THE DIGITAL SERIES TRAVELING MATTE BACKINGS

The Significance of Traveling Matte Cinematography in Modern Motion Pictures

Throughout the technological history of film making during the last quarter of this century, it has been increasingly difficult to overestimate the significance of traveling matte in film production. The following opening paragraphs from my 1984 S.M.P.T.E. paper are illustrative:

> Blue-Max High-Power Blue Flux Projector
> for Large Scale Bluescreen Composite Photography
>
> Jonathan Erland
>
> In the eight years that have elapsed since the release of the motion picture Star Wars, the compositing technique known as "bluescreen" has enjoyed a phenomenal growth. Greater sophistication in the application of this technique has, in turn, led to greater demand for it. One of those demands, heretofore difficult to meet, has now been satisfied: bluescreen on a large scale - 50' by 150' or larger.
>
> BACKGROUND
>
> The compositing process known as bluescreen had its beginnings in the work of Messrs Dunning, Pomeroy and Oliver in the late twenties and early thirties. From Dunning's use of a colored backing to distinguish the foreground from the background, through Pomeroy's five separate compositing processes, to Oliver's insightful application of the lithographic color separating process, these pioneering efforts produced a system of traveling matte photography that was to blossom into a rich tapestry of technical wizardry.
>
> While traveling matte photography has been in the arsenal of motion picture technology for many years, the refinements that occurred in the years since *Star Wars* have catapulted it into one of the most important motion picture processes extant. It has been estimated that from *Star Wars* through the present, motion pictures incorporating traveling matte photography have accounted for approximately $10 billion in revenues. The Academy of Motion Picture Arts and Sciences has acknowledged the importance of this aspect of film technology by granting several technical awards in connection with traveling matte processes including a Technical Achievement Award for the subject of this paper.

When that paper was presented, there were still a number of respectable professionals who were prepared to regard this as overly strong language in support of a niche activity in the filmmaking lexicon. Twelve years later, the language I used then is beginning to look fairly pedestrian, and the revenues are almost incalculable. It was however, sufficient to galvanize Eastman Kodak into addressing the issue of traveling matte in the design of film stocks, and new ones still on the drawing boards will hopefully further facilitate this fascinating form of imagery.

Meanwhile, in the intervening twelve years, massive changes have come about in the way we accomplish composite images, and the Academy's recognition has been expanded to include no less than two of its highest honors, an Academy Award of Merit and a Gordon Sawyer Award to Petro Vlahos for his pivotal contributions to this technology. (While Petro's name did not appear in the excerpt above, he figured mightily elsewhere in the paper and fully half of the references cited were from his writings.) Further, the Academy has expanded its family of Branches to include Visual Effects for whom, of course, traveling matte is the staff of life.

Digital composites

Of course, the biggest single change in traveling matte technology in recent years has been the advent of digital compositing. The most intense developmental activity has naturally been focussed on the I/O apparatus and the software programs for manipulating the images once they have been digitized. The Sci-Tech. Committee has had occasion to review a plethora of scanners, film printers and enough software to warrant the creation of a standing committee. Accordingly, I will abbreviate this aspect of the discussion.

Redefining the backings

To some extent, the assumption was made that the image acquisition part of the equation—the original photography—was a fully matured part of the process requiring no further refinement. But the backing requirements for digital compositing are demonstrably different that those for photochemical composites. For example, in the days of photochemical optical composites, blue was essentially the only record available to us for motion picture work. Only the most rash and foolhardy practitioners dared attempt green screen and then only as a desperate measure. With the advent of electronic compositing systems, the whole subject of the backing screens that provided the matte field demanded redefinition.

It is a popular misconception that traveling mattes are simply sophisticated photographically derived rotoscopes, in other words, a switcher permits either one of two images to appear at a particular place in an image. It's true that the earlier iterations of bluescreen in motion pictures and chromakey in television functioned in much that way. But mattes for the modern digital compositing process can be seen to have gradients which enables them to reproduce translucent images such as shadows or glass objects or smoke. The images, now becoming known as the Alpha channel, are continuous tone rather than the hi-con film mattes.

In photochemical film optical composites, this was only possible by employing very pure bluescreens exposed to a precise density, shot "clean" (meaning no garbage mattes) which permitted the use of either a very thin or even no cover matte at all in the composite. Such conditions were ordinarily extremely difficult to achieve in normal stage operations.

In Ultimatte (Vlahos) matte extraction logic, as applied to digital film composites today, the process (while still quite similar), is freed from confinement to the Blue record and readily incorporates garbage and window mattes without any compromise of the finely detailed continuous tone feature.

The starting point for a digital blue or green screen color difference composite is a matte generated by subtracting the value of one color from the value of another for each pixel in the image. (Whether this is accomplished through software or through analog video circuitry, the net effect is the same.)

With Blue logic, the raw matte is a gray scale image whose value at each point is simply the amount by which Blue exceeds the higher of the other two colors. The result is a matte which is dead black anywhere Blue is less than Red or Green and some shade of grey wherever Blue is the predominant primary color.

This matte is subjected to a variety of adjustments before it is used to process the foreground and background images, but the crucial point here is that the matte is generated from the absolute levels of the color components for each pixel. A pixel having values of 200 Blue, 100 Green and 100 Red will yield a pixel with a value of 100 in the matte while a darker pixel of the same hue with values of 100 Blue, 50 Green and 50 Red will yield a matte value of 50.

In other words the Ultimatte electronic or digital color difference matting process is a function of the luminance or brightness of the backing as well as the chrominance (hue) or purity of its color and the uniformity or consistency of the matte field.

What emerges quite clearly from this description of how the Ultimatte (and other comparable matte extraction programs) work is that chrominance, (the purity of the backing color), luminance (the brightness of the backing color) and uniformity (the lowest possible variations in chroma and luminance) are crucial to the process of creating a matte and to the subsequent composite image.

The Development of the Digital Series of traveling matte backing materials

A review of the existing traveling matte backing materials extant at the time of the introduction of digital compositing revealed serious inadequacies in these criteria. Composite Components Company was brought into existence to redress this situation.

Individual components had been addressed on an ad hoc basis, in some cases with considerable success. The contributions of Stewart Filmscreen, my own work during my tenure as Director of Research and Development at Apogee Productions as well as that of others have been well documented in the American Cinematographer Manual. What was particularly lacking was a consistency among the various components available for matte backings so that, for example, painted elements could be filmed in conjunction with fabric backings with relatively little difference in chroma and luminance. Also lacking was a luminance level sufficient to ensure that shadows could be retained from the backing and carried into the composite scene without noise. This fundamental lack of luminance in the conventional backing materials had confounded many efforts to produce traveling mattes in daylight without expensive supplemental lighting.

Thus we resolved to start again from the very beginning with the goal of developing a suite of materials optimized for current motion picture negative stocks. Working outward, so to speak, from the film emulsion spectral sensitivity curves through the camera lens, we sought to target the requisite dyes and pigments that would yield the maximum actinic effect for a given quanta of illumination.

Previous work with fluorescence and phosphors gained during the development of the Reverse Bluescreen process and fluorescent lamps for traveling matte illumination indicated that these processes could be helpful. Accordingly dyes and pigments and phosphors were developed that would produce the whole panoply of backing materials: paints and fabrics, and fluorescent lamps to illuminate them. Not all of these elements were new, for example the design for the blue fluorescent lamps was first produced at Apogee in 1986, and went into service on the film *Spaceballs,* where one thousand such lamps complete with solid state high frequency power supplies illuminated what was probably the largest front lit Tempo bluescreen till that time. What was new was that now all the spectral response curves were in much closer alignment, yielding negatives with the higher ratios preferred by the Ultimatte algorithm.

The physical properties of various fabrics were examined and the traditional backing material known as "Tempo" was rejected in favor of a four way stretch nylon fabric. The new fabric permitted the ability to stretch it into an aluminum frame, forming an absolutely smooth wrinkle-free surface. It is far less bulky than Tempo and can be readily laundered to maintain a high level of performance as a matting field. To facilitate both the ability to stretch into a frame and its launderabilty, the Digital screen is not hemmed and grommeted in the conventional fashion but is provided with garter snaps to which are attached cords for tying. This approach further provides greater flexibility, as the snaps can be relocated on the screen to adjust the size and shape for various situations.

The use of the stretch nylon fabric also facilitated various ancillary devices such as slip covers for flags and sandbags as well as cable sleeves, pipe covers, etc. Additionally, the material is the ideal choice for creating matte costumes, including gloves and hoods. The material provides an extremely smooth, lightweight form-fitting costume, permitting excellent freedom of movement.

The proliferation of traveling matte photography has required that mattes be acquired in a steadily widening range of environments. Day exterior is now commonplace, and underwater mattes are steadily gaining popularity. The Digital Series fabric screens perform exceedingly well underwater. The fluorescent dyes in the Digital Fabric exploit the underwater phenomena by which the longer wavelengths of light are progressively absorbed during passage through water. Thus a Digital Green screen is able to absorb the predominantly blue light and transform these shorter wavelengths into the longer wavelengths of Green. Similarly, the Digital Red screen will likewise effect the same conversion, and may be employed as means to restore some red component to underwater ambient light by deploying it as a bounce.

In yet another underwater application, the Digital Series backings are provided as a segmented floating raft. The segments are provided as small hexagonal shaped pads of plastic such as polypropylene incorporating the dyes and pigments of the Digital Series. When an appropriate quantity of these floats are deployed on a water surface, they conglomerate into a continuous raft and form a backing field for traveling matte filming from either above or below the waterline. Among the advantages of this approach is that the raft remains permeable to air rising to the water surface which would otherwise be trapped against a solid membrane screen and form ever larger bubbles having the optical property of mirrors and destroying the backing field. Of course, the segmented screen also permits the ready ingress and egress of people and equipment directly through the raft. The raft can also serve to either reflect light (white floats) or exclude light from the tank (black floats).

Based as they are on fluorescent dyes and pigments, the Digital Series of backings will illuminate under Blacklight radiation and thus lend themselves to blacklight matting processes such as Reverse Bluescreen.

While the design goal laid out for the Digital Series traveling matte backing system was principally aimed at producing superior quality mattes and composite imagery, there are collateral benefits in the form of quite substantial cost savings. This stems from the significantly lower light levels required for these high luminance materials. We have reports of many cases where the backing lighting package was reduced to a third or less of the package required for conventional backings. Since the lighting package is by far the greatest expense for traveling matte shoots, the consequence is that these screens frequently save several times their own rental cost.