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Electronic Color Scanners

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Electronic Color Scanners

Abstract

Process color photography has been continually developing for many years. In fact, color printing techniques are still benefiting, through additional sophisticated requirements, and from a discovery made about 300 years ago. At that time Sir Isaac Newton, British scientist, mathematician • and philosopher, placed a glass prism in the path of a narrow beam of sunlight entering his room through a pinhole in an opaque window shade. He determined that ordinary white light is a mixture of colored lights.

Unfortunately, in practice, ideal pigments for three-color inks do not exist and this impasse greatly complicates the job for the photo-processor. To improve the accuracy and speed of color reproduction, one of the newest methods of color correction being employed today is the electronic scanner. Electronic color scanning is accepted today as a rapid method of producing very high quality color separations.

This research paper attempts to uncover some of the "mystery" associated with these electronic marvels in a systematic presentation. Conventional techniques in color separation theory are described first, . including types of copy and color dimensions involved in separation work. With a practical understanding of traditional (conventional) color separation techniques clearly defined, the reader is introduced to early attempts at developing working scanners, some popular present day scanners and finally an outlook into the future growth and potential use of color scanners in the graphic communications industry throughout the world.

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DEPARTMENT OF
INDUSTRIAL TECHNOLOGY
University of Northern Iowa
Cedar Falls, Iowa 50614-0178

WAGNER RESOURCE CENTER

ELECTRONIC COLOR SCANNERS

A Research Project for Presentation
to the Graduate Committee
of the Department of Industrial Arts
and Technology
University of Northern Iowa

In Partial Fulfillment of the Requirements for
the Non-Thesis Master of Arts Degree

by

Kenneth Francis Hird

June 21, 1974

Approved by:

Graduate Committee, Chairman

June 26, 1974
Date

INTRODUCTION

Process color photography has been continually developing for many years. In fact, color printing techniques are still benefiting, through additional sophisticated requirements, and from a discovery made about 300 years ago. At that time Sir Isaac Newton, British scientist, mathematician and philosopher, placed a glass prism in the path of a narrow beam of sunlight entering his room through a pinhole in an opaque window shade. He determined that ordinary white light is a mixture of colored lights.

Unfortunately, in practice, ideal pigments for three-color inks do not exist and this impasse greatly complicates the job for the photo-processor. To improve the accuracy and speed of color reproduction, one of the newest methods of color correction being employed today is the electronic scanner. Electronic color scanning is accepted today as a rapid method of producing very high quality color separations.

This research paper attempts to uncover some of the "mystery" associated with these electronic marvels in a systematic presentation. Conventional techniques in color separation theory are described first, including types of copy and color dimensions involved in separation work. With a practical understanding of traditional (conventional) color separation techniques clearly defined, the reader is introduced to early attempts at developing working scanners, some popular present-day scanners and finally an outlook into the future growth and potential use of color scanners in the graphic communications industry throughout the world.

In order to produce the necessary printing plates for full-color (process) printing, the original full-color art (or photograph) must be photographically separated, involving the extraction of the component hues of the full-color image in order that each of the hues may be recorded on a separate photographic emulsion--an emulsion capable of ultimately producing a positive image. Separation requires the extraction of not only the solid areas of a hue, but also the percentages of the hue that are found in other hues. As a result, a separation negative will carry a great variety of tonal areas, some of which will print in the hue itself, and others which will be contributing factors of different hues. This extraction or separation is accomplished by photographing through a filter, making a separate exposure through a different filter for each component hue.

Full-color (process) printing was an accomplished fact even before a commercially practical method of color photography was perfected. A full-color illustration, executed by hand, could be filter-separated into its three component colors. From these, halftone plates could be made. The first reproduction of color art was made from black and white photographs which had been tinted by hand. The development of a practical color photographic film was the final link in the chain of processes which contribute to printing as we know it today.

A more recent development, now available for the preparation of separation negatives, is known as the color scanner. Although scanners are used to produce separation negatives for lithography, letterpress, gravure and screen printing, the primary consideration of this research project is the preparation of separation negatives for lithography, featuring the Hell Chromagraph DC 300 electronic color scanner. The Meredith Publishing Corporation in Des Moines, Iowa is used as a locale to observe the first Iowa installation of such a scanner.

Acknowledgments

I am indebted to those who have assisted me in the preparation of this research project. Without their assistance and guidance this project could not have been completed.

Mr. William Rocap, Mr. Dick Garwood, Mr. Kenneth McDougall and Mr. Jim Knee of Meredith Publishing Corporation, Des Moines, Iowa for having allowed me to observe the installation and operation of their Hell Chromagraph DC 300 color scanner during the months of August, September, October and November 1973.

Mr. Roy H. Fuller, Hell-Color Metal Corporation (HCM), Great Neck, New York for his cooperation in providing literature and answering specific questions related to the Hell Chromagraph DC 300.

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January, 1974 Kenneth Francis Hird

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SECTION A

Color Theory in Relation to Full-Color Printing

Color printing is divided into multicolor and full-color printing. In multicolor printing the printer matches the different colors of the original image with different color inks. In full-color printing the printer does not match any particular color of a color original with any individual color ink but reproduced all colors of the original by means of three specific full-color inks: yellow, magenta, and cyan.[1]

Multicolor printing does require considerable skill but its principle does not pose any problem. It is easy to understand that the printer matches the colors of the original with the colors of the printing inks. However, a whole gamut of colors can be reproduced with three different color inks.

Stripped to its primary essentials, the main problem of full-color printing is: How to produce with but three colors of ink the same or at least rather similar color sensations that the artist produces without being limited in colorants? To achieve this result the printer must obviously find three different color inks which can be combined in the variety needed for the required color gamut.

Finding the three full-color inks does not solve the problem completely. There must also be corresponding printing-image carriers for these inks. This means that every perceptible area of the original image must be analyzed into three color components, one for each of the full-color inks. Then the result of this process must be incorporated into three different image carriers to which the three inks will be applied. Finally, there must be transfer of the three different ink-images in their correct relative location to the paper and thereby produce the finished reproduction.

Full-color printing is essentially a task of economizing and controlling. These enable the printer to duplicate with three different color inks what the painter or photographer created without any limitation in his colorants.

Inks for Full-Color Printing

Inks play a decisive role in this branch of printing. The three full-color inks are yellow, magenta, and cyan. Each of them should ideally absorb one-third of the visible spectrum and reflect two-thirds of it.

Unfortunately it has not been possible up to now to manufacture full-color printing inks having ideal absorption and reflection characteristics. Two of the three color inks, the magenta and the cyan, are far from perfect. But is is possible to compensate more or less for their deficiencies by various color-correcting techniques.

The color gamut which can be produced with the three full-color inks is very extensive. This wide color gamut is due to the effect of overprinting of one color ink film over one or two others. The overprinting changes the absorption and reflection characteristics of individual color ink films and therewith the color sensations of the viewer.

Overprinting of three full-color inks results in several different absorption and reflection areas. One of them absorbs nearly all incident light and consequently appears black, whereas the unprinted areas of the paper reflect all incident light and therefore appear white. For this reason full-color printing is considered sometimes as eight-color printing.[2]

Subtractive and Additive Color Mixing

At this point a brief explanation of existing terminology is indicated. Many of the difficulties commonly encountered in discussing full-color printing are due to muddy terminology. Many people speak of full-color printing as process work; they often call inks for full-color printing process colors, or, specifically process blue and process red instead of cyan and magenta. All serious workers in the field of color printing are agreed that these two inks must not be designated as blue and red but should always be called cyan and magenta. Blue is the color obtained by overprinting cyan and magenta inks, and red the color resulting from overprinting of magenta and yellow.

The creation of a wide color gamut by overprinting of full-color inks is usually known as subtractive color mixing. This term has a parallel expression in additive color mixing which refers to the mixing of colored lights. It is best to avoid both terms, not because they are wrong, which they are not, but because they complicate the subject without contributing anything. A brief explanation follows.

Subtractive color mixing takes place in overprinting and also whenever physical colorants such as inks, artists' coloring materials, and dyes are mixed. Each of these materials has its own selective absorption range; the final mixture has the combined absorptive quality of all component elements. A mixture of colorants will, consequently, always reflect less color than each of its components. This can also be expressed by saying that such a mixture is subtractive as it always subtracts or takes away some of the light which is reflected, or, in the case of dyes, transmitted, by its components.

Additive color mixing refers to the mixing of colored lights. The final mixture contains all waves present in its components. White light is a balanced mixture of the whole visible spectrum. (This is illustrated in Figure 1.)

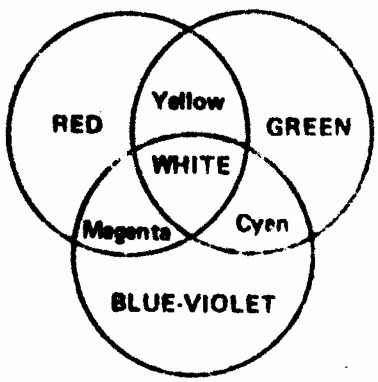


FIGURE 1. The effect of adding three primary colors is obtained by projecting beams of red, green, and blue-violet lights from three projection lamps onto a screen.

Full-color printing combines additive and subtractive color mixing. When a person looks at a printed picture he experiences the results of both additive and subtractive color mixing. When examining a letterpress or lithographic full-color print with a strong magnifying glass it will be found that large dot areas overprint whereas small dots of different colors are often standing by themselves. (Refer to progressive proofs in Appendix 1.)

Color Separation for Full-Color Printing

The great power of full-color printing lies in its economy, namely, in its ability to reproduce a wide gamut of colors with but three different color inks. (In many cases it is practical to use black ink in addition to the three color inks.) The printer requires a different image carrier for every color ink. Therefore, color separation has the purpose of providing the printer with three different records, one each for all image areas that will be present in the final image carrier for printing with the same color ink. This result is achieved by photographing the original image three times, but every time through a different colored filter.

Color separation involves the extraction of the component hues of a full-color image in order that each of these hues can be recorded on a photographic emulsion--an emulsion capable of ultimately producing a positive image--either by the additive process or the subtractive process. Separation requires the extraction of not only the solid areas of a hue, but also the percentages of the hue that are found in other hues. As a result, a separation negative will carry a great variety of tonal areas, some of which will print in the hue itself, and others which will be contributing factors of different hues.

This extraction or separation is accomplished by photographing through a filter, making a separate exposure through a different filter for each component hue. Colored light, rather than white light, is being reflected from the subject. The filter subtracts all of the light reflected by a particular hue.

An additive image is produced by a combination of the physical primaries--red, green, and blue. In order to produce an additive transparency, each primary hue must be recorded as an exposed area (black) on the film negative, so that when a positive is made, the hue will be represented as a transparent area through which light of the same hue may be projected. Three hues of light, superimposed and passing through the separated positive, add to form a full-color image.

In order to filter for the additive primaries, filters of the desired hue are used. Thus, red is separated with a red filter. The filter subtracts the green and blue from the reflected light. Only red light passes through the filter, exposing the corresponding areas of the negative as desired. The green filter produces its complimentary color negative, which is magenta. The blue filter produces its complimentary color negative, which is yellow. (See illustration in Figure 2.)

While it is possible to obtain pleasing results with only these three colors, most color reproductions include a fourth printing of black. The separation negative used for the black negative is usually made through a yellow filter.[3]

Three new terms must be added to the printers' full-color vocabularly at this point. These are yellow printer, magenta printer, and cyan printer. These terms identify the three separation negatives not by the filter colors but by the ink colors with which the image carriers made from these negatives will be printed. The blue filter negative is the yellow printer, the green filter negative is the magenta printer, and the red filter negative is the cyan printer.

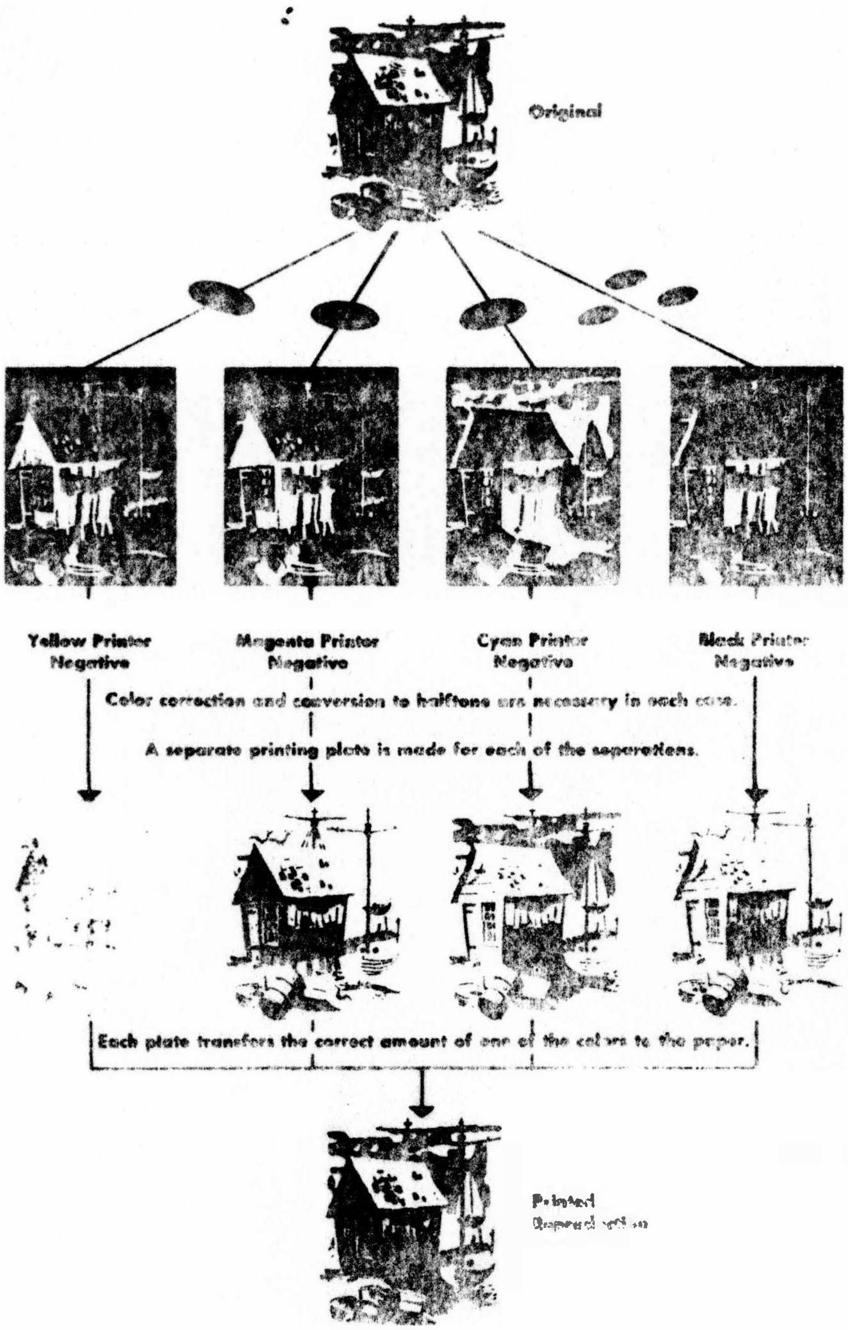


FIGURE 2. Making color separations. From original color copy to printed reproduction.

The filter colors and their reaction upon the copy being separated are listed in Figure 3.

Filter	Subtracts From Copy	Separates From Copy
Green	Cyan and yellow	Magenta
Blue	Magenta and cyan	Yellow
Red	Magenta and yellow	Cyan

FIGURE 3. Filter action upon the copy.

Types of Color Separations

There are two types of color separations--direct and indirect. Direct separations separate the colors and produce a screened negative in one step.[5] Plates are made directly from the screened negatives. Screen positives for deep-etch lithography are made by contact-printing the negatives.[6]

The direct method is quick and economical. It is useful in making screened color separation negatives for surface plates. Sharper reproductions can be made this way because fewer photographic steps are involved. However, the color correction that can be done on screened negatives is limited. (The direct separation method is illustrated in Figure 4.)

Indirect separations are generally made in two steps. First, continuous-tone separation negatives are made with the appropriate filters. Screened positives are then made from these separations. A number of variations from this method of producing indirect separations are also used.[7]

The indirect method is well suited for use with deep-etch or other positive-working plates, because the final product is a screened positive. This method allows the maximum amount of hand color correction on the continuous-tone separation negatives and on the halftone positives which are made from them. It is also possible to incorporate many photographic masking procedures in the indirect method.

In the basic two-step procedure, a set of continuous-tone separations is made first. Most of the corrections can be made on these negatives. Then halftone positives are made from the corrected separation negatives. Additional color corrections can be made on the halftone positives. The positives are then used for making the plates. (The indirect separation method is illustrated in Figure 5.)

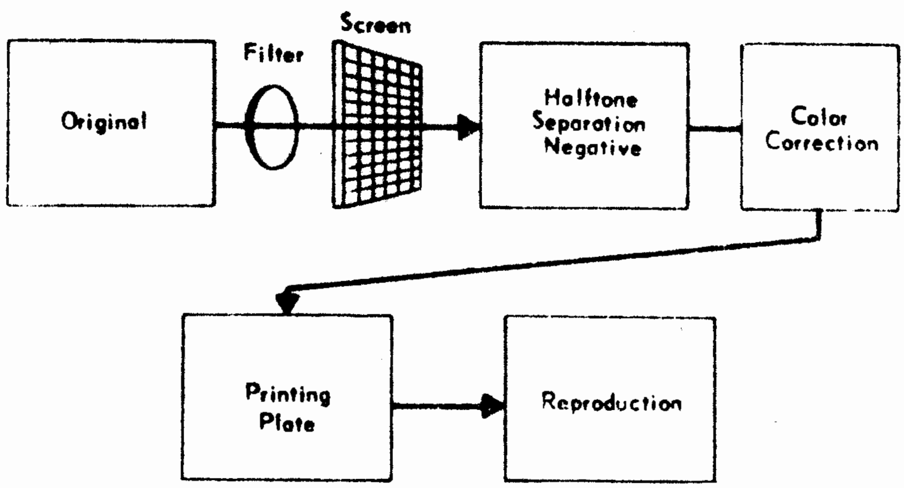


FIGURE 4. Direct method of making separations.

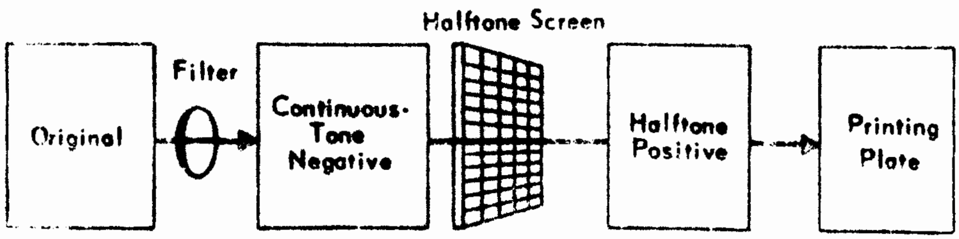


FIGURE 5. Indirect method of making separations.

Contact Screen Angles

When color is reproduced photographically, the image is produced by the superimposition of transparent dyed layers, as discussed earlier. In the photographic print, the combined layers of the transparent emulsion subtract from the white of the paper in order to form a full-color image. In printing, the component hues are deposited on paper as dots of ink. The ideal situation would consist of dots of perfectly transparent ink, superimposed exactly over each other. However, some dots, due to their pattern and size, print partially either on top of or alongside the dots of the first-printed hue. Printer's ink is necessarily more opaque than photographic dye; as a result, some of the lighter dots will be obliterated by the darker ones. This conflict of dot pattern produces an undesirable effect known as moire.[8] (Moire pattern is shown in Figure 6.)

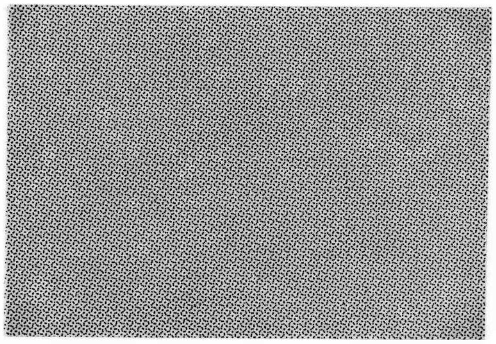


FIGURE 6. Moire pattern.

The moire pattern is minimized by changing the screen angle at which each separation is made, forming a mosaic pattern of the dots which, when viewed at any distance, creates the effect of continuous-tone color. The ideal condition is achieved when the screen angles of the separations are 30 degrees from each other. Thus, in three-color process, the cyan screen is photographed at 45 degrees, the magenta at 75 degrees, and the yellow at 105 degrees. In four-color process, it is impossible to include four 30-degree intervals within the 90-degree range of the cross-ruled screen. Therefore, the yellow--the weakest hue--is photographed at a 15-degree interval, between either the black and magenta, or the magenta and cyan. Thus: black, 45 degrees; magenta, 75 degrees; yellow, 90 degrees; and cyan, 105 degrees.

Color Correction

There is a loss of color fidelity in photomechanical reproduction, due to the inability of the filter to compensate for ink and printing deficiencies, and because the photographic negative does not record the exact ratios of the color densities of the original subject. Consequently, there is a considerable amount of effort expended by the platemaker in an attempt to "correct" his color--to bring it to a point where it most closely duplicates the color of the original.

Color correction has been traditionally accomplished by the hand work of dot etchers--either on the letterpress plate or dot-etched on the litho film positive. Color areas are corrected by dot enlargement or reduction, in the same manner as the black and white halftone.

For example, it is conceivable that a red area on a color proof may not match the hue or the value of the original copy. This red area is composed of dots which appear on the magenta and the yellow negatives plus, in all probability, light dot patterns on the cyan and black negatives. If the printed red appears too orange, the yellow dots must be reduced in size or the magenta dots enlarged. If the red appears purplish, the cyan dots must be reduced and perhaps the yellow and the magenta dots enlarged. If the value of the red is too light, the black dots may require enlarging; if too dark, reduction may be necessary. It is the skill of the dot etcher in visually determining how much on which negative or plate must be corrected that makes him a valued craftsman.

While handwork has always been the basis for color correction, photographic masking techniques are currently eliminating a good deal of such work. A mask is a photographic image which, when superimposed over another photographic image, will improve its reproduction characteristics. A mask may be negative or positive, and may be employed to alter either a negative or a positive image. Simply stated, the continuous-tone mask is a device for holding back unwanted colors so that the wanted color may be recorded in its proper density. There is a wide variety of masking techniques whose uses depend on the nature of the original copy. Masking is an integral part of color separation. Used with the indirect method of separation, masking improves the quality of color reproductions and reduces the work of the color retoucher. Masking can also be accomplished on the color scanner.

SECTION B

Copy for Full-Color Reproduction

Color separation photography starts with the copy. In most cases, the lithographer has had no previous control over it. The copy is given to him and he is expected to reproduce it as accurately, quickly, and efficiently as the state of the art allows. Although copy may have a wide variety of colors and forms, basically it will consist of two types: reflection and transparency copy.[9]

Reflection (Opaque) Copy

This includes all copy made on paper, board, canvas, or other opaque base that requires illumination on its face for photography. Some of the more common types of reflection copy from which the lithographer must make color separations include:

Watercolor paintings. These are made by applying transparent, semi-transparent, or opaque (tempera) washes of color, usually on paper. Transparent watercolors are made from water-soluble dyes. Tempera colors are a mixture of opaque pigments and a binder (gums and other adhesive materials) suspended in water. Tempera pigments are seldom pure in color.

Color blends of watercolors are usually mixed before being applied to the paper. They seldom consist of one color painted over another, except to obtain added detail in dark areas or over pen sketches made with ink.

Both opaque and transparent colors may be applied to the paper either by brush or airbrush. Watercolor artwork may combine brush and airbrush techniques, as well as the use of both transparent and opaque colors.

Transparent watercolors reproduce very well. This is especially true when the colors are clean and reflect well from the surface on which they are applied.

Oil paintings. Oil paints are generally opaque pigments, suspended in linseed oil, although a limited number are transparent. The support is usually canvas. However, a variety of other supports are also used. The paint is usually applied by brush, but some artists prefer to use a palette knife or their fingers. Some paintings are made by a combination of these techniques. The desired color blend can be obtained by mixing paints on the palette, or by over-painting paint on paint until the desired color is obtained visually. Consequently, underlying colors that are not readily visible to the eye may photograph and require added corrections. A painting is generally protected with a layer of clear varnish, which gives the work a glossy finish. Texture of the canvas, brush strokes, and palette knife applications are usually desired in the final reproduction.

Oil paintings which are free from dark shadow masses will reproduce well. If a painting includes deep colored areas with detail in the shadows, it may be necessary to use at least six colors to reproduce the deep browns, blues, and purples adequately.[10]

Casein paintings. Casein paints are opaque or transparent colors, suspended in a vehicle made from a casein derivative. Because casein colors can be mixed with water, they may be used in a number of different techniques and on a variety of absorbent surfaces. The supporting surface may be bristol board, watercolor paper, illustration board, wood panel, or cotton or linen canvas. Thus, from the same media, artwork which resembles an oil painting or a watercolor drawing can be made. Casein colors, if not treated with a layer of transparent varnish, dry with a velvet-matte finish. They have excellent light-reflecting properties for photo-mechanical reproduction. When treated with varnish, casein paintings are hard to distinguish from oil paintings.

Pastel drawings. Pastel colors are generally opaque. They come in the form of sticks made from a paste of finely ground colored chalk. The chalk is applied directly to the paper or illustration board. The end of the stick is used for fine effects, but for flat overall tones or broad strokes the side is used. Pastels can be blended by rubbing with a finger, cotton wad, or paper stump. To protect a pastel drawing from smearing, a flaxative (gum or spirit varnish) is sprayed over its surface. Pastel drawings tend to be soft in texture but pure in color. They usually lack sharp detail. When the paper texture shows through they are difficult to reproduce.

Crayon drawings. Crayons are opaque pigments suspended in a grease or wax base and formed into sticks. They are applied directly to the paper or board in the same way as pastels. Crayons have a hard granular texture, and the colors are not as brilliant as pastels. They are difficult to reproduce, especially when the paper texture shows through.

Carbo prints. These photographic color prints are made by superimposing three pigmented gelatin layers, in register, on a paper support. Photographic color separations are used to print each of the three gelatin layers. The resulting colors are usually clean, intense, and reproduce well.

Dye transfer prints. These are also photographic color prints. They are made by transferring three transparent dyes to a gelatin-coated paper from three different gelatin relief positives. The positive for each color, called a matrix, is made from its separation negative. Each matrix is immersed in a dye solution of appropriate color. The matrix takes up dye proportional to its density. The dye from each matrix is then transferred to the gelatin layer on the paper. This makes a final photographic print in full color from brilliant transparent dyes. A good dye transfer print will generally reproduce well.[11]

Color photoprints. The materials generally used to make photoprints are multilayer, photographic emulsions coated on a white, opaque base. Each of the three principal layers responds to only one of the primary colors of light. After exposure to a positive color transparency or color negative, chemical processing produces a positive print in full color. The most common of these are the Type C Kodak color prints and Anscolor and Gevacolor prints.

Hand-colored photographs. The basic form of this type of artwork is a black-and-white or sepia photograph which has been colored with watercolor paints, oil paints, or colored dyes. The underlying black or sepia image photographs in each of the separation negatives.

Pre-separated artwork. This type of artwork is intended to eliminate the separation of color by photography. It provides a black-and-white image for each of the printing colors. Halftone negatives are made by photographing each of these black-and-white images separately. Skill of the artist who prepares the original pre-separated art determines quality of reproductions made from this type of color copy.

Retouched black-and-white photographs. This is a method of making an artificial color reproduction of a black-and-white photograph similar to pre-separated artwork. A black-and-white photographic print is prepared for each process color to be printed. From the original black-and-white negative, prints are made on a waterproof, non-distorting paper base, such as Kodak Resisto paper. One of these prints for each process color to be used is then re-touched to the density value required for that color, with retoucher's gray paint or neutral gray tempera water-colors. Each of these pre-separated prints is then photographed directly making one of the negatives of a color set.[12]

Bourges colotone. A key image is prepared which may be a retouched black-and-white photograph of a line drawing. Each is attached to a different edge so that they are easily interchangeable while working up the desired effect. These sheets are transparent and colored. The color of the sheets used is the same as the printing color. That is, a yellow sheet is used for the yellow separation, a red sheet for the red separation, etc. Color is removed from the overlay in all areas where that color is not needed. When completed, the result is a full-color illustration consisting of four separate elements. If the artwork has been carefully prepared, a good set of separations can be produced.

Transparency (Transmission) Copy

A transparency must be viewed, and the colors separated, with transmitted light. All of the color films in current use are based on the integral tri-pack or multilayer principle. They consist of three different emulsion layers coated on the same support. They all use transparent dyes and depend on the subtractive theory of color separation.

The subtractive method has produced the most successful color processes from the standpoint of simplicity of use and quality of result. The subtractive process makes use of the three secondaries: cyan, magenta, and yellow, and their ability to subtract the unwanted colors of light in order to produce the colors of the original subject. The following applications of this process find widespread use in the production of copy for process printing.[13]

Kodachrome. Kodachrome is a subtractive color film which was first marketed in 1935 and further improved in 1938. It is based upon the coupler system: the emulsion (silver bromide) is reacted upon by a developer which reduces it to silver. The resulting oxidized developer will then react with certain compounds to form dyes. Thus, any light sensitive layer of emulsion which has been exposed to a primary hue can be coupler-developed into its complement, forming the secondary hue necessary to produce a subtractive image.

Most positive films employ the following arrangement of emulsion layers. The top layer is sensitive to blue light only. Therefore, it records only the blue light reflected from the subject. The second layer is sensitive to blue and green light but not to red. A yellow filter between the first and second layer absorbs the blue light and allows only the green and red light to pass. The second layer, therefore, records only the green light reflected by the subject. The third layer is sensitive to blue and red light, and is only slightly sensitive to green. Only red and green light reach it, however, since the blue light was absorbed by the yellow filter. The third emulsion layer, therefore, records only the red light reflected from the subject. The yellow filter layer between the first and second emulsions dissolves out during processing.[14] (Figure 7 illustrates a section of Kodachrome film.)

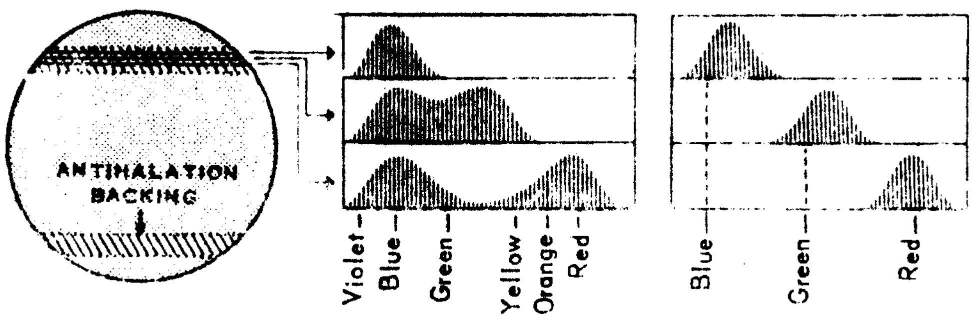


FIGURE 7. Schematic of a cross section of color film. (Left) enlarged drawing of a cross section of Kodachrome film (about 100 times) showing the extreme thinness of the three light-sensitive emulsion layers. (Center) diagram showing the inherent color sensitivities of the three emulsion layers. (Right) diagram showing the effective color separation obtained in the three emulsion layers. The yellow filter layer just below the top layer prevents blue light from penetrating to the middle and bottom layers.

<u>Positive color transparencies</u>. Some films, such as Kodachrome, Ektachrome, and Anscochrome, produce positive color transparencies. A

positive color transparency serves a dual purpose. It can be used to produce separation negatives and it also serves as a color guide for all subsequent operations.

Negative color transparencies. Kodacolor and Ektacolor are processed to make negative color transparencies. A color negative can also be separated. However, it produces separation positives. It has no value as a color guide since complementary colors and yellow-orange mask layer are reproduced in the negative instead of the true colors of the subject. Separations made from color negatives are sufficiently corrected for dye transfer and color print papers. However, for usual process printing inks, additional correction of the separations is required.

Although a basic similarity exists in the chemistry of color formation, the dye images in these various films are not all the same and may require different methods and materials for proper separation. Color transparencies may be separated by projection in the camera, enlarger, or by contact.

SECTION C

Historical Landmarks in the Development of Electronic Scanners

Color scientists analyzed the problem of color printing not only in terms of optics but also mathematically. Seen as a problem of mathematics, the task of color separating and color correcting consists in determining the correct distribution and size of each color dot in every area.

This task is enormous if you consider that an average reproduction in offset lithography or letterpress usually consists of not less than 12,500 and up to more than 30,000 individual dots per square inch, or of not less than 50,000 and up to more than 120,000 dots in the four different ink colors which are normally used for industrial full-color printing. Color correcting means that the various imperfections of paper and inks as well as the adjustments for the black ink must be considered in establishing, first, which color ink should print in every one of the 12,500 to 30,000 dot areas per square inch and second, how large each of the four ink dots must be.[15]

A mathematical solution of this task is beyond human ability but not beyond the scope of electronic equipment which can do in seconds what it would take people years to do. It was therefore only natural that several research organizations began to study the possibilities of applying electronics to color separation and color correction. Electronic color separation and color correction is being successfully used today; it may be supplemented, in certain applications, by masking or by other color correction techniques.

Electronic scanning is a technique developed to produce automatically the equivalent of hand-colored correction. In a scanner all or part of the picture information is converted into electrical signals. These signals, with voltages proportional to the intensity of the light reaching the photocells, are fed into an analog or digital computer.[16]

In scanning it is necessary to convert the original picture to a convenient form of electrical signals. By scanning a picture in successive lines, as in television, it is converted from a two-dimensional array to a one-dimensional array. However, television-speed is not needed in graphic arts scanning. Scanning times of a few minutes to an hour are used with from 250 to over 1,000 lines-per-inch resolution.

There are two basic types of scanners with respect to method of reproduction processes. They are the drum and flatbed respectively. The drum-type scanner operates on the principle of a lathe, whereas the flatbed scanner is not limited to the use of flexible originals, but accepts flat originals and produces an end product which is also flat-mounted during scanning.

First Scanner Introduced in 1930's

Printing Developments, Inc. (PDI). The first scanner was developed by Murray and Morse at Eastman Kodak Company in the late 1930's and a prototype was shown in 1941. It was later taken over by Time Incorporated and its subsidiary, Printing Developments, Incorporated (PDI). The PDI unit scans a single-color transparency on a cylinder, not on a flatbed such as the H&W unit. The PDI scans the image and divides it into a series of lines, converts it to electrical signals, adds corrective information to the signals and then exposes plates to provide fully corrected color separations.

Figure 8 illustrates the PDI unit. The cylinder (1), transparent on one end (2), slowly rotates on its axis. The transparency to be scanned (3) is wrapped around the transparent end of the cylinder and four sheets of unexposed film (4), (5), (6) and (7) are wrapped around the rest of the cylinder. A spot of light from source (8) is deflected by a mirror (9) through the cylinder and color transparency. After passing through the transparency, the beam is split into three separate beams. Each beam passes through a filter, red (10), green (11), or blue (12) and strikes a photocell, (13), (14) or (15). The cylinder travels longitudinally as it rotates, and thus the light spot completely scans the entire color transparency. Resolution can be 250, 500, or 1,000 lines-per-inch, so that scanning time is longer for finer scans.

The photocells produce electrical signals proportional to the red, green, and blue transmittances for each point of the transparency. These signals are fed into a computer (16) which makes the necessary, predetermined color corrections. The computer then modulates the intensities of four glow lamps (17), (18), (19) and (20) focused on the four unexposed pieces of film to provide four fully-masked, continuous-tone separation negatives. Cyan, magenta, yellow and black image carriers are then made from these separation negatives by the usual production procedures.

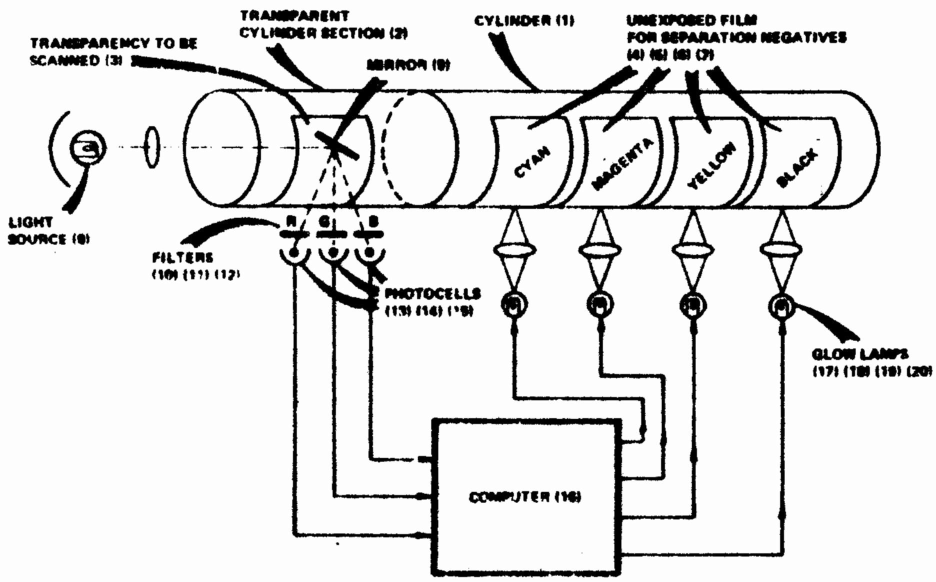


FIGURE 8. Operation of the PDI scanner.

Hardy and Wurzburg (H&W). Another scanner was developed at the Interchemical Corporation by Hardy and Wurzburg and an early prototype was shown in 1940. RCA Corporation acquired the rights in 1945, modified the original design into an all-electronic device which it later abandoned. The early H&W scanner was designed to produce halftone photographic plates from which printing plates could be produced in the conventional manner. The scanner provided full correction for all distortions of tone and color introduced by the characteristics of the special inks and papers used to eliminate individual plate treatment.

Figure 9 illustrates the H&W scanner and suggests the massive size of this early equipment.[17] The four separate photographic plates (1), (2), (3) and (4) were mounted on a single moving carriage (5). On the unexposed photographic plate (4), a fully corrected continuous tone image was exposed. The other three plates were separation positives or negatives of the original picture to be reproduced. In the scanning operation, the carriage (5) oscillated in a path equal to the width of the separation, thus enabling the whole area of the separations to be covered by a pattern of parallel lines.[18]

Three projectors (6), (7), and (8) focused sharp points of light on the three color separations. The projectors and separations were so aligned that the same parts of the picture were illuminated simultaneously on each separation. The light passing through the separations fell on three photocells and produced three electrical signals. These were fed into an electrical circuit network (9) in which electronic computing circuits stored color correction information for the inks, papers, dot overlap, etc. for a particular printing job. The corrected electrical signals from (9) were then fed into another network (10) which provided the modulation signal necessary to operate the lamp in exposing head (11) to produce the desired color-corrected image on the plate (4).

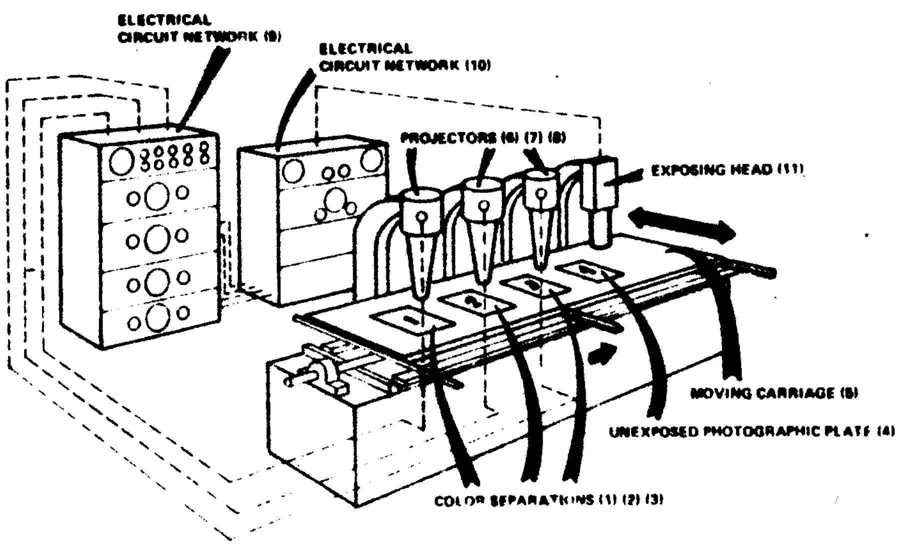


FIGURE 9. The Hardy and Wurzburg scanner, built by the Interchemical Corporation.

Each separation was scanned separately and a new, unexposed plate was placed on (4) for each scanning sequence. Three halftone plates were then made from the three corrected separation negatives produced.

In a later modification of the H&W unit by RCA (Rydz and Marquart, 1954), the separations and plate being exposed remained stationary, and scanning was accomplished with a focused beam from a cathode ray tube (CRT).[19]

Scan-A-Graver. In 1947 one of the first practical applications of electronic scanning was developed by the Graphics Division of Fairchild Camera and Instrument Corporation. The Scan-A-Graver (illustrated in Figure 10), automated the photoengraving process of making relief image plates for letterpress printing. This machine scans and perceives photographic copy, and the resulting electrical impulses operate a heated stylus which burns dot formations on the surface of a plastic plate. Composed of four parts--the copy cylinder, the scanning head, the engraving head, and the engraving cylinder--it resembles a small lathe. An electric eye in the head scans the original photo as it rotates on the copy cylinder. The light impulses control a heated pyramid-shaped stylus which burns into the surface of the plastic plate mounted on the engraving cylinder. Where the original values are light, the stylus burns deeply; where they are dark, the impressions are shallow. Neither etching nor handwork is required. Plastic plates are proofed in the same manner as conventional photoengravings. Excess plastic is easily trimmed and the plate is mounted on wood or base metal with double-sided tape. The resulting plate is always the size of the original; there is no provision

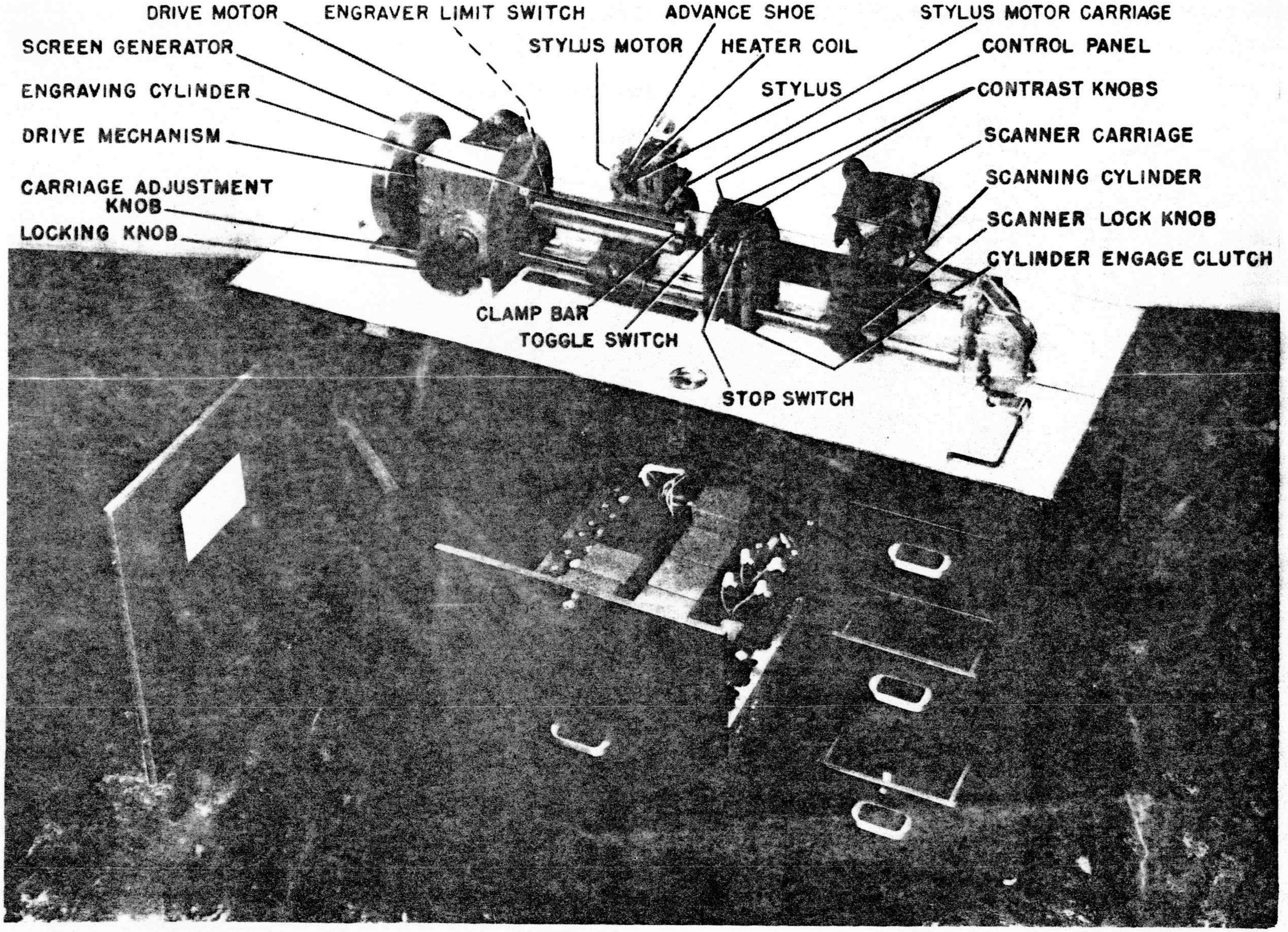


Figure 10. The Scan-A-Graver produces plastic plates suitable for letterpress.

for enlargement or reduction. The maximum accommodation is 8"x10". This size plate can be produced in 30 minutes. The Scan-A-Graver can produce 65, 85, 100, and 120 screen halftones. The machine cannot make line cuts, nor is it suitable for color work.[20]

Scan-A-Sizer. A later improved version of the Scan-A-Graver was marketed as the Scan-A-Sizer, a machine capable of enlarging or reducing and engraving in a single operation. The original copy is placed flat in the machine and scanned with an oscillating mirror. The machine will make enlargements or reductions up to four and one-half times the original size, produce finished plates in a choice of screens in any size up to a full tabloid page, work 50 percent faster than the Scan-A-Graver, and even permit a photo to be reduced or enlarged more along one dimension so that, for example, short cars can be made longer or square pictures can be made to fit oblong spaces.[21]

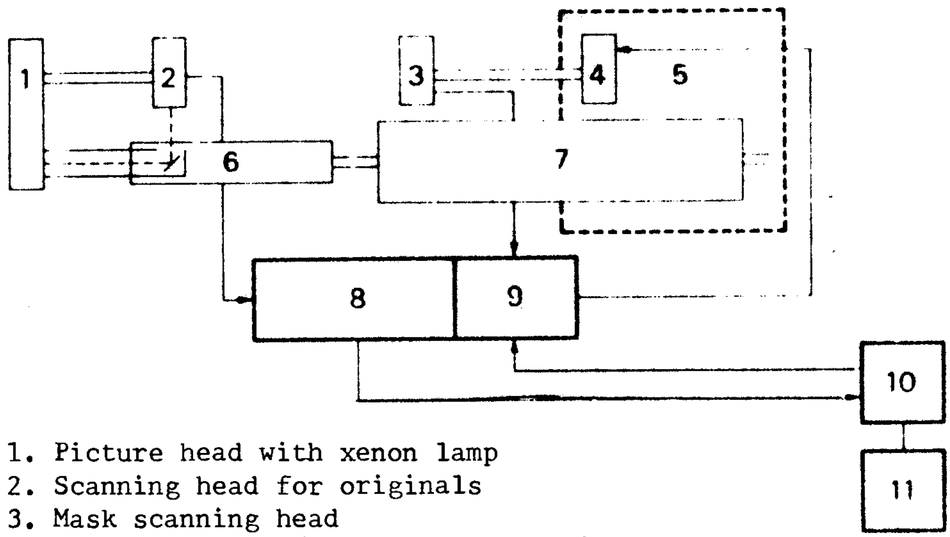
Fairchild Scan-A-Color. This unit was introduced by the Fairchild Camera and Instrument Corporation in 1964. It operates on the principles similar to those used in the PDI scanner, but has the added capability of handling both color transparencies and flexible opaque surfaces. Less complicated scanners are available that produce one separation at a time. They have been priced low enough to enable moderate-size shops to have one on the premises.

Hell Chromagraph. The Hell Chromagraph DC 300 (refer to company brochure in Appendix 2), is an electronic color scanner for production of corrected continuous tone and screened color separations for all printing processes. Color transparencies, color negatives or flexible reflection pictures are suitable as scanning copy. Enlargements or reductions can be accomplished in an extremely wide range between 33-1/3% and 1685%. Selectable resolution pitch is 350, 500, 750 and 1500 lines per inch. The maximum format of 16"x20" for originals, masks and separation films permits the production of color separations for full-page illustrations, large picture combinations and complete magazine and journal pages in one operation.[22] (The Chromagraph DC 300 is illustrated in Figure 11.)

All color transparencies, negatives and flexible color reflection pictures are suitable for use as reproduction copy. The original is mounted on the scanning drum (6) and illuminated by a xenon lamp (1) and the light picked up by the scanning heads (2) and (3) and modulated by the picture content which is first converted by four photomultipliers (8) and (9) into electrical signals. Three of these signal voltages reproduce the proportion of blue, red and green light in the scanned picture area; the fourth is used for unsharp masking. These four voltages are processed in the four-channel color computer (10), whose many possibilities of general color correction, extended selective color correction, under-color removal, color addition, normal and neutral steepening of high-lights, partial picture correction, color cast compensation offering control and gradation control with pre-selection for the printing process.

Adjustments at the color computer can be pre-selected before exposure of each color set for all its four color separations. This ingenious pre-selection is in the interest of saving time.

Screened color separations are obtained by loading the film cassettes (5) with film and a contact screen pre-angled according to the separation



1. Picture head with xenon lamp
2. Scanning head for originals
3. Mask scanning head
4. Recording head (contone or screen)
5. Recording area with recording drum
6. Scanning drum
7. Main drum (mask and recording drum)
8. Color computer with extended selective color correction
9. Control panel for combination work and partial picture corrections
10. Digital scale computer (electronic cabinet)
11. Power supply cabinet

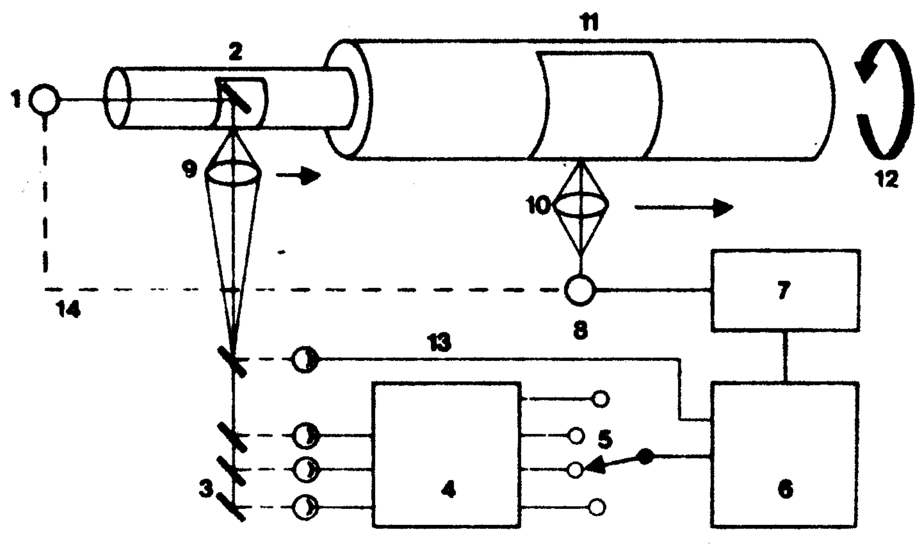
FIGURE 11. Chromagraph DC 300 color scanner.

color. The film and screen are clamped together automatically on the recording drum (7) and held in position by vacuum. Power supply cabinet (11) is an integral part of the electronic computer cabinet.

Crosfield Magnascan. This unit (refer to company brochure in Appendix 3), produces in a single step, screened separations enlarged to final size, thus eliminating the need for additional equipment and drastically reducing material costs. Transparencies or reflection copy originals up to a maximum size of 10"x12" can be mounted on the analyzing drum. This drum is removable so that planning can be carried out in advance and remote from the scanner. Separations can be produced up to a maximum film size of 20"x24". The separations can be positive or negative, continuous tone or screened, right reading or wrong reading. The Magnascan can enlarge or reduce. The range of enlargement is from 30% to 1650%. Enlargement can be made from any part of the original and a convenient viewing arrangement permits accurate location of the area to be scanned.[23]

The Magnascan has an optical system providing high intensity light. Conventional screened positives can be produced very quickly on the scanner. Fiber optic guides conduct light from a high intensity xenon lamp. This lamp is modulated by an electro-optic crystal. A conventional contact screen is superimposed on the unexposed film and vacuum channels in the exposing drum hold the screen and film in perfect contact. Any screen ruling can be used. A pressure roller is provided to ensure that the film and screen are mounted on the output cylinder without distortion and in perfect register. A punch register system is incorporated in the unit to facilitate any requirements of the printer. The unit is not daylight operating but can be operated under subdued light.

Figure 12 illustrates the Magnascan unit. The color transparency to be scanned and the unexposed film are first mounted on the two rotating drums. A small spot of light (1) is projected from the inside of the transparent analyzing drum. The light passes through the transparency (2) into an optical system which splits it into its red, blue and green components, and projects it onto three photomultipliers (3). The electrical outputs from the photomultipliers are passed to a computer (4) which carries out the functions of color separation, tone correction, black printer generation, and undercover removal (5) and (6). The operator selects the appropriate color channel. The output from the computer controls the brightness of a spot of light (8) projected onto the unexposed film (11). The analyzing and exposing drums are coupled together and rotate as one. Each time the drum rotates, one scanned line of the picture is stored electronically and is played back during either the same or the following revolution to the exposing lamp at a different speed, depending upon the enlargement required. The more slowly it is played back the greater the degree of enlargement. For reflection copy, a light source is mounted outside the scanning drum and the reflected light is collected by the same optical system which is used for transparencies. For unsharp masking a fourth photomultiplier (13) collects light from the original. The spot of light scanned is slightly larger than the one for the color analysis photomultipliers and is used to generate a minute fringe around contrasting tones giving the optical illusion of increased sharpness.



Schematic diagram of the Magnascan

1 Xenon lamp for analysis and exposure
2 Original
3 Colour separation mirrors, photomultipliers
4 Colour computer
5 Four colour selector switch
6 Tone and UCR computer
7 Digital store for vertical enlargement
8 Light modulator
9 Analysing lamp advance
10 Exposing lamp advance for horizontal enlargement
11 Enlarged separation
12 Drum rotation (both drums)
13 Unsharp masking channel
14 Fibre optic light guide

FIGURE 12. Crosfield Magnascan color scanner.

<u>Hunter-Penrose Autoscan</u>. Figure 13 illustrates this unit. The original (1), usually opaque, is scanned by the light beam from projector (2) which is moved mechanically or electrically over the image area. The light reflected from the original goes through the camera lens (3) and strikes the photographic plate (4). Image definition is not limited by light spot size or number of scan lines-per-inch. However, the optics must be able to provide the required resolution by means of normal photographic exposure.

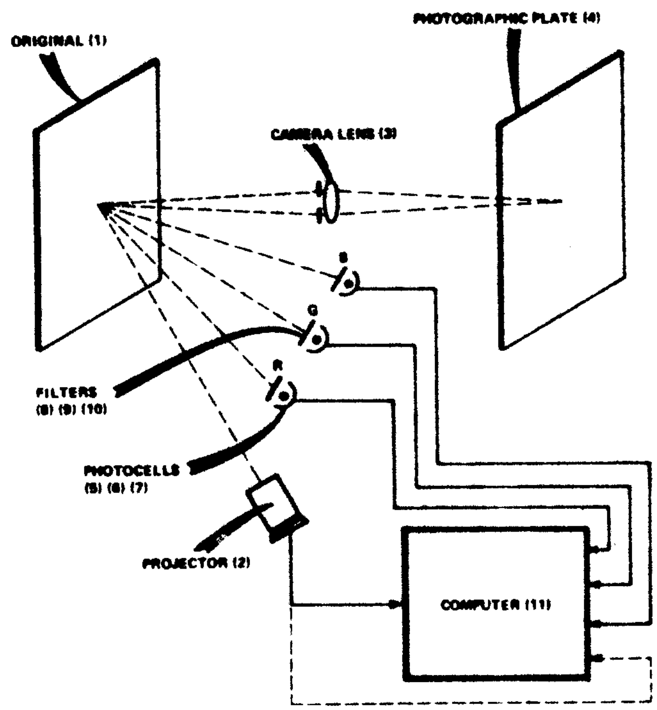


FIGURE 13. Hunter-Penrose Autoscan scanner.

Three photocells (5), (6) and (7) are arranged so that they "look" at the original picture through three color filters (8), (9) and (10) while it is being scanned. The photocells thus can provide signals proportional to the red, green, and blue reflectance of each spot on the original. A red filter is then placed over the camera lens and the computer (11) compares the red signal with what is required for correct exposure to the red separation at that point, taking into account the magnitudes of the green and blue signals at the same point. The luminance of the light spot is then altered until it gives the correct exposure, the electrical circuits thus applying a feedback control to the light. Green, blue, and black separations are made in the same manner by using different constants in the computer and placing green, blue, or neutral filters over the camera lens.[24]

SECTION D

The Hell Chromagraph DC 300 Color Scanner

Designed by Dr. Rudolf Hell of Kiel, Germany, the Chromagraph DC 300 is an example of an electronic daylight-operating scanner for production of corrected continuous tone and screened color separations for all printing processes. Color transparencies, color negatives or flexible reflection pictures are suitable as scanning copy.

The equipment is manufactured in Kiel, Germany and distributed in the United States by Hell-Color Metal (HCM) Corporation, 115 Cutter Mill Road, Great Neck, New York 11022. Presently there are slightly over 40 of these model units in operation throughout the United States.[25]

"Installation of the scanner is accomplished in two stages: After initial erection and wiring on the owner's premises, three weeks are scheduled for 'de-bugging', i.e., factory technicians thoroughly check the unit at every stage and calibrate it to factory specifications. In the second phase, one week is scheduled for production runs on the scanner under technician supervision. It is customary that the key company representative who will operate the unit be thoroughly briefed and given final instructions at this time. This individual will have already attended an intensive training school at Great Neck, New York where complete instruction and familiarization is part of the scanner purchase agreement."[26] (See purchase price, Appendix 4.)

Color separations up to a format of 16"x20" for lithography, letterpress and gravure printing can be produced with the Chromagraph DC 300 color scanner.

Theory of Operation

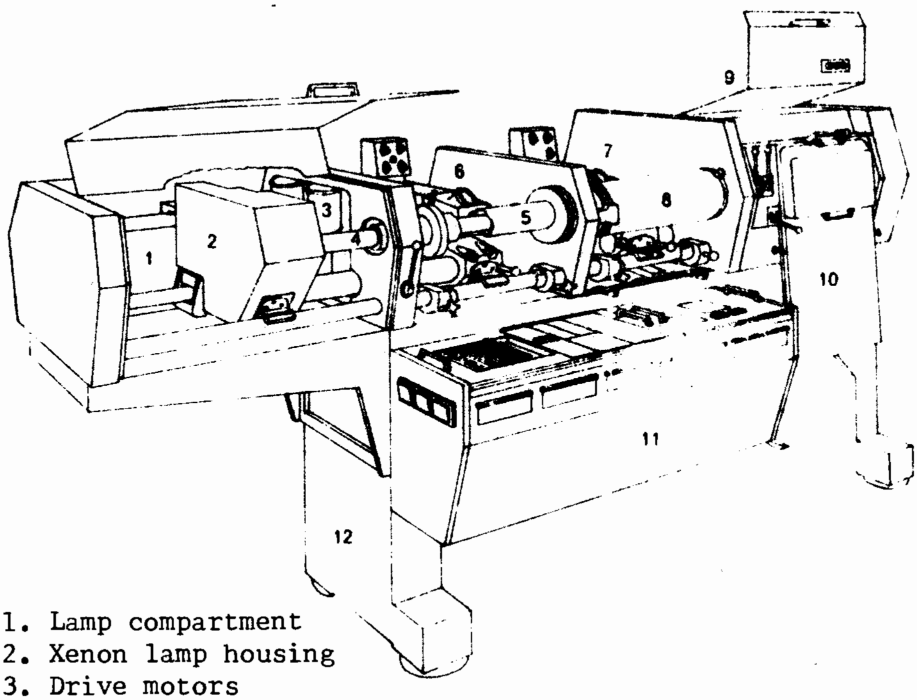
All electronic color separation scanners, including the Hell Chromagraph DC 300, are equipped for color correcting. Color separation is based on the usual color filters; the DC 300 can accommodate both reflection and transmission copy. In this case, the light picked up by the scanning head and modulated by the picture content is first converted by four photomultipliers into electrical signals. Each minute area is evaluated electronically in terms of the proportions of each of the printing colors that will be used. These color values are translated into electrical currents by photocells. The computer evaluates these currents which represent the influence of ink, paper, tonal range, etc., and adds or subtracts from them upon command from a selective color correction mode on the machine.

These modified currents are then fed into an exposing light source. The light varies in intensity in proportion to the corrected values of each element in the area scanned, and so exposes the corrected color separations on film. The product of the DC 300 color scanner is a balanced set of corrected continuous tone and screened color separations for any printing process desired.

Screened Separations

Pre-angled contact screens (a recent development eliminates the use of contact screens and incorporates the laser beam to project screens of any desired ruling through optic fibers onto the film, see Appendix

5), in matched sets, which are inserted with the film in a daylight-operated cassette (10), as illustrated in Figure 14, enable the separations to be screened in one operation. The cassette is clamped on the recording drum automatically and without the possibility of distortion. Gray scale and register-cross exposures can be accomplished in one press of a button. A 17-step gray scale with accurately pre-set densities can be exposed into each separation for regular checking of the gradation of film and development. The gray scale is produced by



1. Lamp compartment
2. Xenon lamp housing
3. Drive motors
4. Transparency arm
5. Scanning drum (interchangeable)
6. Scanning head
7. Mask scanning head
8. Mask drum
9. Exposing area
10. Daylight cassette
11. Color computer with control unit and extended selective color correction
12. Base frame

FIGURE 14. Chromagraph DC 300 components.

is larger or smaller than the selected recording resolution by the scale alteration factor. For example, with eightfold enlargement and a selected resolution of 350 lines per square inch, the original is scanned at 2,800 lines per square inch. The scale adjustments are made separately at the electronics cabinet for the axial and circumferential directions, thus enabling picture subjects to be extended and compressed in order to achieve special graphic effects, as illustrated in Figure 15.

"The scale adjustment control has another advantage in that it allows the operator to 'stretch' or 'compress' separations by small unnoticeable amounts to allow for bleed, cut-ins and under- or over-sizing errors."[27]

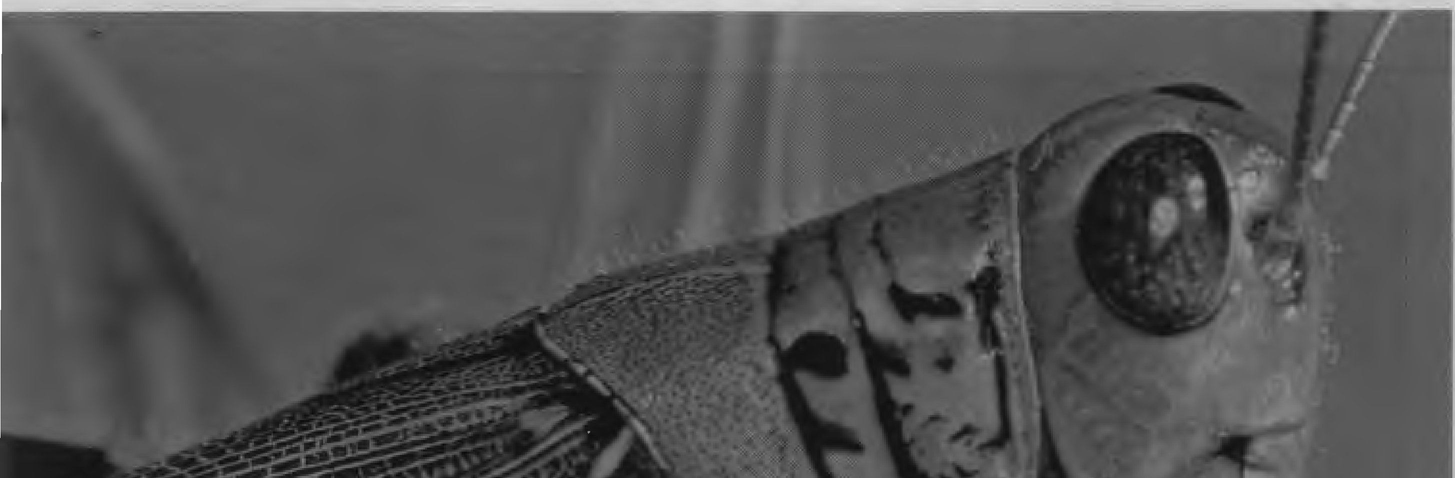


FIGURE 15. Special graphic effects can be achieved by use of axial and circumferential controls on the DC 300 color scanner.

a digital program and not by scanning an original. The same is true for register crosses. Fully automatic film and screen mounting on the recording drum is accomplished with the actuation of a lever. Punch register is provided for all film. After exposure (9), the cassette is removed and transported to a darkroom for film processing. The directly screened separations produced by the scanner are on Eastman Kodak M.P. Ortho film and almost universally developed in E.K. Kodalith Model 324 film processors. This is because the extra speed of the M.P. Ortho film is necessary due to the lower amount of exposing light available on a scanner compared to conventional screening.

Reduction and Enlargement

Apart from same-size reproduction, a range from 33-1/3% reduction to 1,685% enlargement can be accomplished by means of a digital scale computer and the use of scanning drums (5) of different diameter. The three scanning drum diameters are ¼, ½, and 1/1 of the recording drum diameter. This results in maximum enlargements up to 422%, 844% and 1,685% for the different drums.

Electronic Sizing

Sizing is adjustable between 133% and 1,685% for color transparencies with a maximum size of 5-1/8" x 5-1/8" when using the smallest scanning drum; between 66% and 844% for color originals with a maximum size of 10" x 16" using the medium-sized scanning drum, and between 33-1/3% and 422% for color originals with a maximum size of 16" x 20" using the large scanning drum.

The originals are scanned with a number of lines per inch, which

Selective Color Correction

The extended selective color correction facility is used chiefly for adaptation of the color separations to the papers and printing inks used. There will be instances in which color separations corrected in the normal way will not always lead to printing results conforming to requirements of the customer or the individual design matter. There may be imperfections which must be eliminated by additional corrections. To accomplish this task, a color computer is provided with an extended selective color correction facility in addition to basic correction.

Gradation and correction can be adjusted for all four color separations before work is started, thus alleviating any necessity for further adjustment between the color separations. Special controls for compensation of color casts in highlights and shadows, correction of light pastel shades, neutral steepening of highlights, under-color removal, color addition and partial picture correction can all be controlled at the color computer unit.

Control Masks

Certain copy will lend itself to use of a control mask. The mask enables the operator to reproduce difficult combinations, which may consist of several picture subjects, line drawings, texts, logos, trade-marks and tonal areas or other decorative details. The control mask can also be used for partially retouching by adding or subtracting constant densities in the case of flesh tones or increasing or decreasing contrast in individual color separations.

Partial picture correction may also be used for extreme color changes, i.e., reproduction in green of a dress that is blue or red in the original. (See example in Appendix 6.) Intensification of specific colors can also be achieved with partial picture correction. The degree of unsharp masking can also be altered in specific areas by means of the control mask, i.e., to alter the characteristics of texture in a fur coat without altering the flesh tones of the model.

Step-and-repeat work is achieved by use of a control mask by recording the color separations on film in the axial direction. Repetition in the circumferential direction of the drum, also controlled by the mask, can be achieved by repeated reading out of picture information from the core memory.

Recording Unit

The recording unit which houses a recording drum and recording light source are housed in a light-tight compartment on the right side of the scanner. The recording resolution is selected by push-buttons. A glow-lamp, which can be modulated and is electronically stabilized, is used as the recording light source. The recording drum contains several pins and vacuum system which hold film and screen in position during the recording process. A braking shoe is coupled to the recording drum and is activated during shut-down sequence.

Power Supply Cabinets

Power packs, drive motors, memory and digital store electronics are contained within two cabinets which occupy a space several feet distant from the scanner. On installation, the two cabinets are grouped to form a three-door arrangement. Careful consideration must be given to placement of the scanner and power units, since it should be free from any vibration and contamination. Air conditioning is mandatory.

SECTION E

The Printing Division of Meredith Corporation

The Printing Division of Meredith Corporation, located in Des Moines, Iowa, is the sixth largest producer of magazines and catalogs in the United States. The 600,000-square-foot plant, completed in 1959, is one of the most modern printing facilities in the country. It processes over 80,000 tons of paper annually through 30 printing presses, and prints more than 12 million magazines a month, many of which are addressed in the plant and shipped to postal stations throughout the country.

The division prints several publications for Meredith's own Magazine Division--including Better Homes and Gardens, Successful Farming, Apartment Life and a number of special interest publications. The division's services also include contract printing of other companies' publications, including Vogue, House and Garden and Bride's magazines.

An increasingly important area of activity is commercial printing, an operation that produces such items as athletic programs for Coca Cola, catalogs for Lord & Taylor and Earl May seeds. The division has sales offices in New York, Chicago and Des Moines. Outside customers now make up approximately one-third of the division's business.

Besides manufacturing and storage areas, the Des Moines plant houses administrative, sales and business offices for the division, a cafeteria, medical facilities, research department, maintenance shops and personnel and employment offices to serve the 1,300 people who work there.

Men and women at Printing Division work in three shifts, around-the-clock, plus weekends during peak production periods. They handle every aspect of printing production, from setting type and mixing ink to binding, wrapping and addressing the finished product. Meredith Corporation is a media company operating four divisions. The three other divisions are Magazine, Consumer Book, and Broadcasting.

Meredith's corporate headquarters are at 1716 Locust Street in Des Moines. At this same location are the headquarters for both the magazine and Consumer Book Divisions. In this building are the test kitchen, photo studio, circulation, advertising, and editorial offices. Better Homes and Gardens, Successful Farming, Apartment Life and other special interest publications such as Christmas Ideas, Travel Ideas, and Home Building Ideas are written and edited there. The same operations for the Consumer Book Division are handled in this building. This division publishes more than 50 Better Homes and Gardens "how-to" titles, including the New Cook Book, Family Medical Guide, Baby Book, Handyman's Book and Creative Home Library books.

The Broadcasting Division operates four AM radio, five television and two FM radio stations--eleven stations in all. They are located in Kansas City, Omaha, Phoenix, Syracuse and Bay City-Saginaw-Flint, Michigan, and serve over 14 million people.

Sales, advertising and editorial offices for the various divisions are spotted throughout the United States and Meredith is represented in many foreign countries. Meredith has expanded its activities in the field of communications to include several new operations. One of these is Meredith/Burda, Inc., a rotogravure printing plant in Lynchburg, Virginia. This company is 50% owned by Burda Druck GmbH, Offenburg, West Germany.

Edwin Thomas Meredith, Sr., founder of Meredith Publishing Company, was born in 1876 and raised on an Iowa farm. He was introduced to the publishing business at the age of 19, when, as a wedding gift from his uncle, he received the Farmer's Tribune, a Populist newspaper. The gift was accompanied by a note on the publication's financial statement: "Sink or swim."

Meredith swam. He dropped the Populist views of the Tribune and made it pay in a small way. But he wanted a more significant publication with a well defined purpose, so he sold the Tribune and in October, 1902 published the first issue of Successful Farming. In spite of several seemingly insurmountable lack-of-funds crises, Successful Farming made substantial circulation and advertising gains, and by 1912, Meredith had a new building to house his growing company. With a successful farm magazine to his credit, Meredith turned his attention to an urban-oriented magazine. Fruit, Garden and Home came off the presses in September, 1922, and in 1924, the name was changed to the current Better Homes and Gardens.

At the age of 44, Meredith was president of one of the largest publishing houses west of the Mississippi, had been appointed secretary of agriculture in President Woodrow Wilson's cabinet, and was president of the Associated Advertising Clubs of the world. He was also a pioneer in helping establish the 4-H Club movement, and loaned thousands of dollars to deserving farm boys and girls whose only collateral was their signatures. At the time of his death in 1928, E. T. Meredith was being discussed as a candidate for the Democratic presidential nomination.

The magazine publishing industry is faced with rapidly escalating costs, particularly costs of printing paper, production, and postage. Some magazines with page size comparable to Better Homes and Gardens (632 agate lines) have cut their formats to news magazine size (429 agate lines) as a means of partially offsetting higher manufacturing and delivery costs. Based on considerations of both reader and advertiser interests and on a strong belief that the graphic display advantages of the large page have been important assets in the magazine's success, Better Homes and Gardens has decided to retain its present page size.

Printing work for outside customers received a major boost with the announcement in September 1973 of a long-term agreement to manufacture 10 Hearst Corporation publications. Beginning in the Spring of 1974, Meredith will print, bind, and mail monthly issues of Harper's Bazaar, House Beautiful, and Town and Country, plus seven annual and semi-annual House Beautiful supplements. Combined circulation of the monthly magazines is 1.5 million copies; the supplements range from

150,000 to 200,000 copies per edition. The Hearst business, expected to generate manufacturing revenue in excess of $4,000,000 annually, will fill all available letterpress production time at the Des Moines printing plant and require the installation of one new press (already acquired) and another bindery line. Currently, major customers for letterpress printing are the company's largest-circulation magazine, Better Homes and Gardens, and three magazines of Conde Nast Publications, Inc., Bride's, House & Garden, and Vogue.

During fiscal 1973 the Printing Division expanded its capability to provide high quality and service to web offset customers by installing new equipment used in printing preparation. Among these new pieces of equipment is a Hell DC 300 electronic color scanner used to prepare color photographs for web offset printing. The scanner separates original photographs into component colors, resizes to fit artists' layouts and color corrects to copy specifications.

The Hell Chromagraph DC 300 at Meredith is fully operational and currently produces color separations for selected publications on a time available basis. First complete production operation included color separations for the January 1974 issue of Single magazine (example in Appendix 7), excluding all national advertising color separation which were produced using conventional processes or supplied.

"With regard to the function and maximum productivity that can be expected from the DC 300 at this point, it has already proven to be a faster process than anything now available in the direct screening-to-size of photographic prints. The quality thus far achieved is superior to anything yet produced using conventional color separation methods at Meredith."[28]

The whole process of picture reproduction consists of a number of single steps which are especially numerous and therefore time consuming and expensive if the layout specifies a complex picture composition. The first task of the Chromagraph scanner has been to take over the most difficult parts of the process, i.e., tone and color correction. It was soon recognized that considerable time and material expenditure could be saved by the use of a scanner. Moreover, electronically produced color separations are characterized by a highly consistent quality which allows standardization of the subsequent processes.

In magazine production at Meredith, there is a desire to obtain conformity of flesh tones on all pages of the publication. Since important parts of the image, such as clothing, must be taken into account when setting up the color correction, the task is made easier by simply employing the selective color correction system on the unit. Selective color correction is mainly concerned with the extension of the electronic four-channel color computer so that special printing colors can be matched, e.g., the Kodak scale, the Europa scale, and special colors for packaging work. Other requirements concern unusually critical hues which are often unsatisfactory in the original copy.

The firm of Dr.-Ing, Rudolf Hell recently announced a major achievement with the introduction of electronic screening using a laser beam on the Chromagraph DC 300. Meredith intends to make a field conversion to laser beam on its machine but not for at least a year. A DC 300 equipped for laser screening can be switched over to contact screening and continuous tone operation by the operator.

Currently there is one technician fully qualified to operate the color scanner. This individual is in the process of training another employee which is expected to take approximately six months. This training routine will continue until one back-up man is trained for each lead man for an equivalent of three 8-hour shifts. Full production is expected within one year.

All employees have to be fully cooperative and a great deal is required of the management and the departmental managers. The reward for all this extra effort consists of job satisfaction, enthusiasm and interest in the work.

Considering the fact that Meredith publications are produced by the most modern systems, involving sophisticated and highly complicated processes and equipment, there is reason to understand why employees are proud of past achievements and future goals. However, this is just the beginning of a long road to a fully integrated system of complex graphic communications technology.

SECTION F

Future Role of Color Scanners: One Solution

A solution to the many practical, economic, labor and quality problems besetting color copy printing preparation may be forthcoming from a system utilizing a digital computer that has been developed by Ventures Research and Development Group (VRDG) in Princeton, New Jersey.[29] Its color scanning system has been designed to make color separations and printing plates with a minimum of skilled labor, yet without loss of quality. Only two or three months are necessary to master the equipment operation satisfactorily. Color separations can be produced at higher speeds and at lower costs than with other methods available.

The VRDG system is composed of a scanner, a digital computer which drives the scanner, a color analyzer used to preset the system and a special color chart to calibrate all elements in the reproduction system. This system has a number of operative advantages, including:

1. Sharply improved color fidelity.
2. Size enlargement and reduction capacity.
3. Integral screening.
4. Adaptability to all inks, papers, plates, and printing methods.
5. Facility for accommodating customer changes in color balance, spot color, and tonal gradation.
6. Accurate proof copy for customer approval.

7. Capability of merging copy.

8. Ability to provide all the above services for remote operation.

The VRDG concept centers about and is made possible by the use of a scanner controlled by an inexpensive digital mini-computer. The computer makes possible automatic measurement and compensation for all the elements of the preparation and printing system, including color separation and screening operations, as well as the plate-making, ink, paper and printing processes. Even the original photographic steps may be included, if desired. Color balance, spot color, and tonal corrections require human judgment--changes for which the scanner can provide by semi-automatic means. It provides an instant picture of modification results as they are achieved so that the operator need have no particular skill in knowing how to effect such changes. Screening and dot formation are handled electronically under computer control.

Copy being prepared for printing is first examined for color balance and the need for spot color corrections through the use of an auxiliary editor device. In the central area of this equipment is a source of light whose color and luminance may be adjusted conveniently. Around the periphery are placed reference materials such as scenes of people, flowers, landscapes, etc., as well as swatches of fabric or other color material deemed important by the client. These materials are illuminated by a standard white light. A transparency of the original copy is placed in the center of the apparatus and the color adjusted until the desired color balance is reached. Local color correction may also be made at this time by retouching either the transparency or a transparent overlay. Tonal adjustments can be made now to change the highlights, midtones or shadows. The practicality of making these corrections before color separations have been made, instead of afterwards, stems from the ability of the separation and printing system to reproduce the copy exactly as presented to the scanner. The advantages of correcting at this early stage are that the ability to make changes may be given to the client and that implementing such changes does not require the high degree of skill necessary when operating on the separations or on the printing plates. Finally, the color correction values and the tonal adjustments determined with the help of the editor are entered into the scanner-computer along with copy size, cropping limits, reproduction size, and screen gauge.

After two high-speed pre-scans for color saturation limitations, the system automatically scans the copy and produces, in succession, the screened separation transparencies. The equivalent of screen rotation to minimize moire is accomplished by the computer.

The Scanner Comes of Age

The original purpose of color scanning was to achieve systematic tone and color correction. It was realized only recently that scanners might be designed to provide color correction and also produce the separations at a speed comparable with, or faster than, those available through conventional photographic methods.

The more recent scanners have been designed to operate at relatively high speeds and are simpler and less expensive than earlier versions.

Some have been specially designed to make separations from transparencies. A transparent drum is used with the cylinders for the original transparency and the sensitive photographic film mounted on the same shaft.

Despite all the development and production activity, the scanner market is not an important growth area in the graphic arts. For various reasons, acceptance of the color scanner has been slower than would have been anticipated in the early days of the business. At best, just over 100 color scanners are being used in the United States at the present time.[30] It appears that the main obstacle to scanner acceptance has been a lack of understanding of their operation and capabilities.

"Upon first learning about color separation scanners in the early 1960's, it was believed the machine had little to offer as compared to conventional color separation methods. However, after seeing several demonstrations on the Hell DC 300 all skepticism of the capabilities of this machine were forgotten."[31]

Color scanners demand the same human judgment at each step of the process as is required with conventional equipment. The complexity of the early scanners and even some current models has discouraged users as well as buyers of printed material from involvement with such units.

"The individual desiring to learn the techniques of scanner operation must have a solid mechanical aptitude. It is not necessary that he possess a background in color separation but should be competent in the area of black and white halftone photography."[32]

The requirement for highly skilled operators has further restrained scanner acceptance. From two to five years of apprentice training are required before adequate skill in color separation and color plate preparation can be achieved.

Although demand for color printing is increasing, the labor supply is steadily decreasing. Insufficient numbers of young people are interested in undergoing the long and stringent apprenticeship program necessary to replace the highly-skilled personnel retiring from the industry.

Management must be able to justify the acquisition of scanners not only from the standpoint of capital outlay but also in the fact that a scanner has an enormous capacity to produce work and therefore volume must be the first criterion upon which the decision is made. If the volume is not a guarantee, the decision becomes uncomplicated. The decision, of course, must be based upon many other aspects, but none so important as to whether the unit can pay for itself in a reasonable length of time through a program of efficiency and high production.

The Lithographer's Union appears to be cooperating with management in an effort to resolve the problems inherent in the acquisition of new sophisticated electronic equipment. Jurisdictional rights are always a key issue in matters of this kind. However, there appears little doubt that the scanner will be included under the lithographer's jurisdiction and not that of the International Typographical Union (ITU), at least for the present time.

Both unions are strongly represented at Meredith Publishing Company, along with thirteen other unions, including custodial and maintenance. The ITU has gone on record internationally as claiming jurisdiction up to but not including the process camera. This jurisdictional "job claiming" within ITU rank-and-file has been persistent in the area of cold type composition for the past 18 years. At that time the new processes were about to be launched into the field of newspaper production.

* * *

SUMMARIZATION

There is little doubt that the color separation scanner is a practical tool which is here to stay. Quality of separation work now coming off the scanners appears to be excellent. Production times have been cut to less than a quarter of the time now required to produce separations using conventional methods. These two factors--quality and production time--are significantly noteworthy as to warrant a conclusion that color separation scanners will have a permanent role in the continued development and expansion of the graphic communications industry. Color printing has made great strides from the basic discovery of the color spectrum by Sir Isaac Newton to the application of computer and other electronic technologies to further improve the graphic arts.

FOOTNOTES

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VITA

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A P P E N D I C E S

APPENDIX 1

APPENDIX 2

APPENDIX 3

APPENDIX 4

HCM CORPORATION
HELL COLOR METAL

CABLE [illegible] Great Neck N.Y.

MAIN OFFICE: 115 CUTTER MILL ROAD, GREAT NECK, N. Y. 11021 P.O. BOX 770 (516) 466-0710

U.S.A. PRICE LIST

DC 300 ENLARGING/REDUCING COLOR SCANNER

See literature for detailed specifications.

Including The Following Standard Accessories:

1 Set of Three Input Scanning Drums
  a. 5" x 5" b. 10" x 16" c. 16" x 20"
1 Set of Three Interchangeable Lenses
1 Set of Three Interchangeable Transparency Illuminators
2 Film Cassettes
1 Cassette Holder
1 Register Punch
1 Tool Kit
1 Set Of Optical Cleaning Instruments
1 Set Of Lamps and Fuses
1 Storage Cupboard for Drums, Instruments, Etc.
1 Set of Consumable Material
1 Operating Manual

PRICE FOB NEW YORK, N.Y.-------------------------------------U.S. $146,000.

Optional Features:

Equipment For Screening Directly On DC 300:

1 Screening device including one set of screens either 120, 133, 150 or 175 lines per inch. Size 16" x 20" prepunched and angled.
Also including one vacuum pump

PRICE FOB NEW YORK, N.Y.-------------------------------------U.S. $ 3,000.
(when purchased with basic machine)

Total Price - DC 300 For Recording Continuous Tone or Screened Color Separations

PRICE FOB NEW YORK, N.Y.-------------------------------------U.S. $149,000.

RHF:lg
10/1/73

APPENDIX 5

APPENDIX 6

APPENDIX 7