ZELACOLOR®, A NEW METHOD OF COLOR SEPARATION WITHOUT THE USE OF INTERMEDIATE TRANSPARENCIES

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Abstract: Essentially, the Zelacolor method utilizes a patented 70 mm photographic camera that is compact and completely portable. The unique use of 70 mm film may be considered as an entirely new development with regard to commercial production techniques. The Zelacolor method exposes the cyan, magenta, yellow and black separation images onto a single strip of 70 mm continuous tone film. Color correction is made possible by a cassette masking system that enables the operator to make one or more masks for each set of separations. Any type and size of reflective copy or three-dimensional object may be used as the subject to be color separated directly by the camera, which is called the Zelacolor Universal Camera. This paper will describe the mechanical design of the camera as well as the functional operation of the complete system.

Introduction

The Zelacolor method of color separating without the use of intermediate transparencies is the result of an extensive research and development project that had its beginning in 1974 when Zelaco S.A., an international holding company based in Lausanne, Switzerland, purchased the patent rights for a camera called the Zelagraph from a French inventor.

A unique characteristic of the Zelagraph was its ability to simultaneously expose the cyan, yellow and magenta color separations directly onto 70 mm film by

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utilizing an optical prism to split the image. The small size and weight of the camera made it completely portable, enabling one to take it on location for the purpose of producing color separations directly from the original subject matter.

Unfortunately, the Zelagraph camera at this stage had three limitations: it did not have the capability of producing the black separation automatically; it did not have the capability of producing photographic masks for color correction; and it did not have a practical way of screening and enlarging the 70 mm continuous tone negatives to final size once they had been imaged.

It was evident from a marketing standpoint that if the concept of the Zelagraph camera was going to work in the commercial graphic arts market, that a method of doing color correction had to be devised, otherwise, the other two limitations were academic.

This in itself necessitated a complete redesign of the Zelagraph camera as depicted in slide 1 which shows the original Zelagraph camera and slide 2 which shows the current redesigned version, now called the Zelacolor Universal Camera.

The main purpose of this paper then will be to describe the mechanical design of the Zelacolor Universal Camera, particularly the masking, film advance, and registration mechanisms, as well as the functional operation of the complete system.

Mechanical Design

Since color separation negatives alone cannot give accurate color reproduction, a unique photographic masking system was incorporated in the Zelacolor Universal Camera. The design of the masking system had to take into consideration that the registration of images from film to film and from exposure frame to exposure frame had to be absolutely accurate. That is, the panchromatic masking film image had to be precisely in the same position and held down squarely against the 70 mm separation film as it was advanced automatically during the exposure process from frame to frame.

Unlike conventional camera-back masking which is done in complete darkness using a pin-strip mounted on the camera-

back for manually registering the films, the design of the masking system for the Zelacolor Universal Camera had to be a daylight working system and have automatic registration.

The automatic registration and daylight parameters were met by designing a light-tight cassette as shown in slide 3. It is machined to extremely close tolerances and has a very precise three-point registration system that insures the cassette will be placed in exactly the same position every time it is inserted into the mask cassette chamber located at the top of the camera. A miniature two-point punch is used to put register holes in the masking film which is loaded into the cassette in the darkroom. Because of the small camera format, the masking film only has to be 3-3/8" x 3-3/8" in size. The cassette is made light-tight by a barn-door shutter mechanism that is actuated by a solenoid within the camera during exposure, and by a removable cover that is placed over the film once it is loaded. Slide 4 shows the masking cassette with the imaged mask in position as it would be during the color separation exposures.

The design of the 70 mm film advance and registration mechanism is comprised of a precision motor driven gear and cam system together with a precision pin alignment assembly and a pressure guide apparatus.

In the first illustration, the sliding door is in the closed position to keep the film from being exposed when loading the mask cassette. The film carriage is at its lowest position with the film threaded over the top section of the carriage to the take-up cassette.

The next illustration shows the mask cassette locked in position with the sliding door open to allow the film carriage to advance the film up into the exposure plane. Note that the film is rolled up to eliminate possible abrasions due to friction.

When the film carriage reaches its maximum travel position as shown here, the pressure guide apparatus drives the film carriage towards the mask cassette in the exposure plane.

Once the exposure has been completed, the motor driven gear and cam assembly is activated by a microswitch that lowers the film carriage and advances the film forward one

frame, precisely.

Functional Operation

Functional operation of the Zelacolor Universal Camera is very simple. Any photographer who has had experience with color photography and some technical exposure to the principles of color separation can learn to operate it in a very short time.

A typical environment for the camera would not be unlike that which is now being used by any professional photographer, that is, a studio with sufficient space to accommodate the camera and lighting equipment.

The 70 mm film that we have been working with in the camera is Kodak Separation Negative Film 4133, Type 2, in 75 foot rolls. It is perforated on both sides much like 35 mm film and is characterized by Kodak as a fine-grain, moderately fast, high-contrast, panchromatic film.

It is placed into a light-tight cassette and then loaded into the camera where one end of the film is attached to a smaller light-tight take-up cassette. Each separation set requires approximately 1.5 feet of film, therefore, approximately 50 sets of separations can be imaged from each roll. The take-up cassette can store up to five sets of imaged separations before the film is slit by means of an internal cutting blade and the take-up cassette removed to process the film.

The operator focuses the camera through an eyepiece mounted on the rear of the camera, and by adjusting the camera-back, which is movable, sets the image perspective.

Depending on the subject, flat artwork or three-dimensional objects, either a 135 mm or 210 mm lens is placed in the camera. Other lenses can be used, but these two are sufficient for most applications.

Standard color filters as used in conventional systems are mounted in a seven station filter wheel assembly forward of the lens at the front of the camera. Filter selection is activated electronically by an operator control box that is attached to the camera tripod. This control box also incorporates the switches to activate the film advance mechanism and the mask shutter during the exposure sequence.

After the input of densities for the exposure calculation have been made, the probe is removed from the mask cassette chamber and replaced with the mask cassette which has been preloaded with pan masking film. A tone control and a color correction mask are made using the red and green filters. Since highlight and shadow contrast can usually be controlled at this point by the photographer through the placement of his lights on the subject, it is usually not necessary to make a highlight or shadow detail mask.

Once the masks have been exposed and processed, they are reloaded into the mask cassette which has a built-in two point registration system and placed back into the camera for the separation exposure sequence -- cyan, magenta, black, yellow. The operator uses the control box to select the proper filter and to sequence the film forward in perfect registration for each exposure.

Depending on the type of lighting used, electronic flash or tungsten, the exposure time or aperture setting is given to the operator on the digital display so that correct adjustments can be made to gain the proper exposure result. For example, when electronic flash lighting is used, the operator presets the exposure value which is kept fairly constant and the microprocessor automatically calculates and displays the correct aperture setting. In figure 1, we can see what the exposure values and aperture settings would be for a particular subject when the mask and color separation exposures are made through various filters.

Filter Wheel	Filter No.	Aperture	Exposure Value
Mask 1	33	F22-2/3	1.26
Mask 2	58	F22-2/3	1.26
Cyan	25	F32	1
Magenta	58	F22-2/3	1.26
Black	85B	F32	.26
Yellow	47	F22	1.59

Figure 1. Camera Settings with Electronic Flash

Conversely, when tungsten lighting is used, the operator presets the aperture and the microprocessor automatically reads out the correct exposure values. In figure 2, we can see what the exposure values and aperture settings would be for a particular subject when the mask and color separation exposures are made through various filters.

Filter Wheel	Filter No.	Aperture	Exposure Value
Mask 1	33	F22	5.04
Mask 2	58	F22	5.04
Cyan	25	F22	3.17
Magenta	58	F22	8
Black	85B	F22	2
Yellow	47B	F22	16

Figure 2. Camera Settings with Tungsten Light

Once the color separation exposures have been completed, the film is processed in preparation for the next step--using the Zelascreen Enlarger to make screened film positives to the proper size.

Zelascreen Enlarger

The Zelascreen Enlarger has been specifically designed to form an integral part of the Zelacolor method. As input, the 70 mm continuous tone separation film is accommodated in any length depending on the number of separation sets on the film strip. A sprocket drive mechanism in combination with a precision cam controls the movement of the film forward from frame to frame in perfect register for imaging on the copyboard. This is similar to the film advance and registration concept used in the Zelacolor Universal Camera.

A Multiblitz, 600W stroboscopic type light source is used to expose ortho positive film through a magenta contact screen up to 20" x 24" in size. Unlike direct-screen enlargers, the Zelascreen Enlarger is operated in red

safelight conditions due to the fact that ortho film is used at this stage as opposed to pan film.

As with any color separation process, placement of the highlight and shadow dots in the screen positives is very critical because this is a subjective judgment on the part of the operator. At this point, the operator must also consider dot size characteristics in anticipation of dot gain in the particular printing process to be used. The Zelascreen Enlarger has been designed with this in mind by incorporating a light sensing probe that allows the operator to very accurately measure the light projected through the separation negative onto the copyboard. When the probe is placed in the projected highlight areas, the highlight balance knob is turned until a null reading appears in the digital display of the highlight measure window at which point the correct exposure would be simultaneously calculated and displayed. This procedure is repeated for the shadow area.

The electronic control system of the Zelascreen can compensate for every variable of the photographic process and can produce a complete set of screen positives in a very short time with minimum risk of error.

Conclusions

The Zelacolor method of producing color separations is a unique method that will allow even small trade shops, printers, in-plant shops and newspapers to do color separations easily, economically, productively and with high quality. On the basis of its 70 mm film size, material consumption in relation to normal production methods is drastically reduced which results in substantial savings.

For many years, the indirect color separation method offered the most flexibility and the most advantages to quality printers and trade shops. The color correction, using masks, was good and the screen positives were very suitable for dot-etching because of the soft-dot. But, this method involves several manual steps, and up to sixteen individual pieces of film which makes it very expensive in terms of labor and film costs.

The Zelacolor method overcomes these disadvantages with a system that can be described as a highly automated, indirect system. Labor and film costs are minimized due

to the fact that from the beginning of the mask exposures to the four developed separations on 70 mm film, it is possible to require less than 15 minutes of time and only $2.40 worth of materials.

In the configuration as just described, the Zelacolor Universal Camera, when mounted on a tripod, is utilized in a somewhat portable manner to do color separations directly from the original subject without the use of intermediate transparencies. This, in itself, is unique and leads to considerable cost savings in the production process by combining the creative photography with the color separation photography.

However, recognizing that it will not always be practical to color separate directly from the original subject, the Zelacolor concept has been taken a step further and other product configurations developed.

In one of these developments, the Zelacolor Universal Camera is mounted on a horizontal optical bench which we call the Zelaprint® and can now be utilized to do color separations from input of existing transparencies up to 8" x 10" in size. It is still a daylight operating unit which is made possible by the enclosed design which houses the transparency holder, the automatic filter wheel assembly, the light source and a special lens assembly that is used to focus the light projected through the transparency and onto the 70 mm film. All operator controls for color correction mask exposures, and color separation film exposures are conveniently located on a control panel mounted at the front of the Zelaprint unit.

In another product development, the Zelacolor Universal Camera is mounted on a vertical frame which we call the Zelaflat® and can now be used to color separate directly from reflective copy or three-dimensional objects placed on the copyboard. With the use of a projection lightbox placed on the copyboard, existing transparencies can also be color separated. The Zelaflat has a dual automatic size and focusing system to compensate for the change in the height of the copyboard plane when changing from reflective input to transparency input. Operator controls for exposures, sizing, and focusing are mounted in a separate module.

From a basic concept then, three distinct systems have evolved -- Zelaprint System I, Zela Universal Camera

System II, and Zelaflat System III. These systems will now be marketed in North America and Mexico by American Zela, Inc., East Norwalk, Connecticut.

Literature Cited

Southworth, Miles, F.
1979 "Color Separation Techniques", (Graphic Arts Publishing, Livonia, New York) pp 134-139.