsion which is very susceptible to handling marks.

In distinguishing the base from the emulsion, you will notice that the base has a very slick, almost sticky feel when brushed with a fingertip. If you hold a sheet of film vertically, the emulsion faces you when the punch holes are at the top and the film notches are along the top right edge.

Since my tests are 4 x 4 3/4 inches (10 x 12 cm), my film is cut into quarters. A 10 x 12-inch (25.4 x 30.5 cm) sheet will produce quarters which leave a centimeter or more of clear area around each matrix. If I were contact-printing this 2 x 2 1/2-inch (53 x 66 mm) negative, I could cut the film into ninths 3 1/4 x 4 inches (8.5 x 10 cm) or even twelfths 3 1/4 x 3 inches (8.5 x 7.6 cm) and still have adequate borders. You should leave at least 1/5-inch (1/2 cm) on three sides and 2/5-inch (a full centimeter) on the fourth, since you will need room to handle the matrix during processing and transferring. Return the cut film to the box while you set up the enlarger.

C-26

A test exposure is made by exposing the matrix in three strips which differ by equal exposure factors. Since I have some idea of the correct exposure time, I am going to use 1/2 stop exposure differences (.15 density units). According to the table, the long exposure would be 1.4 times the base exposure and the short exposure 0.7 times the base. That works out to 14-, 20- and 28-second exposures.

If I were more certain of my exposure, I might use 1/3 stop differences (.10 density unit = 1.25 times and 0.8 times). If I was working totally blind, I would use a full stop difference (.30 density unit = 2 times and 0.5 times). I never use equal time differences because they do not work out to equal density differences in the matrices, and they would make it more difficult to estimate the correct exposure if it lay between two of my test strips (as it most likely will).

For my first test, I have used one of the cut rectangles with a punch hole in it. It is not as important with this test if I should lose a little of the image because of the hole. My exposures are made in the same fashion that one would test-expose any piece of photographic paper: I hold an opaque card under the lens, close to the film and gradually move it out of the way, exposing the film in steps. I use a white card since the matrix film is almost black; you will have trouble seeing how much of the film is exposed to the enlarger light. It is easier to see how much of the image still falls on the card (this is somewhat a problem when test-stripping a contact print).

Before exposing the film, first turn the enlarger on 15 to 30 seconds before you begin the exposure in order to give the negative time to pop, if it is going to. You will not have this problem if you are using a glass negative carrier. If you aren't, all focusing and exposing should be done with warmed-up negatives.

Furthermore, check to make sure that you have the red separation filter in place prior to exposing your film. It is an easy thing to forget until you are used to this process.

Processing Matrices

C-60 a, b, +c

When you have finished your matrix exposure, put the film in a light-tight box while you set up the processing chemicals.

You will need three trays, one each for developer, fixer and water. The developer tray should be as small as possible, for reasons that will become clear. The size of the rinse and fix trays doesn't matter.

Fill the rinse tray with cold water, anything under 68°F (20°C) will do. It should never be hotter than that. The fixer should also be at 68°F (20°C) or cooler. If the rinse and fixer are too warm, you will get some developer activity even after the film is removed from the developer tray, and you may get fog on your film. Do not use an acid rinse bath to stop development, just water.

Any non-hardening fixer will do. KODAK Rapid Fixer, Part A used at film dilution, works well. Be sure to leave out the hardener. You can also use KODAK FLEXICOLOR Fixer and Replenisher for Process C-41, diluted according to instructions, or ordinary 60% ammonium thiosulfate solution, diluted 1:7 with water. Ordinary black-and-white fixer will not work, since it contains hardeners which defeat the whole idea of the process. The fixer may be reused until the matrix clearing times exceed 30 seconds.

A working developer solution is mixed from KODAK Tanning Developer A and B just before use. Once mixed, this developer has a very short tray life. It must be used within 5 minutes. I mix my developer while the film is pre-soaking in the water bath to keep oxidation to a minimum. The amount of developer needed depends on the area of the film and the tray size.

Normal contrast developer consists of 1 part A mixed with 2 parts B. You can minimize contrast by reducing the amount of B, down to a 1:1 ratio. Contrast can be increased by raising the A:B ratio as high as 1:6. In any case, you must use a minimum of 1 mL of A for each square inch of Pan Matrix Film, or you will exhaust the developer before development is complete. This is true no matter what A:B ratio that you are applying. For example, a sheet of 10 x 12-inch film needs 4 1/4-5 ounces (125-150 mL) of Part A, while a 16 1/2 x 21 1/4-inch sheet requires about 13 1/2 ounces (400 mL).

The total amount of developer that you will need also depends on the surface area of the tray. If the volume is too low, the developer will oxidize before the development time is finished. You should use not less than 5 mL of mixed developer for each square inch of tray area, no matter how much A is in the developer. For normal matrix development, your tray area will usually determine the minimum amount of developer required to mix. If you are using a high-contrast ratio or are processing several sheets of film at once (see later discussion), then the film area will control the amount of developer that you mix.

Unfortunately, the interrelationship among oxidation, development exhaustion, and film and tray areas is so complicated that these recommendations are only a guideline. The symptoms of insufficient development are reduced density and contrast, with the shadows suffering the most. If you suspect a problem, try processing an identically exposed matrix in 50% more developer. If the second matrix has more contrast or has denser shadows, then you can assume the first matrix was underdeveloped.

A cautionary note: Do not try increasing development time to correct the problem. This will really cause problems because you will be pushing exhausted and oxidized developer.

Measure out the required amounts of Tanning Developer A and B into two beakers and bring their temperatures to 69°F (20.5°C). When the two parts are mixed, their temperature will drop between a quarter and a half degree; the working developer should be used at 68 ± 1/2°F (20 ± 1/4°C). Set the two beakers next to the empty developer tray.

Turn out all lights and place the exposed Pan Matrix Film, emulsion side up, in the water-filled rinse tray. Rock the tray a few times to make sure the film is covered with water. While the film soaks, pour both beakers of developer into the developer tray. Rock the tray for 15 seconds, thoroughly mixing the two parts. First lift the left edge of the tray and set it down. Then lift the right edge, the front edge and the back edge. This left-right-front-back agitation pattern provides the most uniform and thorough mixing. The agitation should be rapid but not frenetic; about one second per ''lift'' is adequate.

After the matrix film has soaked for 30 seconds or so, lift it by one corner and let the water drain for 10 seconds. Place the film in the developer-filled tray and immediately start continuous agitation, using the left-right-front-back pattern. This is very important -- poor agitation and poor developer coverage of the film are the source of most processing problems.

After 2 minutes of agitation, lift the film by its corner, immediately place it in the water-rinse tray and resume the agitation pattern. After 30 seconds of constant agitation, lift the film and drain it for 5 seconds. Place it in the fixer bath and begin constant agitation for 30 seconds. At the end of this time, you can turn on the lights. The film should be translucent blue-black with hardly any image visible. If it looks cloudy and lighter gray in spots, the undeveloped silver halides have not been completely fixed yet; this indicates exhausted fixer. The matrix should be fixed with intermittent agitation for another 1 1/2 minutes. It can be left in the fixing bath for 15 minutes or more with no ill effects.

Wash out the developer tray and fill it with water at 120°F (50°C). Place the fixed film in the water, emulsion up, and start agitating the tray. The unexposed regions of emulsion will melt and dissolve, staining the water deep blue.

After 30 seconds, pour out the first rinse. Lift the matrix from the tray by one corner and pour fresh hot water into the tray. Replace the matrix and agitate the tray for another 30 seconds. By now, most of the gelatin will have melted, and the relief image should be clearly visible.

It is very important not to spray or pour water directly on a freshly processed matrix. The emulsion is so fragile at this time that any direct stream of water can actually remove image gelatin from highlights.

At the end of the third rinse bath, scrape the edges of the matrix with your fingernail to remove the bits of gelatin which are still adhering to the edges. These thin veils are normal and do not indicate an error on your part, but they must be removed or they will get into the dye baths and affect other matrices.

Transfer the matrix to a fourth clean rinse bath; the water should stay clear, indicating that all excess emulsion has been washed off. Lift the matrix out and hold it in front of a bright white surface. Check the shadow areas carefully for any signs of a dark patchy or bubbly looking scum overlying the normal shadow C-27 densities. This scum is caused by fogging development on the surface of the emulsion. The most common causes are a light leak in your darkroom or chemicals that are too hot. This fog layer floats away from the thinner portions of the image, but remains attached to the shadows because there is not enough undeveloped gelatin between it and the image layer.

This fog layer is quite different from base-layer fog which appears as a slight veiling density in highlights. Base-layer fog may be caused by light leaks during the exposure of the matrix or it may be a ''normal'' result of manufacturing tolerance in Pan Matrix Film. Unless it is heavy, it is not serious. Surface fog, though, must be removed or the matrix discarded.

You can remove the scum sometimes by putting the film back in the hot water and <u>very</u> gently rubbing a fingertip over the affected area. Avoid touching the extra-delicate highlights; the shadows are durable enough (barely!) to tolerate this. You must remove the scum while the film is still wet. Once it dries, the scum becomes permanently attached.

The washed-off matrix should soak in the final hot rinse for several minutes to remove the last traces of fixer from the emulsion. Additional time or rinses do no harm. While the film is soaking, set up two trays filled with cold water 60-68°F (15-20°C). The first can be tap water; the second should be distilled or deionized water. Place the matrix in the tap water tray and agitate it for 30 seconds. Transfer it to the second tray. After a 30-second rinse, hang the matrix to dry.

It is important to chill the matrix thoroughly. This prevents ''drooling'' or reticulation of the emulsion as it dries. The distilled water rinse also helps prevent reticulation and water-spotting, both of which would show up as defects in the prints. TABLE II on page 00 lists the processing steps in condensed form.

An optional procedure at this stage is to harden the matrix. If you treat a processed matrix with a weak formaldehyde solution, it toughens the gelatin, making it more resistant to scratching and abrasion. You will find that scratches caused by ''human error'' take a lot of work to spot out in the finished print; the printing life of a set of matrices is usually determined by how much of this spotting work you are willing to put up with. I have found that hardening the matrices significantly extends their useful life.

WARNING: Formaldehyde is poisonous and a suspected carcinogen! It is absorbed through the skin, and it was recently discovered that it can penetrate all types of laboratory gloves. You must use careful laboratory techniques to avoid any contact with the usual concentrated form of the chemical (37% formaldehyde), and you should minimize contact with the hardening bath. If you do not feel sure of your laboratory skills, please skip this procedure.

The hardening bath is a solution of KODAK PHOTO-FLO 200 Solution and 37% formaldehyde. Mix 2/3 ounces (20 mL) each of PHOTO-FLO 200 Solution and formaldehyde solution with 1 gallon (3.8 L) of water. This is enough hardener for many matrices; I discard the solution after running about a dozen sets of 10 x 12-inch matrices through it.

You can harden the matrices at any time. I do it right after the first chill bath and before the distilled water rinse, but you may prefer to let the matrices dry first and treat them later with hardener. I am also treating old, unhardened matrices which I have printed for some time; I feel it is never too late for a little additional insurance.

Harden the matrix by bathing it in the hardening bath for 2 or 3 minutes at 68°F (20°C). Rinse it in two or three changes of cold water. If it is a freshly made matrix, rinse it in the distilled water bath and hang it up to dry. If it is a previously dried matrix, either hang it up to dry or put it into the dye bath in preparation for printing.

A hardened matrix transfers slightly less dye to a print than an unhardened one, but the difference is very minor. You may notice a bit of dye coming out of the matrix into the wash water after a transfer. Obviously, you will get the most consistent test results if you harden your test matrices as well as your final ones, but even when I have treated older matrices which were not made with hardening in mind, they have always printed well after treatment.

These test print matrices may be force-dried with a stream of warm air to save time. This is definitely not recommended for final matrices since the hot air may alter or distort the matrix emulsion, resulting in matrices that would not print uniformly. Such defects are not as important when they occur in test strips. Normal matrix drying time is between 1 and 3 hours, depending on humidity and temperature; a forced-air set-up can reduce the time to 10-15 minutes.

Do not dye and transfer matrices before they have dried once. A freshly processed matrix is so fragile that you are very likely to damage it. The drying process makes the emulsion harder; it is much less prone to scratching, although it always remains a delicate material.

The illustration here shows my finished cyan test-matrix illuminated by a light table. A step tablet has been included for reference; each step represents a .15 density unit (1/2 stop) change in density. The matrix appears both underexposed and low in contrast, as compared to the test print. Highlights, in particular, look washed out. In fact, the matrix will print a

C-28
C-37

dye image that is much darker and shows more contrast. The only way to be completely sure of the matrix quality is to use it to transfer a dye image.

Making Test Prints

KODAK Dye Transfer Paper is available in various cut sheet sizes and in 42-inch by 30-foot rolls. If you expect to do much printing, the roll is a very good investment. It is the most economical way to buy Dye Transfer Paper. You can cut the paper to exactly the sizes that you need, eliminating waste. Since the paper is not light-sensitive and lasts indefinitely, it is easy to store and handle.

An alternate to KODAK Dye Transfer Paper is ordinary fiber-based black-and-white paper which has been fixed, such as KODABROMIDE or KODAK MEDALIST F Surface Papers. Fix the unexposed paper for the normal time and wash it for 30 minutes. You can use it immediately or dry it and save it for future use. KODAK F-5 Fixer or KODAK Photo-Fix work well because they contain aluminum salts that act as a mordant. Do not use rapid fixers or non-hardening fixers. If you can find some outdated paper at a discount, this is a very inexpensive way to get a suitable paper for dye transfer printing.

Dye Transfer Paper should be washed before it is conditioned to remove any loose gelatin from the paper's surface. These bits of gelatin can adhere to a matrix, producing a flaw in the prints. A 1- to 2-minute wash in cool water is adequate. The washed sheet of paper needs to be conditioned in a bath of one part KODAK Dye Transfer Paper Conditioner mixed with three parts water. The conditioning bath prepares the paper emulsion to receive the printing dyes and provides a neutral environment in which the transfer may occur.

The working solution of Dye Transfer Paper Conditioner will last a long time. At the end of a printing session, store it in a glass or plastic jug. You should filter it between sessions to remove any dust or dirt that has settled into the bath. Otherwise, you may use the solution until it thickens and runs off the paper in sheets like boiled maple syrup.

The paper must be conditioned for at least 20 minutes. It can be left in the conditioner for 2 hours with no ill effects. While the paper is soaking, you can prepare the matrix for printing.

Take your dried test matrix and soak it in a tray of 95-105°F (35-40°C) water for a minute to swell the emulsion. Then drain the matrix and transfer it to a tray of cyan dye working solution (instructions for preparing dye baths are included with the dyes). The matrix should be agitated regularly so the emulsion is exposed to fresh solution. The gelatin will absorb all the cyan dye it can in 5 minutes of constant agitation or 8 to 10 minutes of intermittent agitation. I always dye the matrix for a minimum of 10 minutes, just to be safe.

While the matrix is in the dye, make up a jug of 1% acetic acid. Because you will be using a lot of this, I suggest you make it up by the gallon. Pour 1 1/4 ounces (38 mL) of glacial acetic acid into a gallon jug that has been filled with cold water. Precise measurement is not necessary. Shake well.

Since you will use a lot of rinse, I strongly recommend that you use glacial acetic rather than 28% acetic acid. Glacial acetic is between 1/3 and 1/5th the price of 28% acid for each ounce of acetic acid, depending on the size bottle that you get. I buy mine by the gallon jug. It is not very expensive and it never goes bad.

Pour some of the 1% acid into a clean tray for a holding bath. Take another small, clean tray and pour in 6 3/4 ounces (200 mL) of 1% acid for a rinse bath.

C-29
C-30

Lift the fully dyed matrix by one corner and let the excess dye drain off. Drain the matrix until the dye starts to come off in drops, not in a stream. Always use this degree of draining to obtain the most consistent prints.

Put the matrix in the rinse bath and agitate it for 1 minute. Pour out the discolored rinse and pour in some fresh rinse bath and agitate the matrix for 1 more minute. (This second rinse can be saved and used with your next print.) Once the matrix has been dried once, you do not have to worry about pouring liquid directly on it. Transfer the rinsed matrix to the holding tray.

Place a sheet of conditioned paper in the middle of your transfer easel and squeegee it down with the print roller (or rubber squeegee). This removes the excess conditioner, but still leaves the paper moist. Take your test matrix out of the holding bath. Then holding it emulsion down, touch one edge to the paper to form a bead of liquid. The bead should run the length of the edge, but should not be so broad as to touch the image area.

C-31
C-32
C-33

Hold the matrix firmly in position with your left hand. Take the print roller in your right hand and roll the matrix into contact with the paper. You will not need to use much pressure. Just let the weight of the roller pull down the film in front of it. The idea is to let the roller squeeze out a bead of liquid between the film and paper just in front of the line of contact. This bead carries away any small air bubbles or bits of dust that would interfere with the transfer if they were trapped between the matrix and the paper. Once you start rolling, do not stop; the motion should be a smooth one.

The matrix should be left in contact with the paper for at least 5 minutes for the cyan dye. I usually wait 10 minutes for test strips to make sure that there is a complete transfer of dye from the matrix to the print. Extra transfer time will not hurt, unless it gets so long (about 15 minutes) that the dyes have a chance to bleed in the paper.

At the end of the transfer, slip a fingernail under one edge of the film and peel the matrix off in a smooth motion. If you wish to save the matrix for future reference (a good idea for beginners), wash it in running water at 95°F (35°C) for a few minutes and hang it up to dry. Write the exposure data along one edge of the film with a waterproof pen. You will find this kind of record very helpful.

Wipe the damp print off with a paper towel and dry it. You can use a paper dryer, a floodlamp, forced hot air-drying, or you can just hang it from a film clip and let it air-dry at room temperature. Dye transfer prints show a slight ''dry-down'': a dried print will be about .05 density unit darker and about 5 CC less magenta than a wet print.

The length of time it takes to dry has little effect on the print as long as it does not stay wet for too long. Beyond a half-hour, there may be diffusion of the dyes in the print which will make it less sharp. I usually do a lot of post-printing work on my prints -- spotting and edge bleaching -- which involves getting the prints damp again, so I want to minimize drying times. I wipe my large prints with paper towels and set them on FIBERGLAS Screens under a photoflood lamp. They dry in less than20 minutes. I blast small test prints with a hair dryer, and they are done in 5-10 minutes.

The photograph on this page shows my finished cyan test print. You can compare it to the test print by viewing both through a red separation filter. There may be some distortion in reproduction, but in the originals, the middle strip of the test print looks too light, while the darkest strip is slightly too dark. C-34

The dye transfer print can reproduce a longer range of tones than the EKTAFLEX Print Material; therefore, any comparisons should be made between middle grays and highlights, not between shadows. In this instance, the woman's skin and blouse provide good points of comparison. The shadows and the grass are dark enough that they are not reliable matches.

In other words, just as in conventional black-and-white photography, I want to expose my matrix film for the lowest film densities, as well as process and print the film for the maximum densities. Based on what I see in this print, I am going to fix my base cyan exposure time at 25 seconds.

Ring-Around Printing

My next step is to make a full-color test print. You would do the same using either the color head or tricolor approaches. My color test print is called a ''ring-around'', which usually consists of a central print that is ''correctly'' color-balanced. Around that central print is a ring of prints with a range of color and exposure differences. By looking at one print, one may see the effects of an increased amount of magenta filtration; by looking at the opposite print, one may see decreased magenta filtration. This array of prints makes it easy for the printer to see the precise effect of a variety of filter or exposure changes.

Shown here is the pattern of exposures that I will use to produce a single print with ring-around information. The cyan printer (red light exposure) is given a uniform exposure for the calculated base time. The magenta printer (green light) is exposed in a pattern of vertical test strips, as shown, with the central strip receiving the base exposure and the side strips receiving greater or less exposure (just as I did for my first cyan test). The yellow printer (blue light) has a horizontal pattern of strips. C-35 C-36

When these three matrices are printed together, only the center square will have a combination of exposures that matches my basic exposure data (i.e. 25 seconds at f/22 with zero-filtration). Each of the surrounding squares will show a color and density shift from the central square. All the color shifts are of the same magnitude -- in this case, 30 CC or 1 stop -- but each square has a different hue, with opposite color shifts paired on either side of the central square. This gives us nine test prints for the work of one.

The magnitude of the shift is a matter of choice. As I mentioned, my filter pack usually doesn't vary by over 30 CC. A 30 CC ring-around therefore will usually encompass a correct balance. This produces strip exposure times of 12 1/2, 25 and 50 seconds for the green and blue light exposures.

When exposing a set of matrices, I keep my enlarger bulb on between matrix exposures to make sure that the negative remains popped and warm, and does not shift or change focus between sheets of film. After I have finished the red light exposure, I insert a dark slide into my enlarger's filter holder to keep any light from reaching the already exposed film. I can then leave the enlarger on while removing the exposed sheet and replacing it with a new sheet.

Don't forget to change filters between exposures. I mark mine along one edge with luminescent tape to enable finding them while I work in the dark.

The exposed matrices can all be processed together in one tray of developer. I like to do this, using a large enough tray to keep the sheets from overlapping. It is rather difficult to rock the tray with one hand, while I use the other hand to make sure the films stay separated. Still, I find it easier than processing the sheets individually. If you prefer the latter, make sure to use fresh rinse water and developer for each sheet of film.

In the photographs on page 00, the three processed and dried matrices are on a light table, which helps to tell how good they are before I print them. For instance, the grass is green, and the man's hat and pants are fairly neutral. That tells me the dark magenta strip is too dark, since it has darker grass than either the yellow or cyan printers' central square would have. The middle strip's grass is plausible, but the hat and pants are still definitely too dark. Seeing that the lightest magenta strip is certainly too light, I know that I have encompassed the correct magenta exposure.

Similarly, I decide that the middle yellow strip is going to be close to what I want. As before, the only way to tell for sure is to print the matrices. It is very helpful to learn how to ''read'' matrices and avoid wasting your time printing obvious rejects.

I am going to lay down the dyes in the following order: magenta, yellow and cyan. Since I am not using register pins, I plan on aligning the matrices by eye. If I laid down the yellow first, the image would be too hard to see for aligning the second color. Magenta dye transfers more slowly than cyan and is more prone to problems during transfer. Since the paper is most receptive to dye for the first transfer, I will lay down the magenta first and minimize my difficulties. Next, I lay down the yellow. The yellow and magenta images combine nicely to form a red-orange print that contrasts with the blue-black of the cyan matrix. This makes aligning things by eye much easier.

After it is dyed, the magenta printer is rinsed and rolled in the same way that the cyan printer was in the first exposure test. As before, use a 10 minute transfer time for each color to be sure that you have a complete transfer of dye from the matrix to the paper. While the magenta matrix transfers its dye, rinse the yellow printer and put it into the holding bath.

After the magenta dye has finished transferring, peel the matrix off the paper and set it aside. Take the yellow printer out of the holding bath, and touch one edge of the matrix to the paper to form a large bead of liquid. By hand, lower the entire matrix into light contact with the paper as shown here, so that it floats on a layer of acid and conditioner. Little transfer of dye will take place until you squeegee the matrix down. C-38 C-39

Slide the matrix into alignment with the magenta image, then firmly hold down the left edge of the matrix to keep it from shifting. Set the roller down in front of your fingers and roll away from your hand. Then run the roller back over the film to insure good contact. Let the yellow matrix transfer for 10 minutes.

This transfer technique is utterly at odds with the one which you will be taught for transferring large, pin-registered matrices. I don't recommend it for anything but small tests where quick results are allowable, and it does not matter if you spoil a print or matrix.

While the yellow matrix is transferring, examine the magenta matrix on a light table to see if it has retained any dye. Untransferred dye will easily be seen as colored blotches in the shadow portions of the image. If you find much untransferred dye in the deepest shadows, return the magenta matrix to the holding bath, and roll the matrix onto the print again after the yellow transfer is finished. Use the same alignment and rolling procedures for this second magenta transfer that you used for the yellow printer.

After the magenta and yellow transfers are completed to your satisfaction, align and transfer the cyan matrix over the red image already on the paper, using the same methods that you used for the yellow transfer step. After 10 minutes, peel off the cyan printer and check it for untransferred dye. Once you have completed the cyan transfer, you can dry the print and judge the color balance and density. C-40 C-41

The finished ring-around is shown here. All the squares in the left column or top row are off-color. The bottom row also is off; it is too blue. This leaves us with the central square (no shift) and the right-center square (-30 CC magenta). Neither of these looks correct; the color balance that I want is somewhere in between. According to my viewing filters, the central square is about 30 CC too magenta in color, equal to 15 CC enlarger filtration.

I am happy with the cyan density so that base exposure time remains the same. Since the yellow middle row is good, no change is needed in the blue light exposure either. My only correction is to add 15 CC magenta filtration to the enlarger to correct for the excess color. My new printing data is 25 seconds at *f*/22 with a 15M filter pack.

If I were using the tricolor approach, I would leave the yellow and cyan exposures at 25 seconds. Since I wish to reduce the green light exposure, I check Table I to find out the equivalent of 15 CC filter change (30 CC print color change). The exposure factor is 0.7, so my new green light exposure is 0.7 x 25 or 17 1/2 seconds.

These calculations may confound the novice when the results are not this simple (they often will not be). In normal color printing, one tends to separate the concepts of print density and color balance. For example, one might say a print is too light and too green. What does that mean? Is it only the magenta dye that is weak? This could make a print light and green. Or are the cyan and yellow images too strong as well? Perhaps all three dye images are too light, and the magenta is merely the lightest? We need more precise descriptions.

By comparing the ring-around print with the test print, we can get an idea of the overall error in terms of density and color balance. KODAK Color Print Viewing Filters can help us pinpoint just how great the error is. But in order to determine correctly what must be adjusted and how, we have to consider each dye layer individually. That is why it is useful to compare the two prints by viewing them through the color separation filters. The objective is to be able to relate the precise imformation about the individual dye layers to the overall impression which the print conveys of its color and darkness.

To refine my printing data, I will make a second ring-around. Even though the only exposure change is the magenta printer, I will remake all the matrices. First, this insures that all the printers have received exactly the same processing. Secondly, changing the filter setting on a color head usually has a slight effect on the matrices because the filters have unwanted color absorbtions or dust.

This ring-around will use a .10 density unit (10 CC) color shift which works out to 1.25 times and 0.8 times exposure differences. The cyan matrix still has a 25 second exposure, while the other matrices have strips of 20, 25 and 31 seconds.

In the finished print, the center square looks best (my new guess wasn't too far off) but it appears to be slightly cool in color. According to the viewing filters, it needs about 10 CC more red (a 5 CC red filter change) but otherwise looks good. The cyan density still appears fine.

To increase my magenta and yellow dye images, I need to raise the exposures for those matrices. Normally, I would keep my exposure time and remove 5 CC M and 5 CC Y from the filter pack. This isn't possible; there is no Y filtration to remove, and I would end up with a 10M, -5Y, 0C filter pack. Since negative filter numbers don't exist, I will add equal amounts of filters to all three primaries to bring them up to the real values. Since the filter change is the same for all colors, there will be no relative color shift.

Adding 5 CC to everything gives 15M+0Y+5C filter pack. But I don't want to change the cyan exposure by 5 CC; I like the print as it is. I need to increase the exposure time in order to compensate for the reduced red-light intensity. In Table I, 5 CC is equal to 1.12 times, making my new exposure time 25 x 1.12 or 28 seconds.

If that seems confusing, think of it this way. I want to get more magenta and yellow printer exposure to increase the amount of red in the print. I could do that by increasing the exposure times, but since all the matrices receive the same exposure time, that would also increase the cyan printer. Instead, I dial in a little (5 CC) cyan filtration, reducing the red-light intensity and cutting the cyan printer's exposure.

If you use the tricolor approach, you would handle it this way. The central square needs 10 CC more red color. This means that you need to increase the magenta and yellow printer exposures by 5 CC (see Table I on page 00). The exposure factor equal to 5 CC is 1.12 times; your new green- and blue-light times are 25 x 1.12 or 28 seconds.

Making a Full-Size Print

C-42

We are finally ready to set up a full-size image. To do this properly, you should have some sort of focusing screen which indicates the allowable boundaries of the image. A sheet of white paper works very well. The photograph here shows my small exposure easel with such a sheet in place. I have marked the usable limits of the matrix film with black marking pen. As long as my projected image lies within those borders, I know I have sufficient room on the matrix.

Allow between 1 1/3 and 1 1/2 inches (3 1/2 and 4 cm) of clear film at the punched end. This provides space to apply the roller to the matrix when rolling prints. The other three borders should be 1/3- to 3/4-inches (1 to 2 cm) in width. This gives enough room to handle the matrix without touching the image area and makes allowance for the fact that two sheets of film will not be punched in precisely the same location. If you try to run an image to the very edge, you may find that it is cut off at the edge on one or more matrices because of different hole positions.

The maximum image dimensions work out to be about 9 1/2 x 10 1/4 inches (24 x 26 cm). If you are printing to a standard 8 x 10-inch format, you will have about 1 1/4 inches (3 cm) of spare film width. A full-frame 35 mm enlargement will have about 2 3/4 inches (7 cm) of extra width. You can trim off the excess for use as test strips, if you like. Make sure that you don't trim more than 1 1/3 inches (3 1/2 cm) off either side of prepunched film, or you may trim off one of the punch holes. If you are punching your own film, you can trim the full 2 3/4 inches (7 cm) from one side and punch it afterwards.

Once you have composed and focused your full-size image, it is a good idea to run a last exposure check. There will not be any relative color shift, only a cyan test is needed.

My enlarged print will be 10 1/4 inches (26 cm) long. By using the correction formula that I gave earlier, I figure my correction factor: $(26 + 6.6)^2 / (12.5 + 6.6)^2 = 1063/365 = 2.9$. This works out to 82 seconds at *f*/22 or, opening the lens two stops, 20 seconds at *f*/11.

For this test, I used a strip of film about 8 x 2 inches (20 x 5 cm) and laid it vertically across the middle of the image area. The results can be seen in the photogaph here. It is important to note that since the highlights match the test print closely, this exposure will do. Had I found that the exposure was not to my liking, I would have adjusted all three matrix exposures by some amount. I would not change the filter pack because I don't want to alter the color balance.

C-43

If you were doing this by the tricolor method, here is what your exposures and calculations would have been like: To summarize, our first ring-around gave us red, green and blue exposure times of 25, 17 1/2 and 25 seconds at _f_/22. For our second ring-around, we want + and - .10 density unit exposures for the magenta and yellow printers. This is equivalent to 1.25 times and 0.8 times exposure factors. Thus, our magenta strips are exposed for 22, 17 1/2 and 14 seconds; our yellow strips get 31, 25 and 20 seconds.

The result, according to the viewing filters, is 10 CC too cyan in color, or .05 density unit off in exposure. The table says to decrease either the cyan exposure by 0.9 times or increase the other two by 1.12 times. Since there is a proper cyan density, we increase the blue and green light exposures, thus giving final exposure times of 25 seconds, red; 19 1/2 seconds, green; and 20 seconds, blue.

Our full-size print needs 2.9 times these exposures which works out to red, green and blue times of 73, 57 and 82 seconds at f/22 or 18, 14 and 20 seconds at f/11. The final cyan exposure test would be for 18 seconds.

Double check everything before turning out the lights. Is your lens stopped down and the red filter inserted? Is the vacuum hooked up to the easel and the switch accessible? Can you find the matrix film and the scissors in the dark, and do you have an empty box to put the exposed film in?

C-44
C-45

Turn off the room lights and turn on your enlarger. Also check the focus after the negative warms up, and insert your dark slide into the filter holder. Remove a sheet of matrix film from the box. Hold the film by the unpunched end and press the holes onto the register pins, the small hole first, making sure the film is emulsion side down. Smooth it away from the pins lightly before turning on the vacuum to make sure that it is lying flat.

Next turn on the vacuum, turn off the enlarger, remove the dark slide and start your timed red light exposure. When the exposure is over, reverse those steps: Insert the dark slide, turn on the enlarger again and turn off the vacuum. Remove the exposed film from the register pins; be careful not to jar the easel while doing this. Put the film in a light-tight box.

Now you may remove the red filter from the enlarger and install the green filter. Repeat the preceding steps to expose the green light matrix. After the exposure is over and after you have removed the magenta matrix printer from the easel, clip off one corner of the film at the punched end for later making correct sheet identification.

Once again, repeat the preceding steps for the blue light exposure. This time you should clip both corners of the punched end of the film. When all three sheets are in the light-tight box and when the original film box is closed, you can turn your lights back on.

Set up your processing trays and solutions. A good size tray for 10 x 12-inch matrix film is an 11 x 14-inch tray. For the 16 1/2 x 21 1/4-inch film, you may have to go to a 20 x 24-inch tray. Some of the so-called ''16 x 20-inch'' trays are actually an inch or two bigger and will easily accommodate a large sheet of matrix film. CESCO Trays, for example, are usually bigger than their nominal specified size.

There are two different ways to process full sheets of film. One method is described in the instructions packed with KODAK Pan Matrix Film, whereby all three matrices are processed at one time by interleaving them in the developer. You can process a full set of 16 x 20-inch matrices in slightly more than a litre of mixed developer. This approach also saves time and insures that all sheets are processed in exactly the same developer mix at the same temperature. The difficulty is that it is very hard to give all three sheets exactly the same uniform agitation with the very short development time permitted, or make sure that each sheet receives enough agitation. This can produce such defects as streaks, blotches and small light spots in the finished matrix (and prints made therefrom).

I prefer to process each sheet of film separately using the agitation system that I described previously for processing the test matrices. In this way, I can provide extremely uniform and reproducible development. The odds of scratching a matrix by mishandling it in the developer or rinse are diminished as well. For images where uniform development is especially critical, single-sheet development is essential. But you have to take extra care in preparing the developer -- the A:B ratio must be precisely the same for each sheet and the solutions must be brought to identical temperatures. The total developer volume for each sheet must also be identical. Usually, you will need to use more developer than you would processing the sheets together, if you follow my guidelines in that matter.

I process my sheets one at a time, taking into consideration the extra chemicals and effort which it takes to be the insurance that guarantees good matrices. I am able to save some time by leaving the developed sheet of film in the fixer while I develop the other matrices. Once the room lights are back on, I turn the fixing sheet emulsion side down so that the next sheet to go into the fixer does not scratch it. All together, it takes about 12 more minutes of time. If you choose this approach, remember to use fresh developer and rinse water for each film sheet.

Film processing is done in the same manner as for the test matrices. Do not force-dry your final matrices; let them air-dry at room temperature. All three sheets should be hung in the same orientation while drying to minimize the effect of any variations that the drying might introduce. When the film is dry, store it in the paper sleeves provided with the film. You can insert one sleeve inside another to make three separate slots for the processed matrices.

Rolling Prints

The matrix-making process is a straightforward (if lengthy) one. Anyone with modest darkroom skills can make adequate matrices. But good matrices are less than half the battle to achieve fine prints. The process of producing prints from matrices is a demanding art. Patience and dedication are definitely virtues. There are several manual skills to be learned and the controls available are numerous. Learning to make truly sublime prints takes much more time.

Dealing with a run of bad matrices or prints can be most frustrating. When you are having a difficult time, do the sensible thing and stop working for a while. Give your brain a day to cool down, then sit down and carefully and calmly think over what you have been doing. You will probably come up with two or three ideas of what went wrong.

To make prints, you will need six or seven 11 x 14-inch trays. Three of them will hold the dye baths, one will hold paper and conditioner, and one will hold the acid holding bath. The sixth tray is used for acid-rinsing the matrices and washing them out after transfers, if you don't have room for a separate wash tray.

Filter the dye and conditioner baths before each session. Start preparing the matrices and paper as described earlier. While the paper and matrices are soaking in their proper baths, pour a litre of 1% acid into the holding tray. Pour 13.5 ounces (400 mL) of the acid into the rinse tray.

Set up your easel on a flat, level, waterproof surface. If you don't have a waterproof table, lay a piece of oilcloth down to protect the table. The easel should be brightly lighted. I have a 150-watt gooseneck lamp mounted about two feet above my easel.

The most difficult dye to transfer -- the magenta -- goes down first. Use a 5 to 7 minute transfer time. Follow with the yellow dye for 5 minutes; the cyan goes down last and will normally transfer completely in 5 minutes.

It is very important to check each matrix after transfer to make sure all the dye has really been picked up by the print. If you see any hint of color in the shadows of the matrix, put the matrix back into the holding bath, then drain and reroll. After 3 or 4 minutes, the residual dye should have completely transferred to the print.

After the magenta matrix has been completely dyed (8 minutes with constant agitation, 15 with intermittent agitation), drain it completely as you did with the test matrices, and put it in a rinse bath. Rock the tray for 1 minute, pour out the discolored rinse, add more 1% acetic acid and agitate it for another 10 seconds. The matrix is then transferred to the holding tray; the second rinse may be saved to use with the next print. The purpose of the second rinse is to keep the holding bath from getting discolored. Excessive dye in the holding bath can stain prints.

Take a sheet of the conditioned paper and lay it on the transfer easel, with the end separated about 1/16-inch from the pin strip. Squeegee off the excess liquid by firmly rolling the print roller away from the pins or by using a rubber squeegee. Surface tension will cause the paper to adhere to the easel top. C-46

Lift the magenta printer from the holding bath and drain it until it drips. With one hand, hold the film by the unpunched border, and press the film onto the register pins with the other hand. Take care to make sure that the gelatin image does not touch the paper or the bead of liquid that forms between the end of the film and the paper. Run your finger along the end of the matrix, just in front of the pin strip to spread the bead uniformly across the width of the film.

Lay the print roller on the matrix film, just in front of the register pins. Use your other hand to support the film so that the gelatin still does not contact the paper or the liquid bead; the film should be pulled into contact with the paper under the weight of the roller, but nowhere else. Smoothly, and without hesitation, push the roller down the matrix, gently pulling it down into contact with the paper. Continue to hold the film at a high angle in front of the print roller --at least 45°-- and let the roller do the work. This should not be a tug of war between your hand and the print roller; you simply want to keep the matrix from dropping onto the paper ahead of the roller. Let the roller do the work of making the contact; a light pressure, combined with the natural weight of the roller, is enough. Try to be firm, without being forceful.

C-47
C-48
C-49
C-50

The film should curve smoothly off the roller. The liquid bead that will form in the front of the roller carries away dust particles and air bubbles that will otherwise be trapped between the matrix and the print paper. If you drop the matrix ahead of the roller, you will trap bubbles; these will be visible in the prints as a streak or row of small minus-density dots usually a few tenths of a millimeter in size and irregularly shaped.

Do not pull the matrix so tight that you must exert a lot of force on the roller. You can also cause the matrix to creep slightly by too much tension, causing misaligned transfers. If you hesitate in the middle of the rolling, you will get a light and dark bar in the print because the dye will start to leach out of the matrix into the stationary bead of liquid.

The print rolling technique takes practice. It is by far the most difficult manual skill associated with the dye transfer process. More prints are lost because of rolling-generated flaws than for any other reason. Don't be discouraged if you throw away 50% or more of your early prints because they show rolling-generated flaws of one sort or another. This is perfectly normal.

Prepare and transfer the yellow and cyan matrices in the manner that I have described previously. After each matrix has been transferred, it should be washed for a couple of minutes in hot running water before being returned to the dye bath or hung up to dry. Keep an eye out for untransferred dye. If a secondary transfer does not get all the dye into the print, you may have a problem, such as incorrectly prepared solutions, a warped transfer easel or poor rolling technique. For the moment, though, ignore any problems until you have more prints and experience with which to compare them.

If everything has gone well, you should have a flawless (although probably off-color and wrong density) dye transfer print. Most likely, you will have some minor problems that practice will clear up. If there are persistent problems, check out the Dye Transfer Troubleshooting Chart on page 00. C-51

My first print from the finished matrices (See accompanying photograph) is well within the range of acceptable results. I would prefer that it have a touch more contrast, and it needs about 5 CC more magenta. Both these adjustments are easily made by either modifying the rinse baths or the dye baths, as the next section will explain.

Altering The Image

C-52
C-53
C-54
(intersperse in section)

A perfect set of matrices is uncommon. There are almost always improvements that can be made in the prints produced from those matrices. An impressive (and sometimes bewildering) array of controls exist which allow the printer to adjust the dye transfer print to meet the artist's intent and vision.

Briefly, you can:

1) Reduce the density of a color -- the usual way of controlling print density and color balance.
2) Add density to a color.
3) Reduce highlight density, only.
4) Reduce shadow density.
5) Increase overall contrast.
6) Reduce overall contrast.

Each dye layer in the print is produced independently, so these controls may be applied in any combination desired to whichever colors need modification. For instance, you can clear the magenta highlights at the same time that you increase the cyan contrast while slightly reducing its density, leaving the yellow untouched. This is not as far-fetched as it sounds since it describes one set of modifications which I had to make to a print.

The above adjustments can usually be accomplished by any of several methods. Each particular method produces a slightly different result. Table III on page 00 summarizes the techniques that I use, and detailed descriptions of each method follow.

Sodium Acetate (NaAC) -- Make a 15% stock solution by dissolving 1 pound (45 kg) of NaAC in .8 gallons (3 L) of water. A working solution (5%) is made by diluting 1 part stock solution to 2 parts water. NaAC is used to reduce the overall density of a color or a print. Minor reductions result from adding 1/2%

working solution to the first acid rinse (e.g. 2 mL NaAC solution in 400 mL of rinse bath). Strong reduction comes from using several percent NaAC. Notice that NaAC tends to remove highlights and lighter tones more rapidly than shadow densities, but excessive amounts of NaAC (above 4-5%) will degrade the blacks.

Never reuse a rinse bath which has been modified with NaAC or any other chemical. Altered rinse baths should be prepared fresh for each matrix. Also, the second rinse should always be straight 1% acetic acid.

KODAK Formula R-18, Highlight Reducer -- Mix 5 grams (or 5 mL, by volume) of sodium hexametaphosphate (CALGON) in 1 quart (946 mL) of hot water. Dilute to make 1 gallon (3.79 L) of working solution; this will keep indefinitely. Very small amounts of R-18, as little as 1/4%, in the first rinse will slightly clear up highlights or remove stain. Larger amounts of R-18 can be used to reduce highlight tones or eliminate them totally, without degrading shadow densities. R-18 will also remove dye stain resulting from chemical or thermal fog in matrices.

Additional Acid -- The concentration of the first acid rinse can be raised by adding 1-5% glacial acetic acid to the working solution. The additional acidity will cause the matrix to retain more of its dye. By adding dye solution to the rinse bath, one can increase the amount of dye in the matrix even more. This produces a print with slightly more contrast and density.

The amount of extra dye picked up depends on the amount of acid added to the rinse, the amount of the dye added to the rinse, and the length of time that the rinse is used. This is the only case where a rinse bath is used for substantially longer than 1 minute. As a broad guideline, you can add anything from no additional dye to 10% dye (working bath) to the rinse, and use the rinse from 1 to 5 minutes.

This technique is beneficial for improving a print that is a little flat or too light, but you must keep track of the amounts of acid and dye added as well as the exact rinse time in order to get reproducible results. Also, this technique will produce varied results with different colors of dye, since each has a distinctive sensitivity to acidity.

Altered Dye Baths -- You can substantially alter the contrast of a print by adding either acetic acid or triethanolamine to the dye bath. These chemicals change the amount of dye a given thickness of gelatin will pick up. The more acid in the dye, the higher the dye concentration in the matrix and the darker the print appears with more contrast. Conversely, the more triethanolamine added, the lower the dye concentration and the lighter and flatter the print. Major changes in the maximum black (D-max) result from using these controls.

Don't vary the dye bath from print to print as it is easy to throw the dye set out of balance, making it impossible to print a neutral and correct color or gray scale. It is better to mix up a set of high- or low-contrast dye as needed, in addition to the normal-contrast set. The dyes will keep in stoppered bottles; when you make a print, you can select the dye set which you want to use, much as you might select one grade or another of black-and-white photographic paper to get the desired contrast.

Recommended amounts of 10% triethanalomine and acetic acid are included with the instructions for the dye kits. You can use intermediate amounts or more than is recommended to achieve the desired contrast. Notice that the information provided on the data sheets represents ''average'' dye responsiveness. You may find that you will have to rebalance the dye set for neutrality (see page 00 for further information) after adding the ''correct'' amount of chemicals. Do not assume that a modified dye set will be balanced just because the normal set was.

Developer Ratio -- By varying the proportions of Part A to Part B in the KODAK Tanning Developer, you can change the contrast of the resulting matrix. This is a good way to get modest differences in contrast without fiddling with rinses or dye baths. A ratio of 1:2, A:B is considered normal contrast. By reducing the A:B ratio to 1:1, you can get about one grade contrast decrease. Raising the ratio to as high as 1:6 will increase contrast by a grade. Intermediate ratios, of course, are usable.

If a different ratio is applied, keep in mind my earlier remarks about the minimum amounts of Part A and of mixed developer needed to properly develop your matrices. You may have to make adjustments in the amounts of each part which you are using to meet those requirements.

Altering the developer ratio does <u>not</u> change the D-max of the matrix, unlike modifying the rinse baths. Generally, altering developer ratios changes the range of exposures that print the range from true black to white. Altering the dye bath does not alter the printable range of exposures directly, but does alter how black the ''true blacks'' are in the prints.

Permanganate Reduction -- Potassium permanganate (KpM) acts as a matrix bleach and hardener. It is an extremely useful tool for adjusting the density of one or more of the colors in a print, if used carefully. The effects of KpM are <u>not</u> reversible; if you over-reduce a matrix, you cannot restore it. KpM behaves somewhat differently from NaAC. It takes very high concentrations of KpM to bleach out the highlights of a print; KpM works mainly on the middletones and shadows. While NaAC slightly increases contrast and reduces the printable exposure range by excessively reducing highlight tones, KpM actually reduces contrast only a little and extends printing range. When C-56 used in combination, you can obtain almost perfect proportional reduction of color. KpM will also reduce the amount of wasted dye, since the matrix only absorbs the dye that will be printed. KpM is useful in situations where there are highlight tones that must be preserved in a print.

I do not recommend using KpM as the sole control for dye density. Dye printing characteristics will vary slightly from batch to batch; if you take a matrix down to exactly the right density for one dye set, it may turn out to be too reduced to print well with the next set. The best approach is to use KpM for the major portion of the reduction and then use a combination of R-18 and NaAC (as the print dictates) to make the final adjustments.

KpM may be mixed as a 2% stock solution that will keep indefinitely. Dissolve .70 ounces (20 g) by weight or .5 ounce (15 mL) by volume of KpM crystals in 33.8 ounces (1 L) of hot water. Stir well until all the crystals are dissolved. To use as a matrix reducer, mix from 1 to 20 mL of the stock solution in a litre of water. Use this solution once and discard it. Do not use smaller volumes of working solution, and do not use it for more than 1 minute in order to avoid exhausting the solution.

Thoroughly wash the matrix in hot water for several minutes before using the KpM. Agitate the matrix continuously in the KpM bath to make sure you get uniform reduction. The effect of KpM is both cumulative and proportional, which means that a 10 mL/L solution will reduce the density by 10 times as much as a 1 mL/L solution. Also, one 10 mL/L treatment will have approximately the same effect as ten 1 mL/L treatments. Use one 1 mL/L treatment to get small changes in density; use one or more 10 mL/L treatments to achieve changes of 1/2 stop or more in any given color. After treating the matrix, pour out the used KpM solution, and immediately pour in a 1/2% solution of sodium bisulfite. This will instantly neutralize any residual KpM. Agitate the solution for 15 seconds and pour out the bisulfite solution.

The matrix should be washed for 3 to 5 minutes in hot running water to remove any traces of bisulfite, before hanging it up to dry or returning it to the dye bath. Remember, this process is not reversible and therefore it is best to do your reductions in small steps.

C-55 (A-E)

Negative Masking -- This technique for contrast control is described in KODAK Publication No. E-66, Printing Color Negatives. A thin black-and-white positive is made from the original color negative and sandwiched with it during matrix exposure. This reduces contrast in the negative so that it does not exceed the exposure range of the matrix film. Since the mask affects all matrices identically, color saturation and separation are not decreased by this procedure. Altering developer ratio or the dye baths also changes each matrix individually, and C-57 reduction of contrast by these techniques lessens color saturation and separation.

Water Rinse -- Occasionally, one has a print which needs substantially more color than the matrix provides, or else it needs a very unusual tonal balance. Several techniques will produce very non-linear tone scales and/or very low-density dye images. These techniques are especially useful when a print needs a second transfer of a color. If you use plain water instead of 1% acid for the first rinse, you will start to wash dye from the matrix at a constant rate, regardless of the density of the matrix. Since density is removed uniformly from all gray levels, the highlights are quickly washed clear, while the middletones take longer and the shadows the longest of all. Tonal separation is retained in the tones that remain. Use cold water -- the longer the rinse time, the more dye is washed out.

Reduced Dyeing Time -- This method complements the previous one. Dye is absorbed uniformly by the matrix, regardless of density, at a constant rate. The highlights are the first to reach full density, then the middletones and finally the shadows. Tonal separation appears initially in the highlights, while the shadow tones remain uniformly gray until they fully absorb their load of dye.

Acid Dye -- Instead of dyeing a matrix in the regular dye bath, you may dye it in a rinse bath to which some dye has been added.

This yields results similar to using a reduced dyeing time, but the matrix picks up dye much more slowly. Reduced dye time cannot really be used much below 30 seconds because it is very difficult to get the matrix into the dye bath, agitate it uniformly and get it out again in a very short period of time. Rinse bath dyeing produces lower densities than you get with reduced dyeing time.

C-58

All three special dye and rinse techniques can be utilized in combination with the aforementioned control methods. Given this extraordinary array of tools for manipulating your prints, how do you decide which to apply? A great deal of the decision-making process simply depends on your taste and what you hope to portray in the finished print. Still, here are some useful guidelines:

Check the highlights. Do they show unwanted color? If so, then one or more of your matrices is overexposed or fogged, or you have some chemical highlight stain. In the case of overexposure, use NaAC to bring the print to line. In the other two cases, R-18 will remove the stain without altering the other tones. If the overall print density seems all right, your matrices are not overexposed.

Check the shadows. Examine the darkest tones under a strong light. If they are not black enough, you need higher contrast. If they are only slightly off, try acidifying the rinse bath for one or more colors. If the density is very low, go to a higher contrast dye bath. In really extreme cases, try double-transferring the offending matrix (or matrices).

If the blacks are so deep that shadow detail is lost, try a lower contrast dye bath. In cases where only a small amount of shadow density needs to be removed, KpM treatment will help.

At this point, you should have a print with approximately the correct placement of whites and blacks on the tonal scale. If the print shows a uniform error in color balance, apply a combination of techniques to correct it. If only the highlights have the wrong color, try KODAK R-18 Reducer. If both highlights and middletones need color correction, use NaAC. If the highlights are all right, but the shadows show color error, use either KpM to reduce density or an acidified rinse bath to increase density. If the entire tonal scale needs to be shifted in color, a combination KpM and R-18 treatment or KpM and NaAC will remedy the situation.

I suggest that you practice a good deal, either printing gray scales or working with a set of matrices which you don't mind damaging. Only your own experience will really let you decide which tools are appropriate. The pictures and descriptions in this book are intended to point you in the right direction. They should not be taken as gospel, nor are they detailed enough to show you all the subtleties of each control method.

In your initial experiments, vary one control at a time to see how each behaves. Then you can try combining them. The techniques do interact with one another to some extent. For example, both R-18 and NaAC excessively reduce highlight densities. If you use more NaAC in a rinse bath, you must cut back on the amount of R-18 to make the highlights remain the same. As another example, high-contrast dye baths tend to stain the highlights more than normal baths while low-contrast ones stain less, requiring you to change the amount of R-18 which you are using.

These procedures should at least get you started. Making them work exactly right for you is the difference between acceptable dye transfer work and <u>fine</u> dye transfer work. You get that from experience, not from a book.

There is much more to making dye transfer prints. You will want to learn how to spot and retouch prints (dye transfer prints take a <u>lot</u> of spotting), how to frame and store your prints as well as how to do special printing techniques and clever derivative prints. And you will probably have a thousand questions that I haven't answered.

However, the purpose of this chapter is to teach you how to make color negative dye transfer prints. Some of what you will still want to learn can be found elsewhere in this book. If you don't find it here, then experiment, invent, ask some of those questions, and make prints, prints and more prints.

You will certainly learn things that I and the other authors have yet to discover. After all these decades, dye transfer is still a developing process; there is a lot we don't know about it.

C-61
(A-D

If you wind up staying with the ''basics''(if anything about this process is properly labeled ''basic''), you will still be able to make prints of unsurpassed beauty. This is something you can be proud of, as well as something from which you will derive great pleasure. Excellence is never unsatisfying.

TABLE I

TABLE OF EXPOSURE AND DENSITY VALUES

Equivalent Exposure Change	Filtration or Density Unit Change	Resulting Change in Print Color or Density
0.4	.40 (40 CC)	-.80
0.5 (-1 stop)	.30 D.U.	-.60 (-2 stops)
0.6	.22	-.45
0.7 (-1/2 stop)	.15	-.30 (-1 stop)
0.8	.10	-.20
0.9	.05	-.10
1.0 (no change)	0.00	0.00
1.12	-.05	.10
1.25	-.10	.20
1.4 (+1/2 stop)	-.15	.30 (+1 stop)
1.6	-.20	.40
1.8	-.25	.50
2.0 (+1 stop)	-.30 D.U.	.60 (+2 stop)
2.4	-.38	.75

(Note that 1 density unit (D.U.) = 100 CC of filtration)

TABLE II

SUMMARY OF PAN MATRIX PROCESS STEPS
(One Sheet of Film Per Process)

Step Function	Temperature	Time	Remarks
TOTAL DARKNESS			
1. Presoak	60-68°F (16-20°C)	1/2-1 min.	Agitate for first 10 seconds, emulsion side up. Mix developer during soak. Drain for 10 seconds.
2. Develop	68+1/2°F (20°C±1/4°)	1 min. 55 sec.	Continuous rocking agitation, emulsion side up.
3. Drain	------	5 sec.	Total developer time is 2 minutes.
4. Rinse	60-68°F (16-20°C)	30 sec.	Constant rocking, emulsion up.
5. Drain	------	5 sec.	Total rinse time is 35 seconds.
6. Fix	60-68°F (16-20°C)	2-15 min.	Continuous agitation, emulsion side up, for first 30 seconds.
ROOM LIGHTS ON AFTER 30 SECONDS			
7. 1st Rinse	115-130°F (45-55°C)	30 sec.	Continuous rocking, emulsion up. Do not hit film with direct stream of water.
8. 2nd Rinse (identical to 1st rinse)			
9. 3rd Rinse (identical to 1st rinse)			At the end of the third rinse, scrape edge of film.
10. 4th Rinse	115-130°F (45-55°C)	2-5 min.	Occasional agitation, emulsion up, to wash out remaining fixer.
11. Chill	60-68°F (15-20°C)	30 sec.	Agitate, emulsion up.

12. Harden (Optional)	60-68° (15-20°C)	3 min.	Agitate periodically in the hardener. After 3 minutes, rinse with several changes of cold water.
13. Distilled Rinse (same as chill rinse)			
14. Dry	Room Temperature	1-2 hours	Do not force-dry final matrices. Hang film by corner to drain.

TABLE III

SUMMARY OF PRINT CONTROL TECHNIQUES

Method	Effect on Density	Effect On Contrast	Effect on Color
ADD TO FIRST RINSE:			
Sodium Acetate (NaAC)	Reduces overall density	Slight increase	Shifts balance away from color
KODAK R-18 Highlight Reducer	Reduces only highlights	Some increase	Shifts highlights away from color
Extra Acid	Increases mainly shadows	Some increase	Shifts balance toward color
ADD TO DYE BATH:			
Acetic Acid	Major density & D-max increase	Major increase	Increases color saturation; shifts balance toward color
Triethanolamine (''Tri-eth'')	Major decrease in D-max density	Major decrease	Decreases saturation; shifts balance away from color
ALTER MATRIX:			
Increase Proportion of B to A Developer	Some increase; no change to D-max	Increase	Slight increase in color saturation
Decrease B to A Proportion	Some decrease; no D-max change	Decrease	Slight decrease in color saturation

Potassium Permanganate (KpM)	Very slight to great decrease in middle, dark tones; no highlight effects	Slight decrease	Shift balance away from color; preserves highlights
ALTER NEGATIVE:			
Mask with KODAK Pan Masking Film	None, with exposure correction	Slight to major decrease	No effect on color
DOUBLE TRANSFER CONTROLS:			
Water Rinse	Removes density from all gray levels equally	(see text for details)	
Short Dye Time	Adds density to all gray levels equally	(see text for details)	
Rinse Bath Dyeing	Has same effect as short dyeing time, but produces lower densities		

MAKING SEPARATIONS FOR DYE TRANSFER PRINTING

by Dennis Brokaw

B-1

The dye transfer process remains today, as it has for decades, the finest medium of color reproduction that there is. A well-made dye transfer print offers a combination of color fidelity, tonal range, sharpness, interpretive control and archival permanence that is simply unavailable by any other means.

It is sometimes said that anyone who can make a good dye transfer print can do anything in photography. While not entirely true, the statement is not without foundation. To command the dye transfer process demands a profound understanding of film exposure and development, color separation and masking (which is a very sophisticated technology), the theory of color itself (which is at the forefront of scientific understanding), as well as the sensitivity and discernment of a true artist who knows instinctively what is right.

This does not happen quickly. It cannot be taught or learned in a short span of time. Beginners can reasonably expect both confusion and many failures. The expert printer is one who has endured both, yet persevered, until gradually he has come to understand and gain control of this most difficult printing medium. Then he has the rare satisfaction that comes only from deep understanding and genuine accomplishment plus the knowledge that he has become a true graphic artist.

A dye transfer print must be slowly and expertly produced. It is inevitably the end product of a host of creative decisions made by a skilled printer. Whether the starting point is a color transparency that must be matched or a color negative whose inverted image is to be revealed for the first time, a dye transfer is truly a work of graphic art.

From a transparency are first made at least two color-correction masks -- soft black-and-white negatives exposed by different colors of light. These masks control tonal-scale reproduction and color purity as well as enhance highlight and shadow separation, and overall sharpness. With the masks precisely registered on the original transparency, three separation negatives are exposed through red, green and blue filters. These negatives are processed to identically matched contrasts and densities.

Alternatively, the original photograph may be made on a color negative film which acts, in effect, as a one-piece set of masked and matched separation negatives. Both approaches yield superb prints. The advantages of working from a negative are that there are fewer decisions and intermediate steps, and less spotting problems. The benefits of working from a transparency are that you see the image you will re-create on paper, and that you have many more opportunities for interpretation.

Individual separation negatives are enlarged, one at a time, in a precision enlarger onto matrix films which are developed in a tanning developer, yielding gelatin relief images in proportion to exposure. Color negative films are enlarged, one color at a time, through red, green and blue separation filters onto panchromatic matrix film.

After development and several washing steps to remove all unhardened gelatin, the matrix films made through the red-, green- and blue-filter separation negatives (or filters, in the case of color negatives) are placed, respectively, in baths of cyan, magenta and yellow dye which they absorb in proportion to their thickness. After two rinses in dilute acetic acid, the dye-carrying matrices are rolled consecutively into contact -- again in exact register -- with a paper specifically treated to withdraw dye from the matrices. Thus, the three dye layers, of which color film images are composed, are effectively re-created on the paper, producing a full color image of extraordinary depth and brillance.

Theory of Color Reproduction

B-2

The remarkable discovery that has made possible all color reproduction, including color photography itself, is that an additive mixture of only three colors of light -- red, green and blue -- can produce a believable visual re-creation of any natural color. It is as though the human eye possesses light receptors discretely sensitive to red, green or blue light. Easily demonstrated after-image phenomena seem to support this theory.

In any color reproduction process, it is important to realize that the best anyone can achieve can only be a believable approximation of the color impressions of an original subject. A true wavelength-for-wavelength match is practically impossible. And color perception and color memory are, themselves, subjective and variable.

The human eye is sensitive to radiation in the electromagnetic spectrum (i.e. light) between 380- and 720-millimicron wavelengths. We arbitrarily call the region between 380 and 500 blue, the region from 500 to 600 green, and the region from 600 to 720 red. When radiation of all wavelengths are added together equally, we see white light. The three colors (red, green and blue) are called the additive primaries. It is these approximate thirds of the visible spectrum that colorants in any tricolor subtractive reproduction process seek to control.

The colorant that governs the transmission or reflection of red light is called cyan. Cyan appears blue-green because it freely transmits green and blue light while absorbing red light. The colorant that governs the transmission or reflection of green light is called magenta. Magenta appears red-blue because it freely transmits red and blue light while absorbing green light. Yellow freely transmits red and green light while absorbing blue light. However, yellow only appears ''yellow'' for your eyes cannot separate out its red- and green-light components.

These colorants -- cyan, magenta and yellow -- are called the subtractive primaries for it is their function to remove red, green or blue light, respectively, from an external source of full-spectrum light. All photographic materials and paints as well as all natural objects (except those that produce light internally) are composed of subtractive colorants. However, only photographic materials and processes depend on mixing solely the three mutually discrete subtractive colorants -- cyan, magenta and yellow -- to achieve a convincing full-color reproduction of any natural subject.

Color transparency film is essentially composed of three layers -- a top layer sensitive only to blue light, a middle layer sensitive only to green light, and a bottom layer sensitive only to red light. After exposure, the blue-sensitive layer is converted during development to a yellow dye-image layer which governs transmission of blue light. The green-sensitive layer, after exposure and development, is converted to a magenta dye-image layer that governs the transmission of green light. And the red-sensitive layer, upon exposure and development, is converted to a cyan dye-image layer which governs the transmission of red light. This three-layer, dye-image sandwich, modulating approximate thirds of a full-spectrum light shone through it, re-creates the impression of colors and shapes perceived by the eye viewing the original subject.

While a color transparency is no more than an approximation of the actual colors of an original scene, it can be more than sufficiently believable, if not to fool the eye, to convince the mind. The reasonable aim of any color reproduction can be no more.

Dye transfer, KODAK EKTACHROME Papers, CIBACHROME Print Material, carbro, offset lithography, gravure printing and all other photomechanical or photographic processes are merely procedures to place on paper, with whatever fidelity the materials afford, colorants corresponding to those present in an original transparency. Each one employs cyan, magenta and yellow inks, pigments or dyes. And these are produced, in turn, through red-, green- and blue-light records of the original photograph, called ''separations.''

There will always be many errors in any color reproduction process. Not only is a wavelength-for-wavelength match between subject and transparency, and between transparency and reproduction, out of the question, but the contrast scales between subject, transparency and reproduction never match. An ordinary color transparency is able to record a brightness range little greater than 1:64. An original scene may well have a brightness range far in excess of that. Yet on film this 1:64 range -- a ''piece out of the middle of the scene'' -- will reproduce with a transparency brightness range of 1:1000 or greater. A color transparency greatly exaggerates apparent contrast.

The three dyes in the transparency, if they were perfect, would absorb only the proper third of the spectrum while freely passing the other two-thirds. In fact, they do neither. It is generally true of all known tricolor primary colorants that the yellow is relatively pure, passing red and green while absorbing blue. Magenta, however, is not so pure a color. It passes red adequately but absorbs some blue that it should not absorb as well as the green that it should. Cyan is notoriously poor, more-or-less absorbing the red that it should, while absorbing some blue as well as a great deal of green that it should not.

The artificial brillance of a transparency enhances its appeal and appears to produce highly saturated colors. Without the original subject at hand for comparison, the mind generally accepts great errors in color transparency balance and discrimination. Color memory is a highly imperfect faculty, and one that few ever consciously try to train. Color perception itself is greatly influenced by the ''surround''. Projection of a transparency image in a darkened room, where all visual reference is absent, can produce acceptance of the most grossly distorted reproduction. On paper, however, the image is seen in the context of the real world, after it has been put through yet another step of reproduction; and there, with all its faults only too obvious, it becomes most vulnerable to criticism.

When a color photograph is reproduced on paper, the transparency's 1:1000 brightness range is once more reduced to 1:64 or less; and when the image is so flattened, tonal-scale and colorant errors become obvious. Indeed, they are compounded throughout the reproduction process as the unwanted absorptions and transmissions in the transparency are multiplied by similar errors in the print colorants. In addition, photographic materials do not render tonal scales in a neat, correct, linear manner, but further flatten contrast at both highlight and shadow ends of the scale. Unless steps are taken to relieve the effects of as many of these errors as possible, there can be no such thing as acceptable color reproduction on paper.

The advantages of the dye transfer process are many. The dye transfer paper, itself, is of excellent quality, to which can be transferred a virtually unlimited quantity of dye. Thus, the potential density range and maximum density of a dye transfer color print is unequalled. Near-absolute control over color balance and individual dye-layer contrast is afforded at every step. Separation and masking techniques allow the printer to ''build into'' his negatives whatever special modifications of color reproduction he desires, such as the lightening of one colorant where another colorant will print. The dyes, themselves, are chosen with an eye toward permanence as well as to proper transmission and absorption characteristics. A well-made and properly cared-for dye transfer print will last more than a lifetime. It is a print of unsurpassed photographic quality.

The separation negatives used in the dye transfer process are, in fact, archival records of the original color image. More photographers should recognize the need for this sort of permanent record, as transparencies, other than those on KODACHROME Film, fade fairly rapidly, even when stored in dry, dark, sealed cabinets. A properly made and preserved set of separation negatives can serve to re-create a color image centuries in the future.

Masking

B-3-8

Whenever a faithful reproduction of a color transparency is desired, masking is absolutely necessary. And although a variety of masking procedures -- highlight masks, sharp masks, split-filter masks, high-percent masks -- are discussed in the following pages, a straightforward two-mask procedure using red-and-green filter 30% masks on KODAK Pan Masking Film 4570 (especially when making enlarged matrices with a condenser enlarger) will almost always suffice to obtain beautiful, near-facsimile prints with excellent highlight and shadow contrast. Difficult or extraordinary masking controls often produce pictorial results that are just as easily achieved by single or overall dye controls in print rolling. Tricky masking should not be undertaken if simple measures will achieve the same results, particularly when one is learning dye transfer.

Arrangement for Contact Masking -- Minimum basic equipment for contacting should include the following:

-- KODAK Register Punch

-- KODAK Register Printing Frame, 11 x 14 inches

-- Transmission densitometer

-- K & M Tri-Level Point-Light Source with T-8 bulb

-- GRALAB Timer or other timer

-- OMEGA, SULA or other Constant-Voltage Transformer, minimum 250-volt capacity

-- KODAK WRATTEN Gelatin Filters, 75 mm (3-inch) No. 29, 61, 47B (and No. 24 if choosing to green-filter mask the red separation when working from KODACHROME 25 or 64 Films)

-- KODAK Diffusion Sheets (0.003-inch)

-- Scissors

-- A table with some means of locating the print frame directly under the K & M Point-Light Source in the dark

In addition, I have a register punch set-up on the edge of a medium-size lightbox. This enables me to check conveniently the transparencies and registered masks for dust in the contact frame, punch masking film in the dark close to where it is going, as well as visually register and punch matrix films.

Ideally, the contacting table should be toward the middle of a room with no highly reflective walls nearby. I work with the K & M Point-Light Lamphouse 56 inches over the work surface for good, even light distribution, with a pulley arrangement to raise and lower the lamphouse when changing filters. I do not use the bare point-light, but rather always a bit of Diffusion Sheet. With the lamphouse at 56 inches, there is virtually no discernible difference in sharpness between the negatives made with a bare lamp bulb and those made with the diffuser. However, all the scratches and dust on the transparency, mask film and contact frame's glass surfaces come through perfectly when using the bare bulb, and not when using the diffuser.

B-9
B-10

Preparing Transparencies for Contact Masking -- In contacting masks and separations, it is convenient to gang two or four transparencies. If working with 4 x 5-inch originals, I prefer to do four at a time on 10 x 12-inch KODAK Pan Masking Film and KODAK Separation Negative Film. It is just as possible to do two on 8 x 10-inch film, or six on 11 x 14-inch film, yet I obtain the best consistency and evenness using 10 x 12-inch film. In this way, two ''four-up sets'' require four sheets of Pan Masking Film which can be developed in one batch, and, subsequently, six separation negative sheets which likewise can be developed in one batch. Thus, with only two exposing/developing sessions, I have eight images ready for enlargement.

To prepare a ''four-up'' gang of 4 x 5-inch transparencies for contacting, I punch a 1 1/2-inch-wide by 10-inch-long strip of old, developed film. I check the transparencies to be sure that there are no hard bends dried into any of the films that would prevent them from lying flat. This is essential for edge-to-edge sharpness. I like to tape the first two transparencies to the punched filmstrip on end with SCOTCH Brand MAGIC MENDING Tape, on the base-side, black edge. I tape the second row of transparencies to the first with thin strips of the MAGIC MENDING

Tape, cut to width, so that the tape never extends into the image area. I add two ''bracing'' strips of tape down the middle of the two rows. And finally, I tape to the punched strip a small 11-step step tablet about 1/4-inch off to one side.

When contacting 2 1/4-inch or 35 mm transparencies, I prefer to tape only a single row of four to the punched strip. And I try not to butt these small originals against the strip, but keep them separated by about 1/16-inch. There is always a problem maintaining flatness (which is absolutely necessary for sharpness) with small originals, especially 35 mm size.

Highlight Masks

The purpose of any highlight-masking procedure is to preserve or enhance tonal separation between the very highest values of the original, which throughout the reproduction process fall consistently in areas of least film contrast. A ''white on cream'' effect in a transparency will be lost by the time the image gets to paper unless some highlight-mask procedure is used to preserve the uppermost tonal separation. Highlight masks are very important when principal color-correcting masks are not made on KODAK Pan Masking Film, for instance, when KODAK Separation Negative Film 4131, Type 1, is used for masks. Also, using a cold-light enlarger to make matrices produces less print highlight contrast, thus increasing the need for highlight masking.

Highlight masks are either pre-masks or post-masks. The function of a pre-mask is to add false density to the upper values of the original transparency and thereby ''trick'' the principal masks; with the highlight pre-mask removed, the principal-mask-plus-transparency combination shows exaggerated highlight contrast. This helps to maintain separation of high values in the final print. Additionally, a highlight mask can be either a ''cleaning-out'' type of mask -- an extreme high-contrast negative that records density only in the upper of the step-tablet's two high values -- or a ''curve-shape modifying'' type of mask -- a negative of very high contrast that nevertheless has a measurable density range of .4 to 1.0 in the top two or three density steps.

A ''cleaning-out'' highlight mask requires film of the highest possible contrast, such as KODALITH Ortho Film 2556, Type 3, or KODALITH Pan Film 2568. It is exposed so briefly that it records only in the upper of two adjacent light values. It may even be necessary to duplicate the film twice to achieve this extreme sharp tone separation. The exposure is critical and is best determined by trial. With the K & M Point-Light Lamphouse at 56 inches, on power setting No. 1, and with a KODAK WRATTEN Neutral Density Filter, No. 96 (1.0 density) plus a Diffusion Sheet, the exposure is 2 to 5 seconds with KODALITH Pan Film.

The decision whether to highlight pre-mask or post-mask will depend to a great extent on what originals you are working from and what equipment you have. Highlight pre-masking is best carried out by contact from 4 x 5-inch or larger originals. It is a far less demanding procedure. Highlight post-masking is almost imperative when working from 35 mm or 2 1/4-inch originals, and you need to retain all the fine quality of these small transparencies. Highlight post-masking is best done with a precision-register mask and an enlarged-separation system, utilizing an 8 x 10-inch enlarger to expose matrices (such a system is offered by Condit Manufacturing Company). Post-masks can also be registered visually or with pin-register systems on 4 x 5-, 5 x 7- or 8 x 10-inch contact separations.

Making Highlight Pre-Masks -- To make a highlight pre-mask, place the assembly of transparency and step tablet taped to a punched filmstrip, emulsion side up, over the register pins in a register contact-print frame. Under proper safelight (or in total darkness if KODALITH Pan Film is used), punch a piece of high-contrast film and place it emulsion side down over the pins so that emulsion-to-emulsion contact is arranged. Close the register contact frame pressure-back, locate it under the contact light and make the exposure. Process and dry the highlight pre-mask film. While it is drying, it is easily evaluated and, if necessary, a second trial exposure can be made. Once a satisfactory highlight pre-mask has been made, it is placed emulsion up in the register contact-print frame. Then the assembly with transparency is placed emulsion down over the register pins so that the images are in perfect register. From that point on, the usual procedures for making color-correction principal masks are carried out. After exposure of the principal masks, the highlight pre-mask is discarded and not used again in any further step.

It is important not to overdo highlight pre-masking, for if the highlight pre-mask records density well into the upper middletones of the image, it will seriously degrade quality in the final print by artificially suppressing part of the reproduction scale and negating color correction by the principal masks.

Making Highlight Post-Masks -- Highlight post-masks are, in fact, supplementary separation negatives that add density only to selected highest values of the original. Highlight post-masks are made in exactly the same way as separation negatives, that is, through tricolor separation filters with the appropriate color-correction masks over the transparency. KODALITH Pan Film is used, and the exposure is adjusted by trial to obtain optimum results. Theoretically, better control and color correction can be obtained through post-masking than pre-masking, as you are adding a fully color-corrected supplementary separation negative to the normal separation negative and thus can extend post-mask exposure as far into the image middletones as you wish. In fact, a curve-shape modifying post-mask can be made on any very high-contrast film.

To make highlight post-masks, first make color-correction masks in the usual fashion. Then with the red-filter mask fitted over the pins, emulsion up in the open register frame, add the transparency assembly, also emulsion up. Put the red separation filter in the contact light and turn out the room lights. Remove and punch an unexposed sheet of KODALITH Pan Film and fit it over the register pins, emulsion down; set the timer and make the exposure. Store the exposed film in a light-tight box, remove the red filter replacing it with the green filter and repeat the procedure. Trim one corner from the green-filter post-mask. Then replace the red-filter principal mask with the green-filter principal mask, replace the green filter in the contact light with the blue filter, and repeat the procedure to make the blue-filter highlight post-mask. (Not only must you decide what densities you require in post-masking, you must also make certain that you obtain identical densities in all three post-masks as determined by plotting the three step-tablet images.) Trim two corners of the blue-filter post-mask. Develop and dry the films.

If both the post-masks and separation negatives have been exposed with pre-register punched film and you use a matching precision pin-register negative carrier (such as the CONDIT System), you then expose matrices through the separation-negative and post-mask sandwich which is automatically registered. Otherwise, the post-masks must be critically registered visually with the separation negatives taped in place and the two films treated as a single separation negative in matrix-making. No matter what, post-masking introduces the possibility of some misregister in sharp highlight detail. Post-masking is best carried out with large (preferably 8 x 10-inch) separation negatives made either by contact or enlargement from small originals.

Another method for making post-masks is simply to contact-print finished separation negatives on KODALITH Duplicating Film 4574, emulsion-to-emulsion, in register. In that way, the post-masks will contain the full color correction of the separation negatives.

Color-Correction Masking

B-11

In order to retain the high overall level of color purity necessary for fidelity in any reproduction process, at least two color-correction masks are required. All photographic dyes absorb some light that they are not supposed to absorb. Both the dyes in most transparencies and the dyes used in dye transfer suffer similar unwanted spectral absorptions. Color-correction masking prevents these faults from multiplying, which otherwise would lead to muddy, degraded and shifted colors in the final print.

Cyan dyes generally absorb the red light that they are supposed to, as well as some blue light and a lot of green that they should not absorb. It is helpful to think of cyans as slightly contaminated with yellow and heavily contaminated with magenta.

Magenta dyes generally absorb green light and pass red light as they are supposed to, but absorb some blue light that they should not. It is helpful to think of magenta as moderately to severely contaminated with yellow.

Yellow dyes are generally quite pure, absorbing blue light as they should while passing almost all red light and most green light. Although some yellow dyes act as though faintly contaminated with a trace of magenta, they can usually be regarded as ''perfect''.

Since there is nothing you can do about the spectral absorptions of the dye colorants themselves, all that is left is to avoid compounding the problems. This is done by making masks whose effect is to lighten one color where another color is recorded. It is of enormous importance that you understand the following principals of color-correction masking.

The dye image that the mask records is determined by the filter used to expose the mask. For example, a red-filter mask records the cyan image. That mask will serve to lighten any of the three colors where cyan is recorded, depending on which negative's contrast it is used to reduce. A green-filter mask records the magenta image. It will serve to lighten any color where magenta is recorded, depending on which negative's contrast it is used to reduce. A blue-filter mask records the yellow image, and will lighten any color where yellow is recorded, depending on which negative's contrast it reduces.

The color lightened is determined by which separation you make with your chosen mask in place. For example, a red-filter mask employed when making the red-filter separation will lighten cyan when cyan is recorded (in other words simply reduce cyan contrast overall). However, a red-filter mask used in making the green-filter separation will lighten magenta where cyan is recorded. If you use the red-filter mask in making the blue-filter separation, you will lighten yellow where cyan is recorded. However, if you use a green-filter mask when making the blue-filter negative, you will reduce yellow where magenta is recorded. And if you use a green-filter mask when making the red-filter separation (as may be necessary with KODACHROME 25 and 64 Films), you will reduce cyan where magenta is recorded.

The basic mask corrections used in making most dye transfers are: The red-filter mask is used to make the red-filter separation and the green-filter separation; the green-filter mask is used to make the blue-filter separation.

The amount of dye removed from any one layer is determined by the density range of the mask relative to the density range of the dye layer that it is employed to mask. For example, if a red-filter mask were to be developed to a density range of 3.0, and, subsequently, used to mask a transparency with a cyan image density range of 3.0, the image would vanish through the red-filter as the result would be the cancellation of the cyan image. On the other hand, if you used that red-filter mask when making the green-filter separation of a transparency whose magenta image has a density range of 3.0, the result would be that you would remove all magenta where cyan was recorded. Masks of reproduction can lead to spectacular ''derivation'' prints.

In normal work from most transparencies, utilizing present dyes, masks in the 25-35% range are usually satisfactory. The density range of the mask is controlled by development time: the longer the development time the greater the density range -- and resultant lightening effect -- of the mask. Also, film other than KODAK Pan Masking Film is apt to be necessary for masks stronger than 35%.

Split-Filter Masking -- Additional color correction can be obtained by split-filter masking, either by exposing through two different filters consecutively or by using a single filter which transmits light that otherwise would pass through two separate filters. For example, a KODAK WRATTEN Filter No. 15 (deep yellow) is equivalent to a combination of a KODAK WRATTEN Filter No. 29 (red) and No. 61 (green). The development of a mask made this way and subsequent separation negatives must be considerably more than that given a mask exposed through a sharp-cutting filter. This is necessary to obtain the basic level of lightening that you require (for instance, the red-light component of the No. 15 Filter transmission) plus the additional lightening that you desire (the green-light component of the No. 15 Filter transmission). The selection of filters and ''percent'' development necessary is something that you should not undertake until you have gained a thorough familiarization with masking in the ordinary way.

In the hands of an experienced printer, split-filter masking opens up limitless opportunties for creative and interpretive color rendition, as well as offering means of correcting the most grossly degraded color in original transparencies. After all, color purity is a matter of removing the complementary or graying color from a mixture. Split-filter masking affords the printer the opportuntiy of carrying out ordinary color correction plus removing up to 100% of the graying complementary color.

To brighten red, add blue-green mask density when making the red-filter separation (to lighten cyan where yellow and magenta will print). To brighten greens, add red-blue mask density when making the green-filter separation (to lighten magenta where cyan and yellow will print). And to brighten blue, add red-green mask density when making the blue-filter separation (to lighten yellow where cyan and magenta will print). These masks enhance color purity in proportion to their development.

B-12

Making Color-Correction Masks -- To make color-correction masks, raise the K & M Tri-Level Point-Light Lamphouse to 56 inches above the contacting table. Insert the red filter and a 3-inch-square KODAK Diffusion Sheet (0.003-inch) in the lamp's filter holder. Set the transformer to power setting Nos. 5 or 6 (setting No. 5 is adequate for a new bulb but as it burns down, setting No. 6 will be necessary). With the transparency and step tablet taped to a punched film strip and the assembly fitted over the pins, emulsion down (emulsion to the glass), turn out the room lights and remove an unexposed sheet of KODAK Pan Masking Film 4570 in a size large enough to cover the entire assembly. Hold the film emulsion up, center it in the throat of the register punch and punch it. Turn it over so that it faces emulsion down, and fit it over the pins. Close and lock the register frame pressure-back. Locate the register frame glass-side up, directly under the contact light and expose 20 seconds. Remove the exposed mask film and store in a light-tight box. Turn on the room lights.

Remove the red filter from the contact light and replace it with the green filter, retaining the 3-inch square of Diffusion Sheet. Turn out the room lights, remove a second sheet of unexposed Pan Masking Film, punch it and fit it over the pins, emulsion down. Close and lock the pressure-back, locate the register frame under the contact light and expose for 36 seconds. After exposure, trim one corner for subsequent identification.

Develop masks in a tray just large enough to hold them. Use a volume of developer sufficient to provide 1-inch of solution in the tray. Two mask films are developed back-to-back, turning them often and using tray-tilt agitation. More than two masks are agitated by constant interleaving agitation, that is, withdrawing the bottom film and placing it on top, withdrawing the bottom film and placing it on top, and so on. Fix and dry as directed.

To obtain 30% masks using KODAK Pan Masking Film, develop 3 1/2 minutes at 68°F (20°C) in KODAK HC-110 Developer with the working stock solution diluted to 1:10. If KODAK SUPER-XX Pan Film is used for masking, development is 3 1/2 minutes at 68°F (20°C) in the HC-110 Developer with the working stock diluted to 1:20.

In working with originals 2 1/4-inch square or smaller, it is difficult to obtain adequate mask effectiveness since KODAK Pan Masking Film has no anti-halation layer and the image diffuses too broadly. Better control is obtained by using KODAK SUPER-XX Pan Film 4142 for the masks. The exposure times are 25 seconds through the red filter and 20 seconds through the green. It is also advisable if SUPER-XX Film is used for masking to provide for some diffusion. This is done either through adding a piece of KODAK Diffusion Sheet (0.003-inch), rough side toward the glass, between the transparency assembly and the SUPER-XX Film when making the exposure or by placing the register-print frame with film in place on a rotating turntable, located off-axis of the contact light, and spinning it during exposure of the principal masks. Otherwise, the procedures are the same except following the development and fixing, when SUPER-XX Film requires an additional 15 minutes running-water wash to remove traces of blue or magenta sensitizing dyes. Also, with SUPER-XX Film, principal masks often necessitate highlight masking.

Important: Always check finished masks by plotting densitometer readings of the mask's step-tablet image. Times for exposure and development may vary slightly with your working conditions. The plotted curves of the two masks should superimpose, as well as lay symetrically centered in the graph. A 30% mask will have a density range of about 1.0 in the step-tablet image corresponding to densities of 0.0 and 3.0 in the step tablet.

A properly made color-correction mask does much more than merely correct unwanted dye absorptions. It enhances sharpness by reducing image scale (thereby eliminating overexposure in the highlights) and by introducing edge effects through both diffusion and adjacency phenomena (the local exhaustion of developer where dissimilar densities are developing). In addition, KODAK Pan Masking Film is expressly designed to have very low contrast at both ends of its scale. The effect of this is to increase, relatively, the highlight and shadow contrast in the separation negatives, just where it is needed to retain highlight separation and rich, deep shadows in the final print.

A mask that is considerably overexposed produces results of increased highlight contrast but lowered shadow contrast in the final print. Conversely, a considerably underexposed mask produces increased shadow contrast but flattened highlights in the final print. Mask exposure adjustment is a very useful tool in controlling print rendition. Not only the density range but the shape of the mask curve should be planned in accordance with the print rendition previsualized.

Finally, there is an occasional use for a dead-sharp mask to enhance apparent sharpness. This is usually made on KODAK Separation Negative Film, Type I, exposed 25 seconds through the red filter and 23 seconds through the green filter, and developed 2 1/2 minutes in HC-110 Developer, 1:20 at 68°F (20C°). Since the registering of a dead-sharp image on the base side of a transparency will inevitably lead to some very slight misregister, this introduces a fine, ''bas-relief'' effect that, if well-controlled, is not obvious in the final print, where very brilliant edges are formed around fine detail. As with masks on SUPER-XX Film, a highlight pre-mask is apt to be necessary with this procedure.

Color Separation Negatives

B-13

The separation negative is the very heart of the dye transfer process. Although there is endless prior and subsequent control, the greatest care should be taken in making separation negatives. Just as it is impossible to make a really fine black-and-white print from an improperly exposed and developed black-and-white negative, a poorly made color separation negative will never yield all the quality latent in the original image.

The ideal separation-negative set will contain all the information in the original, so transposed that the full details of each layer will be faithfully reflected in the final print. Retaining even deep shadow details that will not be obvious in the final print will contribute to the impression of superb print quality in the same way that a fully exposed black-and-white negative delivers a subtle richness to a fine black-and-white print. At the same time, highlights and upper middletones must remain clearly defined and separated; neither underexposure or overexposure can be tolerated. An overexposed negative may produce flat highlights whereas an underexposed negative will surely produce harsh, black shadows with little or no detail. The optimum negative just barely recovers detail from the most dense part of the transparency dye layers (rarely do transparencies have matching maximum densities in all three layers). Plots of the step-tablet images in the separation negatives should coincide exactly. In addition, the negatives must be developed to the optimum density range for the printing contrast of your particular enlarging equipment.

To monitor the masking and separation process, a step tablet of at least 3.0 density range (either an 11- or 21-step tablet is satisfactory) should always be taped alongside the transparencies being separated. It is reasonable to assume a working density range of 3.0 in every good transparency. This will be the density range upon which all of the following masking and separation guidelines will be based.

To make the separations, open the register-print frame and carefully clean both sides of the glass. To suppress Newton's Rings, pick up a very small amount of fine powder, such as OXY-DRY Offset Powder, in an ear syringe and gust the inside surface of the glass with small puffs from the syringe. There should be no more than a barely-perceptible coating when the glass is viewed obliquely against a strong light. Place the open register-print frame over a light table or horizontal illuminator, and put the red-filter mask over the pins, emulsion up.

If the transparencies contain any large, even-tone pastel areas, such as an expanse of sky, gust a faint coating of the fine powder on the emulsion surface of the transparencies. (If there is any humidity in the air, Newton's Rings will tend to form between the emulsion surface of the transparency and the emulsion surface of the separation negative film during exposure.) Simply waving the films through a faint cloud of powder gusted into the air is sufficient to break up the optical contact that produces Newton's Rings.

With the contact light raised to 56 inches and set at power setting No. 5 with a new bulb (setting No. 6 with an old bulb) and with the red filter (No. 29) and a 3-inch square of KODAK Diffusion Sheet or opal glass in the filter holder, place the transparency assembly, emulsion up, over the pins and inspect it for any dust specks. Carefully wipe or blow away any specks or lint, then quickly turn out room lights and the light table. Remove an unexposed sheet of KODAK Separation Negative Film 4131, Type I. Locate it over the assembly, butted against the pins, emulsion down (but not punched and fit over the pins, as doing so accomplishes nothing but attracts more dust). Carefully close and lock the register-print frame pressure-back, turn the register-print frame over and locate it directly under the contact light, glass side up. Set the timer and make the red-filter exposure, which is 20 seconds with the No. 29 (red) Filter. After exposure, return the print frame to the light table, remove the exposed negative and store it in a light-tight box. Turn on the room lights and light table.

Remove the red filter from the contact light and replace it with the No. 61 (green) Filter. Inspect for dust once again, remove any, then quickly turn off the room lights and the light table and remove a second sheet of Separation Negative Film. Place the film against the pins, emulsion down, in the same way; close and lock the register-print frame pressure-back. Locate the print frame, glass side up, directly under the contact light, set the timer and make the green-filter exposure, which is 18 seconds. After exposure, return the print frame to the light table, take out the exposed film and trim one corner for identification. Store it with the first negative. Then remove the green filter from the contact light and replace it with the No. 47B (blue) Filter.

Remove the red-filter mask from the print frame and replace it with the green-filter mask, oriented the same way, emulsion up. Add the transparency assembly, emulsion up. Once again, check for dust and remove any. Turn off the room lights and light table; remove another unexposed sheet of Separation Negative Film and locate it in the same way, butted against the pins, emulsion down. Close and lock the pressure back, locate the print frame under the contact light, set the timer and make the blue-filter exposure, which is 22 1/2 seconds through the No. 47B (blue) Filter. Remove the exposed blue-filter negative and trim two corners for identification. Store it with the other exposed films in a light-tight box.

With the K & M Tri-Level Point-Light Source power setting at No. 5 or 6, the basic exposures with KODAK Separation Negative Film, Type 1, are:

KODAK WRATTEN Filter Number	Exposure Time
No. 29 (red)	20 seconds
No. 61 (green)	18 seconds
No. 47B (blue)	22 1/2 seconds

You will notice the ratios of red to green to blue are approximately 10:9:11. If, after trial, you determine your negatives require more or less exposure, maintain that ratio. Most importantly, however, plot the step-tablet images of your first set of negatives to be certain that these times do indeed yield superimposed curves with your laboratory conditions. Fluctuations in household line voltage can cause significant variations in the times of exposure due to different light bulb color temperatures. These times were obtained with the standard T-8 bare-filament contour light with current run through a SOLA 250-volt Constant-Voltage Transformer set to produce a constant 118-volt output.

Separation negatives should be processed in trays the same size as the film. Also, trays should be 1/2- to 3/4-full of solution to minimize difficulty in film handling and avoid accidental scratches. Use KODAK HC-110 Developer at exactly 68°F (20°C), with the working stock solution diluted 1:15 -- and with a total volume of developer equivalent to 17 ounces (500 mL) for each sheet of 8 x 10-inch film (50 ounces [1500 mL] for a set of three films). Development is 4 minutes for the red- and green-filter negatives, 5 minutes for the blue-filter negative. Standardization of development techniques is extremely important: the time, temperature (which should be measured with a KODAK Process Thermometer, Type 3), agitation, volume of developer and number of films developed should be strictly standardized if consistently fine negatives are to be processed in trays.

It is significant to note that KODAK Separation Negative Film, Type I, is extremely sensitive during development, so much so that many dye transfer printers prefer to use KODAK SUPER-XX Film which is very easy to develop consistently. However, the far better sharpness of Separation Negative Film makes it my choice of film, expecially with smaller originals.

To handle Separation Negative Film in tray processing, first set the timer to 5 minutes. Turn off room lights and open the box of exposed negatives. Identify the blue-filter negative by the two trimmed corners and place it, emulsion down, in the developer, raise it from the liquid to dislodge bubbles and reimmerse it. When the timer is down to 4 minutes, add the green- and red-filter negatives in the same manner, taking care that they do not stick together. Thereafter, continue development by interleaving constantly. Agitate rapidly enough to cycle through all three films every 10 seconds. When time is up, withdraw the films in the order in which they were placed in the developer and immerse them in the stop bath. Water at 68°F (20°C) with enough glacial acetic acid added to make a 1/2% solution is quite adequate. Agitate the films for 1 minute in the stop bath, then immerse them in the fixing bath. Fix with constant agitation in KODAK Rapid Fixer for 4 minutes, or in KODAK F-5 Fixer for 10 minutes (room lights can be turned on after 2 or 5 minutes, respectively.) Wash films for 1 minute in running water, then treat them for 30 seconds in KODAK Hypo Clearing Agent for archival permanence. Wash for 10 minutes in running water. Bathe the films in dilute KODAK PHOTO-FLO 200 Solution to eliminate water spots and speed drying; hang films to dry in a warm, dust-free place.

Once they are dry, carefully cut the separation negatives from the oversize film and store them in separate acetate sleeves, along with the step-tablet images from that group of separations. All the negatives of one assembled set are then kept in a large glassine sleeve or envelope.

Beginners to tray development and interleaving agitation inevitably encounter problems in film handling, such as scratching and achieving consistent and even development. Practicing the motions with blank film in room light helps greatly in gaining proficiency in tray processing. Also, since once a procedure to make separations is established, it is repeated with only minor variations; it is of utmost importance to zero in at the outset. Exposure times must be determined precisely for your individual working conditions, both overall exposure and the relative times of the three color separation negatives to one another. You will find the following section of particular significance for achieving consistent facsimile reproduction and for controlling your interpretations.

Basic Separation Negative Density Range (BSNDR)

B-14

In standardizing the making of a separation negative set that will ultimately reflect the color rendition of the original transparency, it is necessary for dye transfer printers to determine their basic separation negative density range (BSNDR). This is defined as the density range in the developed step-tablet image corresponding to a density range of 3.0 in the step tablet. Each worker will introduce too many variables in his <u>effective</u> contrast rendering (due to different enlargers, lenses, masking, densitometer error, dye acidity, matrix film contrast, local water hardness, etc.) to specify an exact figure. However, it usually lies between 1.20 and 1.50, when using a good condenser enlarger. For a start, if you use a condenser enlarger, you should strive to obtain the intermediate figure of 1.35 density range in the developed step-tablet image for those original steps corresponding to densities between 0.0 and 3.0. If you use a cold-light enlarger, 1.60 should be your intermediate figure.

The ''X's'' along the horizontal axis at the bottom of the accompanying graph indicate actual densities in a 11-Step KODAK Photographic Step Tablet, No. 2A, read on a densitometer. The plot of the ''M''-points delineate the curve of the step-tablet image read from the developed KODAK Pan Masking Film, with densities plotted vertically above the step-tablet step that is imaged. The plot of the ''S''-points shows the curve of the Separation Negative Film, Type I, with densities plotted vertically above the step-tablet step that is imaged. Notice four things:

B-149

1. Lines forming the vertical grid of the curve-plotting graph paper are arbitrarily assigned .20 density increments, reading from right to left for convenience. Along the vertical-.2-line, the actual density readings from the step tablet are plotted (''X's'').

2. The mask curve (''M''-points) shows a noticeable fall-off in internal contrast at both ends of the scale, with slightly more fall-off at the highlight end of the scale. This mask was made on KODAK Pan Masking Film and was deliberately overexposed somewhat to obtain that increased fall-off at the highlight end

of the scale. This mask has a density range of almost exactly 1.0; with an average-layer maximum density of 3.2 in the transparency, it represents an ideal 30% mask.

3. The separation-negative curve (''S''-points) has a somewhat upswept shape overall, indicating extra internal contrast in the highlight portion. This is a direct consequence of the mask curve shape that was chosen. The weaker the internal contrast in any portion of the mask curve, the greater will be the internal contrast in the corresponding portion of the separation-negative curve.

4. The BSNDR -- the difference between the image of densities corresponding to 0.0 and 3.0 in the step tablet -- is almost exactly 1.35.

It has been determined that the originals, 4 x 5-inch KODAK EKTACHROME Transparencies, have no important shadow detail below 3.2 maximum density in any layer, and therefore this overall level of exposure was adequate to record everything in those shadows without overexposing the negatives needlessly. The set of separations from which these curves were plotted produced superb prints with normal matrix development, the enlargements made in a condenser enlarger, and normal-contrast dyes used in rolling the prints. Note that no highlight masking was used or needed.

There is no way other than by making a number of sets of separations and enlarging them through your enlarger onto matrix film processed in your personal manner, then printing them to ascertain your BSNDR. If you use a very low-contrast enlarger, such as one with a cold-light head or integrating sphere, you will tend to require a rather high BSNDR. If you use an extremely sharp and contrasty enlarger, such as a highly focused condenser or point-light type, you will tend to require a much lower BSNDR. However, a BSNDR of 1.35 with normal matrix development is an excellent starting point for work with an ordinary condenser enlarger with a clean lens and normal condenser efficiency.

If the BSNDR is too low, you will obtain prints that are soft, with poor highlight separation and low color saturation. If the BSNDR is too high, you will obtain prints that are harsh and contrasty, with bare highlights and overly strong color saturation.

There is another factor affecting BSNDR. Matrix film is always exposed through the base side and consequently has no anti-halation backing. Very contrasty negatives contribute to enlarger flare and halation in the film. Both cause serious losses in quality. Softer negatives produce much sharper matrices, yet too-soft negatives introduce errors, especially in highlight rendering that cannot be compensated for by developing for increased matrix contrast. Thus, pay very careful attention to determining your BSNDR, as it represents the one best compromise for your system that will most consistently produce facsimile color rendition without costing definition. A book of records of the effective BSNDR of each negative set that you print, including mask densities, will prove invaluable in establishing repeatable printing procedures.

The foregoing masking and separation procedures are basic for consistently obtaining the best results from standard transparencies, using contact separations and enlarged matrices. Although special problems may be encountered from time to time, the following information may prove useful.

If you cannot develop KODAK Separation Negative Film, Type I, evenly, you will have to use KODAK SUPER-XX Film (in spite of its lower definition which makes it suitable for either contact matrices or matrices made at very low enlargement magnifications). Exposure times, with the light at 56 inches and power setting No. 5, are:

KODAK WRATTEN Filter Number	Exposure Time
No. 29 (red)	25 seconds
No. 61 (green)	20 seconds
No. 47B (blue)	25 seconds

Development time in KODAK HC 110 Developer at 68°F (20°C), working stock diluted 1:10, is 4 1/2 minutes for the red- and green-filter negatives, and 7 minutes for the blue-filter negative. (Adjust according to your handling techniques to obtain the 1.35 BSNDR.)

KODACHROME 25 and 64 Films (not KODACHROME II Film) are rather difficult originals incorporating a cyan layer with extraordinary red-light opacity which ''looks'' extremely dense through the No. 29 (red) Filter, if not to the eye. In addition, all three layers are unbalanced with a noticeable cyan undercut in the highlights and low yellow-layer contrast. If you wish to attempt facsimile reproduction of KODACHROME 25 and 64 Films using the step-tablet image for process monitoring, Kodak suggests using a No. 24 (red) Filter instead of the No. 29 (red) Filter and using the green-filter mask when exposing the red-filter separation negative. Otherwise, procedures remain the same except for the times for mask and separation exposures through the No. 24 Filter. They are: mask, 10 seconds; and separation, 7 seconds, with usual development time.

There are many possible solutions to reproducing new KODACHROME Films, none 100% satisfactory. Among these methods include normal separation and masking with the No. 29 (red) Filter, but developing the red-filter separation only 2 3/4 to 3 minutes instead of 4 minutes to obtain far lower contrast. You can also simply separate in the ordinary way but print with very low-contrast cyan dye. Or you can use some intermediate measure, such as masking with a KODAK WRATTEN Filter No. 11 (yellow-green) or No. 15 (deep yellow) Filter and separating with the No. 25 (red).

No matter what procedure you employ, a faithful visual reproduction on paper of the color rendition of the new KODACHROME Films will be virtually impossible owing to color differences between the transparency cyan and the printing cyan. The problem of cyan undercut, most apparent with the stronger red filters, is easily controlled by slightly underexposing the cyan-printing matrix relative to the other two. Low yellow-layer contrast can be handled by either increasing development of the blue-filter separation by 30 seconds or by simply using high-contrast yellow dye.

Other kinds of problem originals must be analyzed and appropriate corrective steps taken on a case-by-case basis (See Analysis and Previsualization on page 00).

Enlarged Separations -- Prints from transparencies 2 1/4-inches or smaller, when enlarged more than five times, usually gain in quality through the use of enlarged separation negatives. Not only is grain minimized, but it is the best way to mask and retrieve all the definition in the small original while controlling dust and scratch problems.

There are three possible approaches:

1. Make contact masks with subsequent enlargement through an ordinary enlarger. This requires a pin-register system in the negative carrier for registering the masks with the transparency when exposing the separation negative. The difficulty with this approach is that no satisfactory mask film is available. KODAK Pan Masking Film has far too much built-in diffusion to obtain good color correction around fine details and colors. Adequate mask control can be obtained by using a sharper film, such as KODAK Separation Negative Film, Type 1, but films <u>other</u> than KODAK Pan Masking Film lack the built-in fall-off in highlight and shadow contrast which is necessary to retain that very highlight and shadow contrast in the final print. Therefore, if a sharp film is used for masking, a highlight pre-mask is almost always needed -- something that becomes increasingly difficult with small images. Other than a negative carrier with a register system, all that is required for this approach is a good condenser enlarger and a first-rate color-corrected lens. (Apochromatic lenses are <u>not</u> necessary, or really even desirable; fine results can be obtained with modern lenses, such as COMPONON, RODAGON, EL NIKKOR Lenses, etc.)

2. Make a direct enlargement with an ordinary enlarger onto negative film which is developed to 50% extra contrast

and then subsequently masked by contact-positive masks produced from the separations. The mask and separation films are then projected (or contacted) together to expose the matrix. Probably the best film for this procedure is KODAK SUPER-XX Pan Film, which has now slightly enhanced highlight contrast. Once more, minimum special equipment is required. However, flare resulting from the full-range transparency will tend to degrade quality quite a bit. The resultant negative/mask sandwich is also quite dense and makes for long matrix exposures.

3. Make optical masks, which are enlarged masks created by projection in a very sharp (point-light) enlarger system. The transparencies are individually mounted in fluid or oil-immersion register negative carriers. The separations are then made by projection of the transparencies through the optical masks, resulting in very sharp, fully color-corrected separation negatives which are enlarged in a conventional enlarger to make the matrices. Obviously, if the separation negatives are 5 x 7-inches or 8 x 10-inches in size, another enlarger of at least that size is required. This method is generally considered to yield the finest quality for small originals but requires very precise and costly enlarging and register equipment, that is, a point-light system based on a 4 x 5-inch enlarger and an 8 x 10-inch enlarger. This system also affords full masking control, including easy highlight

post-masking. (For further information, contact Condit Manufacturing Company).

Making Matrices

B-15 (A-F)

Matrices are the ''printing plates'' of dye transfer. And, regrettably, making matrices is a very touchy thing because the design of the materials, processing procedures and chemicals is over 50 years old and not what we have come to expect of modern photographic processes. Producing good matrices will tax your darkroom skill to the utmost. In particular, the two-minute development time, wherein you must develop a set of three large and touchy films absolutely identically and evenly, comes close to being an impossibility. To a considerable extent, errors in matrix density and contrast can be corrected through subsequent dye controls. Nevertheless, a set of good matrices is a joy to print and a bad set is an endless headache. As a rule, if after three attempts to roll a good print (a first print and two additional tries with modified rinse treatments or dye adjustments), you still have not obtained reasonably satisfactory results, remake the matrices (See Rolling Prints on page 00).

Matrix film tends to lose speed and contrast fairly rapidly as it ages. It is also especially subject to fogging. KODAK Tanning Developer A Chemicals that have turned brown should not be used. Open boxes of matrix films should not be left in hot or humid places or where there are apt to be chemical fumes. There should also be absolutely no light leaks in the darkroom; any light leaks from the enlarger head or negative stage should be stopped.

KODAK Matrix Film 4150 is handled under a KODAK Safelight Filter, No. 1 (red), with a 15-watt bulb in a suitable fixture. It is convenient to mount one safelight above the enlarger, 40 inches from the easel and off to one side, so that you can easily see to position film over the vacuum channels of your vacuum register board. Matrix film is always exposed through the base side (the shiny side). Contact-made separation negatives are always placed in the enlarger, emulsion up. A second safelight should be located 40 inches above the developing area. To determine matrix exposure, I use an exposure computer in conjunction with test exposure data as described in the following procedures. Matrices are exposed primarily to obtain proper printing density in image highlights and upper middletones. As these are often difficult to locate and read in separation negatives, I like to base first-trial matrix exposures on the off-image maximum density areas in the separation negative film. Either the first step in the step-tablet image or the fully exposed film just outside the transparency image will do. (There may be a difference of about .10 between the two, due to adjacency effect in development.)

Obviously, one very direct way of determining matrix exposure is to expose, process and roll cyan-printer test strips for each new image to be printed. This process is just like making test strips for black-and-white printing; it is safe and sure only if you use identical chemicals, temperature and dilution for the test and the prints. Different mixes of Tanning Developers A and B can yield very different prints. Although this uses quite a bit of film and time, you may opt to work this way. Once you find an exposure via the test-strip method that yields a good print, the rest of the film in that box can probably be exposed quite similarly, making slight adjustments for different images. This is especially true if you have standardized your BSNDR. If you opt <u>not</u> to standardize your separation negative density ranges, you will virtually <u>have</u> to make test strips -- or entire test prints -- for each new image.

If you do not standardize your separations with the BSNDR concept, what you must do is determine another basic relationship between that off-image maximum density and exposure time for your particular enlarger and customary magnification. Once this is known, you can then read the correct exposure time for any other negative densities directly from the exposure computer. To determine this basic exposure/density relationship for your equipment, proceed as follows:

Read and calibrate a small step tablet on your densitometer, marking the steps between 1.2 and 2.0, and clearly identify the step nearest 1.50. Determine what will be your most used print size -- 8 x 10-, 11 x 14-inches or whatever. Place the vacuum register board on the enlarger easel, put a standard-size negative in the carrier, and size and focus the image on the vacuum board. Lock the enlarger at this setting. Remove the negative and place the step tablet in the carrier so that the marked steps will be projected. (Take care to black-mask everything but the step tablet to prevent any stray light leaks.) Cut a 2-inch-strip of matrix film and place it emulsion down on the vacuum board and expose for 5 seconds. Store it in a light-tight box. Cut a second strip and expose it for 10 seconds. After exposure, trim one corner and store it. Cut a third strip and expose it for 20 seconds. Trim two corners and store it. Cut a fourth strip, and expose it for 40 seconds. Trim three corners and store it. Develop, wash and dry the strips in the usual way (See Processing Matrices on page 00).

You are looking for the ''first, just-discernible density'' in the films. An experienced printer can usually identify it by examining the film visually against the light. It is much safer, however, to go ahead and roll cyan dye image from the strips. One of the strips should contain ''that first, just-discernible'' step in the printed image of the density nearest 1.50. If all the images are very dark, your enlarger lamp is too bright and should be changed. If all the strips are very light, your enlarger lamp is too dim and should be changed. Ideally, that ''first, just-discernible step'' should appear at an exposure time near 10 to 15 seconds with a small print size.

Once you have found the exposure time that just barely records the 1.50 (or nearest-to-1.50) step, simply place that exact density opposite that precise time on the exposure computer dial and tape it securely. Thereafter, as long as neither lens aperture nor enlarger magnification is changed, you will read exposure times directly from the dial. It is the time appearing opposite the maximum density of each new set of negatives.

A change in lens aperture is easily corrected for, insofar as it affects exposure calculations. Each *f*-stop represents a halving or doubling of light transmitted. The *f*/5.6 stop transmits twice the light of *f*/8 or four times the light of *f*/11. Similarly, each successive negative density increment of .30 transmits one-half the light. Should you wish to stop down one *f*-stop, simply subtract .30 from your basic computer density setting. Conversely, if you open up one stop, add .30 to your basic computer setting. Either way, you then read your exposure times opposite the new density setting.

A change in magnification is a more complex matter. Light levels can be measured with an easel probe, or a chart of ''master settings'' for each commonly used size -- 8 x 10, 11 x 14, 16 x 20 inches, etc., which can be made through trial. The effects of bellows extension, flare and condenser efficiency at various magnifications affect the actual amount of light delivered to the easel in unpredictable ways. To minimize variables, you should try to keep the enlarger lens constantly set at whatever aperture is optimum for the negative size that you use--*f*/8 for 35 mm, *f*/11 for 2 1/4-inches, *f*/16 for 4 x 5-inches, and so on.

Alternatively, you may read the highlights of the projected image with an easel probe, devising your own chart for determining exposure times for various brightness readings. The difficulty with this system is that there may be *no* highlights, thus leaving you with no reference points. You then face the necessity of building up an elaborate system, charting color densities from the middletones of the original transparency, and using this information to find the exposure that produces an appropriately transposed color density on paper when the matrix is rolled.

You should also be aware of other factors affecting matrix exposure, the most important of which is flare. A very thin negative, such as would be made from a very dark original, will print more heavily than a normal negative, even with the same highlight or off-image densities. Conversely, a very dense negative, such as would be made from a very high-key original, will not print as heavily as a normal negative, even with the same highlight or off-image densities.

With very dark originals, you may have to decrease matrix exposure up to 50%, and for very light originals you may need to increase matrix exposure up to 50%. The exposure given a set of matrices must be governed by intuition as much as by density measurements. Some images may simply seem more correct when ''printed down'' or brightened. Too much matrix exposure, however, always leads to muddy color while too little leads to overly bright color. Slight adjustments in the exposure given individual matrices of a set are useful for correcting minimal imbalance in separation-negative density or transparency color balance. You should not expect faithful reproduction from any set of separations that is mismatched by more than .15 density, nor from any set whose negatives are unmatched in BSNDR or curve shape. (Excellent prints can be made from unbalanced separations, but not faithful ones).

Once you have clearly established by trial your basic time/density matrix exposure relationships, proceed as follows to make matrices for printing:

1. Place the red-filter separation negative, emulsion up, in a glass-type negative carrier and put it in the enlarger. Locate the vacuum register board so that the projected image is centered within the appropriate vacuum channel. Provide for at least a 1/2-inch margin at the top (and nearest the pins) of the film and a 1 1/4-inch margin at the opposite end for subsequent register punching. Turn on the safelights and constant voltage

transformer, and turn off the room lights. Open the box of matrix film and remove and place a sheet, emulsion down, butted against the pins and centered over the vacuum channels. Turn on the vacuum pump and, as the film is drawing down, set the timer. (You have already determined negative exposure times from the exposure computer.) The film is fully drawn down when a slight, ''pebbly'' texture appears over its surface. At that point, make the exposure for the cyan-printing matrix. After exposure, put it in a light-tight box. Turn on the room lights and remove the red-filter negative.

2. Place the green-filter separation negative in the carrier, emulsion up; in the same manner as the first negative, put it in the enlarger and repeat the above procedure to expose the magenta-printing matrix. After exposure, trim one corner for identification and put it in the light-tight box with the first exposed matrix. Turn on the room lights and remove the green-filter negative.

3. Place the blue-filter negative in the carrier, emulsion up; and as with the other negatives, put it in the enlarger and repeat the exposure procedure for the yellow-printing matrix. After exposure, trim two corners and put it with the other exposed matrices. Turn on the room lights and remove the blue-filter negative.

Take meticulous care not to change the enlarger setting between matrix exposures in any way.

Should you ever forget to identify either finished separation negatives or matrices with trimmed corners, you can usually identify them by examining fine details and sharpness. The blue-filter negative and the yellow-printing matrix are invariably the sharpest, while the red-filter negative and the cyan-printing matrix are the fuzziest. The green-filter negative and magenta-printing matrix will be in-between.

Processing Matrices

B-16

Prepare the developing area carefully, making sure everything is ready before turning out room lights. The KODAK Tanning Developer B Solution should be mixed the day before use. It is convenient to mix the Tanning Developer A Solution from one-quart packets just before use. Fill one tray with a film-strength plain hypo (sodium thiosulphate) solution -- at least 1/2 gallon for a set of matrices measuring up to 11 x 14 inches -- and a second tray with plain water at 68°F (20°C). Bring the two Tanning Developer Solutions to about 68-69°F (20-20.5°C). They will cool approximately one degree when mixed. Then pour the A and B Developer Solutions into a third tray, mix thoroughly and turn off the room lights. The mixed developer oxidizes in minutes, so don't fuss over obtaining exactly 68°F (20°C). Set the timer to 2 minutes 20 seconds.

Under safelight illumination, take out and separate the exposed matrices. Place the lead matrix, emulsion up, in the developer and lift the corners of the tray to swirl the solution over the film evenly and as quickly as possible. Start the timer the instant the lead matrix is in the developer. (The timer should be readily visible at eye height, so that you can watch the sweep second hand). Ten seconds later, add the next matrix, emulsion up, and swirl the solution over it. Add the third matrix 10 seconds later, then reach to the bottom of the tray, withdraw the lead matrix, turn it emulsion down, and place it on top. Withdraw the next matrix and turn it emulsion down and place it on top. Follow with the last matrix. (Larger matrices must all be started emulsion down). Thereafter, agitate by smooth, rapid interleaving. When the timer reaches 20 seconds before the 2-minute period, remove the lead matrix and put it into the water stop bath with good agitation. When the timer reaches 10 seconds, remove the next matrix and put it in the water stop bath with the first matrix. When the time expires, remove the last matrix and put it in the stop bath with the other two matrices. In this way, all three matrices will receive as nearly identical processing as possible. With original transparencies containing wide areas of delicate pastels, you may encounter difficulty in obtaining faultless development even with the utmost care. If so, it may help to develop the matrices in individual trays, emulsion up, dividing the same mix of Tanning Developer between them. Identical agitation can be provided by AGITEX Tray Rockers, available through graphic arts suppliers.

Interleave the matrices for at least 30 seconds in the stop bath. Then place them in the fixer, beginning with the lead matrix, keeping them emulsion down throughout. Agitate constantly by interleaving for 4 minutes. When handling films in the fixer, grip them very securely, even dig your fingernails into the margins of the film if necessary. At this stage, matrix film is incredibly soft and slippery; a dropped matrix is sure to be ruined. After fixing is completed, turn on the room lights; dump and rinse the trays of developer and stop bath.

Fill the two rinse trays with water at 120°F (49°C) -- the exact temperature is not critical. Carefully lift the first matrix out of the fixer and place it, emulsion up, in the first hot wash. Agitate by tray tilting for 1 minute or until all the brownish backing is loose from the film. Then place the matrix in the second hot wash tray and dump the first. Refill that tray with hot water. Agitate the matrix for another minute in the second hot wash, and place it back in the first tray in fresh, hot water. Set it aside to soak.

Dump the second tray and fill it and a third tray with water at 120°F (49°C). Remove the second matrix from the fixer and wash it as you did the first, placing it aside to soak following two initial 1-minute washes. Add a new tray and repeat the wash steps for the final matrix. Once the final matrix has been put to soak in hot water, return to the first matrix which has been soaking and run your fingers along the edges of the film to remove any clinging gelatin. Dump and refill the tray with fresh water at 120°F (49°C), taking care that no direct stream of water hits either the front or back of the matrix. Set it aside to soak again. Do the same with the other matrices. It is important all three matrices receive the same total time in the two soak baths, usually at least 6 minutes, although 10 minutes or more will not hurt. (The objective is to remove equally all soluable gelatin from the emulsion to eliminate any unwanted printing density or a change from first to subsequent print rendition.)

After soaking, complete the wash-off water with two 30-second rinses of each matrix in fresh water at 120°F (49°C), followed by immersion for 1 minute in a tray of water at 68°F (20°C). Hang the matrices to dry, orienting them so that each hangs by the same corner.

Throughout, make certain all three matrices of a set receive identical handling during wash-off and drying. Never touch the emulsion of a wet matrix; to do so will ruin it and necessitate the remaking of the entire set.

Once the matrices are completely dry, place the cyan-printing matrix (emulsion up if you are right-handed, emulsion down if left-handed) over the lightbox with the register punch. Center the film relative to the pin holes that you will use, allowing about 3/4-inch from the pin holes to the edge of the image. Tape the film securely in place and punch it. Then lay the second matrix atop the first, align the images critically, tape the second matrix and punch it. Remove the punched second matrix and align, tape and punch the third matrix. Remove all three matrices and store them in the yellow paper folders that come with the film.

Rolling Prints

B-17

Print rolling is the culmination -- the realization -- of all the preceding steps in dye transfer. It should be done in spacious, pleasant, very bright and well-ventilated surroundings. There should be large tables adjacent to a generous sink. An 8-foot stainless sink with low sides, its bottom at a comfortable working height, is ideal. However, trays for small matrices (up to 11 x 14 inches) can be easily handled in inexpensive household stainless sinks countersunk at one or both ends of the print-rolling table. In-line particle filters for both hot and cold water, as well as a temperature-control valve, are useful for the serious worker. But especially there should be plenty of bright light by which to judge the prints as you roll them. Indirect sunlight is the best. However, if the printing area must be lighted artificially, brilliant incandescent lighting, such as obtained with 300-watt bulbs, is a must. Even so, you should take a finished print outdoors in daylight to evaluate accurately yellow-layer density and contrast. Try not to judge prints under fluorescent lighting.

To compare a print to a transparency, it is useful to view them under two different types of lighting: the white light reflected from a snow-white card in full sunlight and the warm light of a 150-watt incandescent bulb. In this way, you will gain the greatest insight into the relative fidelity of the ''transition-to-paper'' which you have made. The white card in daylight is especially helpful during print rolling because you can lay a fresh print on it and view the original transparency against the same background with the same light. I avoid fluorescent-lamp illuminators, even those claimed by the manufacturers to meet critical color-temperature and color-rendering standards.

Printing requires seven absolutely clean trays, large enough to accommodate the matrix film that you are using. (If you print in several different sizes, it is worthwhile to have a set for each size). To roll prints, first mix a volume of KODAK Paper Conditioner sufficient to provide 1 inch of solution in the tray. You can condition up to six sheets of KODAK Dye Transfer Paper at one time (and as you print, add new paper to the Conditioner).

If you use an automatic tray-rocking device, the paper conditions in 20 minutes. If you agitate manually, interleave the paper for 2 minutes or until all sheets are evenly wetted, then allow them to stand for 20 minutes with occasional interleaving. Filter the Conditioner before reusing.

While the paper is conditioning, mix and filter fresh dyes. One-quart amounts are adequate for prints up to 16 x 20 inches. By mixing small amounts which can be dumped after each day's printing, you are assured of consistently fresh dyes that can be individually ''tailored'' to suit the images being printed. If you intend to print a variety of matrices, you can easily mix three sets of dyes in low, normal and high contrast. In addition, as you gain experience in printing, you will often wish to mix dye contrasts by using dyes of two or three contrast grades.

The hallmark of the expert dye printer is his ability to print prints, not gray scales. Balancing a fresh set of dyes is a waste of time. It is usually far better to mix fresh dyes, roll a print and then adjust dye strength and rinse treatments to obtain the best possible rendition of that print. The performance of different batches of dyes can vary due to many factors. Do not assume a new batch will print with either the same balance or contrast of a previous batch. In addition, water hardness and dissolved chemicals may substantially alter the wash-back rate in the first acid rinse. To roll prints day-by-day, it is necessary to get a ''seat-of-the-pants-feel'' for the current processing conditions.

Be especially careful not to allow either Paper Conditioner or any alkaline agent to contaminate the dyes. Do not mix or store the dyes in any glass bottle previously used to contain an alkaline agent. Remember, the chemical/physical principle that makes dye transfer work, in simple terms, is that acids stabilize the dyes while alkalies liberate them. Paper Conditioner that finds its way onto a dyed matrix will immediately make the dye begin to bleed; even minute traces of ammonia will ruin the balance of dye baths.

The actual mechanical process of rolling dye transfer prints is straightforward. Follow the instructions outlined by Ctein, starting on page 00. Each technician has individual working habits, but the underlying routine should remain the same whether the matrices are made from color negatives or separations.

Retouching

Small pin holes, where dye did not print, are easily filled in on either a wet or dry print, with dilute transfer dyes applied with a sharpened wooden toothpick ''brush.'' You can add large areas of color with a cotton swab moistened with dilute transfer dyes to a wet print. Remove small spots of dense cyan color by using a very dilute solution of potassium permanganate, applied repeatedly. If the spot is yellow, use a 10% solution of any household sodium hypochlorite bleach, such as CLOROX, also applied repeatedly. Cyan and yellow spots disappear on contact with their respective bleaching agents. Magenta, however, is removed by rubbing with KODAK PHOTO-FLO 200 Solution, used undiluted -- which is impractical for removing small spots, although quite useful in reducing an overall magenta tint or highlight cast. Wipe the print with a 1% acid swab following any reduction treatment.

The best way of dealing with small spots of dense color is to wet-etch the matrix that carries that color. This is done when the matrix is in the second acid rinse bath. It takes a sharp eye, steady hand and patience. Use a fine, sharp instrument, such as a needle or etching knife, to lift out the spot of dense gelatin completely. The resultant ''hole'' in the print can then be retouched in to match the surrounding area.

Analysis and Previsualization

If there is a single first rule in dye transfer printing, it is <u>take nothing for granted.</u> You must be totally aware of what is happening at every step of the process -- where you are starting from, where you want to go and how to get there. You begin by examining the original transparency for masking, separation, matrix-making and print-rolling procedures; those that work well with one type of original may not work at all with another.

First, analyze the transparency visually, employing the same kinds of light sources that you will use to judge the print. Ask yourself: What is the dye-layer balance of this transparency? Do all three layers seem to have the same contrast? Is there any special tint in the highlights or in the shadows? Is there a pronounced color crossover with highlights of one color and shadows of another?

Look critically at the color reproduction in the transparency. Are the colors correct, too pure or dull and degraded? If colors are off, try to reason why they are off. Is it a simple mismatch in color balance or a more complex matter of unwanted dye absorptions? Are reds ''orangey'' due to too much yellow content or ''magentaish'' due to too little yellow? Think of how to correct what you find -- for if reds are ''orangey,'' you can either reduce yellow-layer contrast or increase the strength of the green-filter mask. If reds are ''magentaish,'' you may want to either increase yellow-layer contrast or reduce the strength of the green-filter mask, or you may do both. Also look at greens and blues in the same way.

Constantly visualize all the ways that you can reproduce what you see. What procedure will improve the rendition? What will hurt it? More and more, as you gain experience, you will find yourself thinking in terms of color separation and masking, even as you see the real world. You will see leaves in terms of cyan and yellow content, and how much magenta there is too. You will come to perceive everything that you see in terms of the three subtractive primaries.

Learn to ''think like film'' when you are working. See the transparency, visualize its image on paper and think backward to plan each step. Will you need a highlight mask? Are highlights and high-value separation already only marginal in the original? Can you get by with a slightly overexposed principal mask and perhaps slightly underexposed separations to achieve a small boost in highlight separation or will you want a sharp tone-separating highlight mask? Can you sacrifice some highlight contrast in order to get crips shadow contrast?

Think of the graphic effects of using KODAK Pan Masking Film which will diffuse broadly around highlight areas versus KODAK Separation Negative Film which will produce much tighter edges. Would you even like a dead-sharp mask to create pronounced edge effects? Furthermore, think of print rendition as it is affected by separation-negative density range. Low-contrast separations produce prints of a soft pastel, almost foggy, appearance; high-contrast separations produce prints of enhanced brilliance, depth and color saturation (a very useful technique for salvaging old, faded transparencies). Normal-contrast separations are best for making slight color balance changes.

Analyze the film on a densitometer, which is especially useful if you have one that can accept the same color filters that you intend to use for separation. Readings made that way can pick up and prevent otherwise unforseen problems, such as the great red-filter density of KODACHROME 25 and 64 Films which is totally invisible to the eye. Also by reading the maximum densities, you gain insight into whether the transparency dye-layer curves are parallel or not -- a fact which you often cannot tell visually. Note the density ranges of the color layers. If they are above 3.5 or below 2.6, you may wish to adjust mask density range and separation-negative development.

This is not to suggest you should modify your entire separation procedure for each original -- far from it. But you should know before you begin what you are up against, what pitfalls may lie in store and how to circumvent them or at least make a reasonable first attempt. The expert printer is not immune to failures. He makes them often, but learns to recognize them, analyze them and take appropriate corrective action. You should never be afraid to experiment, but always when you do, have a specific goal in mind. In that way, you will understand better what must be done to control the interpretive and creative process of dye transfer printing.

SUMMARY OF STEPS -- A Checklist

To make a dye transfer print form an original transparency, using the contact separations method, carry out the following steps in order:

1. Attach the transparency or transparencies, along with a transparent step tablet, to a 1 1/2-inch-wide strip of stable base film that has been punched on the KODAK Register Punch. Use any strong, ultra-thin tape (such as SCOTCH MAGIC MENDING Tape) and tape only to the base side of the films outside the picture area. Make certain the assembly lies flat without any crimps or buckles anywhere. Hanger crimps in sheet film and sprocket holes in roll film can be trimmed away if necessary. Also, 35 mm film may not take flush contact with the separation negative film unless 1/16-inch space is left between the edge of the punched strip and the 35 mm transparency, which can be taped either along the sprocket holes or at one end.

2. Place a KODAK Register Print Frame, glass side down, over a light table or horizontal illuminator and open the back. Place the assembly with the transparencies, emulsion side down, over the register pins. Check for dust specks, which can be wiped or blown away, then turn out room lights. (If a highlight pre-mask must be made, it is exposed emulsion-to-emulsion on extreme high-contrast film (see <u>Highlight Masking</u>

on page 00) and developed and dried. It is then placed in the register print frame first, emulsion up. The assembly with transparencies goes atop that, emulsion down. Additionally, the step-tablet image in the highlight mask should be cut away. Principal masks are then made in the usual way.

3. Take out a sheet of unexposed KODAK Pan Masking Film 4570 in a size large enough to more than cover the entire assembly. (Other films may be used for masking: see <u>Color-Correction Masking</u> on page 00). Hold the film emulsion up, center it in the register punch, and punch it. Place it emulsion down over the register pins and assembly; close and lock the register frame pressure back.

4. Position the register print frame on the contacting table directly under the contact light. With the red, or first, filter in place in the contact light, see the timer and make the exposure for the first mark. Return the register print frame, glass side down, to the light table, open the back and remove the exposed film. Store it in a light-tight box and turn on the room lights.

5. Change the filter in the contact light, then repeat the above procedure to make the second, or green-filter mask. However, after exposure, trim one corner of the mask film for subsequent identification. Store with the first mask film.

6. After exposure, process the masks and dry them. Two mask films can be developed back-to-back in a tray. Up to six mask films can be developed at once by using interleaving agitation. Take care not to scuff or damage masks in any way, and do not lay processed masks flat in a film box before use as they may become scratched.

7. Expose separation negatives by placing the first, or red-filter, mask, emulsion up, over the pins in the open contact frame. Then add the assembly with transparencies atop that, also emulsion up. The images should align perfectly when checked over the lightbox. Inspect most carefully for dust, which is particularly important with small originals. Turn off room lights, remove one sheet of KODAK Separation Negative Film 4131, Type 1, and place it in the register print frame, emulsion down over the assembly, butted against the pins but not punched and placed over the pins. Ordinarily, the Separation Negative Film used is the same size as the masking film. Close and lock the print frame back; locate the frame, glass side up, on the contacting table directly under the contact light. With the red filter in place in the contact lamp, set the timer and make the exposure for the red-filter separation negative. Return the prime frame to the light table, open the back, remove the exposed film and store it in a light-tight box. Turn on the room lights.

8. Remove the red filter from the contact light and replace it with the green filter. Inspect for dust once again over the light table. Turn off the room lights and remove another sheet of KODAK Separation Negative Film, Type 1. Place it emulsion down, butted against the pins. Close and lock the pressure back; position the print frame, glass side up, under the contact light. Set the timer and make the exposure for the green-filter separation negatives. Return the print frame to the light table, remove the exposed film and trim on corner for subsequent identification. Then store it with the exposed red-filter negative. Turn on the room lights.

9. Remove the green filter from the contact light and replace it with the blue filter. Remove the first mask and assembly from the register print frame. Replace the first (red-filter) mask with the second (green-filter) mask, emulsion side up, and put the assembly with transparencies, emulsion side up, atop it. Inspect for dust once more. Turn out the room lights, remove a third sheet of KODAK Separation Negative Film, Type 1, ad place it, emulsion down, butted against the pins. Close and lock the pressure back; and locate the print frame, glass side up, under the contact light. Set the timer and make the exposure for the blue-filter separation negative. Return the print frame to the light table, remove the exposed film and trim two corners for subsequent identification. Store the exposed film with the others and turn on the room lights.

10. Develop and dry the separation negatives, making certain the blue-filter negative (identifiable in the dark by its two trimmed corners) receives its proper additional development time. A final rinse in a solution of KODAK PHOTO-FLO 200 speeds drying while eliminating water spots.

11. With sharp scissors, cut the finished separation negatives and their step-tablet images from the dried films. Take care to identify the step-tablet images with the same corner-trimming code used for the separations -- no corner cut from the red-filter negative, one form the green, and two from the blue. These final separation negatives form permanent records of your color original and should be treated with utmost care to avoid scratches and dust. Storage in individual clear envelopes is satisfactory -- the full set of three placed within glassine envelopes along with their step-tablet images.

Films other than KODAK Separation Negative, Type 1, may be used for making separation negatives. KODAK SUPER-XX Film has long been used for its extremely easy developmental characteristics and linear curve shape -- a help in pastel reproduction -- but it is not satisfactorily sharp for small originals or where detail is important. Other films may not provide matched color curve shape. Also, in reproducing KODACHROME 25 and 64 Films, the green-filter mask may be used to make the red-filter separation negative. Otherwise, the procedures remain the same, except when three masks are used for special effects (see <u>Masking</u> on page 00).

12. To make matrices, first place the red-filter separation negative in a glass-type negative carrier and put it in the enlarger, emulsion up. Attach a sheet of white paper (the same size as the Matrix Film you intend to use) to the KODAK Vacuum Register Board (for prints to 16 x 20-inches), centered over the vacuum channels and butted against the pins. Focus the enlarger and size the projected image so that it does not come closer to the edge of the paper than 1/2-inch on one end and 1 1/4 inches on the other. The margins are needed for handling and registering the matrices. Tape the positioned vacuum register board to the enlarger's easel and attach the vacuum connection to the appropriate channel (which is the largest that will fall under the Matrix Film). Remove the white paper. Turn on the safelights and turn off the room lights.

13. Remove a sheet of KODAK Matrix Film 4150 from its box and place it, centered and butted against the pins where the white paper had been, emulsion side down. (Matrix Film is always exposed through the base -- i.e. shiny side). Set the timer and turn on the vacuum pump, allowing sufficient time for full draw down. Make the exposure for the cyan-printing matrix. Turn off the vacuum pump and remove the exposed

matrix, storing it in a light-tight box. Turn on the room lights.

14. With the greatest care not to move or jar the enlarger setting, remove the negative carrier from the enlarger, take out the red-filter separation negative and place it with the green-filter separation negative in exactly the same orientation, emulsion up. Place the carrier in the enlarger and turn off the room lights. Remove a fresh sheet of Matrix Film, position it on the vacuum register board, turn on the vacuum pump and set the timer. When fully drawn down, make the exposure; turn off the vacuum pump and trim one corner for subsequent identification. Store with the first exposed matrix. Turn on the room lights.

15. Again exercising the utmost care not to change the enlarger setting, remove the carrier from the enlarger, take out the green-filter separation negative and replace it with the blue-filter separation negative, again in exactly the same orientation and emulsion up. Replace the carrier in the enlarger and turn off the room lights. Remove a third sheet of unexposed Matrix Film and locate on the vacuum register board. Turn on the vacuum pump and set the time; when fully drawn down, expose the yellow-printing matrix. After exposure, turn off the pump and trim two corners for subsequent identification. Store it with the other exposed Matrix Films and turn on the room lights.

16. Process, wash and dry the Matrix Films, taking care to treat all three identically.

If matrices are to be exposed by contact, exposure is made through the bases of both matrix and separation-negative films (providing the latter were made by contact). In a contact frame, the separation negative is placed in first, emulsion side to the glass. The Matrix Film is added, emulsion side facing away from the place. To obtain good definition, a point-light for exposure is required. Also, if enlarged separation negatives have been made, you will have to determine their correct orientation, as the original may be placed either emulsion up or emulsion down when making enlarged separations. If the transparency was separated emulsion down, the resultant negatives will have the same orientation as contact negatives. However, if the transparency was separated emulsion up, the orientation will be reversed. Consequently, matrices may be exposed with their base side to the emulsion sides of the separation negatives.

17. To register the dry matrices, place the cyan-printing matrix, emulsion down, over the light table or illuminator with a register punch attached at one end (see Arrangement for Contacting on page 00). Center it so the pin holes that you will use are spaced equidistantly from the edges of the film, position the film into the throat of the punch so that at

least 1/4-inch will remain outside the punched holes, tape it in place on three sides, and punch it. Leave it there. Place the magenta-printing matrix atop the cyan-printing matrix, in the same orientation, align it carefully end to end and corner to corner until all fine details are perfectly registered when viewing straight down, then tape it in place, and punch it. Remove the magenta-printing matrix only and repeat the procedure with the yellow-printing matrix. Finally, remove the cyan-printing matrix and store all three until use, separated from on another in the paper folders provided with KODAK Matrix Film.

18. Condition the KODAK Dye Transfer Paper, up to six sheets at a time, in a volume of dilute KODAK Dye Transfer Paper Conditioner sufficient to cover the paper with 1/2-inch of solution. Agitate manually by interleaving for at least 3 minutes. Paper fully conditions in about 30 minutes at room temperature.

19. While paper is being conditioned, mix and filter an appropriate amount of fresh cyan dye, pour it into a tray just large enough to accommodate the Matrix Film, and place the cyan-printing matrix in hot water. Soak for 5 minutes and drain and place in the dye, emulsion up (See Rolling Prints on page 00).

20. Mix and filter the magenta dye, pour it in a second tray, and add the magenta-printing matrix, emulsion up, after a 5-minute hot water soak. Agitate briefly.

21. Lift and drain the cyan-printing matrix, rinse 1 minute in 1% acetic acid bath, then lift, drain and place in a second 1% acid bath. Dry your fingers.

22. Remove the sheet of dye transfer paper from the Conditioner and squeegee it into position on transfer surface, emulsion up, taking care to allow 1/8-inch between the pins (or pin-strip) and paper.

23. Dip your fingers into the used first acid rinse bath to neutralize any trace of Paper Conditioner. Lift the cyan-printing matrix out of the second acid rinse bath, drain briefly, allowing enough moisture remaining to form a slight bead between the matrix and paper once the matrix is fitted over the pins. Position the matrix over the paper, holding it by the off hand in the <u>center</u> of the far margin and starting near the end holes over the pins (small pin first). Fix the matrix, emulsion down, over the pins. Still holding the matrix off the paper with your off hand, pick up the roller and roll the matrix smoothly, steadily and rather rapidly into contact with the paper, taking care not to tug the film as you are rolling it.

24. The cyan image transfers in about 4 minutes. After it has been transferring about 2 1/2 minutes, dump and refill the first tray with fresh 1% acetic acid. Lift, drain and place the magenta-printing matrix in the fresh acid rinse bath, and place it in this tray. Position and roll the magenta-printing matrix.

25. The magenta-image transfers fully in about 7 minutes. During this time, finish rinsing the cyan matrix in fresh warm water and hang it to dry. Dump the used first acid rinse and replace it with fresh 1% acetic acid. After the magenta image has been transferring 6 minutes, lift, drain and rinse it in the first acid bath and yellow-printing matrix, then place it in the second acid bath. Refill the tray of fresh warm water, remove the magenta matrix and place it in the warm water rinse. Position and roll the yellow-printing matrix.

26. The yellow image transfers in about 3 minutes. Meanwhile, complete the warm rinse of the magenta matrix and hang it to dry. Refill the tray with fresh warm water to rinse the yellow matrix. Dump the used first acid rinse, and when 3 minutes have elapsed, remove the yellow matrix from the print and place it in the warm wash.

27. Lift the print from the transfer surface and dry it, either by gentle squeegeeing on a glass surface or by gently wiping

it dry with soft paper towels. Complete the warm rinse of the yellow matrix and hang it to dry. Retouching can be done on either a wet or dry point.

28. Allow plenty of time for the print to dry fully before mounting, usually at least four hours (although it will largely air-dry in two). The print will shrink and grow somewhat more brilliant as it dries. Once dried, the print can be dry mounted much as a black-and-white print on good board using regular dry mount tissue, although the temperature should be about 220° (C°) or less. When mounting, take care to trim the print in brilliant light to see the exact edges of the color images (unless matrices were exposed in register from a full-register negative carrier system, there is apt to be some slight displacement in the color images).

29. Display prints under glass to ensure adequate protection, or store in well-made boxes with soft tissue protecting the surface of each image. Framed under glass, a dye transfer print offers years of brilliant color and satisfying viewing if given no more than the care deserved by any valued work of art. Do not subject it to sources of ultraviolet light which will eventually fade the yellow dye layer (sunlight and strong fluorescents, for example). Ordinary tungsten lighting is ideal, and illumination of prints with 150- or 300-watt lamps will reveal the rich range of colors. To be

seen to best advantage, prints should be spotlighted in an otherwise modestly lit room with no light reflecting from the walls or ceiling.

Should the print surface ever require cleaning, wipe it gently with a soft swab moistened with 1% acetic acid. Never use any soap or detergent mixture.

PROFESSIONAL METHODS FOR MAKING DYE TRANSFER PRINTS

by Bob Pace

p-1

What is the Dye Transfer Process?

The dye transfer process is a highly accurate photographic system to make full-color prints from either color transparencies or color negatives. Materials used in the process include black-and-white panchromatic films, panchromatic masking films, matrix film in various sizes, dye transfer paper which has been mordanted to accept and hold dyes, and paper conditioner to prepare the paper for accepting the dyes that produce the final color print.

Who Uses the Process? -- The dye transfer process is utilized primarily by advertising agencies that are aware of its many capabilities for producing exacting images. The number of changes and color shifts that they call for is unending. For instance, I have made stripped prints with as many as 37 pieces, that is, 37 different 35 mm transparencies printed together for an advertisement. Strip-ins are made that feature see-through effects, movement, mirror-images and other techniques -- all impossible to do in a camera.

Dye transfer prints are used extensively in advertising billboard production because they can be made extremely large, and art directors can easily take out what they don't want in the final reproduction. A dye transfer print can be readily retouched using techniques, whereby portions of the image are bleached out and redrawn by an artist using the same dyes that made the print. Electronic scanners pick up any foreign material added to a print. Retouchers, who had been using opaque watercolors, have been forced to change to this approach so that the scanner will not see through their work. The dye transfer process is a ''natural'' for retouching because there are chemicals that will bleach the print, allowing the retoucher to add dye corrections and really make the ''art'' ready for the engraver. Much money is spent on the advertising space itself, so an excellent print is a must.

Package designers are a good group to have as customers. They actually do the same kind of work that an advertising agency does, but with less of a budget. Everything that is bottled or boxed has to be designed. Many times a dye transfer print is made for the original package design; it looks like an excellently printed piece, but it is really a one-of-a-kind image.

The work of ''art photographers'' is another reason for the success of the dye transfer process. The finest photographic work in the world has been preserved as dye transfer prints. In fact, the print sometimes becomes the most important part of the whole photographic process because, without an interpretive print to move the viewer emotionally, the artist's work has failed. I don't care how great your picture may seem to you, unless the print is made to the exacting standards of the sharp eye of a true artist, the transparency will not mean very much. If all you ever showed anyone were your 35 mm transparencies and you never made an attempt to dazzle their eyes with a print which has the contrast, color balance and mood that you worked so hard to capture, then you have missed the entire reason for making the photograph. The final print is your interpretation of what you saw in the camera eyepiece that made you take the picture in the first place.

There are many reasons why dye transfer prints are still being used today. No other process has an infinite number of controls. You can vary the contrast or density in any color in any direction. You can lighten or darken isolated parts of it. You can change colors easily. Moreover, you can keep pastel colors clean. These are some reasons why even with competition from prints on KODAK EKTACOLOR and EKTACHROME Papers and CIBACHROME Print Material among others, dye transfer is still the king of all the color processes. No other system can match it, although it is true that some systems may be sharper and easier to produce. In fact, you can actually produce a print in minutes with KODAK EKTACOLOR, EKTACHROME, EKTAFLEX Products or many other processes and some of these prints look fantastic. The only way to really see the difference is to compare each one, side by side. These prints are suitable for stats or for casual pictures, but for professional top-notch prints, dye transfer offers the best choice.

Building a Professional Dye Transfer Laboratory

p. 2

When you are building a dye transfer laboratory or any darkroom, all you really need is imagination and you can make it fit into any kind of space available. When planning a darkroom, first make sure that you have plenty of space around the work areas so you don't feel cramped. This doesn't mean that you have to waste space, but you should predetermine the actual amount of space required to be comfortable.

The second consideration is for some kind of work flow. You should not have to move all over the laboratory to get a chore done. Each stage of the process should be logically placed so that the next step is nearby.

Perhaps the most important consideration is the amount of space that you can acquire. Many amateur darkroom workers use a home bathroom in which to make prints or process film; this works out fine, but it would hardly do for a dye transfer laboratory. After spending over 40 years in the dye transfer field, as well as in other related processes, I know what it takes to set up a working darkroom that is small enough to save space but big enough to really work (See Laboratory Set-Up and Equipment on page 00.)

Lighting is also a critical factor. I like to use flourescent tubes in overhead fixtures. For my workspace, I installed two 4-foot, 4-tube fixtures. I removed the plastic diffusion screens that usually come with the fixtures and installed MACBETH 5000K Tubes from my graphic arts supply house.

I strongly suggest that you paint the laboratory white because then your safelights will really work to your advantage. You should be able to see in the darkest corners. Use light gray for the woodwork trim and flat black around the enlargers and point-light source where it is really necessary. If you shield the enlargers properly so that no stray light bounces around the room, you will not have a fog problem.

Preparation Area

p-3
a+b

This is where all of the work begins. It should consist of tablespace large enough to place three or four 8 x 10-inch transparencies on and still have room left over. Here is where you will put a densitometer, calculator or slide rules, and plenty of paper and pencils for solving problems. You will also need room for at least four different kinds of adhesive tape. Without tape, the laboratory probably would not work at all. You should have provision for compressed air to clean dust off original transparencies or negatives. In addition to bottles of film cleaner, plenty of lintless cloth wipes and facial tissue, you will also need at least two plastic triangles and a few mat knives. (The OLFA Brand Knife is a good kind to get because it is small and the points can be broken off, allowing you to have a sharp blade in seconds.) You will need at least two kinds of magnifiers. The KODAK Achromatic Magnifier, 5X is fine but be sure to have a 12-power magnifier, such as the one sold by Edmund Scientific Company, if you are serious about looking at 35 mm transparencies. You will be able to really see if they are sharp or not.

If you plan to have spotless prints, it is necessary to retouch the negatives. You can use SPOTONE Dye, an opaque paint or KODAK Crocein Scarlet (a red dye for color correction and dodging). The single-edge razor blade is also a handy item. The main thing that you must have is a large lightbox built into the worktable. I have a 26 x 36-inch lightbox. The densitometer is not on the glass. The tape dispensers are on a low shelf, above the work area but close enough to reach. You will also need space for storing transparent sleeves so that they are readily available to protect the transparency when you are finished with a job. It is very important therefore to make sure that the space is adequate.

Make sure that you are able to sit at your work station without being uncomfortable. You can be stuck there for a while when you are cutting a small transparency into a large sheet of film to fit the punch and enlarger carriers. You will be there even longer once you have masks and negatives that need retouching.

Re-Registration and Composing Area

A large combination lightbox/worktable is a significant element in the re-registration and composing area. If you plan to work to a print size as large as 20 x 24 inches, make a lightbox at least 26 x 30 inches in size.

There are a few professionally made lightboxes utilized by the graphic arts trade at good prices. They are usually made of steel, and have good edges so that a T-square can be used accurately. The light source can be modified to fit your needs. In any case, make sure that you ventilate the box, otherwise the top will get very hot and could cause problems with your work.

The worktable should be the regular height of a desk if you plan to sit down or at least to your waist if you plan to stand to work. The light table should have a large sheet of plate glass over a sheet of flashed opal glass enabling you to cut on it. Don't cut on the flashed opal glass since it is too fragile and costs too much.

By taping a set of registration pins (from Condit Manufacturing Company) on this tabletop, you can use it to check register and place friskets (block-out material) on the table for planning tricky layouts. You can also spread out a group of transparencies for examination, providing the light source is the proper color balance. As the main worktable in the entire laboratory, you can use it for spotting negatives, cutting rubyliths and a score of other chores. Leave plenty of wooden space at either end to store the tools that eventually will clutter up the table. Place all knives, pencils and markers in jars to keep them from scattering over the table.

The re-registration and composing area can be combined with the preparation area, if space is limited.

The Exposing Area

p-4 a+b

If you are making separation negatives by contact, the worktable should be about 6 feet x 28 inches. Place the platen hole (a rectangle) in the center. If you plan to use a vacuum platen, make room on the floor for a vacuum pump. If you prefer a filter wheel on the floor facing upward, the filter system should be centered under the platen. Use a carpenter's plumb bob to get it exact. On the left side of the worktable, fasten the film punch permanently. Before doing that, mark off where the little pieces of punched film will emerge from the punch and drill two holes about 1/4-inch in diameter. This will allow the punched pieces to drop through the table, otherwise they would soon clog the punch. Get two small plastic bottles with screw tops. Drill a hole in the caps and either heat-glue or screw them under the holes of the worktable so that the punched pieces of film will fall into the bottles.

p. 24 a & b

You will need some kind of film-notching system to identify the film that you have exposed in the dark. Any small punch will do. Place it in a box as I have described in the drawing; you will also be able to capture the small crescent-shaped pieces of film, thereby making the laboratory even neater.

Keeping the film supply from taking up room is important. I recommend that you purchase a paper safe -- the kind you can either place on a short shelf or the type that you can screw onto a wall, just above the work area. I use a simple box with a spring-loaded door, hinged at the bottom. In the box are three shelves. The top shelf is reserved for KODALITH Pan Film 2568 used for highlight negatives. The second shelf is for KODAK Pan Masking Film 4570, and the third shelf is for the separation-negative material -- KODAK SUPER-XX Pan Film 4142 or whatever you have chosen. I have made a habit of placing all of my film on these shelves, emulsion down, with the film notch at the front right corner. By doing this, I have rarely taken the wrong film out of the safebox. This is a good system to adopt.

A shelf over the work area should be large enough to keep things that you will use occasionally, like a box of anti-static cleaning clothes, a camel's-hair brush or even a can of compressed air. Keep no liquids in this area at all. This should be the driest room in the entire laboratory.

The next room to consider is the enlarging room. If you are working with an 8 x 10-inch enlarger, plan a room at least 8 x 8 feet square. Even a small enlarger needs room around it. You will need a worktable with a built-in lightbox at least 50% larger than the negative carrier that you will be using. Above this worktable, heat-glue about six wooden clothespins 10 inches apart. This is where you will hang the various negatives and masks. In this room, you will need a place to clean negatives. An air pump can be installed, or even a can of compressed air may do.

p-19

The worktable that supports the easel should be about thigh high, providing enough space to work without bending over, and still giving you enough room to get some height with the enlarger. Contact-cement a large piece of sheet metal to the tabletop and paint it black. The vacuum easel should have some fairly strong magnets contact-cemented to the bottom of it as well. These magnets can be obtained at any hardware store. They

p. 23

will keep the vacuum easel in position on the metal tabletop without clamps, tape or anything else; when you want to move it, you can do it easily.

The switch problem with overhead lights has always been a point of contention with me. I can't stand stained walls caused by dirty hands searching for the wall switch in the dark, especially in processing rooms. What I have done over the years is to place a simple, but good quality, pull-chain switch in the porcelain light fixture in the ceiling. It has a string hanging from the fixture. At convenient places on the walls just above my head, I attach springs at each end of the room and run a line to each spring making it taut. Then I attach the line from the light fixture to the horizontal line. Whenever I want to turn on the room light, I simply raise my arm, and no matter where I am, I hit the horizontal line and turn on the light. There are no more stained walls and no more frustrations searching for a light switch.

The enlarger should be vented if it generates any appreciable heat. Place an opening in the outside wall of the building, and with a fan, draw air out of the building. Connect a flexible duct to the light-head of the enlarger to capture the heat and draw it out of the room. This is not only for your comfort, but also for the good of the film.

Laboratory Set-up and Equipment

As I previously mentioned, the amount of floor space required to make dye transfer prints can be quite small, depending on what you have in mind to do.

If you are alone and want to use as little space as possible, consider a one-room darkroom, about 12 x 18 feet in size with a long sink containing rinsing trays and transfer board on one side. There would be room for 20 x 24-inch trays for the dyes and paper conditioner as well as space for a sink next to that for processing the matrices and separation negatives.

The other side of the room would contain the main enlarger for making matrices from 8 x 10-inch separations or whatever size enlarger that you prefer. Leave room for your separation enlarger as well as your worktables and tabletop lightboxes. You could install a tankless water heater if you can't get access to the heater for your home supply. All the other necessities that make a laboratory function could also be included.

On the other hand, you could spend more money and have the separation area in its own darkroom or in the matrix-exposing room. Use your space wisely and most productively. You can work either in a one-car garage or in an elaborate clean laboratory. Take your choice.

Layout

Drying Area -- Drying matrices and negatives presents problems. Never force-dry the separation negatives. They will not stay the same size. If you have to use heat, use a very soft, light heat, blown from a distant heater, otherwise you may get buckling. The same thing applies to the matrices. Don't overheat anything. I have learned the hard way.

Build a drying cabinet 30-inches high, 26-inches wide and 10-inches deep with two doors in front, and mount it on the wall. String three lines near the top of the cabinet with two clothespins on each line. At the bottom, tie three clothespins to elastic bands and attach these bands to the side of the box; in this way you can hang a set of matrices in the cabinet and keep them from banging around in case a draft is caused by the open door or a fan. A small heater at the bottom of this unit will supply all the heat that you need. Make sure that it has metal around it to prevent any possible scorching. This unit will be easy to vent if you mount it on an outside wall. You can also use the dryer for negatives. Of course, you can purchase a film dryer, but watch out for the heat.

Chemical Mixing Area -- Although the area for mixing chemicals need not be large, its size depends on what you plan to mix and with what. If you plan to use something like a simple mixing motor, your sink does not have to be larger than 3 or 4 feet long. The main thing to have on hand is a large, easy-to-clean mixing pail that is calibrated and able to hold at least 5 gallons of liquid. It would be a good idea to have the mixing motor mounted on the wall with a sliding bracket that would allow it to be moved up high out of the way or lowered into the mixing pail for use. Also get two 1-litre and 2-litre graduates and a 1-gallon bucket. If possible, all pails, buckets and graduates should be made of stainless steel. The faucet should have a hose attachment for general clean-up as well as for filling the various pots. You will also need a sturdy thermometer to be sure that you are mixing according to the manufacturer's temperature instructions. This is very important. The manufacturer went through a lot of trouble to make sure his product works well and mixing temperature instructions should be followed carefully.

There should be plenty of room below the sink for storage of bulkier chemicals, plus a shelf above the sink for keeping mixing tools and small chemical bottles. If you plan to use a measuring scale, make sure that you have a space for it that is dry and well-lighted so that you will have no difficulty in seeing the scale measurements properly. Buy a good quality scale because cheap ones rust easily just by being in the same room with all that moisture.

Dyeing and Transferring Area -- This area contains a large sink with a set of rocking shelves on it for keeping the dyes moving and the matrices covered. If your sink is 8 to 10 feet long, you will have plenty of room. It is better to have a separate table for making the transfers because it provides the freedom to walk around the table and have other people examine the print with you. Also, in the case of chemical treatments, you may need more room just for ''retouching'' the print, especially if more than one of you is working in the laboratory.

You will need some way to deliver the acid rinse to your work area. A timer is essential and can be mounted on a nearby wall. The diagrams here show a few ways to build this set-up. You may need a hamper for the towels which you will be using. Have plenty of ventilation to keep the odor of acetic acid from being overpowering.

This area should have as much light as possible. Here is where your work culminates. You may have spent a few days, or at least many hours, to get to this point of transferring matrices, and nothing should interfere with the final stages of the job. You must be able to see out-of-register matrices, skipping (missing color) and unevenness. With plenty of light, you can see what you are doing.

Since the dyes require filtering, you will also need a few electrical outlets for using vacuum and chemical pumps. Another useful item to have at this work station is a rubber floor mat. When you are working to complete a job, you will be standing in one place for hours. A black floor mat makes it easier to stand in one area all day.

Equipment

Lightboxes and Viewing Systems -- When printing photographs, having the proper lightbox is a prime consideration. The use of a lightbox was almost a joke when I began on this color print adventure. Every conceivable kind of illumination was employed and all of them were wrong. There were viewers that used blue bulbs, even though they were incandescent, so someone, at least, thought of having something closer to daylight than just a warm bulb. One box consisted of five blue bulbs, and another box that was fine for looking at X-ray negatives was also pushed into the color field by saying it was accurate. Thus, a great deal of junk infiltrated the color business without much validity. Unlike the rest of the manufacturers, Kodak had a lightbox that used a warm incandescent bulb, but it had a large sheet of blue glass that cooled off the bulb and brought it closer to a 5000K source.

Later came Macbeth Corporation with a clean, easy-to-maintain lightbox that used something new -- a color-corrected fluorescent tube. This tube produced a full-spectrum light that permitted viewing transparencies without the reds turning brown. It provided light at 5000K which has become the standard throughout the world. I am convinced, more than ever, that we need a lot of advertising to alert the public, and especially some of the professional print buyers, about this system of looking at transparencies.

The light source that you use to view the finished print also has to be considered. The quality of the light source in an office building will change constantly as you walk down the hall or go from one room to another. Sometimes, in the past, my prints would not pass inspection because of the light source that the print was viewed under.

Macbeth made an easy-to-assemble booth that has the same color quality as their lightbox and has a fixed light level because of the way that it is built. Most of the advertising agencies use this box to view not only color prints but also lithographers' proofs. While it is a successful device, this viewing booth has not fully solved all the problems of light sources.

I have devised a simple lightbox that has a variable-color light source. The light source can be made to look just like a p-36
MACBETH Box, or I can vary it to any color balance that I wish and make it much brighter or darker. In other words, I can custom-light any transparency to make it look the way that I would like to see it printed. Since the numbers on the controls

of this lightbox are actually filter settings, I use mathematics and expose my negatives and matrices so that I can make a close match to what the client saw on this ''magic box''. Just about any transparency can be altered so that the print can be made to the client's liking.

The reason for this difference in the choice of how to see the transparency is easy to understand. Most of us cannot remember color, especially if it is a scene that was photographed days or weeks ago. The transparency may be brilliant and colorful, but not necessarily correct. When the client has his choice of color balances, I would venture to guess that 99 times out of 100, the client will pick a balance other than that which the standard light source shows him.

Many times, I have been asked to warm up a transparency, and I would wonder just what the client meant. Did he want less cyan, or even more magenta and yellow, and just how much is ''warm it up a little'' -- 10% or 50% or what? With this simple box, these questions are now answered.

Enlargers and Light Sources -- There are many kinds of enlargers, each producing a different kind of image.

Enlargers come in four basic types:

1. The condenser enlarger

2. The point-source condenser enlarger

3. The diffusion enlarger (3200K tungsten bulb)

4. The diffusion enlarger (cold-light head)

The kind of enlarger that you use should be decided only after very careful thought. If you want images that are smooth and clean, and don't want to have to retouch dust spots or dodge-in unevenness from the light source, the diffusion type is for you, especially if you work from rather large-size negatives. Most of the big laboratories make their negatives in the 8 x 10-inch size and use diffusion enlargers to make matrices. The majority of the 8 x 10-inch negatives, however, are made from small transparencies with point-source enlargers. The laboratories are only enlarging these negative images a relatively small amount, so the diffusion system provides a fairly sharp image.

The ELWOOD Enlarger is a big diffusion enlarger used frequently because of its price and the availability of registration carriers made for it by Condit Manufacturing Company. The ELWOOD is no longer manufactured, but you can usually find one in used photographic stores. These enlargers were built to last and they have -- for 50 years. The FOTAR Enlarger is also well-constructed, and the manufacturer will supply any type light source that you desire.

The choice of a light source for your diffusion enlarger is also significant. It can be an incandescent bulb of about 3200K color balance, a color head with quartz lamps (basically the same), a cold-light tube system or even a pulsed-xenon discharge tube.

Each of these light sources has its own special characteristics. The incandescent bulb is the slowest, all wattage being even, because the tungsten filament produces a warm, yellow light; and since matrix film is highly sensitive only to blue light, it takes time and energy to expose the negative properly. The contrast, however, is ideal. You can expose a good negative with a density range of 1.20 and print the entire scale. Quartz lamps produce a brighter light for their size than the normal incandescent bulb, but they also are very hot and must be housed in an enlarger head that has a blower to force-cool it. The result may be enlarger vibration. The quality of the light is the same with these two types. The quartz lamp is usually used in dichroic-head color printing enlargers which contain cyan, magenta and yellow dichroic glass filters. You can add subtractive filtration to the light source to change slightly the contrast of the system. Color heads are rather expensive pieces of equipment for only making matrices, but if you have one, use it.

On the other hand, the cold-light source, which is basically a neon tube or series of tubes, gives a very blue-green illumination. It is extremely fast but very low in contrast because the matrix film is so sensitive to that color of light. It is so fast that it can easily fog film in the darkroom. A problem with this kind of light source is that, being a neon tube, when it is cool or turned off for any length of time, the gases in the tube revert to liquid. When you first start it up, there is a time delay before the full efficiency of the unit is reached and the exposure is uneven. Because the light produces such low-contrast matrices, you must compensate by making separation negatives that have much more contrast; this could be difficult in some cases (See pages 00 for how to find the density range limits of your enlarger).

The pulsed-xenon light source is extremely fast. The color, however, is wrong for making matrices. You must add a KODAK WRATTEN Filter No. 85B to the enlarger head (near the lamps, not the lens) to bring the 5000K balance back to 3200K. Some labratories have used pulsed-xenon lamps as they are, without changing the value of the light, and adjusted the balance of their separations to make the system work.

If you buy a used ELWOOD Enlarger, don't try to use the light source that comes with it. Discard it and make a simple box with four 500-watt enlarging bulbs screwed into recepticals in its top. Line the inside of the box with single-surface mirrors made of metal. This will greatly increase the light output. Place a sheet of flashed opal glass in the bottom of the box above the film plane. This homemade source will provide the most even light for the money. You can purchase light sources for the ELWOOD from the Fotar Company. In fact, Fotar can sell you one that was invented by Glen Peterson, a dye transfer expert from New York. This head has four quartz bulbs around the perimeter of a white, translucent globe, which lights up evenly and smoothly when the electricity is turned on, providing the most even light source that I have ever seen.

You will find a condenser enlarger much more difficult to keep clean as you fight dust, scratches, abrasions and much more in your negatives. But once you have mastered the secrets of cleanliness and learned how to make negatives that are scratch-free, clean and smooth, you will discover sharpness and crisp edges in your images as well as satisfying prints containing endless detail within detail.

The DURST Enlarger is one of my favorite big enlargers because it can be transformed to any kind of system that you want. The condensers for this enlarger are well-made and cover the negative precisely, allowing you to use all of the available light.

My favorite separation enlarger is the OMEGA DII with variable condensers. Separation filters can be placed in a carrier above the negative stage and below the light source where they belong. Registration equipment is available for this enlarger from Condit Manufacturing Company.

There are also quite a few smaller enlargers available. When deciding on an enlarger, remember the appropriate choice of light source and the availability of registration equipment. If you choose a condenser enlarger, make sure the condensers are the right size and that they are free from defects.

Light sources for condenser enlargers are similar to those for diffusion enlargers with one exception. The point-light source makes the condenser enlarger by far the sharpest of them all. The enlarger must usually be dedicated to one image format at a time. The point-light is focused through the condensers to the image in the negative gate, and the image is focused onto the easel. Everything is locked down and the separation negative, or whatever you are making, is exposed with the lens at its maximum aperture. If you want to print another size image, you must change condensers, refocus the point-light source, change the lens, and finally, focus the image onto the easel. This super sharpness also applies to any dust, scratches, fingerprints or Newton's Rings projected with the image. A combination of surgical cleanliness and expert retouching is necessary to remedy the problem. When you must make large prints from small 35 mm transparencies, however, all the trouble is worth it. You can go from a KODACHROME Slide to a set of 8 x 10-inch separation negatives and then make 40 x 60-inch matrices or larger with reasonably sharp images using a point-light source negative-stage enlarger with a liquid gate, plus a good diffusion enlarger to make the matrices.

When thinking of getting a new enlarger, consider what kind of prints you want to make. You can make soft prints with a condenser enlarger and contrasty prints with a diffusion system when you learn how. Each system has its good and bad features. If you can design your own system and find a machine shop to make the things that you need, go ahead with your equipment preparation. No matter what system you choose, the lenses which you use should be the very best that you can afford.

Separation Filters -- The separation filters that are used today by most of the color printing field to make dye transfer prints include: KODAK WRATTEN Gelatin Filters No. 29 (red); No. 61 (green); and No. 47B (blue). Other filters have been used in the past but we have settled on these tried-and-tested three. These filters are sharp-cutting and even though they are not perfect, they give us the ability to make very accurate separation negatives. The same filters can also be used for making masks. In fact, if you were able to figure it out, you could duplicate the effect of any other filter in the spectrum with just these three.

If you make a set of separation negatives of a KODAK Color Guide with these three filters, you will see what is wrong with the entire filter system. If there was such a thing as perfect color separation, the need for color correction would not exist; but since the filters are not perfect, we have to do the best we can with them. The red filter is quite good since only a small amount of the other two colors are able to get through. However, the green filter lets more of the other two colors pass through; but the shock is when you see how much of the other two colors infiltrate the blue filter and really spoil the yellow (See Masking for Color Correction on page 00 for how to combat this problem).

There are other filters utilized in making dye transfer prints. For instance, the No. 24 Filter (orange-red) is used to produce the cyan negative when making separation negatives from 35 mm KODACHROME Film (K-14 Process).

p-20 a, b + c

Registration Negative Carriers -- Registration negative carriers are indispensable if you plan to spend your time making prints and not worrying about how to get them in register. If you can devise a method of placing the carrier in the exact location in the enlarger everytime, by all means do so. If you can't, you will need to buy the necessary equipment.

You can purchase the DURST Enlarger with a registration carrier, but the pin system should be small enough not to make big holes in the clients' priceless original. In the CONDIT System, the two small holes in the diagonal corners never interfere with the image.

The register punch does not always fit the pins in the glass perfectly; here is a method that I recommend for getting a perfect fit. The CONDIT Pin is cemented into a hole that has been drilled part-way into the glass. The base of the pin is 1/8-inch in diameter and the pin stem is 1/16-inch in diameter. The pin stem is not placed in the center of the base, but is offset slightly. The cement holding the pin can be heated and softened for adjusting the pin closer or farther away from its counterpart at the other end of the diagonal. I punch a sheet of film to fit the pins and cut it in half between the punch holes with a new, sharp blade. Then I place each half on the pins and look at the space where they are supposed to meet. I use a magnifier, sold by the Edmond Scientific Company, that is actually a 50-power microscope with a reticle built into the viewing system. This enables me to see spacings to 1/1000 of an inch. The two cut ends of the film, which I can also see, may be off position. By heating one of the pins from the bottom of the glass so that the cement will relax long enough to use needle-nosed pliars to turn the pin slightly, I can correct the gap between the film cuts to within 1/1000 of a an inch. When the cement cools, I have a more perfect fit of film and pins than I had before. This system works well for 8 x 10-inch pin glass and even better for 4 x 5-inch pin glass, but it is absolutely imperative for pin glass for small-size films, such as 2 1/4-inch and 35 mm.

p-3 II

You should be able to position the carrier in the enlarger as often as you wish, without the image going out-of-register. It should enter and leave the housing without friction or sticking of any kind. With a proper carrier, you can make an exposure with a certain kind of mask in the carrier; remove it and replace it with another piece of film to make another exposure, and be sure that the image falls in register on the matrix.

Oil -- Making enlarged separations is where the need for a ''liquid'' negative carrier is felt most. By using castor, mineral or silicone oils, the refraction problem is solved. All three oils have the same or very similar refraction indices to glass. This means that if an oil is used between the two pieces of glass, the ''sandwich'' acts as if there were only one piece of glass being used. If you put anything in between the pieces of glass, it too, becomes part of the glass. The oil first eliminates the refraction problem; second, it removes light scratches and abrasions; and third, it keeps the image perfectly flat, preventing out-of-focus edges.

The registration negative carrier has to be modified to use oil by cementing the lower glass to the carrier frame on all four sides so that the oil will not leak out. The cover glass will then float on the oil-covered separation negative and mask sandwich. (Condit makes an excellent liquid-gate registration negative carrier system for the OMEGA DII Enlarger, as well as for many others).

What kind of oil will do the job properly? Both castor and mineral oils are almost inert, but they have the ability to soften the emulsion of the transparency and make it easy to damage. Because silicon oil does not have that disadvantage, it is my choice. I use DOW CORNING Silicone Oil No. 200 with a viscosity of 100. The oil is easy to remove when you are finished with the separation negatives. I remove the transparency from the carrier, separate it from the mask and place it on a clean sheet of absorbent paper. Then I flow some lighter fluid on it to dilute the oil and use a good film cleaner and as many blotting motions as possible.

p. 21

When I use oil for making the separation negatives, I have to replace the mask each time that I finish with one of the colors. I use a palette knife to lift the cover glass every time that I have to make a change, since the cover glass must be spotless at all times. The procedure involves adding the proper amount of oil to each part of the film ''sandwich'' and to the top of the mask. I place the cover glass on the ''sandwich'' in such a way as to force the bubbles out of the system completely. By keeping the bottom of the ''sandwich'' clean and by placing each cleaned element into its proper position, I am sure that the entire group of pieces is dirt-free. The outsides of the ''sandwich'' are easy to keep clean. Once you try this system, you will hesitate to return to anything else. p.39 A-6

Vacuum Easels -- The vacuum easel is one of the most frequently used tools for making dye transfer color prints. In the days of wash-off printing, a sheet of glass was placed over the matrix film to keep it flat during the exposure. The vacuum easel did not take long to catch on. Printers got tired of seeing dust marks and out-of-focus images caused by refraction of the glass distorting the image.

A good vacuum easel is the BY-CHROME Easel. The beauty of this simple easel is that it will accept any size film from 4 x 5 to 20 x 24 inches. The entire surface of the easel is covered with thousands of little holes; since the easel is center-loaded, there is no problem with film being sucked down tightly (See the accompanying diagram for making your own easel). p.22

Register Punches and Pins -- Without a KODAK Register Punch or a CONDIT Punch, or even a homemade punch, it is impossible to get professional results. Registration is most exasperating when things do not fit properly. In the early days of dye transfer, all prints were registered by hand, but it became a problem because it put the emphasis on registration instead of making an accurate balance and getting proper contrast and density.

There is a wide choice of registration systems for matrices. You can, of course, get a KODAK Register Punch and use a KODAK Register Vacuum Easel and a KODAK Transfer Board. (The latter two are no longer being manufactured, but can be found second-hand.) Alternatively, get those made by Condit or other manufacturers. The important point is that the system must work perfectly every time. You can use the two-hole system provided by Kodak or try a three-hole or four-hole matrix punch. The pins can be purchased separately. (Condit makes a stainless steel Pin-Strip with the configuration of the KODAK Punch -- one strip for small matrices and one for larger matrices.) Here, you do need 1/4-inch holes. Handling wet matrices with tiny register holes is impossible; you must be able to get the matrix on the pins quickly and smoothly so as to roll it onto the paper before all the liquid drains from it.

Mount your matrix punch on a large sheet of heavy, clear plastic (PLEXIGLAS) so that you can move it from place to place or put it on your lightbox to reregister matrices when necessary.

The registration equipment that I use is made by Condit. However, if you are handy, you can make a system by using a good-quality stationery paper punch and by purchasing round pins that will fit the punch holes. Pins are supplied with stems on the bottom for setting into boards or with plastic tabs for you to tape them easily into position. Making this type of registration system is quite inexpensive.

You can also set pins into your own, homemade vacuum register board and transfer board. Here is a method of doing your own system: Punch a sheet of matrix film, mark the center of the sheet and position it on the register board. Mark the board with the centers of the holes and drill holes for the stems of the pins with a fine carbide drill if you are making a granite board. Use a diamond drill if you are drilling glass. Wood or metal can be drilled with any good bit. Next, place the pins in the punched sheet of matrix film and set them into the drilled holes so that the film lies flat on the board, without buckles or bulges. Use a slow-setting epoxy cement to enable you to adjust the pins to their exact position before it sets.

Light Sources for Contact-Printing Systems -- There are many methods to make separation negatives by contact. You can use an enlarger for a light source, an incandescent bulb with a diffusion system or a pulsed-xenon system. Forget about cold-light sources for making negatives because the color is wrong and cannot be corrected. If you like to work with a condenser enlarger, use the aforementioned light sources or a point-light source. By utilizing the enlarger as a light source, you will get a bonus. The balance that you decide on for exposing masks and negatives will be the same. Only the light level will have to be changed by adjusting the f-stop.

You can also use a K & M Point-Light Source which comes in several different models. The light source is a 20-volt bulb that burns at 100 watts when set at full power. This unit comes with a three-step transformer enabling you to select three levels of illumination. Besides the transformer, this unit consists of a beehive lamp similar to the KODAK Safelight. You can probably make your own system without too much trouble (See diagram).

The next size up from this unit is the same light source transformer and 7-hole filter-wheel which is activated by pushing one of seven buttons on the control box; the wheel will turn to the hole that you want. This is a very impressive unit. It saves lots of time and also helps your back because you will not have to bend down or reach up to change filters.

The next model up is a rather elaborate system of two wheels and 15 buttons. The kinds of filters and their combinations are almost unending. All of these K & M Light Systems use the same 20-volt transformer and can be mounted above your workbench or below it. The advantage of having it above you is that you can work with a vacuum system and eliminate Newton's Rings. The light can be placed at a greater distance, thereby giving you more of the point-source effect. You can even place this system down the hall, high up near the ceiling and aimed towards a mirror above your table in order to provide even greater distance. With the push-button system, you can put this filter-wheel anywhere that you wish, but don't get carried away. The light source should be close enough to keep your exposures within reason.

If you plan to place the filter-wheel system below your table, that will also work well. If you do not want to buy a light source, you can make your own (See diagram). With a few items purchased from any electrical supply store, you can make a simple wheel and lightbox. Condit Manufacturing Company makes a system using a 75-watt bulb and two wheels, which is one of the nicest units that I have ever seen. p-10 a+b p-11 a+b

Voltage Stabilizers -- Every time a refrigerator or other heavy-duty appliance goes on (and it is somehow connected with your incoming power line), your voltage will fluctuate. When it does, you will not be able to repeat any of your exposures. The stabilizer should be the kind that automatically places your voltage at one level and keeps it there. There are a number of stabilizers on the market. I purchased a SOLA Stabilizer from a surplus electrical house and found the price to be right. Whatever you get, make sure that it fits the wattage of the equipment which you intend to use. Too high a wattage will not work properly; too low a wattage will cause the stabilizer not to work for very long.

Anytime the voltage shifts, there is more affected than just the brilliance of the light bulb and the exposure density. The color balance will shift and create problems. You can make prints for years not really knowing why the colors seem to be changing periodically. There are many reasons for colors to shift, but you can eliminate one cause by stabilizing your enlarger's energy input.

Any exposing device, such as an enlarger or contact lamp, should be connected to a voltage stabilizer. You will easily make up the cost in savings on film and paper.

p-37

Densitometers, Meters and Analyzers -- The serious dye transfer color printer, or anyone else who is interested in the technical aspects of the photographic field, should be familiar with densitometers, meters and analyzers. They are valuable tools used to make valid calculations. p-25 a, b + c

The densitometer is an electronic instrument which reads densities from a negative or transparency by means of a photoelectric cell and a calibrated light source. The film is placed between the two units and the more density that is recorded, the higher the reading on the scale in density numbers.

This is called transmission density. With an added unit, the same machine can read prints; a small light and a photoelectric cell in a probe can read the densities in a print as they are reflected up from its surface. Of course, this is called reflection density. Because the machine has four channels, with red, green, blue and no filters, it can read densities in color as well as in black-and-white.

In the past, workers in the carbro process knew from experience what a good set of separation negatives looked like. Although they did not know about H & D curves or about the sensitometry and densitometey of photography, the carbro printer made black-and-white separation prints that represented information on the three primary colors in a picture. This was before color transparencies were invented, so no one could argue with him if his prints did not quite match the original scene.

We are now in the age of fast color printing with video analyzers to help even the least experienced operator make acceptable color prints.

Making dye transfer prints is extremely complicated compared to any other type of color printing except lithography. In order to make a dye print, we must know the density range limits of our enlargers, the density range of the original transparency, and the exact densities on every sheet of film that goes into the separations. Without a densitometer, it is impossible to read the step tablets and come to any conclusions. All the calculations for making valid conclusions begin with getting accurate density readings. A densitometer therefore is really essential.

The kind that you get is not important as long as it is accurate and repeatable. I have had success with densitometers made by Macbeth Corporation and ESECO/Speedmaster Corporation. There are many others on the market. Some sophisticated units cost thousands of dollars, so beware when shopping for a densitometer.

There is quite a difference between a densitometer and a printing meter or analyzer. The densitometer is designed to read transparencies or black-and-white negatives (or color negatives) off-easel with a transmission system, or prints with a reflection system; the meter or analyzer reads the projected image on the easel. The printing meter reads only black-and-white densities while the analyzer reads color images as well (and was designed for printing color negatives).

When I have to make a set of matrices and there is nothing in the image that I can read for a neutral patch, I read the middle step of a three-point transparency guide on the easel with a meter. A good meter with a scale that reads either in exposure time or in logarithms is suitable. The idea here is to rely on the reading of the transparency guide rather than the image for exposure data.

There is another reason to use an on-easel meter. If you are asked to make a print 8 x 10 inches in size and the same print 11 x 14 inches and 16 x 20 inches in size, how would you get all the densities to match?

With an on-easel meter, it is not a huge undertaking. Simply take a reading of the light source without a negative in the enlarger. After making a set of matrices and changing size, place the probe back into the light beam on the easel, again without a negative, and adjust the *f*-stop until you get the same reading as before. You can be sure that the new set of matrices will receive the same relative exposure as the first set. Start with the largest size matrices so that you will be stopping down and not run out of *f*-stops.

It is also helpful to use a meter on-easel since the flare that is built into any enlarger can cause trouble. The image is altered because of the limitations of the original photograph; there is nothing that can be done about it. For example, if you have an original transparency that has a dominant color, it will be lighter in the separation negative of that color than the other two, such as a girl in a red dress with a red hat against a red background. The separation negatives will look strange. The red-filter negative will be quite dense, while the green-filter and the blue-filter negatives will be quite thin. With a large-size blow-up and a bright enlarger, the entire room lights up when you print either the green- or blue-filter negative. This will actually create a lot of fog in the matrices because of the flare, and will necessitate giving those negatives less exposure. How much less? Only an on-easel meter can tell you.

Flare is not present in a scanner because it is employs a contact system. Since no one is going to use a 20 x 24-inch camera so that you can make large prints by contact, the problem remains. Incidentally, a diffusion enlarger produces more flare than a condenser enlarger. The point-source system will produce the least.

Slide Rules and Calculators -- If you plan to make great dye transfer prints, you don't want to spend your time trying to figure out what went wrong with your set of negatives, matrices, masks or whatever. The entire process of producing a dye transfer has to be controlled with some mathematical precision; you have to learn how to use a slide rule or a scientific calculator. This does not mean that everything has to be done quickly. However, you will not want to waste time figuring out new exposures for a second test print. The worst thing for you to do is to make tests by trial and error and by guesswork.

The densitometer readings that you take should be calculated by using the logarithmic scale on the center moving stick of a slide rule. Use this scale by placing any number on the density scale against a density number. By moving only the hairline to a new density, you should be able to get a new number on the density scale.

If you have an exposure time of 10 seconds and have to increase the time because of a density difference of +.30, your new exposure should be 20 seconds. Try this with the density and the logarithm scales only. If you can find that equation, the rest is easy.

If you can't use a slide rule, try using a calculator. This really is not any easier, but if you have someone show you the steps, at least you will come up with some answers.

Transfer Boards -- Glass or Granite -- Using glass for the transfer board is difficult because it is rarely flat. If the surface is not absolutely flat, the problems can be numerous. If you use polished granite, bleeding problems will not exist because of its complete flatness. Granite also holds the dye transfer paper in place without slipping because it does not flex the way glass does. Condit Manufacturing Company can supply the proper sizes of granite, polished and smooth, with the pins that you request inserted into the granite in the appropriate position.

Vacuum-Contact Frames -- There are times when you will have to make very accurate reverse images of large friskets or masks. If you ever intend to do montage or photocomposition printing as a regular part of your work, I suggest that you consider using a vacuum-contact frame. It is unequaled for making sure that the contact is really tight.

Rocking Systems and Sinks -- The trays that contain dyes and paper conditioner should be in a constant state of movement whenever you have matrices or paper being prepared for transfer. No doubt you have seen illustrations showing how to make a table set-up with rocking shelves. This is fine if you are handy and are able to build such a system. I have a different plan for rocking the trays to keep them level at all times and to avoid stains on the wall from uneven rocking.

The size of any sink depends on its intended use. If you need it for mixing chemicals, and very little else, a fairly small sink will suffice. If you want to develop matrices up to 20 x 24 inches, your sink should be at least 8 feet long, or 10 feet is even better. For big matrices, make the sink about 30 inches wide by 10 feet long and about 10 inches deep. The diagrams outline some ideas for keeping the working part of the sink level, and at the same time, enabling chemicals and water to drain out. Include a full-size backboard to act as a splashboard as well as a place to install faucets for water or chemical delivery.

Have a shelf on the wall behind the sink high enough so that you will not scratch matrices as you work, but low enough to store such items as graduates, timers and other essentials. A good place to put your main chemical solutions, such as KODAK Tanning Developer A and B and fixer, if you don't plan to deliver them from another room, is in tanks installed where you have access to them on this overhead shelf near the ends of the sink.

I like the idea of using a water chiller and heater to keep chemicals at the proper temperature. This requires a tank built into the sink. Block off one end of the long 10-foot sink and make it waterproof. Install a separate drain in the bottom of this enclosure from that in the main body of the sink. With a small recirculating pump, keep the water moving in the small tank by drilling two holes in the bottom and attaching the proper fittings so that the pump can work. If you place a water chiller in the line between the pump and the small tank, you will be able to have the water brought to temperature and held there all day long. Pump the tempered water through the tanks of chemicals with a 25-foot coil of plastic tubing. Add plastic tubing from the tanks to the front of the sinks and install a push-button faucet through the front wall. This will make it possible to draw off your chemicals easily and at the proper temperature. If

p. 9
a+b

you place the developer tray in the water-chilled tank, you will be able to repeat processing temperatures accurately. p-14 a+b

The sink used for transferring dye can be 8-feet long. That is big enough to hold all the trays needed for dyes and rinses. Look again at the diagram that I have provided, and it will show how I prefer to move my matrices when they are being dyed.

The sink used to develop the separations need not be large because you use three small trays for developer, stop bath and fixer. Keep your chemical storage tanks on shelves above the sinks so that a simple gravity system will deliver the chemicals. p-5 It will be easier for you to control processing if you can also chill or heat these tanks. Maybe you can incorporate both the matrix chiller and the separation chiller in the same system.

When building your sinks, make sure that you use either marine or exterior plywood. If you use FIBERGLAS Material to make the sinks waterproof, use plenty of ventilation when you apply it. p-13

Negative washing can be done in the same tray used for the developer. This will keep the developer tray clean at all times. The sink used for processing separation negatives should have a lightbox above it the same length as the sink, in order for you to view the separation negatives and masks after they are fixed and washed. A large piece of glass, covering a piece of flashed opal glass, can be used as the viewer faceplate. By placing the lightbox over the sink, you can utilize the glass face to squeegee your wet films on prior to drying. p-18

The room used for processing matrices should be much larger. If the sink is 8 feet long, you will have room for your trays but not much more. With a sink at least 10 feet long, you will have space for graduates and thermometers and for the chemicals that are needed for processing. I used to keep my chemicals in 20-gallon, plastic garbage pails with covers. By placing the large pails on dollies, I could move them easily. Still, I like the system of having the chemicals in one room and delivering them to my work station via plastic tubing, ending with a faucet coming through the wall of the sink (See diagram). It is much neater and takes up less space.

In the room for processing matrices it is very important to have ample elbow room. I would use the same pull-chain system for the overhead light. You will not need a lightbox in this room. If you place an overhead line above the front of the sink, strung up high enough for you to hang your matrices after washing, they can drain before you move them. This will keep your floors much drier. Use plenty of light in this room as well as in all other processing areas. If you cannot see and remove the dirt that may get through the air-filtering system, you will never get it out of the matrices.

Filtration Systems for Dyes and Other Chemicals -- Dye filtration is very important. When you mix the dyes, use distilled water because across the country the tap water composition varies extremely. The more minerals that are present in the water supply, the worse it is. Getting clean whites on borders outside of the exposed area on the matrix film is nearly impossible with water that has a high mineral content. Rubbing the clear area of the matrix really should not have to be done, but the dyes will adhere to the film if the water is not pure. Even though you use distilled water, you may still have the problem. In Los Angeles, the problem was so acute that we had our water deionized and super-filtered. Water was tapped from our main supply and run through a deionizing system. Part of the system included an extremely fine sand filter that reduced the size of any particle to 3 microns -- that is really small; your eye can't see 25 microns.

Frequently, organic dyes form little globules (or mold) quite soon after the dyes are mixed. All sorts of contraptions have been devised to filter the dyes, and most of them work rather well. The one that I like best is something we worked out after trying many approaches.

p-8 a&b

We purchased a vacuum flask to which we added a rubber stopper with a hole through it that would support a small filter made by Pall Western Company. These filters are generally used to filter blood, and are extremely fine. We added a funnel to the top of this filter. By utilizing a small vacuum pump attached to the vacuum flask, we pulled the dye through the filter quite quickly. Without vacuum, the dye would just sit there hardly going through the filter. Of course, we purchased a pump for each color dye and one also for the paper conditioner. The filters last at least a year even if you filter the dyes every day. They are only the size of your fist but have over a yard of filter material folded up in the housing.

When mixing the 1% acetic acid rinse, the question arises, ''How much should I mix at one time?'' That depends on how many prints you plan to run each day. We currently use a 60-gallon rectangular tank for our acid rinse. If you wish, you can use a pail or a 20-gallon plastic trash can. After measuring exactly how much water the tank holds, figure out how much glacial acetic acid you need to add to the water to bring the tank to a 1% solution (10 mL added to enough water to make 1 litre). A 20-gallon trash can (80 L) would need 27 ounces (800 mL) of glacial acetic acid added to enough water to make 80 litres of 1% solution.

p-6

p.7 a&b

To the bottom of this tank I would add a small external pump -- the Little Giant Series. These pumps have chemical resistant chambers and will pump the chemicals to the station where you need them. Add a CUNEO Water Filter to the line and receive the added protection of a dirt-free acid rinse. If you get dirt in the acid rinse and it reaches your matrix, you will have problems. You can wipe the matrix clean with a chamois cloth, if the matrix has been hardened, but sometimes even that may not be enough. In other words, keep your chemicals clean. It may not be necessary to filter the developers and fixers, but where it counts is where you have to be cautious. Water filters can be obtained in nearly any micron size. The smaller the micron size, the sooner it will clog up; however, this should not happen very often.

P-17

You can purchase small distillation units which will make about 5 gallons of distilled water a day. That may be enough for you. Use this clean water for all your needs -- the dyes, the paper conditioner and especially the acid rinse.

Copy Cameras -- A very valuable piece of equipment to have is a copy camera. Unfortunately, it is quite expensive. However, if you know how to use one, it will make up for its cost in a very short time. There will be a time when a client will have a piece of original artwork to be copied and inserted into his layout. There is no other method of photocopying that will match the quality of direct in-camera separation negatives. After making all of the necessary masks, you will be able to produce a print that is accurate in every detail.

It takes practice to establish the proper exposures and developing times but once they are established, they hold without too much trouble because you do not depend on different densities or contrasts. All you have to do is reproduce the step tablet. Of course, color correction is necessary since you are working with something that is easily comparable. You can place the color print next to the original art, and judge where it needs correction. The only problem which you may face is that there are times when nothing that you do will get the color as close as you would like. The dyes and inks used in commercial art occasionally contain traces of fluorescence that will affect the overall color in a way that cannot be copied.

The copy camera can be either a horizontal or a vertical type. Some of them come with expensive exposure systems. Many are capable of copying an image and reproducing it in a size range from 25% to 400%. You can use a copy camera in many ways -- to copy paintings, commercial art, other photos, layouts and lettering. The list could go on forever.

Roller-Transport Processing Machines -- The most accurate way to process film is in an automatic roller-transport processor like the KODAK VERSAMAT Film Processor. It is repeatable to such a fine point that you must use a densitometer to discover a density difference between processed sheets of film. The speed of the machine can be set very accurately, and the temperature is exactly where it should be. The biggest advantage, besides accurate processing, is the speed with which negatives can be finished. If you are contemplating a large, busy operation, look into roller-transport processing. Another advantage of this type of processor is that it enables you to use film like KODAK Separation Negative, Type 1 or Type 2. These films are finer grained than most and are really suited to automatic machines rather than hand processing.

One drawback to this otherwise wonderful machine is that it needs very special maintainence and understanding. For instance, if you attempt to process regular negative film and lithographic film in the same machine, developer by-products will eventually build up and cause chemical fog in the lower densities of continuous-tone negatives. If you are making a snappy highlight negative, probably you would rather use a more active developer. Most of the larger photographic laboratories in New York City have more than one roller-transport film processor so that they can develop highlight masks (on lithographic film) and principal masks together, with regular negative film processed in different machines with various chemical solutions.

Magnifiers and Dryers

The worst thing that you can do is to deliver an out-of-focus print to the client. No matter what kind of eyesight you have, you will still need a good magnifier. The KODAK Acromatic Magnifier, 5X is very good. It has a flat field and is easy to adjust. You will need such a magnifier to reregister matrices.

There are times when you will want to use an even more powerful glass. Edmond Scientific Company makes a number of magnifiers and has a catalog showing what is available.

You will also need negative focusers. The new grain magnifiers are excellent. Focusers work best with condenser enlargers. The grain pops into focus quite easily. If you are using a diffusion enlarger, you may be better off with the simple mirror-type focuser that reflects back to a piece of ground glass. I use both types.

Dryers are really a problem. The flat kind that takes a print on each side is probably the best for low volume. A large drum dryer is suitable, if you have ten individuals making prints all at the same time. For the average laboratory turning out a print every so often, a 20 x 24-inch flat dryer is excellent. At one time Bessler Manufacturing Company made a dryer that was a small drum; after you placed a print on the apron and rotated it until the entire print was in the machine, the equipment dried the print perfectly smooth. I have not seen a dryer like that for some time. If you find one somewhere, buy it. p-12

If you make large prints occasionally and have no way of drying them properly, follow these steps: Make the large print with extra paper all around; while it is still damp, place it on a sheet of MASONITE Hardboard. Using gummed paper tape, attach all four sides of the print to the hardboard, and let it dry naturally. A little coaxing from a gentle light heat and soft fan will help. Don't rush it. When this print is dry, it will be shrunken like a skin on a drum -- perfectly flat. The tape can then be peeled off and the hardboard prepared for another print.

How to Obtain Proper Exposing and Processing Information Before Making Separation Negatives

There are five areas involved in preparing to make separation negatives. They are:

1. DETERMINING THE DENSITY RANGE LIMITS OF YOUR ENLARGER
2. DETERMINING THE REQUIRED COMBINED MASK AND TRANSPARENCY DENSITY RANGE
3. MAKING YOUR OWN TIME/GAMMA CHART
4. AVERAGE DENSITIES AND HOW THEY WORK
5. EXCEPTIONS TO THE RULES

The Enlarger Density Range -- Determine the density range of your enlarger and any photographic material that you plan to use (such as black-and-white paper, color-print materials, matrix film or any other material that is the final step in making a print). Do this by placing a 21-step step tablet in the enlarger. Mask it so that no extraneous light will cause fogged film.

Make a series of exposures of the step tablet on your material (in this case, matrix film). Make sure that one of the exposures is sufficient for the image to be neither over- or underexposed.

Process the matrix film normally and after it has dried, place it in a rocking tray of cyan dye for 5 minutes. Rinse the matrix off for 1 minute in a 1% acid rinse, place it in a second rinse for 10 seconds and then transfer it to a sheet of prepared dye transfer paper. Transfer for 5 minutes, then remove the matrix and look at the cyan image through a red filter. Examine it closely. The highlight density differences will tend to disappear at a given point on the image and so will the dark density differences. Where these two ends lose detail indicates the density limits of the material. Mark these two points on the original step tablet. With a densitometer, read the two original steps and subtract the low reading from the high reading. This is the density range that your enlarger will handle.

The Required Combined Mask and Transparency Density Range -- The majority of transparencies will have too much contrast to make direct negatives and will require masking in order to reduce the overall contrast to a range that the enlarger can handle. The second stage of this system is to find out what the range of your combined mask and transparency should be before making separation negatives.

The first question is: ''To what gamma should I develop these negatives? Should it be .70, or .80 or .90?'' It could be any one of these. What really determines the proper gamma that you choose is that the yellow printer (blue negative) will require a much longer processing time in order to achieve the same contrast curve slope as the red and green negatives. This longer developing time sometimes results in a chemical-fog situation, where the yellow shadows build up density and ruin the contrast of the negative. Because of this, I make my negatives to a constant gamma of .70 and eliminate this fog problem, and get everything else to fit that gamma.

In order to establish the proper combined mask and transparency (CMT), divide the gamma of the negative (.70) into the enlarger range; the answer is the necessary range of the combined mask and transparency.

An example:

Enlarger range 1.00 divided by gamma of development .70 = 1.428 or 1.43

This means that any transparency that does not fit the range of 1.43 has to be masked. The number 1.43 is the end result when making masks for any transparency to be separated for this enlarger.

Read a transparency with a densitometer:

the shadow 2.65
the highlight .... .40
the density range 2.20

the required CMT 1.43

the difference .... .77

Divide the difference (.77) by the original density range (2.20) and the answer is .35. The mask must be developed to a contrast range (gamma) of .35.

The choice of the filters that you use when exposing the mask is quite important. For dye transfer, use at least a red and green filter. Without getting too concerned with other systems, such as double-masking and split-masking, all you need is one red-filter mask to make the red- and green-filter negatives, and the green-filter mask to make the blue-filter negative. This will allow the best color saturation and color correction without becoming too involved.

The mask can really be exposed on any negative material. KODAK Pan Masking Film is designed to give a soft, diffused image that, when placed with the original, will prevent small areas of contrast from being affected by the mask. The result is a somewhat sharper-looking print, and it is also easier to register with the original. However, sometimes when a light object, such as a woman's white hat, is placed against a blue background, the diffusion that is built into the masking film will cause flare around the hat, and you will see a dark halo. In order to eliminate this occurrence, make your mask on KODAK Separation

Film, Type 1, or any other similar film, and dilute the developer until you find a dilution that works.

p-26 a, b + c

The Time/Gamma Chart -- In order to find the proper exposure and development times for the masks and negatives, it is necessary that you make your own time/gamma charts. Although the established way is to make detailed curve plots for each piece of film, the system explained here will make this chore a little simpler.

Using a contact printer and a fixed white light (a K & M Point-Source is excellent) plus a No. 29 Filter (red), make a series of exposures of a No. Q-6C, KODAK Three-point Transparency Guide, across a sheet of KODAK Pan Masking Film. Vary the exposures by 2 seconds each, and place as many of these as possible on one sheet. Now make an identical set of exposures on a second sheet. Process these two sheets of film in a very dilute solution of KODAK HC-110 Developer or any developer that you feel comfortable with, such as KODAK Developer DK-50. Process the first sheet for 1 minute and 30 seconds and the second sheet for 4 minutes at 68°F (20°C). Examine the first sheet; with a densitometer, find the lightest step in any image that reads .40. Circle it. Record the exposure time. Read and record the density range. Do the same with the second sheet. You should now have some information that you can use. If you divide the density range of the circled mask image by the range of the original (approximately 1.95), you will get the required percentage of the mask (gamma). The exposure time has been recorded for each circled mask step tablet.

Prepare a sheet of graph paper as follows: Place the development times across the bottom, the gamma percents up the left side and the exposure times up the right side. Along the bottom, find the 1-minute-and-30-second development time and along the left side, find the gamma that it produced. Where these two lines meet, make a mark on the graph. Do the same for the 4-minute development time and the gamma that it produced. Join these two marks. This is your gamma development chart. In order to find any gamma up to .40, just look up the left side until you find the desired gamma and look across to the right until the graph line intersects the gamma line. Then look down to the bottom of the chart and you will find the proper development time. Whenever one film is developed longer than another one and has had the same exposure, the density will increase as well as the contrast. In order to keep the level of density of the mask within bounds, it is necessary to reduce the exposure as you develop more and to increase the exposure as you develop less.

The newly made gamma chart can include an exposure chart. On the right side of the chart, you will find the exposure times. Find where the 1-minute-and-30-second development time and the exposure intersect, and make a mark. Do the same with the 4-

minute development time. If you connect these two marks, you will have an exposure line.

To use the chart: After you have decided on a specific percent for your mask, find the gamma required on the left side of the chart. Look down and find the developing time. Then where the developing time intersects with the exposure line, a new exposure will be found on the right side of the chart.

Make another chart for the No. 61 (green) Filter. The same procedure is also used when finding the numbers for the separation negatives. Use the proper separation negative material and the set of separation filters required for the task (KODAK WRATTEN Filters No. 29, 61 and 47B). The more sheets of film that you process, the more accurate will be the curve shape. Instead of using only two sheets for finding the high and low limits, try three.

Average Density -- While the subject of average density has been formerly neglected, it is significant because the exposures of the masks and negatives present a problem. When taking a picture with a camera, you know that you must change your shutter speed or aperture in order to make the correct exposure on the film. The same problem with exposure occurs when making a set of separation exposures from a transparency. Every transparency has an average density. Some are light and high-key and some are dark and low-key; all are different. It is rare for two pictures to have the same overall density, unless they are part of a situation where models just change poses and the photographer keeps pressing the button.

To find the average density of a transparency, use a densitometer to read the shadow and highlight portions of the transparency.

Add the shadow reading...........	2.75
to the highlight reading.........	+ .40
and get the density range........	3.15
then divide by 2 and get.........	1.575 or 1.58

The average density of this transparency is 1.58.

If you expose two sheets of film with identical exposures and develop these two sheets at varied times, the resulting densities will be very different. The longer you develop, the heavier the densities will be, so a shorter exposure time should be used; the shorter you develop, the lighter the densities will be, so a longer exposure time should be used. This is shown on the time/gamma chart on page 00. But all of these exposure times were based on the use of a Three-Point Transparency Guide. This Guide has its own average density (1.95).

Calculations were based on an average density of 1.95. If you take ten random transparencies and read them to determine the average densities, you will find that no two will be exactly alike. If you are using the time/gamma chart based on 1.95 (average density) and have a transparency that has an average density of 2.30, the difference is +.35. In this case, .35 added to the original exposure (using logarithm) should give the mask or negative the proper density so that all of the information will be properly recorded. Remember that the function of the mask is twofold: First, and most important, is contrast control; second is color correction. The color-correction function requires that the density of the mask be fairly constant. The heavier the density, the more the colors will be affected; the lighter the density, the less they will be corrected. The aim is to have all of the masks placed in the same level of density regardless of the developing time. This is done by constantly adjusting the chart exposure with modifications to bring the exposure where it belongs.

Exceptions to the Rule and How to Handle Them -- There are times when a good densitometer reading is impossible to obtain and a different approach must be used. For instance, this is the case when there is a 4 x 5-inch transparency of a white kitchen with a white refrigerator, white table and chairs and white just about everywhere. On top of the refrigerator is a small, black flower pot with white flowers in it. Would you read the white and black areas in this picture and consider them for determining an average density? No! The areas of white so dominate the entire image that if you based your exposure on these two readings your film would be overexposed and lose detail in the highlight portion of the photograph.

Look at another transparency taken at the same time in the same room but the black flower pot is missing. Now, what do you read? Obviously, the pictures are identical, except for the pot. You really should not even try to determine a contrast mask based on readings of this one-sided transparency. If you try to determine the contrast readings and average density from a low-key photograph of a coal miner in a mine with just enough light to see some dim detail in the picture, you will have the same difficulty in achieving good results.

The solution to this occasional dilemma is as follows: Do you remember the Three-Point Transparency Guide? In order to make an average density range, you had to read the high and low steps. In order to find the exposures for one-sided shots, make a test from a normal transparency. When the exposure looks just right, read the high and low steps. Record them. You will now have three items to work with:

- An average density
- A shadow density
- A highlight density

If your new transparency fits the ''normal'' look, use the average density mode. If your transparency is low-key, use the shadow reading to determine the exposure. And if your transparency is a high-key shot, use the highlight reading to determine the exposure. This method will keep the main parts of the transparency on the straight-line portion of the characteristic curve of the film. This should solve the problem of ''odd'' transparencies.

When faced with these ''odd'' originals, you will need to determine the contrast range of the mask. If it is difficult to assess the contrast range by densitometer readings, then you must resort to your own eyes. I am sure that you can tell when a transparency is contrasty or flat. The subject matter alone will help you decide that issue. The following chart should help you to find the most accurate mask range when problems occur.

If the transparency is	Make the mask
very flat	10%
flat	15%
slightly flat	20%
normal	25%
slightly contrasty	30%
contrasty	35%
very contrasty	40%

If you are unable to get adequate readings, you can refer to this chart and come up with very good prints. If you miss one category, you can still correct the error when making negatives, matrices, or in the adjustment of the dyes.

Highlight Negatives

p-27

Making a set of highlight negatives is one of the most critical steps in the entire separation-negative process. If you have a ''perfect'' set of separation negatives and a poorly made set of highlight negatives, your work will be wasted. If you have a picture of a person in a light blue shirt and your highlight negatives are off in the wrong direction, the shirt may appear in the print as being gray or even warm in color. I may be exaggerating a little, but I am trying to emphasize that the three highlight negatives should be well-balanced so that the Transparency Guide images look and read alike, and the overall density is correct.

These highlight negatives (some call them highlight masks) are necessary because both the matrix film and the separation film have sensitometric flaws in them. When you add principal masks to bring the transparency to the proper contrast, the masks flatten the top (highlight) end of the separation-film curve, killing density differences in the highlight detail. Therefore, you must make additional high-contrast negatives to bring back that detail.

Also, the matrix film characteristic curve has a very flat toe portion (where the highlight detail is recorded), and the negative must be masked even more heavily to record increased detail. Obviously, the highlight negative is important and must be made on very high-contrast film.

There are several ways to make highlight negatives. You can expose three color-corrected highlight negatives -- one for the red separation, one for the green separation and one for the blue -- on KODALITH Pan Film 2568, in contact with the transparency and emulsion-to-emulsion. (If you are making only one white-light highlight negative, you can probably get away with using KODALITH Ortho Film 2556). Since both KODALITH Films are extremely fast in comparison to KODAK SUPER-XX Pan Film 4142 or other separation-negative materials, you have to reduce the exposing light level to a point where it is usable. The light levels which I use on the K & M Point-Light Source are in variable click-stop stages, so I can go down from 20 volts to about 8 volts for the highlight negatives without problems. I find the correct ratio of exposure by binding a neutral step tablet with the transparency so that its image is included in all three highlight negatives. The proper density for masking some of the highlight detail back into the image is about .30 to .40 in the densest part of the negative. Highlight negatives can be made first and used later by adding them to the separation negatives when you make the matrices. This is called <u>post-masking</u>.

There is another way to do it. You can build highlight masks into the whole system first by exposing highlight negatives, and after processing, place them, emulsion-to-emulsion, with the transparency when you make the principal masks (See page 00). The principal masks are made with their emulsion to the base side of the transparency in this case, then you remove the highlight negatives and use the principal masks and transparency combined to make the separation negatives. This is called <u>pre-masking</u>.

This procedure prevents exposure in the highlight portion of the principal masks so that they remain fairly clear. Even though the rest of the image has been masked, the highlights have not. As a result, when you make the final separation negatives, the highlight areas automatically show more density. This is a rather good method of masking highlights when you have subjects, such as cut-glass or crystal, and you don't want to lose the detail.

Pre-masks have to be much stronger than the .30 or .40 density that is needed for post-masked highlight negatives -- somewhere around .60 density to give sufficient separation. This is important because when you incorporate the highlight negatives with the principal masks, you reduce the overall strength of the high-contrast highlight negative as you transpose it to the reduced contrast of the low-contrast film needed for the principal mask.

Sometimes, when a transparency is particularly poor, you may have to resort to making pre-mask highlight negatives and another set of thinner highlight negatives to add later as post-masks.

To arrive at the proper exposure for highlight negatives on KODALITH Pan Film, first make a series of exposures on a sheet of the film with the KODAK Three-Point Transparency Guide through each of the three KODAK WRATTEN Filters -- No. 29 (red), 61 (green) and 47B (blue). I use the No. 1 tap on my NUARK Point-Light System which is about 8 volts. You will have to add neutral density filters to the separation filters because this film is extremely fast. After you make these short exposures on one sheet, process it in a dilute solution of KODAK HC-110 Developer. (I recommend using the small 16-ounce bottle of concentrate to make 7 gallons [26.5 L] of developer.) You can also use KODAK Developer D-11, but the contrast is much higher and you may wish to use that only when you really need higher-contrast masks. It will require about half the exposure that HC-110 Developer needs.

You may be tempted to determine visually which of the exposures through the three filters match, but utilize a densitometer to obtain accurate readings. When you have found exposures that read very close to .30 or .40 density, you are ready for the next step.

Read only the lightest step on the original Three-Point Transparency Guide. If it reads .55 density, make a chart, such as the one here, that lists all of the probable densities in the highlight areas of the transparency.

Highlight Density Chart

Density	Red	Green	Blue
.10	4.0	3.6	4.8
.15	4.5	4.0	5.3
.20	5.0	4.5	6.0
.25	5.6	5.0	6.7
.30	6.3	5.6	7.6
.35	7.0	6.3	8.5
.40	7.8	7.0	9.5
.45	8.8	7.8	10.5
.50	10.0	8.8	12.0
.55	11.2	10.0	13.4
.60	12.6	11.2	15.2
.65	14.2	12.6	17.0
.70	16.0	14.2	19.0

These times have been calculated in logarithms. The exposures on the .50 lines are accurate and were found by making all of those exposures.

If you have a density of .35 in your highlight area, your exposures will be: red, 7 seconds; green, 6.3 seconds; and blue, 8.5 seconds. Remember to develop these films in the same strength developer in which the tests were made; if you change developer, you will have to modify your exposures. The balance would stay the same; only the relative difference would have to be recalculated. KODAK Developer D-11 would need about one-half the exposure used for KODAK HC-110 Developer.

Using an Oil Carrier to Make Highlight Negatives -- Make sure that you mask off any extraneous light escaping from the oil carrier. Place the Three-Point Transparency Guide along the bottom of the carrier so that the important parts will show through the spaces left by the sprocket holes. The same sprocket holes should have been used for the Guide when the principal masks were made.

Remove the masks completely and reinsert the transparency, making certain that there are no bubbles in the oil. Once again, by trial and error, I came to the exposure that I now use. I set my meter to the white or lightest part of the transparency that I can determine and use the *f*-stop to determine the amount of light that will be exposing my sheet of KODALITH Pan Film. In order to expose my red filter properly, I add a neutral density filter to my light source. Its density is about 2.3 which indicates how fast the film is to red light. The exposure is 15 seconds. For the other two exposures, I remove the neutral density filter and expose the green for 2 seconds and the blue for 4.8 seconds. These highlight negatives are processed in KODAK HC-110 Developer or in KODAK Developer D-11. If you use the latter, you will have to cut the exposure by 50%.

Specular Highlight Masks -- Can you envision what a print would look like if it contained an image of a white shirt with fine detail in the cloth, photographed on a white background? Many times in the past I have made beautiful carbro prints that were just that -- white on white. The carbro prints were made from original silver negatives, exposed one at a time, usually on glass plates in an 8 x 10-inch camera. The fact that the negatives I worked with were made from the subject and not from a transparency meant that the tonal scale of the original negative was intact; no masks were required to lower the contrast. Separation negatives from transparencies are actually copies and must be masked to restore the tonal scale.

Sometimes the highlight negatives fail to do their job of sufficiently increasing the contrast in the highlight portion of the image -- for many reasons. When highlight negatives are needed to increase the highlight contrast of a transparency, it is because the highlights have been flattened by the principal mask required to restore the tonal scale of the ''copy''. However, if the whole picture is white, like the ''white-on-white'' shirt photograph, you will find that even properly made highlight negatives will not do the masking job correctly. You still will need additional highlight contrast.

Use a film called KODAK High-Speed Duplicating Film 2575 to make a contact exposure from one of the highlight negatives and develop it in KODALITH Developer. You will have a duplicate of your highlight negative with much more contrast. You can control just how much coverage you need with the exposure time. This specular highlight mask, which fits only the highest highlight tips of the image, is added to the separation negative and the normal highlight negative when exposing the matrices. Making stronger highlight negatives will not work. You need to catch the extreme highlight end of the scale with this specular mask. It is similar to making a ''highlight of your highlight.''

Principal Masks

P-28

The phrase principal mask means the main or primary mask. To make a principal mask, find the proper exposure. Use the Three-Point Transparency Guide to make a series of exposures on one sheet of KODAK Pan Masking Film 4570. Process the sheet for 2 minutes and 30 seconds at 70°F (21°C) in a very dilute solution of KODAK HC-110 Developer (the same as you used for the highlight masks). With a densitometer, find an exposure that reads between .35 and .4 in the lightest step of the masked Three-Point Transparency Guide image, note the exposure and when you have to expose a transparency that has a similar shadow area, use that exposure time. The separation-negative image will have detail and tone down to the deepest shadow. If you don't have detail in the shadow portion of your mask, the shadows in your separations will remain contrasty, but the rest of the transparency will have been masked and reduced in contrast.

Principal masks are made similarly to highlight masks except that they are exposed through the back of the transparency, emulsion down. Expose one sheet of principal mask material through a KODAK WRATTEN No. 29 (red) Filter and another sheet through a No. 61 (green) Filter. This will provide a somewhat accurate color-correction system as well as reduced contrast.

The flaws that are inherent in dyes, filters, films and developers are reasons why perfection is difficult to achieve. In the past, masking was only used to achieve color correction. Contrast correction was never considered a serious problem because the separation negatives could be easily scaled up and down in contrast. My theory is that the principal mask should be made to reduce the original contrast of the transparency to a level which makes it easier to produce good separation negatives.

Masking for Color Correction -- I do not recommend using only a single mask procedure if you are serious about making a quality print; a two-mask procedure using both red and green masks is the minimum that you should do. However, making two principal masks is not the ultimate answer. If you split the exposure for the first mask by exposing half of the time through a red filter and half through a green filter and if you register that mask with the transparency to make the red-filter negative, all of the warm colors will stay cleaner while the blues and greens will still be fairly bright. Cleaner means that less of the unwanted color (less cyan) will actually be deposited in the red areas. If you make a red-filter mask with only red light and register it withthe transparency to make a red-filter negative, the reds will be too dark and the blues and greens will be lighter.

<u>Split-filter masks</u> will do a lot to keep your colors from becoming too saturated and dirty. Here are a few ideas for making split-filter masks: One-half red- and 1/2 green-light to make the mask for the red-filter negative; 100% red-light to make the mask for the green-filter negative; and 100% green-light to make the mask for the blue-filter negative. This system will work well when you have important warm colors in the photograph, such as flesh tones or sunsets. However, if most of the photograph is blue or green, use 100% red-light to make a mask for both red- and green-filter negatives, and 100% green-light to make the mask for the blue-filter negative; the cool colors will be improved.

Exposing Techniques for Making Separation Negatives

There are a number of ways to expose film in a darkroom set-up to make separation negatives. One method is to use an enlarger as a light source and make the masks and separation negatives on a vacuum easel, thereby eliminating all lenses. This will provide very sharp results and prevent Newton's Rings. It also enables the use of the same light source to make both the negatives and the matrices. This technique is obviously for a small laboratory where there is plenty of time to wait between making prints.

Making Contact Masks -- If you don't have a light meter of some kind to monitor the light level at the exposure plane, you can use one specific enlarger-to-easel height and always use the same *f*-stop. The easel can be made quite easily, or you can purchase a vacuum-contact frame that will permit you to expose contact negatives through a mask in exact register. This system can also be used for making enlarged separation negatives. To make contact separations, you will need two sets of diagonal register pins on the vacuum easel, each set the opposite configuration of the other.

The procedure is to make the principal masks, emulsion up, with the transparency, also emulsion up. After the masks are processed, the opposite set of pins is used to print the negative film, emulsion up, with the transparency in contact, emulsion down and with the mask on top, also emulsion down. If you do this any other way, you will get an edge-effect from the thickness of the mask. With this method, the images will be in the same position as when they were made; the emulsion-to-emulsion contact of the transparency and separation film will insure the sharpest negatives.

Another technique substitutes any of a number of light sources for the enlarger in making the contact masks and separation negatives with a vacuum easel on a bench-top. This is perhaps the most popular system, professionally. You can use almost anything that has a glowing element as the light source. It can be a point-light source, an enlarging bulb or a small 75-watt frosted bulb. You can use a simple light source on the floor, pointing up at a platen in the bench. Filters can be changed by hand or put on a wheel and moved by a small motor. Condit Manufacturing Company has a great system with the filters in a wheel with WATERHOUSE *f*-Stops built in (See Light Sources for Contact-Printing Systems on page 00). It sits on the top of the bench and faces downward through a hole in the bench-top to an angled mirror which reflects up to the printing platen in another hole in the bench, thereby lengthening the light-path and giving it somewhat the effect of a point-light source.

The drawback to this system is the problem of Newton's Rings, but there are several ways to solve it. Spray into the air a tiny amount of Lithographer's Offset Powder (a dry powder that has been used for years in the printing industry to help separate paper sheets as they go into a press). When you think that all of it has fallen to the floor, pass the sheet of glass or film through the almost invisible cloud. Enough dust will be deposited on the surface to eliminate most of the Newton's Rings. If you try this with 2 1/4-inch film, you might get away with it. Don't waste your time trying it with 35 mm film. You will have very visible chunks of pumice in your images, unless you are making very small prints. I have been successful in using ARID EXTRA DRY Deodorant (unscented, of course) to relieve the surface tension of small films. You can also place a sheet of processed and dried KODAK TRANSLITE Film on the glass and expose through it. You will not get the crisp effect of the point-light source, but you will eliminate the Newton's Rings. Don't try to use anything smaller than 4 x 5-inch film with this approach.

The next system is my latest idea. I make all of my masks by contact. If my original transparency is 35 mm or 2 1/4-inches, I usually make enlarged separations, but my masks will be the small contact-size.

By predetermining the exact contrast of the principal masks and combining them, one-at-a-time, in contact with the transparency, I can quite easily make fully formed separation negatives with all the detail in the shadows and highlights. The use of silicone oil in a liquid carrier is important in my system.

Making Enlarged Masks -- Another technique for making enlarged separation negatives is to make enlarged masks, then expose through them to make the final negatives. This has been going on for over 30 years. First, the transparency is placed in an oil carrier which is inserted into the gate of a special type of enlarger equipped with a point-light that can be moved up or down to fit the focal length of different size condensers and lenses. The lens is always used at its widest opening, which is why only the best lenses are used. The OMEGA DII Enlarger is the most popular piece of equipment for this purpose because it accepts separation filters in a special drawer near the variable condenser location (out of the image-forming area), and because it fits the point-source system made by Condit. The point-light source for the OMEGA DII is a microfilm head that uses a 20-volt electrical system. Either a continuously-variable voltage control or a click-stop control, such as the one on the K & M Point-Light Source, is used for making contact separations. This is not to say that other enlargers cannot be used.

After the transparency is properly sized and the image positioned correctly on the vacuum easel, a spacer sheet, made of the same film to be used for the separation negatives that have been flashed to black, processed and dried, is then placed on the easel. This is followed by the masking film, emulsion down. The vacuum is turned on and everything on the easel is sucked down tightly. The first mask is exposed through the red filter, and the process is repeated again for the green-filter mask and any other masks which you may want to make.

After the masks have been developed and dried, the spacer is removed from the easel and replaced with the unexposed separation-negative material (KODAK SUPER-XX Pan Film, or any other comparable film), emulsion up. The mask is placed on top of the separation film in the same orientation that it was when it was exposed (emulsion down). Although the negative is being exposed through the base of the masking film, the image will be very sharp, not only because of the point-light source, but because the mask is being pulled down tightly to the negative film by the vacuum and the emulsions are in contact; there is no room for diffusion.

My only objection to this technique for making separation negatives is that the flare problem still exists, even though new, super-coated lenses are used.

You must choose whichever technique that you feel comfortable with for making separation negatives; there are pros and cons for any enlarging system, and each person must select the method best suited for the situation.

Flare -- I believe that the flare produced by every enlarged transparency diminishes the accuracy and crispness of the original image unless it is eliminated where it starts -- in the carrier inside the enlarger.

Here is an example of what I mean. There are two KODACHROME Transparencies, each 2 1/4-inches square. Since the size of the final print is to be small (11 x 14-inches), it makes no difference if the separation negatives are contact or enlarged.

Transparency A shows a white polar bear against a white snow bank with very little dark areas in it. Transparency B is a photograph of a black man in a tuxedo in a darkened nightclub, against a very dark background. Which of these two transparencies should be separated by making enlarged negatives and which should be made by contact?

The white-on-white transparency should be exposed by contact when making the separation negatives. The amount of flare that is introduced by projecting such a light subject in an enlarger will destroy most of the detail in the upper end of the step tablet, and most of this particular picture is in the upper end of the scale. A point-light source should be used to remove any possibility of softness in the separation-negative image. When the final negatives are exposed in the enlarger, they will be dense enough to eliminate any cause for flare.

In contrast, the dark transparency will result in a better set of negatives if it is exposed by enlargement because the dark image will not flare. If the negatives are enlarged to the size of the finished print, contact matrices can be made, eliminating even more flare. These negatives have to be produced with the transparency in the enlarger, emulsion up, so that the negatives can be exposed, emulsion down, on the matrix film. (This is why the new scanners are producing some of the sharpest reproductions in history; they omit optical problems completely. The separation negatives from them are usually made to reproduction size in order that everything from the separation negatives on is made by contact). In doing dye transfer, we usually don't have the luxury of using a scanner. Therefore, it is important to understand why some prints lose their detail and sharpness.

p.44

Making a Two-Piece Strip

If you receive a layout from a client with two photographs in the same layout, you will have to do a few things before you actually proceed to make a print with two elements in it. Let's make up an imaginary two-photo print and call it by its proper name -- a two-piece strip. It is a picture of a woman, dressed formally, sitting at a patio table on a lawn with her dog. The table is set with candles and flowers. The scene which I just described was photographed in a studio, and the 4 x 5-inch transparency had some of the studio equipment in its background. The other transparency is a beautiful picture of San Francisco taken from a hill on the Oakland side of San Francisco Bay. It was taken late in the day with a 35 mm camera, and you can see the Golden Gate

Bridge in the distance. It is needle-sharp and looks great. Our problem is to insert this beautiful scene behind the lady on her patio, and most important, make a very tight strip so that it looks natural.

We know what the print is supposed to look like. We have to make the finished picture look as if it really was photographed on an outdoor patio at the right time of day. Initially, we make a copy of the layout so that it fits on an 8 x 10-inch piece of film. We use a piece of 8 x 10-inch KODALITH Ortho Film in a vertical camera to copy it. After we expose the film, we process it in a weak solution of KODAK HC-110 Developer (the strength that we use for masking) for a few minutes, using a red safelight so that we can develop the film visually. This is to be the master layout for our separations.

Since I believe in making things to the right size and position from the very beginning, I make all the negatives enlarged. After making certain that the details required by the layout are in this smaller form, I punch the 8 x 10-inch sheet of film with a diagonal punch and place it on my vacuum easel.

After preparing the sheets for making negatives (described on page 00), I accurately size the background image and make it fill the 8 x 10-inch layout. I proceed to make my set of negatives with all the masks necessary. These negatives are made with a

105 mm APO EL-NIKKOR Lens, which is extremely sharp and is currently used by the major laboratories in the United States.

Putting these negatives aside, I change lenses and condensers and size the 4 x 5-inch transparency to fit the same layout -- size for size and in position. When they also are dry, I have both sets ready to go.

The next step is to size everything to the layout. In fact, the print has to be bigger than the layout so that after retouching, the work that is done to the print will be almost impossible to see when it is reduced to reproduction size -- a significant reason for the vacuum frame. Remember that all of these steps are done on a vacuum easel and an enlarger that does not move. Everything is locked tight.

I now expose a large sheet of KODALITH Film with the image of this lady at her table and process it in a soft developer if it needs to be outlined physically, or in a strong lithographic developer if the outline of the image is easy to separate. Once this sheet of film is dried, I make a tight cut-out using a material called RUBYLITH (it is red) or AMBERLITH (it is light and amber in color). These two materials can be scored with a blade, and the cut portion peeled away. I now place this cut-out RUBYLITH material back on the easel to be copied using the enlarger as a camera. I replace the negative in the registration carrier with a fresh sheet of KODALITH Film (diagonally punched), emulsion side down. By using a light source to light the easel, I can photograph the RUBYLITH image onto the film plane in the enlarger. I process this sheet in KODALITH Developer for extreme contrast and make a reverse image on another sheet of KODALITH Film (contact). The result is two masks -- one to hold out the lady at her table and one to print her in.

If for any reason a full-size reverse image of the large RUBYLITH cut-out has to be made, I would use a contact-vacuum frame which usually comes supplied with a vacuum pump and a gauge. After placing a set of register pins in the frame and putting a new sheet of large KODALITH Film and the RUBYLITH cut-out on the same set of pins and after closing the frame, I turn on the vacuum pump and watch the gauge. It slowly sucks the air out of the frame and makes it as tight as a drum. The gauge should read about 25 pounds vacuum. When it does, you are ready to expose the sheet using an overhead light source (point-point preferred). You will have to establish your own developing and exposing times. Most of the lithographic developers require about 2 1/2 minutes. The resulting reverse image will enable you to expose each half of the two-piece strip with accuracy. If you ever have to hold back lettering in one area of the layout, you can easily make a large KODALITH mask. After reversing it in this vacuum frame, you can use it either way, burn in or hold out.

Processing Separation Negatives and Masks

The methods for processing separation negatives and masks include: hand processing in a tray, a roller transport system and tank or tube processing. Each of these systems has advantages and disadvantages. For instance, in hand processing in a tray, it is difficult to be exact in repeating time and agitation. The advantage is that it is fast and very inexpensive, and it involves relatively simple chemicals. Only three trays are required, and they can easily be temperature-controlled by placing them in a tank of water that is regulated by a thermostat. If you follow my suggestions, you will be able to repeat your agitation quite consistently and reliably.

Here is a tip: If you decide to tray process, buy an inexpensive metronome from a music store and set it to beat 60 times a minute. If you can move three sheets of film in a tray from the bottom to the top, one every second, there is no reason why you will not be able to process evenly and without trouble.

I recommend the following method of tray processing: For three sheets of 8 x 10-inch film, use 34 ounces (1000 mL) of developer, stop bath and fixer. Make sure the temperature is consistent. Most thermometers are not precise, but if you use the same one, make sure it reads the same each time.

The timer is important. You should be able to see each second clearly. I have used a GRALAB Timer for years, even though it runs in the opposite direction from a normal clock.

After the lights are turned off, place the three sheets of film on a table or other dry area near the processing sink, face down. Insert the red-filter negative into the developer, first face down, then face up, then face down again quickly. To prevent bubbles of air from being trapped, use a swirling motion and by placing all five fingers together on top of the film and pushing down, dislodge most of the air bubbles. Do this with all three sheets as you feed them into the tray at 5-second intervals. Move one sheet of film from the bottom to the top of the tray, always with the emulsion down. By following this procedure, you should be able to get extremely smooth backgrounds. All it takes is practice. If you start your timer and add a sheet every 5 seconds, add 5 seconds to the timing of the second sheet that you enter into the developer, and 10 seconds to the third. The rate of agitation is unique. No one will develop film the same way that you do.

Making the Matrices p. 30

The final stage is making matrices or ''running the print''. This is where you can make life easy or a nightmare. The problem is how do we figure out the first exposure. Place the red-filter negative in your enlarger carrier, emulsion up, on the registration pins. Place the cover glass over it to see if it fits snugly. All film should fit without being stretched; this is a common reason for misregister. Remove the cover glass and place the other pieces of film on the pins on top of the red-filter negative in order: first, the highlight mask, then the specular mask, then the very important sheet of RUBYLITH or orange masking material with the negative image area cut out to eliminate any white light from escaping the carrier. Finally, add color-correction masks (see page 00) or any other hold-back mask.

Enlarge this image including the Three-Point Transparency Guide to the size that you want. After focusing with the lens wide open, stop down to between _f_/8 and _f_/11. Place a sheet of 8 x 10-inch matrix film on your easel, emulsion down, under safelight conditions. [A KODAK Safelight Filter No. 1 (red) is recommended.] Make a series of test exposures across the film at 3-second intervals, as follows: Cover the film with a sheet of black paper, and leave about a 1-inch section uncovered on the left side. Expose this 1-inch piece for 3 seconds, then move the black paper another inch to the right and expose another 3 seconds. Keep doing this until all of the film has been exposed. If you do this correctly, it will be exposed in a series from 3 to 30 seconds.

Process the sheet in KODAK Tanning Developer A and B, with a ratio of one part A to two parts B for 2 1/2 minutes at 68°F (20°C). Place the sheet in a stop bath (1% acetic acid solution) for 45 seconds, then in a non-hardening fixer until it clears. Now you can turn on the white lights. Rinse the sheet in hot water with repeated changes until you think all of the untanned gelatin has been removed. Wash it at least three times. The hot water should be between 110 and 120°F (43 and 40°C). After washing, chill the matrix film in a water bath 68°F (20°C) and dry it. If you don't dry it, you will have to wait too long for it to dye properly.

After drying, place the matrix in a tray containing fresh cyan dye. After about 5 minutes, rinse the matrix in the first tray of 1% acetic acid rinse for about 1 minute to remove the excess dye; place it in the second tray of 1% acid rinse and then transfer it to a sheet of KODAK Dye Transfer Paper that has been prepared in KODAK Paper Conditioner. Roll the matrix down with determination, let it sit for 4 or 5 minutes, then peel the matrix off the paper. It really is not necessary at this point to dry the print. Place it in a viewing area where you can see the transparency as well as the test print. You should be able to find the exposure that looks closest to the transparency by viewing both the print and the transparency through a KODAK WRATTEN No. 29 (red) Filter. Can you find one of the exposures that most nearly matches the density of the transparency? If you cannot, you will have to modify your exposure either up or down until you find something close.

In this case, the 15-second exposure looks good. At this point, there are a few options in ways to find the other two exposures:

You can read the middle step of the Transparency Guide on a densitometer and arrive at some numbers that can be calculated, but that would not really be accurate enough.

You can also make paper bromide prints from each separation negative and try to match neutral areas in the photograph, then figure out the relative speed differences. That is not as accurate as it should be.

You can use a meter on the easel and by reading the middle step on the Transparency Guides, get enough information to give you all three separation exposure times. This is the way I do it.

You can introduce color correction at this point. Suppose that you decide that the transparency is not the color that you would like to see in the final print. You can add filters to the transparency until you are pleased with the look. By adding the value of the filters to the proper matrix exposures, you can achieve a proof print that will reflect the changes that you are looking for.

The exposure for the cyan matrix is 15 seconds. Set your densitometer at a reading of 10 on the ''second scale.'' Replace the red-filter negative with the green-filter negative and all of its companions, including the specular highlight mask. Read the middle step of the Transparency Guide. It reads 11.5. Do the same with the blue-filter negative. It reads 12.5. The next step is simple mathematics:

(15 is 1.5 x 10)

Negative	Meter Reading	Exposure Time
Red Filter (Cyan Matrix)	10	15 sec.
	(10 x 1.5 = 15)	
Green Filter (Magenta Matrix)	11.5	17.25 sec.
	(11.5 x 1.5 = 17.25)	
Blue Filter (Yellow Matrix)	12.5	18.75 sec.
	(12.5 x 1.5 = 18.75)	

If you wanted to add .10 density to the magenta (10 magenta filtration), add .10 using the logarithm scale on your slide rule or scientific calculator. The new exposure is 21.6 seconds.

For the time being, use the exposures of 15, 17.2 and 18.7. Expose a set of matrices in the order cyan, magenta and yellow. Notch the film anyway you see fit for identification. Process them by placing them in the combined KODAK Tanning Developer A and B at 15-second intervals and interleaving them for 2 1/2 minutes. You may harden the matrices when you are through with the hot water portion of the process. This is an option and not necessary, but I do it. When everything is dry, place the matrices in their respective dyes and let them rock for 5 minutes. They should be completely dyed by that time.

Making Matrices by Contact -- The technique of making matrices by contact is not often done today. It is great if you have a large negative (see pages 00 for how to make large negatives). If you make a 16 x 20-inch negative reversed and printing emulsion down on a sheet of matrix film, and if you make your exposures with a point-light source and a print frame, you will eliminate flare and probably have the best print that you will ever make.

Overexposure on a sheet of matrix film will cause trouble because you will have to use so much chemical control to remove the unwanted dyes that you will end up with a very flat and maladjusted print. Make sure that you have a very accurate exposure. You can be 5% heavier than normal at the most and right on the button if possible, but never get underexposed. If you get too light, you will end up restrengthening your dyes by using extra replenisher and putting acid in them. That is the worst thing you can do. I will show you how to get your matrix exposures exactly on target. There are a lot of ways you can do it, for example, by utilizing black-and white bromide prints and also electronic meters, such as densitometers, analyzers and on-easel photometers.

Using a Meter to Make Matrices -- Working with an on-easel densitometer or analyzer to expose matrices will make life a little easier. It is really all you need. The more sensitive the meter is, of course, the better. If you use a meter, make sure that the image of the Three-Point Transparency Guide appears on the easel. A simple zeroing of the cyan M step reading with the magenta and yellow M steps will provide a close approximation of the transparency.

p-32 a, b + c

When you have decided on a particular set of exposures, don't try to make a ''final'' set of matrices. Instead, print only a small portion of the transparency to see how close you really are to your desired balance. If your print is too far off for you to see what is wrong with it, make another test or look at the results through the correction filters used in making prints on EKTACOLOR Paper. If you can determine what filtration corrections are needed, simply use logarithms to determine the new exposure. For instance, if you need a .30 magenta and a .15 yellow addition to your print, you will have to add 100% to the magenta exposure and 50% to the yellow exposure.

Using Black-And-White Bromide Prints to Judge Dye Transfer Color Matrix Exposures

p-31 a, b, &c

Making a set of black-and-white bromide prints from a set of separation negatives is not new. In the years before the KODAK Wash-Off Relief Process and dye transfer, the only real color process was tricolor carbro. With the carbro system, black-and-white prints were made on silver bromide enlarging paper from the separation negatives because it was the bromide print that was combined with the color pigments in order to produce a final color image. This was routine for every carbro printer. When dye transfer made its appearance in 1947, the people who were used to making bromides to establish balances kept making them. There were a few variations to their final use, but the end result was worth the trouble.

One technique was to mix up a reliable black-and-white developer, like KODAK Developer D-72. Using a paper that had a No. 2 grade, we made a bromide print from the cyan printer and compared it to the transparency by looking at both of them through the same KODAK WRATTEN No. 29 (red) Filter that was used to make the red-filter separation in the first place. We were looking for a comparison that was very close for density. We tried to find an area in the photograph that had a white or some kind of neutral tone. We made exposures of the magenta and yellow printers until the areas that we were trying to match looked about the same density on the bromide prints. We found a white shirt or other neutral area and folded the magenta and yellow bromide prints, one at a time, over the cyan bromide print to examine the same three areas closely for a density match; we kept adjusting the exposures until they matched. In fact, with enough experience gained, a good carbro printer could adjust the balances slightly to make grays look either cool or warm.

When dye transfer came along, the problem was how to determine the proper exposure for the matrix film when all we really had made were black-and-white prints. The answer was to expose the same section of the photograph onto matrix film from the cyan printer. Numerous exposures were made to find a density that was close to that of the cyan bromide print. When we found this exposure, the rest was rather easy. If 10 seconds was our bromide exposure and 20 seconds was our matching matrix exposure, then a factor of 2 was applied. The next step was to use the factor to arrive at the proper exposure times for the other matrices.

Although the process sounds comparatively simple, there were many other items that needed serious attention. The developer had to be kept at the exact temperature. The mixture had to be repeatable, and the age of the developer had to be considered.

Repeatability was the biggest problem to solve. But there was a way to overcome this. Instead of worrying about these factors and not knowing if the contrast was even close, we simply used a KODAK EKTAMATIC Paper Processor and KODAK EKTAMATIC Selective Contrast Paper. This paper is selectivley controlled for contrast by using KODAK POLYCONTRAST Filters. The age of the developer has no bearing on the system since the developer is incorporated in the paper. The activator solution in the machine works with a replenishment system; temperature has little to do with its repeatable performance. This takes the guesswork out of making bromide prints because as long as the machine is kept clean and replenished, the results are repeatable.

Contrast is another difficult issue, but the remedy is relatively easy. A contrast has to found in the black-and-white paper that closely matches the contrast of the matrix film. Make a series of black-and-white EKTAMATIC Paper prints of a 21-step silver step tablet, using every filter in the POLYCONTRAST Set, until you find one that matches a cyan-dyed image of the matrix film exposure of the step tablet. Examine both the cyan image and the black-and-white prints through a No. 29 (red) Filter. You should be able to find not only the proper contrast level but also the proper exposure factor.

If your system indicates that the filtration for a No. 3 paper grade is needed to match the same contrast of matrix film, then whenever you make bromide prints for this purpose, use the No. 3 Filter. This will be true for as long as the bulb in your enlarger is still working, and the paper and film emulsions have not changed.

Once you have established a close relationship with the contrast and density that is required to make a good copy of the step tablet, try a real set of separation negatives.

First, make a series of test-strip exposures from a cyan printer (red-filter) separation negative onto matrix film. Use an 8 x 10-inch sheet so that you can place many exposures on it. Process, dye and transfer the sheet normally. In a well-lighted area, compare it to the transparency from which it was made. Use a No. 29 (red) Filter to look through as you evaluate for the proper density. When you find the proper exposure time, go back to the darkroom to expose a full 8 x 10-inch sheet of matrix film and, again, process it, dye it in cyan dye and transfer it to paper.

Expose a number of test strips on one sheet of EKTAMATIC Paper to the same image that you used for the matrix film. Remember to use the proper contrast filter when making these bromide prints. Select the closest density and re-expose a full 8 x 10-inch sheet, then compare it to the cyan dye print which was previously made. This time look for density and contrast comparisons. If your bromide print is too flat or too contrasty, you probably did not get a very accurate set of tests originally. Use POLYCONTRAST Filters to increase or decrease the contrast of the bromide print until one matches the contrast and density of the cyan dye image. Remember to use the No. 29 (red) Filter whenever comparing the bromide print to the cyan dye image. Once you have found this match, write down the data. You have now established the difference between the bromide exposure and the matrix exposure. Divide the paper exposure into the matrix exposure. This number is the factor used with which to multiply bromide exposures in order to find the matrix exposures. Here is an example: The bromide exposure is 20 seconds and the matrix exposure is 35 seconds. If you divide 35 seconds by 20 seconds, the resulting factor is 1.75. Therefore, any time you make what you think is the proper density exposure on a black-and-white bromide print, multiply the exposure by 1.75 and the answer will be correct for exposing the matrix film.

Now we come to the second half of this important technique. You already know what is required to make a matrix look like the bromide print. The next step is to make a bromide print that will produce a fine image. This can be done without the use of an analyzer or any other kind of electronic marvel.

You should use a decent set of separation negatives for this part of the system, or you will be very disappointed in the results. Make bromide prints from the cyan printer until you think the density looks great. (Don't forget the red filter when comparing bromides and transparencies.) Try to find a neutral area, such as a white shirt, a gray panel or gray sky, or anything that has almost no color in it. Make further bromides from the magenta and yellow printers until all of the gray or neutral areas in each look about the same density. Also fold the three bromide prints adjacent to each other under a good light source and examine them closely. When you are satisfied that they balance, make a small set of test matrices of the same area, process them and transfer them. If you have a sharp eye and can see small differences in density, you should get an accurate color test. Don't try going directly from a set of bromide prints to a full set of matrices yet -- not until you have made a number of sets of tests to verify your judgment. If you have good judgment and imagination, you should be able to make many different kinds of flesh tones by carefully producing small, deliberate changes in the overall balance.

What do you do when there are no neutral areas in the transparency to examine? This is the second way to make bromide prints that very carefully match the transparency. When making the separation negatives, add the Three-Point Transparency Guide to the edge of the transparency so that it will show in the final separation negatives. The primary reason for the Guide is to enable you to determine whether or not the overall balance of the separations is close enough to continue making a print. Here is where the Transparency Guide can be used to produce a very good set of bromide prints which, in turn, will provide a much more accurate color print.

Be sure that the Three-Point Transparency Guide shows on the outside area of the bromide print made from the cyan printer. Make your bromide print as near as you can to the overall density and contrast by using the red filter and developing near-identical comparisons. When you have accomplished this, make bromide prints of the other negatives until all of the Guides (not the image) look alike. When you think they look identical, make your calculations and expose a set of matrices. You will be pleased with the results because you have eliminated the most destructive part of printmaking -- the uncertainty of the effects of flare.

Remember that Kodak made it easy to make bromide prints. This system makes it simple to understand how the entire separation process works. Because you can make bromide prints and get an accurate balance, you will be free from some of the toughest problem prints that you will ever face. For instance, you might make a set of negatives of a photograph of a dancer, who has red hair, lips and nails and is wearing a red dress and shoes in front of a red wall. Your separation negatives should look something like this: The red-filter negative will be quite heavy, the green quite empty, and the blue almost as bad as the green. If you have a Transparency Guide in the photograph, you can read it with a densitometer and come up with the correct exposures, providing that it is made by contact. However, if you should attempt to make a set of matrices from image readings alone and are going to use an enlarger, then disaster will strike. You will probably want to sell the densitometer because you will think that it has failed you. The real culprit here is flare. Try an experiment with a set of negatives made from a transparency with a predominant color. Make a set of matrices based on image readings alone; read the middle step of the Transparency Guide on the easel with an on-easel meter. The difference in balance will amaze you.

Making Prints

You are now ready to make the actual transfer. There are many ''schools of thought'' on the subject of rolling matrices or what we call ''running prints.'' I will tell how I like to do it, and I will explain how some other laboratories do it.

After rinsing the first matrix in the first 1% acetic acid rinse for 1 minute, drain it and place it in the second 1% acetic acid rinse. While it is in the second tray, put a sheet of paper previously prepared in KODAK Paper Conditioner on the transfer surface, about 1/4-inch away from the registration pins. Roll it down tightly, and squeegee it off the surface so that all traces of Paper Conditioner are gone. At this point, with a clean sponge, freshly moistened with acetic acid rinse, sponge the entire surface of the paper. Pick up the matrix in such a way as to hold as much of the liquid as possible, and then trail the acid rinse across the area near the pins to make a bead of liquid where the matrix image will start. Hold the matrix so that the leading edge is in your right hand as you guide it to the first pin, while your left hand holds the center of the trailing edge. Once the pins have been engaged, pick up the roller with your right hand and place it in front of the pins. Meanwhile, your left hand is holding up the matrix so it does not touch the paper where there is any image. Try to ''square'' the roller against the pins by pulling the roller back against them. Once you feel that you have the roller properly set, commence the roll-down, all in one motion. Lead the matrix in front of you, and don't put any pressure on holding the matrix film with your left hand. After the initial roll, let it sit untouched for a minute or two.

Most other laboratories will not moisten the print paper with 1% acetic acid rinse because they feel that this slows down the ability of the paper to accept the dyes. They might be right. But I know that with my method the matrix will transfer without any air bells which cause skipping (missing spots of color).

Let the matrix sit for about 2 minutes, then squeegee the print thoroughly, before you start the magenta matrix through its trip in the first and second trays of acid rinse. Leave the magenta matrix in the second tray while you carefully lift the far edge of the cyan matrix; as you slowly peel it away from the paper, use your roller on the matrix film as a weight to pull against. This will prevent the paper from moving. Look for any skipping or possible lack of transfer. If you see evidence of color on the matrix film, replace it and let it sit longer. If the color persists in not transferring, moisten a piece of cotton with Paper Conditioner. After lifting the matrix enough so you can see the affected area, dab a little Paper Conditioner on the blank spot, then reroll.

When that transfer is complete, run the next color. The order of color transfer is not critical, but in order to keep some continuity, run the cyan first, magenta next, and yellow last. If you have a print that is predominant in magenta, by all means break the order and transfer that color first.

Repeat the same pattern for the yellow matrix. Make certain that each matrix removed from the print is washed in running water to remove all traces of Paper Conditioner and other dyes. The magenta matrix will pick up some of the cyan dye, and the yellow matrix will absorb some of the magenta and cyan dyes. Rinse these matrices and drain them before replacing them in the dyes.

Now, you have made a proof print. Does it come close to your expectations? If it does and this is your first print, you have done your job right. But if it doesn't quite fill the bill, don't be discouraged. Try the method again after you have reviewed and mastered the various steps involved.

The Final Viewing, Retouching and Finishing

The stages of viewing, retouching and finishing are the culmination of all the previous work. If something was wrong from the very beginning of the job, this is where it really appears. To work efficiently, you will need a well-lighted room or part of a room. If you prefer daylight for viewing your final work, make sure that it is north light, not sunlight. North light is preferred by artists and retouchers, but frankly, most people do not look at color prints near open windows. The only people who are dogmatic about looking at prints properly are the production managers of advertising agencies. Most other buyers of color prints have as many ways to view a print as there are light sources.

The worst way to look at anything pertaining to color is with uncorrected fluorescent lights. Most rooms are lighted with 2800K lights. These are really too warm for my taste; yet, most galleries that display paintings have very warm, bright lights shining on the artwork. Even if you make dye transfer prints for an art director of an advertising agency, it does not mean that he will look at the final print with the correct light.

Follow what is considered the standard by the entire engraving field in the United States -- the 5000K print viewing box and the 5000K standard transparency viewer. Of course, you may vary your interpretation of what you think the final print should look like, but you will have a standard starting point.

Not all transparencies look as good as they can when viewed by only one light source. That is why I previously mentioned the variable light source which I use when I work with my clients.

The viewing area in your laboratory should be big enough to place at least three prints against the viewing wall so that comparisons can be made easily. If you don't want to purchase a manufactured viewing box, you can place your own color-corrected lights above your workspace; by measuring the strength of the lights at the viewing level, you can approximate a ready-made system adequately. A transparency viewer should be placed close enough so that easy comparisons can be made with originals. p.35

Spotting and Bleaching -- No matter how carefully you have made it, any dye print will contain a few unwanted spots here and there. Making these spots disappear is not difficult. You only need fine artist's brushes, some dye transfer dye concentrate for all three colors, and a little practice. Buy the best quality brushes that you can from an art supply store in the No. 00, 0 and 1 sizes. Try them out before you buy them by dipping them in a glass of water and flicking them toward the floor. If they come naturally to a single point, they are good; if they form several points or a bushy tip, don't buy them. You will need a white porcelain dish for holding a few drops of each of the dye concentrates from the set of dyes that you have been using to make prints. Also have handy a small glass of 1% acetic acid, some cotton batting and lintless blotters.

If you have a colored dot in the print that is lighter than the surrounding area, it means that there was a speck of dust in the enlarger when you made the matrix; if the spot is darker than the surrounding area, it means that you had a dust speck in the enlarger when you made the separation negative. The first type of spot can be repaired easily; the dark spot is more difficult, and if there are many of them, it is easier to remake the separation negatives -- this time with greater attention to cleaning the transparency.

To spot a small, light area in a print, wet your brush in the 1% acetic acid solution and pick up a tiny amount of dye the color of the surrounding area. (You will find that usually you will have to mix at least two dyes, and often all three to get the color even close.) Now stroke the brush on the blotter paper until it is almost dry, then, with the tip of the brush, dot a little of the dye into the light area. Keep the dots tiny and fill the area with them. If you work slowly and don't get too many dots in the area, you will be able to match the surrounding color exactly -- after a bit of practice. Good reading glasses or a magnifying glass helps with this type of work.

Dark spots must be bleached with chemicals and each of the dye transfer dyes has its own bleach. Cyan dye can be bleached with a weak solution of potassium permanganate. Mix about 1/3 ounce (10 g) of potassium permanganate in 32 ounces (1 L) of 1% acetic acid solution. Try to make it look like a ''Vin Rose'' wine color. Using a cotton swab or an old retouching brush, dab a little of the solution on the spot and watch it carefully. It usually bleaches rather rapidly. You can stop the action by applying fresh 1% acetic acid solution. The darker you make the potassium permanganate solution, the more dye it will take out. You can also reduce larger areas of cyan dye by applying the bleach in a very weak solution with a cotton swab. Too much bleaching will result in a loss of sharpness. If you get a stain from the stronger solutions of potassium permanganate, you can clear it with a 1% potassium metabisulfite solution. Add 1/3 ounce (10 g) to 32 ounces (1 L) of 1% acetic acid solution; sponge this solution on the stained area until it is clear. Follow this and any other bleaching action with 1% acetic acid solution, applied with a cotton swab. You will notice that this will prevent bleeding of the dyes and fading of the print with time; plain water will destroy the print.

Magenta dye is easier to remove than the others. Apply undiluted KODAK PHOTO-FLO 200 or PHOTO-FLO 600 Solution to the area with a cotton swab. Let it sit for a very short time (3 or 4 seconds), then wipe it off with a cotton swab moistened in 1% acetic acid solution. Be careful because there is a danger that, as you wipe away the PHOTO-FLO Solution, you may stain a clear area with dissolved magenta dye. Do not use too much PHOTO-FLO Solution and learn when to stop. Large areas can be reduced by diluting the PHOTO-FLO Concentrate with 1% acetic acid, but if the print needs extensive work, it is easier to make another print and use wash-back controls.

The yellow dye was the biggest retouching problem for many years. However, we found that a 25% sodium thyocyanite solution will remove it quite easily. Apply it with a brush or cotton swab, and wait until the print begins to look quite purple before stopping the bleach with 1% acetic acid. Some of the color will come back as you rub on the acid.

Finally, you can bleach an area down to pure white by using a much stronger solution of potassium permanganate combined with a sulfuric acid solution (See the Formula section on page 00).

With any of these chemical solutions, be very careful about splashing on your skin or in your eyes or mouth; they are dangerous!

After any chemical treatment, return the print surface to the proper condition with a 1% acetic acid treatment.

When evaluating a print for retouching, remember that there are two ways to go. You can remove color, but you can also add color. If parts of a print are too red, blue or even yellow, you can bleach the offending color or you can add a little of its complementary color. If the print is red and light, a wash of cyan dye will neutralize the red and add a little density as well. However, if the print is red and dark, all you can do is remove the red by taking out yellow and then magenta in a time-consuming session.

The Dry Mount Press and Its Use

The final touch is mounting the print. There is no magic here -- only good, clean workmanship. Use a good press. I prefer a large model called MASTERPIECE, made by Seal Manufacturing Company. Kodak and Seal both make very good dry mounting tissues. The temperature control on the press should be set no higher than 215°F (102°C). Preheat the press and all of the items to be placed in it before you use the dry mounting tissue. Use double-weight mount board and ordinary mat board, not the "archival" kind that has been acid-neutralized with sodium hydroxide; it will make the dyes bleach out completely where the print touches the mat.

Make sure before you start dry mounting prints that the area is absolutely free of dust and dirt. Use a vacuum cleaner on the table, on the press and on all sheets of mount and mat board to remove any bits of material that might get between the print and the mount board and cause a bump in the final presentation. Clean the bottom of the hot press-platen with a tissue; you might be surprised at what you find stuck there.

After the print and the mount board are clean and have been preheated in the press for about 10 seconds to remove any moisture that may be in them (cover the print with a sheet of lintless blotter paper to keep it from scorching), turn the print over on the clean, flat tabletop and tack a piece of dry mounting tissue to the back. Use a tacking iron, made for the job and available at photographic supply stores. I make my "tacks" in the middle of the sheet. Make sure that no wrinkles appear; you will see them in the print. Next, position the print on the mount board, face up and centered. Now lift three corners of the print and tack the dry mounting tissue to the mount board, again without wrinkles. Cover the print face with blotter paper and place the sandwich in the press. Open and close the press several times quickly, then close and lock it down for at least 30 seconds. When the time is up, open the press, remove the mounted print and quickly place it, face down, on the cool tabletop. Place a weight, such as a large book or package, on the back of the mount board to hold it down firmly. When it has cooled, test the tightness of the mounting by bending the board slightly back-and-forth. It may pop loose and you will have to do the whole job again; if this happens, leave the sandwich in the press longer.

Most advertising agencies prefer dye transfer prints that are not mounted to heavy board because the scanners used to separate the print for press plates require that the print be completely flexible so it can be wrapped around the scanner drum. If you must mount the print for a scanner, use 2-ply STRATHMORE BRISTOL Board which will bend easily.

The presentation of the print is almost as important as the quality of the image itself. You can have a beautiful print, but if it is presented improperly, you may lose the account. After the print is mounted, you should cover it with a protective sheet of tissue or clear plastic. Cut a mat to frame the print for an even more attractive presentation. This may not be necessary for advertising agencies, but it is almost a requirement for anybody else. Remember to put your name on the back of the print with any other pertinent information. You never know where your next account will come from, and your work is your best advertisement.

A SUMMARY: MAKING SEPARATION NEGATIVES--TWO WAYS

Basically, there are two ways to make dye transfer prints: by making contact separation negatives or by producing enlarged separations. Let's see how each process works. First, I will make a set of separation negatives by contact, I will explain how the matrices are made, and we will then run the print together. Then, I will make a second set of negatives enlarged from a 35 mm transparency to 8 x 10-inch film, and finally I will make a set of matrices using a slightly different system for determining exposures.

Overall Plan

With either method of making separations, you should have a logical plan to follow. These are the steps for making the print:

1. Analyze the transparency. Determine what it should look like as a print.
2. Determine the density range of the original (if there are no good blacks or whites to read on a densitometer, make a judgement by eye).
3. Determine what the limits of your enlarger are and what film you plan to use with the density range of this subject.
4. Determine the <u>average density</u> of the original.
5. Decide the need for straight- or split-masking.
6. Determine the correct gamma for the masks.
7. Verify the exposures and developing times for the masks. Expose, process and dry the films.

8. Determine the average density of the combined mask and transparency.
9. Determine the exposures for the separation negatives. Expose, process and dry the films.
10. Determine the highlight negative exposures. Expose, process and dry the films.
11. Determine the need for specular highlight masks.
12. Determine the exposure. Expose, process and dry the films.

Contact Separation Negatives

p-40

In the first method, the transparency is a scenic on 2 1/4 x 2 3/4-inch film. I make my matrices with a 4 x 5-inch OMEGA DII Enlarger, equipped with a registration negative carrier solidly braced to prevent vibration.

Initially, I prepare the transparency for making the separations. I use a 4 x 5-inch sheet of discarded film the same thickness (4 mil) as the transparency. I secure the transparency, emulsion up, in the exact center of the 4 x 5-inch sheet with two small pieces of masking tape attached to each end. Very carefully placing a straightedge along one side of the transparency and using a new blade, I cut a line through the 4 x 5-inch sheet as close to the transparency as possible. I do this to the other side as well and tape the cut edges to the transparency. I remove the first two small pieces of tape from the uncut sides, carefully cut the film and remove the cut-out piece of film so that the transparency lies in a tight "window" in the 4 x 5-inch sheet.

Next, I add the Three-Point Transparency Guide to one of the long sides of the 4 x 5-inch film, near to the transparency. (I will use the images of the Transparency Guide only as a indication to determine when I have reached the specific goals and percentages required for the masks and negatives. They will not be printed.) I turn the assembly over to tape carefully all edges with 3M Polyester Tape (silver), which will not dissolve when I use film cleaner. I place the tape on the base side of the films so that nothing will be on the emulsion side to prevent perfect contact with the separation film.

Probably the most important decision in making a print is determining what the print should look like and finding what there is in the transparency that has to be altered to produce a professional-looking result. Notice the image on page 00. Even though it is on a printed page, pretend that it is a transparency. The highlight area has a density of .55; the shadow area reads 2.95. The density range is 2.40 (2.95 -.55).

I have a density range of 2.40. My enlarger has a range limit of 1.25, which means a good set of masks must reduce the contrast of the transparency so that the range of the combined transparency and principal mask will be about 1.65. I must develop the separations to a gamma of .75 in order to achieve a final density range of 1.25.

Using the following formula, I reduce the transparency by masking:

Shadow density =	2.95
Highlight density =	-.55
Actual density range =	2.40
Desired density range =	-1.65
Difference =	.75

In order to find the proper mask percentage, I divide the difference by the actual density range:

Difference =	.75
Actual density range =	-2.40
Mask percentage =	.312, or 31%.

The chart for determining exposing and developing times for principal masks on page 00 indicates that 30% is achieved by developing for 2 minutes at 70°F (21°C) in KODAK HC-110 Developer in a dilution of 16 ounces (473 mL) of concentrate in water to make 7 gallons (26.5 L) of working solution. This chart was made according to the instructions described earlier on page 00.

Also in that chart are exposures and developing times for several KODAK WRATTEN Masking Filters: No. 29 (red), 61 (green), 85B (orange) and 33 (magenta). The figures will work perfectly, provided the original transparency has an average density of 1.35. The calculations were made from step-tablet readings so that I could determine developing times for each gamma.

If the transparency does not have an average density of 1.35, use the logarithmic scale on a slide rule or an electronic calculator to find the new time.

The new exposure for this transparency should be:

Shadow density =	2.95
Highlight density =	+.55
The sum =	3.50
Divide by 2 =	1.75

The 1.75 is .4 higher than the average of 1.35; therefore, the exposure should be increased by adding the logarithmic difference of .40 to the times for each mask. My original exposure for the No. 29 (red) Filter was 15 seconds and for the No. 61 (green) Filter, 34 seconds. Adding the logarithmic

difference of .40 to these figures will result in 37.6 seconds for the red and 78 seconds for the green. These times may seem rather long, but they depend upon the density of the transparency. Quite often, the exposures will be shorter than the figures listed.

For this particular transparency, I decided to make a set of split masks. The mask that will be combined with the transparency to make the red-filter separation (cyan printer) will be made with half of the exposure through the No. 29 Filter and half through the No. 61 Filter. The mask that will produce the green-filter separation (magenta printer) will be made with the No. 29 Filter alone, and the mask that will produce the blue-filter separation (yellow printer) will be made with the No. 61 Filter. The assembly is pictured here.

I prefer to use KODAK Pan Masking Film 4149 for making principal masks because it is made specifically for making masks. The film has a diffused, flared image and has a contrast level that is easily developed to the proper density range. Every so often there is a need for a sharp masking material, rather than the soft, diffused Pan Masking Film. Then I use KODAK Separation Negative Film 4131, Type 1, developed in the same developer, but with an added equal part of water to 1 part of working solution.

I use a 20-volt NUARK System, set at tap No. 5 (about 18 volts) for my mask-making light source. It has a 20-volt bulb that is about 3200K and has a continuous spectrum.

The masks are processed in a tray that is temperature-controlled by placing it in a larger tray of tempered water or in an automatic water-tempering system. I use a timer that has a luminous dial, not just a bell. I am very accurate with process time and temperature since everything depends upon repeatability of processing.

Next I read the Three-Point Transparency Guide, looking for a 30% masking density. I verify the mask percentage by dividing the density range of the masked Guide by the density range of the original Guide. In this case, the original density range is 1.97; the mask density range is .59, which is satisfactory. If the masks happen to be off .02 in either direction, I can still use them; the contrast changes which are necessary later will be minimal. It is important to verify every step of the process.

I am now ready to expose the separation negatives. I prefer to use KODAK SUPER-XX Pan Film 4142 because it has excellent color response and processes quite easily in a tray. However, there is a small obstacle to overcome initially. Do you remember that I had to change the exposure for the masks because of the difference in average density of the original transparency compared to the one that I used to make the charts? Every transparency has its individual average density. To make the chart, I chose one that I liked and found the exposures to be: red filter, 6 seconds; green filter, 8 seconds; and blue filter, 9 seconds. These times were based on one transparency with specific high and low densities, including the masks. This new average density is to find out what exposure will place the main image densities of the transparency on the straight-line portion of the characteristic curve of the separation film.

The chart indicates that the average density for my exposures is 1.80; anything other than that has to be calculated. The transparency that I am working on has an average density of 2.30. The difference is .50. If I add logarithm .50, I get a new set of exposures: red filter, 19 seconds; green filter, 24 seconds; and blue filter, 28.5 seconds. The developing times which I am currently using (determined by the emulsion characteristics of the separation film) are red-filter negative -- 3 minutes; green-filter negative -- 2 minutes, 20 seconds; and blue-filter negative -- 4 minutes, 20 seconds. All of these times are figured for a developer temperature of 70°F (21°C).

I like to use KODAK Developer DK-60a, which is no longer packaged by Kodak. However, the formula is available and easy to mix. This developer provides a snap and a slightly high contrast that I personally prefer. I like to see detail in my work and don't like mushy prints! Also, I found that the blue-filter negative has a better chance of being developed to a higher contrast without showing the chemical fog that most developers produce just before reaching the proper gamma. With other developers, I never have trouble with the other two negatives, just the blue-filter negative. I am not bothered by grain because most of my work becomes 8 x 10-inch negatives. If I were making separation negatives on 35 mm film (some people do), grain would be a major factor.

I develop the separation negatives in the same manner as the principal masks and make sure to identify the sheets of film by clipping corners or punching notches in them to identify them in the dark. I move the films through the process in an orderly, repeatable manner and use fresh chemicals each time, including stop bath and fixer. The least expensive part of the process should not be the place to try to save money, so I use plenty of chemicals in the trays. Craftsmanship is most important at this stage. Therefore, I try to be consistent, accurate and careful.

I fix the separation negatives for at least twice as long as it takes to clear them and wash them until all traces of the pink anti-halation dye have disappeared -- at least 10 minutes in water that is within 5 degrees of the processing temperature. To speed things up, I keep changing the wash water in the tray to get rid of as much fixer as possible. Believe it or not, fixer left in the negative will alter its exact size and eventually ruin it. I wash my valuable separation negatives very carefully.

After washing the film, I wipe away the water with a soft squeegee, such as those for car windshields or the commercial kind used for washing windows; I hang the film to dry in a dust-free, gentle breeze with as little heat as possible. These polyester films will change shape if they are heated for too long a time. I prefer to air-dry mine, for I usually have enough work in my laboratory to hang a few sets while I work on others.

The final step in making separation negatives is to read them on a densitometer. I don't read the image itself, only the Transparency Guide image; I don't print the Guide, but it will tell me if the overall contrast, balance and exposure are correct. It is virtually impossible to get a perfect-reading set of negatives, but once in a while a set comes up that is extremely close. I keep trying to make perfect separation sets.

Highlight Negatives -- On page 00, I explained how I arrive at the proper exposure times for making highlight negatives on KODALITH Pan Film 2568. (The exposure chart is on page 00.)

Since I found that this particular transparency had a highlight reading of .38 density, I had to decide whether to expose at .35 or .40. I guess I could have interpolated the new exposure, but I went with the .40 density exposure and let the highlights appear a little brighter. My post highlight negatives were exposed: red, 7.8 seconds; green, 7.0 seconds; and blue, 9.5 seconds. They looked great!

p-41
(A-F)

Version Two, Making Enlarged Separation Negatives

There is another method of making separation negatives, which is illustrated by my using a 35 mm KODACHROME Transparency in an oil-filled carrier and making enlarged separation negatives.

In this process, I first mount the 35 mm transparency in a sheet of 4-mil film about 2 1/2-inches square. By placing the transparency, emulsion down, in the center of the sheet and following the same procedure as for the 2 1/4 x 2 3/4-inch transparency in making contact separations, I cut a rectangle in the 4-mil blank to fit the transparency, and tape it in place. The emulsion side is the proper side to tape. Using silver polyester tape, 1/4-inch wide, I tape all four sides, but leave the sprocket holes showing on one side. The spaces will allow the Transparency Guide densities to show through. I use a 2 1/4-inch punch made by Condit Manufacturing Company which makes a 1/16-inch hole at each end of the diagonal; there is plenty of room for the 35 mm transparency. After punching this prepared sheet for registering, I place it on a sheet of glass which has pins that fit the punch holes exactly.

I know that my 8 x 10-inch enlarger (an ELWOOD Enlarger with a modified lamphouse) has a limited density range of 1.2. This is the key number. You should know what your enlarger limit is for the material which you plan to use -- in this case KODAK Matrix Film 4150 (See page 00 for my method of finding the enlarger range). If I know the density range of my transparency, I can proceed. The first thing to do is read the transparency on the densitometer. The readings are:

Shadow density =	2.65
Highlight density =	-.45
Density range =	2.20
Desired density range =	- 1.60
Density difference =	.60
Divide .60 by 2.20 =	.272 or 27%

According to my Principal Mask Chart (See page 00), the developing time to achieve a 27% mask is 2 minutes and 45 seconds at 70°F (21°C).

The exposure to make these masks should be about 15 seconds for the red filter and 30 seconds for the green filter, provided that they are to be made from an original transparency with an average density of 1.35. Do I have an average density of 1.35?

Shadow density =	2.65
Highlight density =	+.45
Sum =	3.10

Divided by 2 = 1.55 or .20 density higher than my standard density

By adding .20 in logarithm to our exposures of 15 and 30 seconds, I have new exposures of 23.7 and 47.5 seconds. Because I want to improve the warm colors and still keep the cool colors alive, I will split the mask exposures as follows:

Red-negative mask =	11.9 seconds, red filter
	+23.8 seconds, green filter
Green-negative mask =	23.7 seconds, red filter
Blue-negative mask =	47.5 seconds, green filter

This combination of exposures on KODAK Pan Masking Film 2568 at the No. 5 tap setting on my NUARC Power Source were developed in a dilute solution of KODAK HC-110 Developer for 2 minutes and 45 seconds at 70°F (21°C). These exposures should produce a good set of miniature masks. They will be contact-printed with the 35 mm transparency by placing both the original and the mask, emulsion down, in that order in the vacuum-contact frame. After applying vacuum to the platen, I make the prescribed exposures. If I mask the glass properly, I can expose all three masks on one piece of film. The only thing to watch for, in addition to common problems like dirt and dust, is flare (See page 00 for how to handle these problems).

The main decision here is whether or not the masks should be made as small as the original transparency, or by enlarging the masks, expose contact separation negatives through them. The latter is the system used by the overwhelming majority of laboratories around the world.

Now that the masks have been made by contact, I am ready to make the separation negatives. I use a 4 x 5-inch registration carrier that takes 2 1/4-inch sheets of film. These sheets have been punched in a diagonal punch and will fit the pins in the carrier. Since this particular carrier is leak-proof, I have the option of using silicone oil.

Although I can enlarge this 35 mm image to any size on a vacuum easel, I like to make my separation negatives to 8 x 10 inches. The larger the separation negatives, the less trouble there will be with the grain of the KODAK SUPER-XX Pan Film showing in the final print.

Once this image is sized, I make sure that everything is locked tightly in place. Nothing should be allowed to move. My vacuum easel has built-in magnets in its base; it will stay put on the metal-clad table.

After stopping the lens down to at least f/8, I make a series of exposures through the KODAK WRATTEN Filter No. 29 (red). My processing time for the red-filter negative is 2 minutes and 50 seconds at 70°F (21°C) in KODAK Developer DK-60a. I read the shadow areas of these tests on the densitometer, trying to find a .40 density. When I find that particular density, I make a note of the exposure, and then place the probe of my analyzer on the lightest area of the image. I make sure to program this density into the meter so that, any time in the future, I can find the proper f-stop for a new transparency.

When you are making contact separations, the level of the light source is constant; only the exposure time is changed, depending on the density of the original. When making separation negatives by enlargement, the time remains constant and the f-stop changes.

By trial-and-error, I know that my basic ratio for exposing a 35 mm pre-masked transparency is:

KODAK WRATTEN Filter	
No. 24 (light red)	8 seconds
No. 61 (green)	20 seconds
No. 47B (blue)	14 seconds

(If the transparency had been on EKTACHROME Film instead of on KODACHROME Film, Process K-14, the exposure would have been: No. 29 (red), 20 seconds, with the rest remaining the same. The make-up of the KODACHROME Film, Process K-14, with its much longer cyan scale, requires a change in the red filter to balance the curves of the negatives.

My developing times for a set of enlarged separations are different from those for a contact set. The reasons are that the light source is different and the images are going through enlarger optics.

The developing times with my system, temperature and agitation are:

red filter	2 minutes, 50 seconds
green filter	2 minutes, 20 seconds
blue filter	4 minutes, 20 seconds

The goal is to make sure that the exposure level is proper -- the shadow densities fall around .40 and the Transparency Guides match as closely as possible. Remember that you are not printing them; you are only using them as guides. They should read alike to be perfect. However, they rarely will, primarily because of flare. Different amounts of light coming through the transparency govern the amount of flare that is introduced with each separation exposure. To get separation negatives to read exactly alike is almost impossible, unless you are making them by contact.

Making Matrices

The procedure for making matrices on KODAK Matrix Film 4150 is similar to making black-and-white prints. The film is sensitive only to blue light, so that you can use a KODAK Safelight Filter No. 1 (red) and a 15-watt bulb at a 4-foot distance. This helps when handling large-size matrices.

In this example, I will make a set of 16 x 20-inch matrices. After I have sized the job on the easel, I use the information gained from exposing the other set of separation negatives to tell me where to start. Knowing that the exposures from the last set of negatives produced good matrices, I use the recorded information to set up the new cyan matrix. I read the transparency guides at this time, mark them and figure out the new exposures by calculating the differences between the readings of the new guides and the old. Before making any exposures, I make sure that I am satisfied with the overall color balance of the original transparency. If I do not really like it, I use viewing filters to find a balance that I do like and either add or subtract the filter densities from the calculated exposure times to obtain a correctly balanced set of matrices. Only then will I make the three exposures through the three separation negatives onto the large sheets of KODAK Matrix Film 4150.

The exposures are 14, 16 and 20 seconds for the cyan, magenta and yellow matrices. They are processed normally and require no specular highlight mask.

Therefore, my method of making dye transfer prints is not complicated and can be done by anyone. It is not essential to have all the equipment that I have mentioned to make high-quality dye prints. There is no question that the proper hardware helps to produce a supurb print, but more important is the person doing the job. You must know what you are doing at all times, and always be alert to where you are in the process. This is not easy to do and many times in the past I have been frustrated. But when the work comes out right and the client is pleased with the results, it is worth the time and effort that I put into making the print.

A-39 (A, B, C, D)

A Dye-Withdrawal Control Technique

The control of highlight density is critical in making matrices. Usually giving a slight degree of overexposure makes sure that all the highlight detail is recorded in the matrix, rather than being lost in washed-out highlights. When the overexposure is too much, the print will appear not only dark, but low in contrast due to veiled highlight areas. This technique, which consists of creating a fourth matrix containing a negative relief image, makes it possible to withdraw or extract small amounts of dye from the printing matrices prior to their transfer to the print surface. The effect of this fourth matrix is similar to that obtained by the conventional use of highlight reducer in that the whites are made whiter; with the withdrawal matrix, excess dye in the middletones also can be reduced for color correction.

After the first unadjusted print has been rendered from a set of matrices, visual judgment will dictate what improvements, if any, a withdrawal matrix can make. A dark or dull print can be improved because withdrawal will make it lighter and have more contrast in the highlights. Veiled whites can be purified and made more brilliant than those obtained by using conventional highlight reducer. The withdrawal technique is particularly helpful in minimizing stain build-up from multiple transfers required when printing more than one color picture onto one sheet of paper (montage color printing).

Making the Withdrawal Mask -- This is a low-contrast negative relief image usually printed from the cyan matrix that is heavier than normal. Make the withdrawal matrix by printing it in contact with the undyed cyan matrix.

Exposure -- Use the enlarger that made the matrix set. Remove the negative from the carrier and place a punched sheet of matrix film on the register board under the enlarger with the emulsion away from the light source. Register the cyan matrix over this with the emulsion facing the light source. Since matrix film lies relatively flat, and since sharpness is not a prime consideration, it is not necessary to use a cover glass. Simply brush the top matrix with the back of your hand to bring the two films into contact.

Use KODAK WRATTEN Filters No. 47B (blue) and No. 96 (1.0 density) in the light beam. The blue filter helps to lower the image contrast, thus permitting more dye to be withdrawn from the middletones of the printed matrices. The neutral density filter is necessary because of the extermely low density of the printing matrix. When working from a matrix film original, expose the withdrawal matrix for the same exposure time as the original cyan matrix. For a KODAK Pan Matrix Film original, however, expose for about twice the exposure time of the cyan matrix.

Processing -- As with any matrix film to be developed to a relief image, use KODAK Tanning Developer A and B in the normal manner and at the normal dilution. But instead of placing the film in a fixing solution after development, place it in a 1% solution of acetic acid for 1 minute before turning on the white lights. Then wash it off conventionally in hot water and dry it. The muddy appearance of the unfixed matrix, due to its extremely low density and contrast, makes it readily distinguishable from the main set.

If the matrix should prove to be overexposed, redevelop it normally in Tanning Developer. Redevelopment will super-harden the relief image and reduce its dye extraction power by about half.

Printing with the Withdrawal Matrix -- 1. Place the regular matrices in their respective dye baths; put the withdrawal matrix in a tray of 1/4% acetic acid solution. Prepare a tray of KODAK Matrix Clearing Bath CB-5. This bath will be used to remove residual dye from the withdrawal matrix after each use.

2. Place a sheet of dye transfer paper on the transfer board. After the cyan matrix has been rinsed and is in the regular 1% acetic acid holding bath (second acid rinse), engage the

withdrawal matrix over the register pins with the <u>emulsion side up</u> and lay it carefully on top of the dye transfer paper. Next, remove the cyan matrix from the holding bath, drain it and lock it over the register pins with its <u>emulsion side down</u>. Roll it quickly into contact with the withdrawal matrix and allow them to remain in contact for 2 minutes.

3. Remove the cyan matrix from the transfer board and place it in the holding bath. Remove the withdrawal matrix and place it in the matrix clearing bath; then roll the cyan matrix into contact with the paper in the normal way, emulsion-to-emulsion.

4. While the cyan matrix is transferring, rinse the magenta matrix in the usual manner and place it in the 1% acid holding bath. Rock the withdrawal matrix in the clearing bath to remove the residual cyan dye, rinse it in two or three changes of warm water and put it in the 1/2% acetic acid bath. Then position it, emulsion up, over the register pins and on top of the transferring cyan matrix. Roll the magenta printing matrix, emulsion down, into registered contact with the withdrawal matrix and allow it to remain for 2 minutes.

5. Remove the magenta printing matrix to the 1% acid holding bath and the withdrawal matrix to the clearing bath. Peel back the transferred cyan printing matrix, rinse it and return it to

the cyan dye. Finally, transfer the magenta printing matrix to the paper.

6. Repeat steps 4 and 5, using the yellow printing matrix.

The entire transfer time is only slightly longer than usual when following this procedure. If the highlight areas of the print appear to be washed out, the withdrawal matrix has too much exposure. Reduce its dye absorptive power by redeveloping it in Tanning Developer, or make a new withdrawal matrix. Experience will indicate the proper method.

Color-Correction Masking with a Contact Intermediate Negative Matrix Image -- A conventional withdrawal matrix produces most of its effect in the highlight areas of the picture, much like a highlight mask or the use of highlight reducer. Dye extraction can be further extended into the middletones by making a withdrawal matrix of lower than normal contrast. To do this, first make an intermediate negative matrix and superimpose it on the original positive printing matrices to lower their contrasts; this, in turn, produces the low-contrast withdrawal matrix. Make the negative intermediate matrix by exposing through all three stacked, registered printing matrices for approximately twice the time required for a conventional withdrawal matrix. Then process it to a negative relief image, dye it yellow and dry it. Since matrix film is sensitive only to blue light, the yellow dye additionally increases the contrast of the intermediate matrix.

When used with the printing matrix to make the withdrawal matrices, its increased contrast will lengthen the scale and extend the effect of those withdrawal matrices more into the middletones of the picture.

Superimpose the intermediate negative matrix over the cyan printing matrix to make a withdrawal matrix for use in the cyan and magenta printing steps. Also superimpose the intermediate negative matrix over the magenta printing matrix to make a withdrawal matrix for use in the yellow printing step. These two withdrawal matrices will give a minor degree of color correction similar to the red- and green-filter principal masks used in making color separation negatives from a transparency.

The withdrawal technique is not intended to be used as a substitute for the masking of the color separation negatives.

Applications of the Withdrawal Technique -- All standard dye transfer printing controls can be used in conjunction with the withdrawal matrix technique. These operations are always performed first. When usual techniques are not adequate, withdrawal methods may help. For instance, it may be possible to save a set of overexposed matrices. One good feature of the withdrawal system is that it generally need not be considered until after the first print has been made. At this point, experience will dictate whether or not the withdrawal procedure can be beneficial.

Withdrawal matrices also make it easier to use printing techniques such as dodging, flashing, block-out printing and derivations.

<u>Dodging</u> -- In dye transfer printing, dodging is next to impossible when exposing matrices. However, dodging the withdrawal matrix is relatively easy. Any area in the withdrawal matrix or matrices can be held back or overprinted to achieve a considerable amount of local control.

<u>Flashing</u> -- A uniform flash density can be added to the image exposure on a withdrawal matrix which will increase the amount of dye extracted from the printing matrices. Flashing can be particularly advantageous in lightening excessively dark subjects.

<u>Block-Out Printing</u> -- A high-contrast withdrawal matrix can be made for certain types of subject matter in which local areas, such as white or pastel backgrounds, need to be kept clean in the print. Expose the withdrawal matrix through either a sandwich of all three printing matrices or any single matrix that has little or no density in the area where dye removal is required. After washing the matrix in hot water, use a cotton swab to wipe away the gelatin image from all areas except the one in which dye extraction is to occur.

Derivation and Posterization -- The withdrawal technique can broaden the conventional controls of density and contrast. It can be used to extract dye from selected areas of individual derivation matrices to create special effects. It can be used similarly in photo-posterization to increase levels of color purity and apparent color saturation.

Making a Fourth Matrix for a Black Printer

A-40 (A+B)

In the photomechanical industry, four printing plates are normally used to produce a color picture. To the cyan, magenta and yellow plates, a black plate is added. The fourth plate is needed because printing is done on paper that is not particularly absorbent -- usually a paper stock that is more-or-less highly calendared or coated with clay. The inks that are used are quite thick and oily. They don't penetrate into the fibers of the paper, but rather remain on the surface where they are dried rapidly by heaters. When the ink gets too heavy, such as when the halftone dots are getting close to 100%, the heaters don't dry the ink and it stays wet as the paper goes through the next set of printing plates, thereby causing a mess. To prevent this problem, printers cut the exposure of the three color printing plates part way up the density curve and replace the heavy triple ink densities with a single laydown of ink from the black printer. The black ink dries as fast as the colored inks do; there is no more undercolor, wet ink smearing on the press.

In the dye transfer process, the paper is coated with a gelatin emulsion that readily accepts relatively large amounts of dye -- far more than is necessary to make a truly maximum black density when all three colors are equally present. A black dye is not necessary for the purpose. However, there are circumstances when black dye will solve a problem caused by job demands or failures of other parts of the system. Often text must be surprinted into a photograph by the dye transfer laboratory; a single, high-contrast, black-printing matrix does the job far better than three high-contrast tricolor matrices because there are no problems in registering minute lettering. In many transparencies, flare from the scene degrades the higher densities in the picture. Silhouettes turn smokey-blue or the heavier shadows have a bluish cast. In such cases, a normal-contrast, black-printing matrix, exposed only enough to record the shadow areas, will correct the problem.

Making the Black Negative -- After exposing the normal tricolor negatives, without changing aperture or magnification, expose a sheet of KODAK SUPER-XX Pan Film for half the time needed for the red-filter exposure. Use a KODAK WRATTEN Filter No. 12 (yellow) in the light beam. Process the film by itself in the same concentration of developer used for the separation negatives for 4 1/2 minutes at 68°F (20°C). Fix, wash and dry the film normally. Clip all four corners as a means of identification.

Preparing the Black-Printing Matrix -- After exposing and processing the three normal matrices, without changing the aperature or magnification, expose the black-printing matrix for one-half the time used for the cyan matrix. Process the black-printing matrix separately and use the normal processing technique. Clip all four corners for identification.

Printing the Black Matrix -- Prepare the black dye bath as described below, put it in a fourth dye tray on the rocking table (if any) and immerse the black-printing matrix in it for 5 minutes. After transferring the tricolor matrices, follow with the black-printing matrix in the normal manner. The usual printing controls work as well with the black transfer as with the tricolor transfers.

Black Printing Dye -- Dissolve the neutral component of KODAK Retouching Colors (dry) in 34 fluid ounces (1 L) of warm water. Add 5 mL of a 5% sodium acetate solution and 5 mL of 28% acetic acid solution. If you want a higher contrast, double the amount of acetic acid. This dye will change color as it is used because the components are exhausted differentially. Add small amounts of KODAK Film and Paper Dye concentrate of the proper color to bring the dye back to neutral.

Making Monochrome Prints

A-41
(A-D)

The impact of an ordinary black-and-white photograph is often heightened by changing the black to some other color. From the beginnings of their art, portrait photographers have toned their prints a soft sepia-brown to imitate flesh tones. Bromoil printers often used colored inks rather than black to make their impressionistic images.

In the dye transfer process, making a single laydown of dye can be done simply, since no color-balance problems exist. Prints in any desired color and in any key, high or low, can be made from a single matrix. You can use any type of black-and-white negative for making a good matrix because the matrix developer can be varied to suit negatives of a density range from 0.5 to 1.30. Color negatives will produce good tonal renditions of a scene in monochrome if you use KODAK Pan Matrix Film for the relief image. Interesting filter effects, similar to those made on black-and-white film with color filters over the lens of the camera, are also possible with color negatives and Pan Matrix Film.

Producing the Matrix -- Making a matrix for a monochrome print differs from preparing a matrix for a full-color print only in the extent that dodging and burning-in of areas during the exposure are as easily done as in black-and-white printing. Make small test prints, as though producing the first red-filter tests in zeroing-in a new matrix emulsion, before making a full-size matrix. Start your test exposures at about twice the normal matrix exposure and go to at least an exposure of four times the normal exposure. The highlight areas of the matrix, when viewed against the bottom of a white tray, should appear like those of a black-and-white print. The image should not be overprinted, but all the details should show. The shadows need not be black if the negative is thin, since the thickness of the relief image, which dictates the shadow density, can be controlled in the developer by the ratio of KODAK Tanning Developer components A to B. Process the matrix normally.

Mixing Monochrome Dyes -- Any color dye is possible by mixing the three KODAK Film and Paper Dyes together in different proportions. However, use KODAK Film and Paper Dye Buffer Yellow with the mixtures as the buffering agent. Three example formulas for soft gray, sepia and red chalk are on page 00 in the section on Formulas.

For black printing dye, use the same formula as for making a black printer (above).

The appearance of the dye solution does not indicate the final color of the print; you have to make a transfer to see the hue and density of the mixture. Then only by recording the dye formula can you repeat the tone in the future.

All of these dyes will change color as they are used because the components are not taken up equally by the matrix. You can replenish the solution with dye concentrate, but it is almost impossible to maintain the exact color for a run of more than a few prints unless you mix a larger quantity of dye at the outset of printing.

Making the Transfer -- Since the monochrome matrix has considerably more exposure -- and more gelatin relief density -- than a normal matrix, its dyeing time must be doubled to 10 minutes. All other steps in the transferring sequence, including density and highlight controls, should be normal.

This type of printing can be carried further by making double or multiple transfers of dye, either of the same color or different colors. The effect of a double transfer of the same dye is to accentuate the shadow areas. Usually highlight reducer must be used to keep the highlights from being darkened. A second transfer of the same color with a matrix reduced with sodium acetate gives a three-dimensional appearance to a monochrome print, similar to a double-dot photomechanical reproduction. The dye reduces from the highlights and middletones first, leaving density only in the shadows. Multiple transfers with different color dyes also renders unusual effects when one transfer is reduced chemically. There is no limit to the possibilities for color combinations and interesting effects.

Hand-Coloring Matrices

A-42
(A+B)(large)

In 1950, Kodak introduced the KODAK FLEXICHROME Process to the photographic industry as a method of making prints and transparencies in full color from black-and-white or color originals by applying dyes of various colors to a gelatin relief image. The image from a single negative was exposed onto a material called KODAK FLEXICHROME Stripping Film. The film was developed to a relief image which was dyed with a black "modeling agent." The image was then removed from the film base ("stripped") and placed on a sheet of white, cleared photographic paper. When it had dried, it appeared to be an ordinary black-and-white photograph. However, when KODAK FLEXICHROME Colors were applied to the paper with a brush, they were immediately absorbed by the image, according to the varying thickness of the gelatin relief image. Unabsorbed color was then removed by blotting. The print responded semiautomatically to the treatment, accepting only a certain amount of the color applied to its surface and modifying it with black to give it the appearance of colored objects in light and shadow. Extreme highlights and white areas did not accept color, consequently they remained white. The applied color gradually removed and replaced the black dye within the image, its effect being apparent in the light and middletones before it could be seen in the deeper shadows. The black remaining in the print played its proper part in establishing tonal values, just as in nature. The final print showed a gradual scale of colors ranging from black to white through any given hue.

The FLEXICHROME Process was used for a number of years in the portrait and commercial photographic fields, particularly in the catalog industry where illustrations of dresses could be made in every color sold, from a single black-and-white original photograph. When the KODAK EKTACOLOR Negative Process gained popularity in the 1950s, the FLEXICHROME Process was discontinued. However, it is still possible to make hand-colored images in almost exactly the same manner as with the FLEXICHROME Process. KODAK Matrix Film 4150 is an excellent substitute for FLEXICHROME Stripping Film because it has the same sensitometric sensitivity. A white backing, substituting for the paper to which the film was stripped, can be provided by painting the base side of the processed matrix with white, water-based latex paint. KODAK FLEXICHROME Colors are still available as KODAK Retouching Colors (dry). Ordinary smooth-surfaced paper towels can be used in place of the blotters originally provided. It only remains for a special developing method to produce the properly hardened relief image on the matrix.

Procedure -- Place the negative in the enlarger so that the image appears <u>reversed</u> in its right-to-left orientation when projected on the easel.

1. <u>Expose</u> the matrix with its base side toward the light source. Make small test strips to ascertain the proper exposure, or use previous experience with making dye transfer matrices since the process is the same.

2. Develop the matrix, emulsion up, in KODAK Tanning Developer A and B for 2 minutes at 68°F (20°C), using constant tray-tilt agitation.

3. Stop the development in a bath of 2% acetic acid for 1 minute. After 30 seconds, the room lights can be turned on.

4. Wash the matrix in four changes of hot water at 120°F (37.7° C), and then place it in a cool rinse at 68°F (20°C) for 30 seconds. Be sure to wash out the trays between hot water washes to remove particles of gelatin which, otherwise, may become attached to a matrix.

5. Harden the matrix in KODAK Special Hardener SH-1 for 1 minute at 68°F (20°C). (See page 00 in the Formulas Section.)

6. Dry the matrix without washing in a dust-free atmosphere with light heat to speed drying.

7. Dye the matrix from 3 to 5 minutes at 65 to 70°F (18 to 21°C) in a tray of black "modeling agent" made from KODAK Retouching Color, Neutral, mixed as for black dye (See page 00). Agitate the tray frequently or use an automatic tray rocker.

8. Rinse the matrix twice in 2% acid rinses for 30 seconds each.

9. Dry the matrix until all water droplets are evaporated. Wipe the film edges with a damp viscose sponge to help remove droplets.

10. Color the matrix by removing it to a drawing table with proper lighting (See page 00) and tape it, emulsion up to a sheet of mounting board. Use the dry colors provided in the set of 10 jars (nine colors and remover) of KODAK Retouching Colors.

There are only four basic steps in coloring in the FLEXICHROME manner. These are repeated continuously with variation to accommodate different circumstances: Apply color to the print, blot, rinse and blot. Initially, apply color to the local areas in the print, where it is absorbed by the gelatin relief image. Pick up the color from its jar with an artist's sable-hair brush that is wet with a 2% acetic acid solution. Remove the unabsorbed color remaining on the surface of the print by blotting -- not rubbing -- with a paper blotter. Remove the slight remaining sediment by rinsing the area with 2% acetic acid solution applied with a brush or cotton swab. Finally, remove the acid solution with more blotting. Mix two or more colors on a glass palette, using 2% acetic acid as the medium. Then use plain water to rinse the brush and to remove some of the dye to lighten the image where necessary.

Any color can be modified or changed to any other color without disturbing the general scale of values in the image. Mistakes in coloring are not serious because they can be readily corrected. The last dye applied to the print gradually removes and replaces the dye that was there before. Therefore, it is possible to recolor an area several times, modifying the color scheme each time until the desired result is obtained. Large areas are done with a large brush in a freehand manner; smaller areas and details are recolored carefully with a fine brush. Highly concentrated dye solutions replace other colors rapidly; conversely, weak dye solutions blend with others, replacing them slowly. Moving the brush back and forth over the area provides more uniform results by eliminating streaks caused by uneven dye absorption by the gelatin relief image.

Acetic acid activates the absorption of the dyes by the gelatin and also fixes them temporarily so that they will not wash out of the image as long as it is in an acid condition. Also, use acetic acid to rinse and clean the surface of the print without washing away dye. The plain water used to rinse out the brushes will also remove color from the print. After using water as a reducer, always reapply a wash of acetic acid to stop the action.

Apply the blotting paper gently and without much pressure. Let the paper do the blotting by itself as much as possible. Too much pressure or a scrubbing motion may injure the gelatin relief image.

The KODAK Retouching Colors Remover does just that -- it takes away the colors from the gelatin and allows more white background to show through. The Remover will not function at all in an acid condition. Mix the Remover with plain water, apply it with a brush and blot the area in the normal way several times until the acidity of the area is overcome and the color reduces to the density that you want. Then stop the remover action by rinsing the area with acid solution.

Continue working the dyes into the print until you are satisfied that it is finished, then allow the colored print to dry thoroughly.

11. Protect the emulsion surface by spraying it with one of the color print lacquers available at photographic supply stores. Either glossy lacquer or any variety of matte or semimatte lacquers work well, depending upon the subject matter of the photograph. Be sure to do any spraying in a well-ventilated area away from heat or open flame.

12. Whiten the base side of the matrix by painting it with white water-base latex paint.

You can transfer the image to dye transfer paper, rather than lacquering the emulsion and whitening the base of the matrix, by rinsing it in 2% acetic acid solution and following the otherwise normal transferring technique.

Restoring Faded Color Prints

A-43 (A+B)

Color prints that have faded, for whatever reason, can usually be successfully restored to full color and density by using color separation and dye transfer techniques. Make in-camera color separation copies of a faded print to reduce it to its basic components of red, green and blue image records. Evaluate the negatives for loss of density and contrast in the image and remake the separation negatives with corrections in exposure and development to compensate for their deficiencies.

Each type of color print has its own fading characteristics. Maintain records of successful restoration procedures, and start with those figures when another photograph of that type is to be restored.

Mount the faded print in a contact-printing frame or on a copy board, include a KODAK Paper Gray Scale (KODAK Color Separation Guide and Gray Scale, No. Q-13 [small] or No. Q-14 [large]), and place register marks at each side of the print. A-44 (A+B)

First, make a set of balanced separation negatives by using the gray scale as a standard, then measure densities in the image to determine the extent of the fading (or additional stain level); finally, make exposure and development corrections on another set of separation negatives. Post-masking for color correction serves as another tool for restoring color and contrast. The corrections don't have to be exact because succeeding matrix exposing and printmaking steps provide enough controls to correct minor errors.

A-45 (A+B)

Before printing, matrices will have to be registered by eye after they are processed and dyed (See page 00).

Substitute Papers for Dye Transfer Printing

KODAK Dye Transfer Paper is designed to work best with KODAK Matrix Films and KODAK Film and Paper Dyes and Dye Buffers as a system for producing color prints. However, many other papers can be treated so that they will absorb dyes in essentially the same way. The treatment consists simply of fixing sensitized photographic paper in a specific mordanting fixing bath, washing it and either using it immediately or drying and storing it for future use. Other types of paper, such as artists' watercolor paper, drawing paper or special, handmade papers, can be coated with gelatin and then similarly mordanted.

Fresh or out-of-date photographic paper may be used. Rough-surfaced papers are difficult to transfer dyes upon without creating mottle. Matte-surfaced papers and papers with too thin a gelatin layer don't produce sufficiently brilliant blacks. Trial-and-error treatment of various papers is the best approach to determining which surfaces are best suited to particular needs. KODAK RC Papers may be used, but color papers require special treatment since they contain optical sensitizing and coupler dispersions; they usually retain a stain if simply treated in a mordanting fixer. The stain can be avoided by treating color papers in a bleach-fix solution, such as KODAK EKTAPRINT 2 Bleach-Fix, for 5 minutes, then washing for 5 minutes before proceeding with the mordanting fixer bath. KODAK RC Color Papers have adequate gelatin thickness to produce good dye transfer prints. There is a light color shift noticeable in dye transfer prints on hand-mordanted paper. However, normal controls in transferring are sufficient to compensate for this shift.

The principle involved in mordanting photographic paper centers the replacement of the light-sensitive silver halide salts in the emulsion with aluminum salts, which act as a precipitant for the dyes and maintain optimum dye sharpness. This is accomplished by bathing the undeveloped paper in an acid fixing bath that contains the aluminum salts. Not all acid fixing baths will do the job. Two that work well are KODAK

Photo-Fix and KODAK Fixing Bath F-5 (See the <u>Formulas Section</u> on page 00).

Treatment may be carried out in room light. However, some papers with a high sensitivity to light may "print out" before they can be immersed in the fixing bath for a sufficient time, producing a reddish or yellowish stain which cannot be removed by fixing. Therefore, immerse the paper in the fixer under safelight conditions before turning on the lights.

Fix the paper at room temperature for a minimum of 3 minutes. Longer fixing time does no harm. Wash the paper for 10 to 20 minutes or as long as necessary to remove residual hypo. The paper may be used immediately by placing it in KODAK Paper Conditioner, or it may be dried with mild heat by hanging it from clips and then stored for future use. Treated paper will keep indefinitely.

Non-Photographic Paper -- Because dye transfer dyes must have a gelatin layer to which to transfer, non-photographic papers or other surfaces must be gelatin-coated before the mordanting process to receive the dyes.

Use one of the formulas on page 00 in the <u>Formulas Section</u> to make a gelatin solution for coating paper or other surfaces to receive dye. Swell the gelatin in cold water and then dissolve it in the 10 ounces (295 mL) of water called for in the formula.

Use the water hot. Add the rest of the components. Filter the solution and, while still warm, float the paper on it for 3 minutes. Dry the paper. Add more gelatin to the mixture or repeat the floating of the paper to get a thicker layer.

An aluminum sulphate mordanting solution may be used to prepare the gelatin for receiving dye (See page 00 in the Formulas Section).

When coating plastic, metal, fine-woven cloth or wooden sheets with gelatin, make several coatings of plain gelatin, drying between coats, then several coatings of gelatin and M-1 Mordant Solution, again drying between coats. For an even, glossy surface, make repeated coatings.

Dye images can be transferred to almost any flat, relatively smooth surface that will hold a coating of gelatin and come into intimate contact with the relief image on the matrix. The possibilities are limitless.

Matrix Film as an Artist's Tool

A-46
(A-I)

The flexibility of the dye transfer process allows segments to be used out of context with the system as parts of other processes. The graphic reproduction medium of lithography has fascinated artists and designers for hundreds of years. It is a process of printing from a flat stone or metal plate by a method based on the repulsion between grease and water. The design is put on the surface with a greasy material, and then water and printing ink are successively applied; the greasy parts, which repel water, absorb the ink but the wet parts do not. A limited number of prints can be put on paper before the image deteriorates. As you can imagine, working on a piece of granite that is several inches thick, or even a sheet of aluminum or zinc, is not the most convenient way to produce a piece of artwork. The press that is needed to make the prints presents an additional expense to the high cost of stone or prepared plates.

Now a similar effect can be achieved without such hinderances. The artist works with pencil, crayon, pen, brush and ink or with any medium that leaves an opaque or semiopaque imprint on a sheet of frosted acetate or tracing paper. In a darkroom, the artwork is exposed onto a sheet of high-contrast film, such as KODALITH Ortho Film 2556, Type 3. That film, in turn, is printed onto a sheet of KODAK Matrix Film 4150. The Matrix Film is processed normally, then dyed any color imaginable in mixed KODAK Film and Paper Dye and Dye Buffer, and transferred to KODAK Dye Transfer Paper. Combinations of images can be transferred to a single sheet of paper, or multiple colors used with the same image and densities can be washed-back using the available dye transfer controls. As many prints as needed can be made at one time or at any time in the future. The artist is freed from the stone, with its weight, printing difficulties and expense.

This new application for an old color photographic printing process can be brought to further lengths by drawing on the base-side of the matrix and by placing opaque objects on it before or during exposure. Since all darkroom work is done under relatively bright, red safelight conditions, the artist can see to perform the task of designing the composition. Employing this method of making graphic images opens up a new world of creativity to artists and designers. A-47 A-48

RETOUCHING AND FINISHING

The primary reason for the longevity of the dye transfer process is the ease and the extent with which retouching artists can change the dye image. From the removing of tiny imperfections in a image to the complete transfiguration of that image, the retoucher has the means to do it without the work showing in the final print. This means that advertising illustrations can be worked on to present the product at its very best. Because dye transfer dyes are used to do the restorations of changed areas, when the print is scanned for photomechanical reproduction, no unwanted dye "print through" of retouched areas will spoil the image.

Space forbids detailed instruction in retouching in this book. However, some of the main points of each area can be mentioned. Remember that this is an art and craft in which it takes years to become proficient. If possible, leave important work to the experts, and learn from them before you try retouching a job.

Retouching is possible in each phase of the dye transfer operation. Separation negatives, being black-and-white silver negatives, respond to the same additions of retouching pencil or dye, and reduce to the same bleaches and etching knives that have been used for 100 years. The matrices also are silver and gelatin images on film, and they too can be reduced with chemicals and etched with a fine blade, although they cannot have density added to them. Finally, dye transfer prints can be bleached, one color at a time or all together, to white paper base. They can have dye added to them in several different ways: with a brush, a cotton swab or an airbrush. All of these techniques are applied daily to bring a near perfection to the images of the advertising industry.

Retouching Color-Separation Negatives

Since color separation negatives are the red-, green- and blue-filter records of a scene, it is important to remember that, although they look similar to each other, they are actually completely different in the composition of their densities. For example, the area of a red-filter negative that depicts flesh tones is heavy in density and rather contrasty in the shadows. The green-filter negative looks almost like a normal black-and-white negative, but the lips are almost clear. Finally, the blue-filter negative is rather lacking in density, and every blemish and freckle shows in extreme contrast. One has to get used to thinking in single color relationships when retouching separations.

Chemical Reduction -- Reduce density from areas of negatives by using KODAK R-4a Reducer (See page 00). Tape the negative emulsion up on a piece of clean glass on an illuminator table. Premoisten the entire emulsion with a solution of one drop of KODAK PHOTO-FLO 200 Solution for every ounce of water in your beaker. Moisten a tuft of cotton with the solution, and gently wipe across the entire negative until it is saturated. Remove droplets with the cotton tuft after you have squeezed the liquid from it.

You can alter the strength of the R-4a Reducer by changing the ratio of solutions A and B. To make it stronger, add more A; to make it weaker, add more B. Start by putting one drop of A and 4 drops of B on a glass palette and mix them with a nylon brush. Keep a tuft of water-moistened cotton in your other hand as you pick up the bleach on the brush; apply it first to a piece of blotter to remove the excess, then to the area of the negative to be reduced. Immediately wipe the area with the damp cotton tuft. Keep repeating this action as the Reducer works slowly, until the area has been satisfactorily lightened. You can stop the action of the Reducer by washing the film with repeated applications of water. Wash the negative very thoroughly when you have finished the reduction. Remember also to wash the other two negatives of the separation set for the same length of time to prevent a diiferential change in image sizes. Do not try to balance a set of separations by reducing one overexposed negative; the chemicals change the curve shape of the film when used overall, and will cause impossible-to-solve printing problems.

Etching -- You can completely remove fine detail, such as specular highlights or extra catchlights in eyes, by etching the high densities to clear film base, or with experience, to middletone densities by using an etching knife. Be sure that the blade is sharp before you shave the emulsion away by holding the blade at a right-angle to the surface and pulling it forward in one direction -- never back-and-forth -- with small strokes. Remember to remove the same densities from all three separation negatives in the set.

Adding Dye -- Add dye to the base side of the negatives in the form of KODAK Crocein Scarlet Retouching Dye or the neutral component of KODAK Liquid Retouching Colors. The Crocein Scarlet is a bright red, water soluable dye and its color stands out on the negative so you can see where you have worked. Since KODAK Matrix Film is not sensitive to red, it acts like a neutral density to hold back light. Without help, it is difficult to judge how much correction you have added, since the red dye does not give the same density to your eye as does the silver of the negative. Viewing the area through a KODAK WRATTEN Filter No. 61 -- the green separation filter -- causes the red dye to neutralize and separate exactly as the silver does. You see a green and black negative and it is very easy to judge your addition of dye.

Premoisten the area on the base side of the negative with KODAK PHOTO-FLO 200 Solution as with the Reducer, before adding dye to large areas, and use a cotton swab to apply the dye evenly. Retouch small areas of the negative by stroking the dye on with a fine brush; to come up to a sharp edge or remove tiny highlights, work on the emulsion side of the negative. For normal retouching, dilute the Crocein Scarlet stock solution: 1 part of dye to 10 parts of water. The stock solution, mixed as directed on the package, can be used to spot pinholes or opaque backgrounds. To reduce the dye density, sponge the area with water-soaked cotton; to remove it entirely, use a 3% ammonia solution, then sponge with water to stop the action and remove traces of the chemical. Wash the set of negatives for 10 minutes in running water at 68°F (20°C), then bathe it in PHOTO-FLO Solution before drying it and starting the dye addition again.

Pencil Retouching -- Start applying pencil to the emulsion side first, then if you cannot get enough density, add KODAK Retouching Fluid to the base side and add pencil there. Use a soft grade of retouching graphite, such as 2B or 4B lead, where you need strong density; use harder grades of graphite -- 2H, 3H or 4H -- where there is only a little density to add. Sharpen the pencil to a long, tapered point, or use a graphite lead holder similar to a mechanical pencil, which grips the retouching lead while you work but has a twist-locking device allowing you to retract the lead for safekeeping. Create a stipple effect by putting tiny dots on the emulsion for small defects; use a semicircular movement for larger areas. With any type of stroke, keep it tiny and even so it will blend with the silver densities.

Remove pencil retouching by wiping the negative with dry cotton, or if you have used retouching fluid, by adding another coat of fluid.

Retouching Matrices

The only thing that should be in need of retouching on matrices is black spots from pinholes in the negative or plus-density spots that are the result of gelatin specks or other foreign matter attaching itself to the emulsion during the processing cycle. In either case, you can remove the gelatin relief in the area by etching it carefully after the matrix is dry, or by hardening the spot with KODAK Reducer R-2, which is a solution of potassium permanganate and sulfuric acid (See page 00). (An alternative unofficial formula replaces the sulfuric acid with double the quantity of glacial acetic acid.) Add the solution to the plus-density area with an old brush, allow it to stand for a few minutes and then clear the stain with a 1% solution of sodium bisulfite. Rinse the matrix in running water after treatment.

If you find plus-density spots during the transfer operations, you can remove them so that they will not appear in subsequent prints by swabbing them with cotton while the matrix is in the first acid rinse. This is the best time to try to loosen the matter before the matrix is dried with the spots adhering to it. Once the matrix and spots have been dried together, you must either etch them or harden them with total bleach. In any case, it is better to work on the matrices and leave a white spot rather than a black spot on the resulting print.

Retouching Prints

There are many things that can be done in retouching dye transfer prints. The dyes can be reduced singly using the bleach formulas on page 00, they can be reduced completely together, and they can be added to individually or by mixing dyes to the color desired. A-49 (A+B)
This work can be done with brushes, cotton swabs or an airbrush. A-50 (A+B)

Bleaching -- Dark spots, such as those found in the clear borders of a dye print, can be removed without damage to the surface of the print by careful application of the permanganate bleach used to harden spots in matrices (KODAK Reducer R-2), followed by a 1% sodium bisulfite solution and rinsing. The tiny colored spots that appear in the image area can be reduced with selective bleaches, and black spots from an uncleaned transparency removed with R-2 Reducer. Then add color to match the surrounding area. A-51 (A+D) A-52 (a+D

Etching -- Utilize an etching knife on prints to remove plus-densities, but only as a second choice to bleaching because the knife leaves a change in surface texture that is very noticeable. After extensive etching, the print should be sprayed with lacquer or other finishing spray to hide the knife marks.

Selective Dye Bleaching -- It is possible to bleach individual dyes in a print. The following procedures work well for experienced operators. The bleach formulas are on page 00.

Remove cyan dye with a weak solution of potassium permanganate. Do not add acid to the solution and do not use a permanganate concentration high enough to leave a brown stain. You can remove a light brown stain with 1% sodium bisulfite solution. There is also another bleach for cyan dye which contains sodium persulfate and sulfuric acid. It is cleared with a 1/10% solution of sodium bicarbonate. This bleach is more powerful and works swiftly but is handled in the same way. Pick up the bleach with a cotton swab (for large areas) or an old retouching brush, and apply it to the area. Rinse the area with the clearing bath. Repeat if necessary, then follow with a 1% acetic acid rinse and blot to dry.

Remove magenta dye with undiluted KODAK PHOTO-FLO 200 Solution. Simply moisten a cotton swab with the PHOTO-FLO Solution as it comes from the bottle, and repeatedly swab it over the area. This is not a bleach, but a reducer. To stop the action, swab the area with clear water and then several treatments of 1% acetic acid solution. Be sure to remove all of the PHOTO-FLO Solution because any remaining will continue to release magenta dye from the mordanted gelatin and cause a stain in the picture.

Remove yellow dye with ordinary household bleach -- CLOROX, 101, etc. -- or a 15% solution of sodium hypochlorite. Again, just swab the area with a cotton tuft. Be careful with this bleach because it will also remove the gelatin emulsion if you rub too hard or use too much. A 5 to 10% ammonia solution will also remove yellow dye without danger to the emulsion, but it works more slowly.

The dye can be removed to white paper by using the total bleach formula on page 00. This bleach will remove all the dye. It is not an overall bleach that decreases the density slowly.

Because the dye transfer process is so longstanding, retouchers, over the years, have developed many other bleaches for use in reducing density in prints. DOWNEY Fabric Softener seems to work as an excellent overall bleach, reducing density slowly while maintaining the same color. EFFERDENT Denture Cleaner takes down yellow dye efficiently. There are many others. Kodak has no official recommendations for these products and has not done any stability tests on them.

Charles Carrasquillo of Retouching Chemicals in Los Angeles, California, markets a complete line of dye transfer bleaches (as well as bleaches for other processes). In total, there are 11 different solutions which will remove the three dyes evenly or remove almost any combination of two dyes, leaving one untouched. He also has specific bleaches for each dye.

Always follow any bleaching work on dye transfer prints with a thorough wash of 1% acetic acid solution to restore the proper pH balance to the emulsion and to stop any further bleaching action.

Adding Color -- Small light spots can be filled in with diluted dye transfer dyes, mixed if necessary to provide the proper color. Spotting can be done on either wet or dry prints. Best results are obtained by applying the dye with a fine retouching brush, gradually building up the dye density to match the surrounding area. Spots in dark areas may require several applications, or undiluted dye transfer dye can also be employed. Use a solution of 1% acetic acid to rinse the brush and to dilute the dyes.

Large areas can be colored by using dilute dye on a cotton tuft, following immediately with a swabbing of 1% acetic acid solution. This technique achieves quite dramatic changes in varying backgrounds. For a less startling effect, use KODAK Retouching Colors in the dry form and wipe a color on with a tuft of cotton.

It will change the existing color slightly or strongly, depending on how heavily you apply the waxy substance. The dye sits on the surface of the print in a greasy haze, so you can remove it or change it any way you that wish until you incorporate it into the emulsion with a steam vaporizer.

If the dye transfer print is going to be scanned for photomechanical reproduction, do not add any other colors but KODAK Film and Paper Dyes when retouching. In this way, the retouching will blend photographically with the print image and no "print through" of retouching will spoil the separations.

Print Finishing

Dye prints made on KODAK Dye Transfer Paper can be mounted satisfactorily with KODAK Dry Mounting Tissue, Type 2. This tissue is coated on both sides with a thermoplastic resin which fuses both the mounting surface and the print with excellent adhesion at relatively low temperatures and in short press times. You can use the Tissue for either resin-coated papers or those with a fiber base.

A-53 (A-c)

It is important to start with the dry mounting press set for the recommended temperature range of from 180 to 210°F (82 to

99°C). The platen should be tight enough to bond the print, the Tissue and the mount together in firm contact.

Use a double-weight mount board to keep the print from warping during changes of relative humidity. Do not use either mount board or mat board that has been "acid-neutralized" for archival mounting of black-and-white prints. The sodium hydroxide from the treatment remaining in the fibers will cause any part of the dye transfer that touches it to fade within a very short time. (Mat board can be lined with aluminum foil where it overlays the print to prevent any chance of the mat from leeching dye from the print.)

You can also utilize, as bonding agents, adhesives that have good adhesion properties, no deleterious effect on dye stability and resistance to blistering and wrinkling. The following brands meet these specifications: CASCOREZ G.R.C.-7, SPECIAL #67 G.V. Padding Compound, ELMER'S GLUE-ALL and SCOTCH SPRA-MENT. (Manufacturers' names and addresses are listed in Products and Sources on page 00.) Do not use rubber cement as an adhesive because it will permeate the base fibers and stain the surface of the print.

Protective Coating -- You can enhance and protect the appearance of dye transfer prints by coating the dry, finished prints with one of a number of lacquers and other coatings available from photographic dealers and art supply stores. A-54

Elements that are most distructive to the dyes in a dye transfer print are ultraviolet (UV) radiation in the presence of oxygen and liquids of a high pH value (such as soap and water).

In laboratory experiments, dye transfer prints were enclosed in sealed glass envelopes from which the air had been evacuated and replaced with an enert gas, such as nitrogen. Then the assembly was subjected to a light source containing high amounts of UV radiation for very long periods of time. The dyes in the prints did not fade.

For priceless images, you can have such glass envelopes manufactured, but there are other excellent methods of protecting dye transfer prints that must be displayed under continuous illumination. First, use light sources to illuminate the print that don't give off UV radiation, such as ordinary incandescent bulbs with as low a footcandle setting as possible. Second, coat the print surface with a sealer that will exclude air from the emulsion. In addition to photographic lacquers, you can coat the prints with artist's varnish that is used to seal oil paintings, and with the clear medium for artist's acrylic colors. This acrylic clear medium comes in both gloss and matte finish, can be manipulated on the surface of the print to give either a smooth coat or one with a texture, and dries crystal clear.

Mounting Behind Glass -- If prints are framed behind glass, a slight separation should be maintained between the surfaces of the print and the glass to prevent them from adhering to each other. Use one or two heavy mat boards around the print and drymount it to a double-thick mount board. Also coat the print with lacquer or other sealer. Glass is an excellent UV filter, and will help to protect the print from fading.

The back of the frame should be sealed by glueing a sheet of heavy kraft paper to all four sides and then dampening the paper with a water-soaked sponge. The kraft paper will shrink as tight as a drum head and keep out dust and some other contaminants.

FORMULAS

Safe Handling of Photographic Chemicals

Photographic chemicals, like all chemicals, should be handled with care.

Read Labels and Follow Instructions Carefully: Packages of Kodak photographic chemicals bear precautionary labels where necessary. If no hazard is present or expected in normal routine use, the package will not bear a precautionary label.

Store Chemicals and Processing Solutions Safely: Keep processing solutions and chemicals out of the reach of children. Do not store chemicals or solutions in a refrigerator used for food because they can contaminate food or be mistaken for edible materials.

Keep the Darkroom and Mixing Room Clean: Wipe up spilled chemicals as soon as possible. Powdered chemicals or the residue from dried solutions may become airborne and be inhaled, or they may contaminate other processing solutions. Flush empty chemical containers with copious amounts of water in a sink before discarding them in standard trash containers. Collect used filter papers, cotton tufts, blotters, etc., in plastic trash bags for incineration or pickup by a licensed disposal service.

Wear Protective Clothing: Some constituents of photographic solutions are capable of causing allergic skin reactions. Such reactions are most commonly caused by developers but can be caused by other solutions as well. Wear a waterproof apron and rubber gloves when mixing solutions. Always wear safety glasses or goggles when handling acids or strong alkalis. To help keep chemicals off the skin, wear rubber or plastic gloves during processing operations.

Handle Chemicals Carefully: Always follow formula directions carefully. Add components in the order that they are given. Don't just add a "pinch" -- measure! Never add water to acid, as it may boil and spatter in your face. Always add acid to water -- very slowly, stirring continuously. Stir the water as you add powdered chemicals and be sure that each powder is completely dissolved before adding the next ingredient. Avoid skin contact with chemicals whenever possible. In case of accidental contact, remove chemicals from the skin by washing. If chemicals are splashed into the eyes, wash the eyes at once with running water for at least 15 minutes and seek medical attention. For washing the eyes, keep a hose attached to a cold water tap in the chemical mixing area.

Keep Chemicals and Solutions Out of the Mouth: Although most photographic processing solutions have low oral toxicity, keep them out of the mouth to prevent possible trouble. For example, never start a siphoning action by using the mouth. Do not eat food, and do not smoke where chemicals are mixed or used.

Maintain Proper Ventilation: Vapors from black-and-white processing solutions are not usually a problem, but formaldehyde and acetic acid vapors are emitted by solutions containing those chemicals. Also sulfer dioxide may be liberated by fixing baths. Under some circumstances, these vapors can be irritating. Consequently, all processing rooms should be adequately ventilated. (For a discussion of processing-room ventilation, refer to KODAK Publication No. K-13, Photolab Design.)

Dispose of Used Chemicals Safely: The most common method of disposing of used photographic solutions is to pour them down the drain. When this is done, follow the disposal of the solutions with plenty of clean water. To avoid undesirable chemical reaction between solutions, pour them into the drain one at a time; run plenty of water after each solution is discarded. Since dumping a large quantity of any chemical into the sewers is a potential source of water pollution, large users of processing chemicals should pay careful attention to their disposal practices. For information on this subject, refer to KODAK Publications No. J-28, Disposal of Photographic Processing

Effluents and Solutions, and No. J-52, Disposal of Small Volumes of Photographic Processing Solutions.

If emergency information is needed: Kodak maintains 24-hour poison information. The telephone numbers are:

Business hours: (716) 588-5566

After hours and holidays or weekends: (716) 722-2571

Developers

Negative Developers -- Most of the developers mentioned in the text are available from Kodak in packaged form.

KODAK Developer D-11	Ounces	Metric
Water about 90°F (32°C)	25.36	750.0 mL
KODAK ELON Developing Agent	0.04	1.0 g
KODAK Sodium Sulfite (Anhydrous)	2.65	75.0 g
KODAK Hydroquinone	0.32	9.0 g
KODAK Sodium Carbonate (1-Hydrate)	1.05	30.0 g
KODAK Potassium Bromide (Anhydrous)	0.18	5.0 g
Cold water to make	33.81	1.0 L

Kodak Developer DK-60a		
Water about 125°F (50°C)	25.36	750.0 mL
KODAK ELON Developing Agent	0.09	2.5 g
KODAK Sodium Sulfite (Anhydrous)	1.76	50.0 g
KODAK Hydroquinone	0.09	2.5 g
KODALK Balanced Alkali	0.70	20.0 g

KODAK Potassium Bromide (Anhydrous)	0.02	0.5 g
Water to make	33.81	1.0 L

Matrix Film Developers -- KODAK Tanning Developer A and B has a proprietary formula. Other tanning developer formulas that have long been published are:

Formula No. 1

Part A.

Water about 125°F (50°C)	25.36	750.0 mL
Pyrogallol	0.5	15.0 g
Citric Acid	0.07	2.0 g
Ammonium Bromide	0.14	4.0 g
Cold water to make	33.81	1.0 L

Part B.

Water about 125°F (50°C)	25.36	750.0 mL
Sodium Carbonate (Anhydrous)	7.05	200.0 g
Sodium Salicylate	0.14	4.0 g
Cold water to make	33.81	1.0 L

Mix 1 Part of A to 2 Parts of B.

Formula No. 2

Part A.

Water about 125°F (50°C)	25.36	750.0 mL
Pyrogallol	0.70	20.0 g

Sodium Bisulfite	0.26	7.5 g
Sodium Thiocyanate	0.88	25.0 g
Potassium Bromide	0.35	10.0 g
Cold water to make	33.81	1.0 L

Part B.

Water about 125°F (50°C)	25.36	750.0 mL
Sodium Carbonate	1.76	50.0 g
Cold water to make	33.81	1.0 L

Mix 1 Part A to 1 Part B to 6 parts of water.

<u>KODAK Wash-Off Relief</u> Formulas

Bleach R-10a

Part A.

Water about 125°F (50°C)	25.36	750.0 mL
Ammonium Dichromate	0.70	20.0 g
Sulphuric Acid	0.14	4.0 mL
Cold water to make	33.81	1.0 L

Part B.

Sodium Chloride (uniodized table salt)	1.59	45.0 g
Water to make	33.81	1.0 L

KODAK Special Hardener SH-1	Ounces	Metric
Water at 65 to 70°F (18 to 21°C)	16.90	500.0 mL
KODAK Formaldehyde about 37% Solution	.34	10.0 mL

KODAK Sodium Carbonate (monohydrated)	.21	6.0 g
Water to make	33.81	1.0 L

Non-Hardening Fixers for Matrix Films

The primary recommendation for a non-hardening fixer is KODAK FLEXICOLOR Fixer for Process C-41. However, other fixers can be used without their hardeners, such as KODAK Rapid Fixer. The formula for another non-hardening fixer is below.

KODAK Fixing Bath F-24

Water about 68°F (20°C)	16.90	500.0 mL
KODAK Sodium Thiosulfate (5-Hydrate)	8.47	240.0 g
KODAK Sodium Sulfite (Anhydrous)	0.35	10.0 g
KODAK Sodium Bisulfite (Anyhdrous)	0.88	25.0 g
Water to make	33.81	1.0 L

Matrix Hardening Bath

Water at 68°F (20°C)	128.0	3.79 L
KODAK Formaldehyde about 37% Solution		50.0 mL
28% Acetic Acid Solution	.20	6.0 mL

Add the formaldehyde solution and the acid to the volume of water. Use for 1 minute after the cool rinse in the wash-off cycle. The matrices must be fully dried after using this hardening bath, then rewet in hot water before being placed in the dyes.

Formulas for Transfer Treatments

KODAK Matrix Clearing Bath, Stock Solution CB-5

Water about 90°F (32°C)	32.0	1.0 L
Sodium Tetraphosphate or QUADRAFOS or CALGON Sequestering Agent (Calgon, Inc.)	4.0	120.0 g
Ammonium Hydroxide 28%	1.5	48.0 mL

To prepare a working solution, dilute 1 part stock solution with 11 parts water.

Rinse all three matrices in the clearing bath working solution for 1 minute, then in running water for 1 minute, in 1% acetic acid for 30 seconds and, finally, in running water for 1 minute before returning them to the dyes.

KODAK Matrix Highlight Reducer R-18

Water about 90°F (32°C)	32.0	1.0 L
Sodium Hexametaphosphate or CALGON Sequestering Agent (Calgon, Inc.)	0.04	1.2 g

For routine use in first acid rinse mixed with tap water, add .34 to 1.35 ounces (10 to 40 mL) of KODAK Matrix Highlight Reducer R-18 per gallon of 1% acetic acid rinse, depending on the amount required to eliminate a tint of color in the highlights.

<u>5% Sodium Acetate Solution</u>

Water at 120°F (51.7°C)	1.7	50.0 mL
EASTMAN Sodium Acetate (Anhydrous) [CAT No. T227]*	0.18	5.0 g
Water to make	3.38	100.0 mL

---

*EASTMAN Organic Chemicals are available through laboratory supply houses.

Add 5 to 50 mL of the sodium acetate solution to the first acid rinse to reduce the density of the color in the matrix proportionally throughout the scale, depending upon the amount required to eliminate the excess color. This solution is not stable and should be mixed daily.

<u>1% Acetic Acid Solution</u>

KODAK Glacial Acetic Acid	.34	10.0 mL
KODAK 28% Acetic Acid	1.21	36.0 mL
Water to make	33.81	1.0 L

Monochrome Dye Formulas

Any color dye is possible by mixing the three KODAK Film and Paper Dyes together in different proportions. However, use KODAK Film and Paper Dye Buffer Yellow with the mixtures as the buffering agent. Three example formulas are:

Soft Gray	Ounces	Metric
Water at 68°F (20°C)	5.0	150.0 mL
Cyan Dye Concentrate	.34	10.0 mL
Magenta Dye Concentrate	.27	8.0 mL
Yellow Dye Concentrate	.85	25.0 mL
Yellow Buffer	.34	10.0 mL
Water to make	8.45	250.0 mL

Sepia		
Water at 68°F (20°C)	3.38	100.0 mL
Magenta Dye Concentrate	.34	10.0 mL
Yellow Dye Concentrate	1.85	55.0 mL
Yellow Buffer	.34	10.0 mL
28% Acetic Acid Solution	.50	15.0 mL
Water to make	8.45	250.0 mL

Red Chalk		
Water at 68°F (20°C)	3.38	100.0 mL
Magenta Dye Concentrate	.68	20.0 mL
Yellow Dye Concentrate	1.18	35.0 mL
Yellow Buffer	.68	20.0 mL

28% Acetic Acid Solution	.50	15.0 mL
Water to make	8.45	250.0 mL

Gelatin for Coating Paper

Formula A.	Ounces	Metric
Ammonium Chloride	.15	4.4 g
Sodium Citrate	.23	6.4 g
Sodium Chloride	.05	1.3 g
Gelatin (best)	.02 to 90	.64 to 25.6 g
	(depending on thickness required)	
Water (distilled)	10.00	295.0 mL

Formula B.		
Ammonium Chloride	.23	6.4 g
Gelatin (best)	.02 to .90	.64 to 25.6 g
		(depending on thickness required)
Water (distilled)	10.00	295.0 mL

Swell the gelatin in cold water and then dissolve it in the 10 ounces (295 mL) of water called for in the formula. Use the water hot. Add the rest of the components. Filter the solution and, while still warm, float the paper on it for 3 minutes. Dry the paper. Add more gelatin to the mixture, or repeat the floating of the paper to get a thicker layer.

An aluminum sulphate mordanting solution may be used to prepare the gelatin for receiving dye.

Aluminum Sulfate Mordanting Solution Formula M-1

Part A.	Ounces	Metric
Aluminum Sulphate	7.0	200.0 g
Water to make	33.8	1.0 L

Part B.		
Sodium Carbonate (desicated)	1.41	40.0 g
Water to make	16.9	500.0 mL

Retouching Formulas

KODAK Reducer R-2 for Spotting Matrices

Stock Solution A	Ounces	Metric
Water at 68°F (20°C)	33.81	1.0 L
Potassium Permanganate	1.85	52.5 g

Completely dissolve the permanganate crystals in a small volume of hot water about 180°F (80°C), then dilute to volume with cold water.

<u>Stock Solution B</u>		
Water at 68°F (20°C)	30.42	900.0 L
Sulfuric Acid* (concentrated)	3.38	100.0 mL
<u>Alternate Stock Solution B</u>		
Water at 68°F (20°C)	30.42	900.0 L
Glacial Acetic Acid	6.76	200.0 mL

*Caution: Always add the sulfuric acid orglacial acidic acid to the water slowly, stirring constantly, but never add the water to the acid; otherwise the solution may boil and spatter the acid on your hands or face, causing serious burns.

Sodium Bisulfite Formula

(For reducing stain produced by R-2 Bleach)

Sodium Bisulfite	1.76	50.0 g
Water at 68°F (20°C)	32.12	950.0 mL

To use, mix 1 part of A, 2 parts of B and 64 parts of water. Once mixed, the R-2 Reducer must be used immediately. Apply the Reducer to the dark areas of the matrix with an old brush. Next, apply 1% solution of sodium bisulfite and rinse the matrix in clean water before returning it to the dye.

KODAK Farmer's Reducer R-4a

<u>Stock Solution A.</u>

Potassium Ferricyanide (Anhydrous)	1.32	37.5 g
Water at 68°F (20°C) to make	16.90	500.0 mL

<u>Stock Solution B</u>

Sodium Thiosulfate (pentahydrated)	16.93	480.0 g
Water at 68°F (20°C) to make	67.63	2.0 L

To use, mix 1 part of A and 4 parts of B and apply to the dark spot. Wipe immediately with a water-soaked cotton tuft. Continue this treatment until the area has been sufficiently reduced. Wash the area with water and finish with 1% acetic acid solution.

Dye Bleaches

<u>Cyan Bleach</u>

Potassium Permanganate	0.09	2.5 g
Water at 68°F (20°C)	33.81	1.0 L

Dissolve the permanganate crystals in a little hot water before adding the cold water. Do not add acid to the solution. Do not use a permanganate concentration high enough to leave a brown stain.

You can remove a slight brown stain with 1% sodium bisulfite solution.

Alternative Cyan Bleach

Sodium Persulfate	2.82	80.0 g
Sulfuric Acid* (concentrated)	2.03	60.0 mL
Water at 68°F (20°C)	33.81	1.0 L

*Caution: Add the acid to the water; not the water to the acid. Wear goggles to protect your eyes.

Magenta Dye Remover

Magenta dye is removed by treating the area with undiluted KODAK PHOTO-FLO 200 Solution on a cotton tuft. Carefully remove all traces of the PHOTO-FLO Solution with several baths of 1% acetic acid solution to stop the action.

Yellow Bleach

Use a 5% solution of sodium hypochlorite or a commercial bleach such as CLOROX or 101, full strength.

Alternate Yellow Bleach

Use a 10 to 14% solution of ammonium hydroxide. To make a 10% solution solution, add 0.34 ounces (10 mL) of ammonium hydroxide to 0.60 ounces (18 mL) of water. Clear household ammonia (without detergent) is usually a 5% solution of ammonium hydroxide.

Total Bleach

Stock Solution A

Water at 140 to 176°F (60 to 70°C)	11.8	350.0 mL
Potassium Permanganate	1.76	50.0 g
Water at 68°F (20°C)	20.28	600.0 mL
<u>Stock Solution B</u>		
Water at 68°F (20°C)	32.12	950.0 mL
Sulfuric Acid* (concentrated)	1.70	50.0 mL
<u>Alternate Solution B</u>		
Water at 68°F (20°C)	32.12	950.0 mL
Glacial Acetic Acid	3.40	100.0 mL

*Caution: Always add concentrated sulfuric acid glacial acetic acid to water slowly, stirring constantly, and never add water to acid; otherwise the solution may boil and spatter the hands and face, causing serious burns.

<u>Clearing Bath</u>		
(1% Sodium Bisulfite Solution)		
Sodium Bisulfite	0.35	10.0 g
Water at 68°F (20°C)	33.81	1.0 L

These dye bleaches may be diluted with water to reduce the bleaching action.

Always follow <u>any</u> retouching action on dye transfer prints with a wash of 1% acetic acid solution.

Removing Developer and Fixer Stains from Clothing

In the dye transfer process, the dyes themselves do not stain. Soap and water will remove them from fabrics (and hands) with little difficulty. However, the developers and fixing baths, as with any photographic process, will permanently stain many fabrics unless strong measures are taken to remove the chemicals from the material. Normal washing will not remove the brown stains and bleach alone will not do it. But with the following methods, developer and fixer stains can be removed rather easily. Before using any stain remover, test it on a hidden part of the garment to be sure that the chemicals do not affect the color or damage the fabric. Do not use acid on wool.

Many developer stains will disappear when spotted with hydrogen peroxide. Rinse the garment after the treatment and wash it normally. If the stain presists, soak the stained part in a 5% acetic acid solution for 2 minutes; then rinse it well in cold, running water for 2 minutes, and soak it in full-stength household bleach (sodium hypochlorite) for 10 minutes. Rinse out the bleach and throughly wash the garment in cold water. If the stain still persists, repeat the acetic acid and the bleach baths a second time.

To remove fixer stains, mix the following formula:

Fixer Stain Remover	Ounces	Metric
Thiocarbamide	0.35	10.0 g
Citric Acid	0.35	10.0 g
Distilled water	32.00	946.3 mL

Dissolve the thiocarbamide in the water and slowly add the citric acid. Store the solution in a glass bottle.

Wet the stained area with the solution, and wait until the stain disappears. Flush the area with with cold water, then wash the garment to remove all traces of the chemicals.

PRODUCTS AND SOURCES

Throughout this book, products are mentioned in connection with producing dye transfer prints. This chapter lists all of those products and gives the manufacturer's name and address. The list is as up-to-date as possible at the time of publication; however, there will always be new products and their makers who should be mentioned and were missed.

KODAK Products for the Dye Transfer Process

These products can be purchased at photographic supply stores that ordinarily carry KODAK Professional Products. They are also listed in KODAK Publication No. L-9, KODAK Photographic Catalog.

General Requirements -- (This list does not contain the normal black-and-white enlarging and processing equipment needed for ordinary darkroom work.)

KODAK Register Punch	CAT No. 147 6969
KODAK Register Pins (Special order from Kodak Parts Services, 800 Lee Road, Rochester, NY 14650)	PART No. 106436
KODAK Master Print Roller 12-inch	CAT No. 147 7116
17-inch	CAT No. 147 7124
KODAK Rubber Squeegee, 10-inch	CAT No. 147 7249
KODAK Adjustable Safelight Lamp, Model B (holds a 5 1/2-inch circular filter)	CAT No. 141 2212
KODAK No. 1 Safelight Filter, 5 1/2-inch diameter	CAT No. 152 1509
KODAK Process Thermometer, Type 3	CAT No. 106 4955

KODAK Dye Transfer Paper, F Double Weight
(Available in 100-sheet boxes)

8 x 10 inches	CAT No. 189 0292
11 x 14 inches	CAT No. 189 0268
14 x 17 inches	CAT No. 189 0284

16 x 20 inches	CAT No. 189 0300
16 1/2 x 21 1/4 inches	CAT No. 189 0326
20 x 24 inches	CAT No. 189 0383
20 1/2 x 25 1/4 inches	CAT No. 189 0409
Rolls 40 inches x 30 feet (Sp. 87)	CAT No. 145 5492

Processing Chemicals

KODAK Glacial Acetic Acid,	
16-ounce bottle	CAT No. 146 2836
1-gallon jug	CAT No. 146 2845
KODAK 28% Acetic Acid	
16-ounce bottle	CAT No. 146 2829
KODAK Tanning Developer A,	
packet to make 1 quart (box of 10)	CAT No. 169 1971
packet to make 5 gallons	CAT No. 146 5848
KODAK Tanning Developer B,	
packet to make 1 gallon	CAT No. 146 5871
packet to make 5 gallons	CAT No. 146 5830
KODAK FLEXICOLOR Fixer and Replenisher	
to make 1 gallon	CAT No. 156 5175
KODAK Dye Transfer Paper Conditioner	
to make 1 gallon	CAT No. 146 5814
to make 10 gallons	CAT No. 190 1677
KODAK Film and Paper Dye and Dye Buffer	
Set, to make 1 gallon	CAT No. 190 0042
KODAK Film and Paper Dye and Dye Buffer	
to make 25 gallons	
Cyan	CAT No. 186 5096
Magenta	CAT No. 186 5112
Yellow	CAT No. 186 5138

Requirements for Color Negatives

The only necessary mechanical equipment are a register easel and a register transfer board.

KODAK WRATTEN Gelatin Filters,	
75 mm (3-inch) square	
(Other sizes also available)	
No. 29 (Red)	CAT No. 149 5621
No. 99 (Green)	CAT No. 149 6306
No. 98 (Blue)	CAT No. 149 6298

Matrix Film --
KODAK Pan Matrix Film 4149 (ESTAR Thick Base) for matrices directly from color negatives. Pre-punched in the KODAK Punch Configuration.

25 sheets	10 x 12 inches	CAT No. 144 5345
25 sheets	16 1/2 x 21 1/4 inches	CAT No. 144 5501

Requirements for Color Transparencies

Essential mechanical equipment consists of a register punch, register easel, register contact-printing frame and register enlarger negative carrier for separation-negative making and matrix exposure.

KODAK Photographic Step Tablet (Uncalibrated)	
No. 1A -- 11 steps, 3.75 mm wide	CAT No. 152 3380
No. 2 -- 21 steps, 5 mm wide	CAT No. 152 3398
No. 3 -- 21 steps, 10.16 mm wide	CAT No. 152 3414
KODAK Three-Point Transparency Guide	Publication No. Q-6C
KODAK Color Separation Guide and Gray Scale (For camera separations)	
Small	Publication No. Q-13
Large	Publication NO. Q-14
KODAK WRATTEN Filters 75 mm (3-inch) square (Other sizes also available)	
No. 29 (Red)	CAT No. 149 5621
No. 61 (Green)	CAT No. 149 5894
No. 47B (Blue)	CAT No. 149 5795
No. 24 (Red) for KODACHROME Films	CAT No. 149 5597
No. 33 (Magenta)	CAT No. 149 5662
No. 96 (Neutral density filters of various densities to adjust exposures)	
KODAK Gelatin Filter Frame -- 75 mm (3-inch) (One for every filter in use)	CAT No. 148 6638
KODAK Diffusion Sheets (11 x 14-inches)	CAT No. 152 1012

Black-and-White Films for Color Separation Work

KODALITH Ortho Film 2556, Type 3 (ESTAR Base)	
100 sheets 4 x 5 inches	CAT No. 163 6257
100 sheets 5 x 7 inches	CAT No. 186 2507
100 sheets 8 x 10 inches	CAT No. 193 7507
KODALITH Pan Film 2568 (ESTAR Base)	
100 sheets 4 x 5 inches	CAT No. 110 7929
100 sheets 8 x 10 inches	CAT No. 135 5429
KODAK Pan Masking Film 4570 (ESTAR Base)	
50 sheets 4 x 5 inches	CAT No. 153 4304
50 sheets 5 x 7 inches	CAT No. 153 4502
50 sheets 8 x 10 inches	CAT No. 153 4528
50 sheets 10 x 12 inches	CAT No. 153 4544
50 sheets 11 x 14 inches	CAT No. 153 4643
KODAK SUPER-XX Pan Film 4142 (ESTAR Thick Base)	
25 sheets 4 x 5 inches	CAT No. 147 1614

100 sheets 4 x 5 inches	CAT No. 147 1598
100 sheets 5 x 7 inches	CAT No. 147 1531
25 sheets 8 x 10 inches	CAT No. 147 1499
50 sheets 8 x 10 inches	CAT No. 147 1473
10 sheets 10 x 12 inches	CAT No. 147 1457
10 sheets 11 x 14 inches	CAT No. 147 1432
KODAK Separation Negative Film 4131, Type 1 (ESTAR Base)	
50 sheets 8 x 10 inches	CAT No. 153 9071
50 sheets 10 x 12 inches	CAT No. 153 9097
50 sheets 11 x 14 inches	CAT No. 153 9170

Processing Chemicals

KODAK Developer D-11 (For highlight masks)	
Packet to make 1 gallon	CAT No. 146 4569
Packet to make 5 gallons	CAT No. 146 4577
KODAK HC-110 Developer (Liquid) (For principal masks and separation negatives)	
To make 2 gallons (16-ounce bottle)	CAT No. 140 8988
To make 3 1/2 gallons (28-ounce bottle)	CAT No. 140 8962
KODAK Indicator Stop Bath (Liquid)	
To make 8 gallons (16-ounce bottle)	CAT No. 146 4247
To make 64 gallons (1-gallon bottle)	CAT No. 140 8731
KODAK Rapid Fixer (Liquid)	
To make 1 gallon (32-ounce bottle "A", 3.6-ounce bottle "B")	CAT No. 146 4106
To make 5 gallons (5-quart bottle "A", 18-ounce bottle "B")	CAT No. 146 4114

Matrix Film

KODAK Matrix Film 4150 (ESTAR Thick Base)	
25 sheets 8 x 10 inches	CAT No. 140 4417
25 sheets 10 x 12 inches	CAT No. 140 4433
25 sheets 11 1/2 x 15 1/4 inches (for 11 x 14-inch prints)	CAT No. 140 4276
25 sheets 14 1/2 x 18 1/4 inches (for 14 x 17-inch prints)	CAT No. 140 4334
25 sheets 16 1/2 x 21 1/4 inches (for 16 x 20-inch prints)	CAT No. 140 4375
25 sheets 20 x 24 inches	CAT No. 140 4391
25 sheets 20 1/2 x 25 1/4 inches (for 20 x 24-inch prints)	CAT No. 171 5226
Rolls 42 inches x 100 feet (Sp. 351)	CAT No. 157 5786

Dye transfer production equipment is available through manufacturers other than Kodak. Much of the equipment can be homemade, using purchased components. The following list of manufacturers of products mentioned in this book is correct at the time of publication. Most of the products can be purchased from the same photographic supply houses that carry KODAK Professional Photographic Products or Graphic Arts Products.

American Type Founders
Main Street
Whitinsville, Massachusetts 01588
ATF Powder for eliminating Newton's Rings

American National Standarda Institute, Inc.
1430 Broadway
New York, New York 10018

Aristo Grid Lamp Products, Inc.
65 Harbor Road; P.O. Box 769
Port Washington, New York 11050
Cold-light enlarger light sources

Arkay Corporation
228 South First Street
Milwaukee, Wisconsin 53204
Print dryers and other darkroom equipment

B & B Motor and Control Corporation
96 Spring Street
New York, New York 10012 (Home Office -- branches nationwide)
Fractional horsepower gear motors for use with tray-rocker units. One type is a 1/50 hp, 1725 r.p.m. motor with a 150:1 reduction unit of 12 r.p.m.

Berkey Marketing Companies
75 Holly Hill Lane
Greenwich, Connecticut 06830
OMEGA Enlargers, RODOGON Lenses and other darkroom equipment

Beseler Photomarketing Company
8 Fernwood Road
Florham Park, New Jersey 07932
RODINAL Developer and other items

Borden Chemical Company
ARABOL Department
1829 54th Avenue
Cicero, Illinois 60650
CASCOREZ G.R.C.-7 Adhesive

Bordon Chemical Company
New York, New York 10017
ELMER'S GLUE-ALL Cement

Condit Manufacturing Company, Inc.
Philo Curtis Road
Sandy Hook, Connecticut 06482
Pin-register equipment, granite transfer boards, point-light source and many other components for photography. Also consultants on photographic production problems.

Cuno, Incorporated
402 Research Parkway
Meriden, Connecticut 06450
CUNO-FLO Self-Cleaning Strainers -- water filters

Dow-Corning Corporation
Department A-6019
Midland, Michigan 48640
Silicone oil for liquid-gate negative carriers

Duro-Test Corporation
2321 Kennedy Boulevard
North Bergen, New Jersey 07047
Fluorescent tubes

Durst-ACS, Inc.
1835 East 6th Street, Suite 15
Tempe, Arizona 85281
Enlargers

Electronic Systems Engineering Company
East Airport Road
Cushing, Oklahoma 74023
SPEEDMASTER Photometers and other laboratory equipment

Fotar, Incorporated
432 South River Street
Hackensack, New Jersey 07601
Enlarging equipment

General Electric Company
Lamp Division
Nela Park
Cleveland, Ohio 44112
Electric lamps and fluorescent tubes

Dimco Gray Company
Gralab Instrument Division
8200 South Suburban Road
Centerville, Oklahoma 45459
Timers

Harad Chemical Company
2076 East 22nd Street
Cleveland, Ohio 44115
SPECIAL #67 G.V. Padding Compound, adhesive

Herbach & Raderman, Inc.
408 East Erie Avenue
Philadelphia, Pennsylvania 19134
Vacuum pumps for register equipment

Ilford Photo Corporation
West 70 Century Road
Paramus, New Jersey 07652
CIBACHROME Densitometer, and other photographic instruments

ITT Pneumotive
P.O. Box 4748, 4601 Central Avenue
Monroe, Louisiana 1203 (Dealers nationwide)
Oil-less air compressors and vacuum pumps

K & M Manufacturing Company, Inc.
4931 73rd Avenue, North
Pinellas, Florida 33565
Point-light equipment

Little Giant Pump Company
3810 North Tulsa Street
Oklahoma City, Oklahoma 73112
Pumps

3M Corporation
Commercial Tape Division
St. Paul, Minnesota 55144
SCOTCH Brand Adhesive Tapes
SCOTCH Brand MAGIC MENDING Tape

3M Corporation
Adhesives, Coatings and Sealers Division
3M Center
St. Paul, Minnesota 55101
SCOTCH SPRA-MENT Liquid Adhesive

Macbeth Corporation
P.O. Box 950
Newburg, New york 12550
Illuminators, fluorescent tubes and densitometers

Mole-Richardson Company
937 North Sycamore Avenue
Hollywood, California 90038
SOLA Voltage Stabilizers

Nikon, Inc.
623 Stewart Avenue
Garden City, New York 11530
APO EL NIKKOR Enlarger Lenses

Oxy-Dry Sprayer Corporation
271 Highland Parkway

Roselle, New Jersey 07203
OXY-DRY Offset Powder

Pall Western Company
330 Turnbull Canyon Road
City of Industry, California 91745
Filter designed for filtering blood, useful for filtering dyes

Retouching Chemicals
5478 Wilshire Boulevard
Los Angeles, California 90036
Bleaching chemicals for dye transfer dyes and for black-and-white and color films and papers

Retouch Methods, Inc.
P.O. Box 345
Chatham, New York 07928
SPOTONE Retouching Dyes

Schneider Corporation of America
400 Crossways Park Drive
Woodbury, New York 11797
COMPONON Lenses, SCHNEIDER 8X Magnifier and other items

Seal, Incorporated
Spring Street
Naugatuc, Connecticut 06770
Dry mounting presses

Strathmore Paper Company
South Broad Street
Westfield, Massachusetts 01085
STRATHMORE BRISTOL Mounting Board, filter paper and other papers

Sylvania Lighting Center
Danvers, Massachusetts 01923
Fluorescent tubes

V W R Scientific
P.O. Box 7900
San Francisco, California 94120 (offices nationwide)
A source for Sodium Hexametaphosphate (CALGON)
6.6 pound (3 kg) bottle, Catalog No. JTV 030-9

Westinghouse Electric Corporation
One Westinghouse Plaza
Bloomfield, New Jersey 07003
Fluorescent tubes

X-Acto
45-35 Van Dam Street
Long Island City, New York 11101
Knives and blades for cutting paper and film

To Come -- By-Chrome Easels, Nuark Point-Light Source, ACCO, Cesco Trays, Sula, Agitex Tray Rocker, Gast Vacuum Pump, ATF Offset Powder, J. Green Filter Paper, Rinnai, Digital Log Densitometer, Scoponet Magnifier, Edmond Scientific Co.

Glossary of Dye Transfer Printing Terms

ADDITIVE PRIMARIES -- Red, green and blue light added make white light. Colors to which the human eye is sensitive.

BASIC SEPARATION NEGATIVE DENSITY RANGE (BSNDR) -- Dennis Brokaw's method for finding the density range in a developed step-tablet image corresponding to a density range of 3.0 in the step tablet. Used to standardize the making of separations.

BLOCK-OUT PRINTING -- Using high-contrast film to make images of maximum density for use in removing those areas in subsequent prints.

BROMIDE PRINT -- A black-and-white paper print made from a separation negative to determine the exposure for the matrix film. One of a balanced set of three.

''CC'' UNIT -- Units of measure in percent of exposure density used to identify color compensating and color printing filters.

CHARACTERISTIC CURVE -- In densitometry, (D-log E Curve or H & D Curve) the graph that describes the density characteristics of a film for the development given.

COLOR COMPENSATING FILTERS -- Printing or camera filters of primary or complementary colors in various densities used to correct for minor color deviations in film or light sources.

COLOR CORRECTION -- Removing unwanted absorptions of color in the rendition of a scene by masking the negatives.

COLOR-CORRECTION MASKING -- Making silver masks through separation filters and registering them with the separation negatives to alter the color information in the resulting print.

COLOR HEAD METHOD (FOR DETERMINING EXPOSURE AND COLOR BALANCE) -- Using an on-easel photometer in conjunction with the dichroic filters in a color-printing enlarger head to read and compensate for exposure differences in color negatives, thus maintaining a constant exposure time.

COLOR RENDERING INDEX -- (CRI) A scale from 0 to 100 used to describe the visual effect of light sources on eight standard pastel colors.

COLOR SEPARATION NEGATIVES -- A set of three films that have been exposed to a scene through red, green and blue filters.

COLOR TEMPERATURE -- Term of evaluation for the color quality of a light source as compared with a ''perfect'' black body radiator heated to a certain temperature.

CONTACT PRINTING -- Exposing system in which an exposed and processed film is in direct contact (usually emulsion to emulsion) with a sensitized receiver.

CONTACT SEPARATIONS -- Separation negatives printed by contact with a transparency.

D-MAX -- The maximum density in a print or negative.

DENSITY -- In densitometry, the degree of darkening of a film due to exposure and developing.

DERIVATIONS -- Photographic images that have been drastically altered in density and/or color, usually by means of masks.

DODGING -- Reducing the exposure in portions of a negative image by means of inserting an opaque object into the enlarger light beam when making a print.

DYE BUFFER -- A liquid with a specific pH used to maintain the balance of a dye at the proper acid/base level for optimum transferability.

DYE IMBIBITION -- ''Drinking'' or absorbing dye, as does processed matrix film.

ENLARGED MASK -- A mask made by projection, usually to prepare a set of enlarged separations.

ETCHING -- Removing silver density by scraping the area with a very sharp knife.

FLASHING -- Adding non-image density to a negative or print by means of short exposures to light.

GAMMA -- In densitometry, the slope of the straight-line portion of the characteristic curve (tangent of the angle between the line and the log E scale) measuring the contrast of the film.

GRAY SCALE -- A photographic exposure scale containing a range of density patches, from white paper base to the darkest density obtainable of developed silver.

HIGHLIGHT MASK -- A mask that modifies only the highlight portions of the image.

IN-CAMERA SEPARATION NEGATIVES -- Negatives made sequentially in a camera with separation filters placed over the lens.

MASKING -- Changing the optical properties of a scene on film by adding densities by means of an auxiliary film image.

MATRIX -- A film that has been exposed to a separation negative and processed to have a bas-relief image in order to be dyed and transferred to paper. One of three of a set.

NEGATIVE DENSITY RANGE -- In densitometry, the numerical difference between the density of the highlight areas and the shadow areas of a film.

NEGATIVE MASKING -- Controlling the densities of a negative by making silver masks from it and registering them with it when printing.

NEWTON'S RINGS -- The result of light being warped by uneven contact of films in a printing system. Seen as fine color patterns in non-image areas.

OPACITY -- In densitometry, the total amount of light that strikes a given area of a film divided by the amount of light that passes through that area.

PIN REGISTER SYSTEM -- Method of aligning film images to each other.

PIN-STRIP -- A strip of metal containing two or more register pins placed to correspond to the register punch holes in a film.

PLUS-DENSITY MARKS -- A non-image density in a film, usually caused by fog or abrasion of the emulsion layer.

POSTERIZATION -- A photographic image that has been reduced to no more than four distinct tones and/or colors. See ''Derivations.''

POST-MASK -- A mask that is used with the separation negatives to modify the final print or matrix.

PRE-MASK -- A mask that is used to modify the principal masks during their exposure.

PRINCIPAL MASK -- The primary or main masking film of a set that modifies the color and contrast of a set of separations.

REGISTER VACUUM EASEL -- Enlarger easel with pin-register equipment and vacuum capabilities to hold films or paper immobile during exposure.

REGISTRATION -- The act of aligning separation negative images so that they print exactly on top of one another.

RING-AROUND PRINT -- One of a series of prints of a common subject made with calculated color differences in all six color variables and in measured density changes.

ROLLING A PRINT -- See ''Transferring Matrices.''

RUNNING PRINTS -- See ''Transferring Matrices.''

SPECULAR MASK -- A high-contrast mask used as a post-mask to protect only the specular highlights in a scene from degradation by exposing light.

SPLIT-FILTER MASKING -- Making masks through more than one filter using a percentage of the total exposure for each filter.

SPOTTING -- Retouching dust spots in a print by filling them with dye by means of a fine brush.

STEP TABLET -- A photographic exposure scale containing a range of measured densities, from clear film base to the maximum density obtainable of developed silver, usually in 1- or 1/2 stop increments.

STRIPPING -- Combining of two or more photographic images onto a single sheet of film or paper. Term originated in the carbro process.

SUBTRACTIVE PRIMARIES -- Cyan, magenta and yellow dyes added together make black. Direct complements to additive primaries.

TONE SEPARATION -- In densitometry, the difference between adjoining densities in an image.

TRANSFERRING MATRICES -- The part of the dye transfer process where the dye-laden matrix is placed in contact with the conditioned dye transfer paper, and the transfer of the dye takes place.

TRANSMISSION -- In densitometry, the amount of light that passes through a given area of a film divided by the total amount of light that strikes that area.

TRICOLOR METHOD (FOR DETERMINING EXPOSURE AND COLOR BALANCE) -- Using an on-easel photometer to read exposure times directly through separation filters.

WEDGING -- Differential processing across an image, causing color shifts from area to area.

BIBLIOGRAPHY
Compiled by Harold Boeschenstein, Jr.

BOOKS

Note: For the key to the letter symbols used, see the list on page 0.

Agoston, G. A. Color Theory and Its Application in Art and Design. Berlin, Heidelberg, New York: Springer-Verlag, 1979.
V

Arens, Hans. Colour Measurement. London & New York: The Focal Press, 1967.
V

Astura, Massimo. Manual of Colour Reproduction for Printing and the Graphic Arts. Hertfordshire, England: The Fountain Press, Ltd., 1973.
G,M,N

Beede, Mindy. Dye Transfer Made Easy. New York: Amphoto, American Photographic Book Publishing Co., 1981.
D,H,M,N,O

Billmeyer, Fred W., Jr. and Saltzman, Max. Principles of Color Technology, 2nd ed. New York: John Wiley & Sons, Inc., 1981.

Committee on Colorimetry Optical Society of America. The Science of Color. Washington, D. C.: Optical Society of America, 1966.
V

Coote, Jack H. Colour Prints. London & New York: The Focal Press, 1963, 1972. (Earlier Editions, 1956, 1968.) (Note: See other editions as well.)
D,M,N,O

Doubley, David. The Dye Transfer Process. Private computer printing distributed by Condit Manufacturing Co., Inc., (Sandy Hook, Connecticut), 1985.
D,M,N,O,S

Dunn, Carlton E. Natural Color Processes, 5th ed. New York: George Murphy Inc., 1954.
D,N,O

Evans, Ralph M. Eye, Film and Camera in Color Photography. New York & London: John Wiley & Sons, Inc., 1959.

(Reissued by Robert E. Krieger Publishing Co., Huntington, New York, 1979.)
V

Evans, Ralph M. An Introduction to Color. New York: John Wiley & Sons, Inc., 1948.
V

Evans, Ralph M. The Perception of Color. New York: John Wiley & Sons, Inc., 1974.
V

Evans, Ralph M., Hanson, W. T., Jr. and Brewer, W. Lyle. Principles of Color Photography. New York: John Wiley & Sons, Inc., 1953. London: Chapman & Hall, Limited. (Facsimile Edition by University Microfilms, Ann Arbor, Michigan.)
(Note: A Classic.)
U

Eynard, Raymond A., ed. Color: Theory and Imaging Systems. Washington, D. C.: Society of Photographic Scientists & Engineers, 1973.
M,S,V

Friedman, Joseph S. History of Color Photography. London & New York: The Focal Press, 1968. (Reprint Edition. First Published, 1944.)
D,H,M,N,O

Glafkides, Pierre. Photographic Chemistry, Vols. I & II. (Translated by Keith M. Hornsby.) London: The Fountain Press, Ltd., 1960.
M,S,U

Gould, Robert F. ed. Industrial Color Technology -- Advances in Chemistry, Series 107. Washington, D. C.: American Chemical Society, 1971. (Note: Chapters 1-6, but most especially Chapter 5, "The Perception of Color," by Ralph M. Evans.)
V

Viscount Hanworth. Amateur Carbro Colour Prints. London & New York: The Focal Press, 1955.
M,N

Viscount Hanworth. Amateur Dye Transfer Colour Prints. London & New York: The Focal Press, 1955. (Note: A very useful book.)
D,M,N

Hardy, Arthur C. Handbook of Colorimetry. Cambridge, Massachusetts: The MIT Press, 1936.
V

Henney, Keith. Color Photography for the Amateur. New York: Whittlesey House (Division of McGraw-Hill Book Co., Inc.), 1938.
N,O

Hunt, R. W. G. The Reproduction of Colour in Photography, Printing & Television, 3rd ed. Hertfordshire, England: The Fountain Press, Ltd., 1975. (Note: An indispensible book.)
P,U

Jaffe, Erwin, Brody, Edward, Preucil, Frank and White, Jack W. Color Separation Photography for Offset Lithography With an Introduction to Masking. Pittsburgh, Pennsylvania: Graphic Arts Technical Foundation, Inc., 1965.
G,M,N

James, T. H., ed. The Theory of the Photographic Process, 4th ed. New York: Macmillan Publishing Co., Inc., 1977. (Note: A Classic.)

Jenkins, Philip. Colour Separation Negatives. London & New York: The Focal Press, 1957.
M,N

Judd, Deane B. and Wyszecki, Gunter. Color in Business, Science, and Industry, 3rd ed. New York, London, Sydney & Toronto: John Wiley & Sons, Inc., 1975.
V

Lobel, L. and Dubois, M. Basic Sensitometry, 2nd ed. London & New York: The Focal Press, 1967.
S

MacAdam, David L. Color Measurement, Theme and Variations, 2nd rev. ed. Berlin, Heidelberg, New York & Tokyo: Springer-Verlag, 1985.
V

Miller, Charles H. Handbook for Dye Transfer Printing. Privately Printed, 1978. (Out-of-Print.)
D,M,N

Munsell, A. H. A Color Notation, 13th ed. Baltimore, Maryland: Munsell Color, Macbeth Corp., (A Division of Kollmorgen Corp.).

Overhage, C. F. J. and Gerhardt, Francis H. Principles of Color Sensitometry. Society of Motion Picture and Television Engineers, 1965.
S

Pilkington, W. J. Colour Print Processes. London: The Fountain Press, Ltd., 1956.
Carbro, M,N

Pilkington, W. J. Colour Separation Negatives. London: The Fountain Press, Ltd., 1952.
N

Ryan, Roderick T. A Study of the Technology of Color Motion Picture Processes Developed in the United States, (A Doctoral Dissertation). Ann Arbor, Michigan: University Microfilms International, 1966.
H,T

Southworth, Miles. Color Separation Techniques, 2nd ed. Livonia, New York: Graphic Arts Publishing, 1979.
G,M,N

Spencer, D. A., ed. L. P. Clerc's Photography, Theory and Practice. Vol. 6, Colour Processes. Revised by S. Welford. New York: Amphoto, American Photographic Book Publishing Co., 1970/71 Edition. London: The Focal Press. (Originally published by Sir Isaac Pitman & Sons Ltd.) (Note: The other volumes of this book are also very useful.)
D,M

Spencer, D. A., Mannheim, L. Andrew and Viscount Hanworth. D.A. Spencer's Colour Photography in Practice, rev. ed. Garden City, New York: Amphoto, 1975.
M,N,U

Todd, Hollis N. and Zakia, Richard D. Photographic Sensitometry, The Study of Tone Reproduction. Dobbs Ferry, New York: Morgan & Morgan Publishers, 1974.
S

Wakefield, George L. Practical Sensitometry. London: The Fountain Press, Ltd., 1970.
S

Wall, E. J. The History of Three-Color Photography. London & New York: The Focal Press, 1970. (Reprint Edition). First Published, 1925.
H,O

Woodlief, Thomas, ed. SPSE Handbook of Photograhic Science and Engineering. New York: John Wiley & Sons, Inc., 1973. (Note: SPSE = Society of Photographic Scientists and Engineers.)
S,V

Wyszecki, Gunter and Stiles, W. S. Color Science, Concepts and Methods, Quantitative Data and Formulae, 2nd ed. New York: John Wiley & Sons, Inc., 1982.
V

Yule, John A. C. Principles of Color Reproduction. New York, London & Sydney: John Wiley & Sons, Inc., 1967.

(Note: An indispensible book.)
G,M,N

Key to the Symbols

D Dye Transfer or Dye Imbibition Processes

G Graphic Arts Printing

H History

M Masking

N Separation Negatives

O Obsolete Processes, but ones which use procedures which may be applicable to the Dye Transfer Process

P General Principles of Color Photography

S Sensitometry or Densitometry

T Technicolor Dye Imbibition Process

U Many or most of the above subjects

V Color vision, Visual Perception, Colorimetry and Color Science

Kodak Booklets

Color As Seen and Photographed. Kodak Publication No. E-74 (7-66 ed.), Eastman Kodak Company.

Color Separation and Masking. Kodak Publication No. E-79 (12-55 ed., 5-59 is very much abridged.), Eastman Kodak Company.

Kodak Dye Transfer Process. Kodak Publication No. E-80 (1st ed., 3rd printing, 1956), Eastman Kodak Company. [Although this edition contains some obsolete information, it also includes useful data which were deleted from later editions. (Note: This publication, Dye Transfer Techniques, No. E-81 replaces the earlier editions of No. E-80.)]

Masking Color Transparencies for Photomechanical Reproduction. Kodak Publication No. Q-3 (4-60 ed.), Eastman Kodak Company.

Silver Masking of Transparencies with Three-Aim-Point Control. Kodak Publication No. Q-7A (3-68 ed.), Eastman Kodak Company.

A Dye-Withdrawal Control Technique for the Kodak Dye Transfer Process. Kodak Data Release No. E-80a, Eastman Kodak Company.

The Order of Matrix Transfer in the Kodak Dye Transfer Process. Kodak Data Release No. E-80b, Eastman Kodak Company.

Notes on Dye Transfer. Kodak Data Release No. E-80c, Eastman Kodak Company.

Basic Requirements for Dye Transfer Printing. Kodak Data Release No. E-80e, Eastman Kodak Company.

(Note: These Data Releases are out-of-print. The information contained in them is included in this publication.)

Journals and Other References

Bartleson, C. J. "Criterion for Tone Reproduction." J.O.S.A. Vol. 58, (1968), pp. 992-995.

Bartleson, C. J. and Breneman, E. J. "Brightness Perception in Complex Fields." J.O.S.A. Vol. 57, (1967), pp. 953-957.

Brewer, W. L., Hanson, W. T., Jr. and Horton, C. A. "Subtractive Color Reproduction. The Approximate Reproduction of Selected Colors." J.O.S.A. Vol. 39, (1949), pp. 924-927.

Brown, W. R. J. "Subtractive Color Reproduction: Evaluation of the Actual Color-Reproduction Equations for a Color Process." J.O.S.A. Vol. 45, (1955), pp. 539-546.

Burnham, Robert W. "Visual Selection of Color Film Neutrals." J.O.S.A. Vol. 48, (1958), pp. 215-224.

Dobbins, Richard A., Crocco, Luigi and Glassman, Irvin. "Wide-Range Photographic Photometry." The Review of Scientific Instruments, Vol. 34, (1963), pp. 162-167.
(Note: This paper describes a technique for obtaining uniform development.)

Dorst, Paul W. "A Novel Graphical System for Representing Tone Reproduction Data." J.O.S.A. Vol. 34, (1944), pp. 597-600.

Duntley and Hardy. "Experimental Determination of the Faithfulness of a Three-Color Reproduction." J.O.S.A. Vol. 30, (1940), p. 271.

Evans, R. M. "Visual Processes and Color Photography." J.O.S.A. Vol. 33, (1943), pp. 579-614.

Evans, R. M. "Variables of Perceived Color." J.O.S.A. Vol. 54, (1964), pp. 1467-1474.

Hanson, W. T., Jr. "Color Corrrection With Colored Couplers." J.O.S.A. Vol. 40, (1950), pp. 166-171.

Hanson, W. T., Jr. and Brewer, W. Lyle. "Subtractive Color Photography: The Role of Masks." J.O.S.A. Vol. 44, (1954), pp. 129-134.

Hanson, W. T., Jr. and Brewer, W. T. "Subtractive Color Photography: Spectral Sensitivities and Masks." J.O.S.A. Vol. 45, (1955), pp. 476-481.

Hanson, W. T., Jr. and Horton, C. A. "Subtractive Color Reproduction: Interimage Effects." J.O.S.A. Vol. 42, (1952), pp. 663-669.

Hardy, A. C. and Wurzberg, F. L., Jr. "The Theory of Three-Color Reproduction." J.O.S.A. Vol. 27, (1937), pp. 227-240.

Hardy, A. C., and Wurzberg, F. L., Jr. "Color Correction in Color Printing." J.O.S.A. Vol. 38, (1948), p. 300.

Holland, F. H., Mickelson, R. S. and Powers, S. A. "An Objective Method for Determination of Equivalent Neutral Densities of Color Film Images." I. Brewer, W. L. and Williams, F. C., Definitions and Basic Concepts. II. Morris, R. H. and Morrissey, J. H., Determination of Primary Equivalent Neutral Density. III. Holland, F. H., Mickelson, R. S. and Powers, S. A., Densitometer Calibrations. Paper I: Brewer, W. L. and Williams, F. C. Paper II: Morris, R. H. and Morrissey, J. H. Paper III: Holland, F. H., Mickelson, R. S. and Powers, S. A. J.O.S.A. Vol. 44, (1954), pp. 460-464, 530-539.

Howe, D. J. and Yule, J. A. C. " A Temperature-Compensating Device for Photographic Processing." Photographic Science and Engineering. Vol. 1, (1957), pp. 23-27.

Jones and Condit. "The Brightness Scale of Exterior Scenes and the Computation of Correct Photographic Exposure." J.O.S.A. Vol. 31, (1941), p. 65.

MacAdam, David L. "Photographic Aspects of the Theory of Three-Color Reproduction." "Subtractive Color Mixture and Color Reproduction." J.O.S.A. Vol. 28, (1938), pp. 399-418, 466-480.

MacAdam, David L. "Physics in Color Photography" Journal of Applied Physics. Vol. 11, (1940), pp. 46-55.

MacAdam, David L. "Colorimetric Analysis of Dye Mixtures." J.O.S.A. Vol. 39, (1949), pp. 22-30.

MacAdam, David L. "Color Science and Color Photography." Physics Today. Vol. 20, (1967), pp. 27-39.

MacAdam, David L. "Dependence of Color-Mixture Functions on Choice of Primaries." J.O.S.A. Vol. 43, (1953), pp. 533-538.

MacAdam, David L. "Quality of Color Reproduction." Journal of the Society of Motion Picture and Television Engineers. Vol. 56, (May 1951), pp. 5, 487.

Marriage, Anthony. "Comparison of Masking Methods For Subtractive Colour Processes." The Photographic Journal. Vol. 80, (1940), pp. 364-374.

Marriage, Anthony. "Subtractive Colour Reproduction." The Photographic Journal, Section B. Vol. 88B, (1948), pp. 75-78.

Miller, Carl W. "The Matrix Algebra and Color Reproduction." J.O.S.A. Vol. 31, (1941), pp. 477-482.

Neugebauer, H. E. J. "Theory of Masking for Color Correction." I: Masks Drawn from the Subject. J.O.S.A. Vol. 42, (1952), pp. 740-747.

Neugebauer, H. E. J. "Quality Factor for Filters Whose Spectral Transmittances Are Different from Color Mixture Curves and Its Application to Color Photography." J.O.S.A. Vol. 46, (1956), pp. 821-824.

Onley, Judith W. "Analytical Densitometry for Color Print Evaluation." J.O.S.A. Vol. 50, (1960), pp. 177-182.

Sant, A. J. and Miller, O. E. "Instrument for Selecting Visually Neutral Photographic Dye Images." J.O.S.A. Vol. 48, (1958), pp. 4-8.

Sorem, A. L. and Nelson, C. N. "Spectral and Luminance Requirements of Color-Transparency Illuminators." J.O.S.A. Vol. 43, (1953), pp. 689-697.

Speck, Robert P. "An Improved Masking Method for Color Transparencies." PSA Journal (November, 1945), pp. 461-466.

Sweet, Monroe H. "Color Film Analysis from Integral Density Data." J.O.S.A. Vol. 42, (1952), pp. 232-237.

Trautweiller, F. "Color Correction with a Single Gray Mask in a Halftone Color Print." J.O.S.A. Vol. 54, (1964), pp. 362-367.

Vogelsong, William F. "Color Sensitometry." Image Technology (February/March, 1973), pp. 18-29.

Webb, J. H. "The Summation of Different Color Radiations by a Photographic Emulsion." J.O.S.A. Vol. 26, (1936), pp. 12-23.

West, Lloyd E. "Water Quality Criteria." Photographic Science and Engineering. Vol. 9, (1965), pp. 398-413.

Williams, Franklin C. "Objectives and Methods of Density Measurement in Sensitometry of Color Films." J.O.S.A. Vol. 40, (1950), pp. 104-112.

Williams, F.C., and Clapper, F.R. "Multiple Internal Reflections in Photographic Color Prints." J.O.S.A. Vol. 43, (1953), pp. 595-599.

Yule, J. A. C. "The Theory of Subtractive Color Photography." I. The Condition for Perfect Color Rendering. II. Prediction of Errors in Color Rendering Under Given Conditions. J.O.S.A. Vol. 28, (1938), pp. 419-430, 481-492. III. Four-Color Processes and the Black Printer. J.O.S.A. Vol. 30, (1940), pp. 322-331.

Yule, J. A. C. "Unsharp Masks." PSA Journal (March, 1945), pp. 123-132.

From time to time, articles of interest to the dye transfer color printer may also appear in the quarterly journal:

Color, Research and Application.
John Wiley & Sons, Inc., New York.
V

J.O.S.A. = The Journal of the Optical Society of America

PSA = Photographic Society of America

Color Tests

The Munsell-Farnsworth 100 Hue Test for the Examination of Color Discrimination
Munsell Color, Macbeth Division of Kollmorgen Corp.
2441 N. Calvert Street, Baltimore, Maryland 21218,
(301) 243-2171

The 1978 Color Matching Aptitude Test
Federation of Societies for Coating Technology
1315 Walnut Street, Suite 830
Philadelphia, Pennsylvania 19107

Note: The Munsell-Farnsworth 100 Hue Test should be useful in determining an individual's color discrimination ability and for identifying the presence, type and severity of "color blindness" if it exists in an individual. The 1978 Color Matching Aptitude Test is a more critical test used for rating, according to degree of excellence, the color discrimination ability of individuals already known to have a high ability.