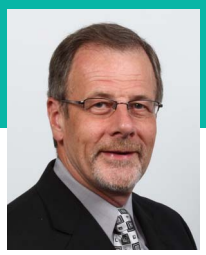

Alan Lambshead

The Continuing Advance of Color Imaging

In 1666, when Isaac Newton first began experimenting with optics, he began to think of color as a function of light. Through his experiments, Newton discovered that you could combine all the colors of light to create white light. He devised the world's first color circle using seven colors, like the seven notes of a musical scale. The trichromatic theory, in which you only need three primary colors to create white or any perceivable color, was first introduced by Thomas Young in 1802 and refined by Hermann von Helmholtz in the 1850s. They postulated that the human retina was made of cones that were responsive to only three colors of light—red, yellow, and blue (later revised to red, green, and blue). Their theories, which were initially based on scientific reasoning and not on experimental evidence, were validated by Thomas Maxwell in 1855.

In the late 19th century, some filmmakers laboriously hand-colored films frame by frame, resulting in colorful but very artificial films. Back then, when films were short, this was practical, but as longer films became a reality, mechanized systems of color tinting such as Pathecolor were developed; however, these still left the viewer with artificial images. In the early 20th century, there were several attempts to capture color in the camera to give a more natural look.

In a technical paper presented in the spring 1937 conference of the Society, titled "The New Agfacolor Process," J. L. Forrest stated, "Many ways of reproducing color sprang up and flourished for a time, until in some cases insurmountable obstacles would appear, and indeed in most cases they did appear, and finally these ideas became history. So great is the stimulation of interest in color photography at this time, and so many very complete bibliographies of color photography have been published, that it is not necessary to discuss more than a very few of the methods that have shown the most promise."[1] Truly, there was a strong push for better color science in the motion picture industry, as evidenced by many successes and failures.

The continual progression of entrepreneurship pushed the science of color motion imaging ahead by leaps and bounds. The beginning of "natural color" films is widely attributed to the Kinemacolor system, a sequential two-color additive process invented by George Albert Smith in 1908. Although the Kinemacolor and other additive systems failed commercially, they proved there was an appetite for natural color films. The first commercially successful two-color subtractive system was developed by Technicolor in 1922 and was later refined to a three-color system in 1932. Throughout the next decades, competing systems such as Agfacolor and Eastmancolor advanced the science of color film, and by the late 1960s, nearly every major motion picture film was being shot in color.

Similarly, since the first experimental color television demonstrations were made in the mid-1940s, there has been a push to reproduce electronically all of the colors that the human visual system sees in real life.

A quick search of the Conference Proceedings of the Society, as well as the articles in the *Journal*, shows literally hundreds of submissions related to color science and its impact on motion imaging over the past century. In recent years, there has been an increasing emphasis on topics related to wider color gamut (WCG) and high dynamic range (HDR) in cinema and television at SMPTE Annual Technical Conferences.

SMPTE has played a significant role in standardizing this advancing technology in both cinema and television. In the Standards Outcome Report from our March 2016 meetings in Santa Clara, Ca., there are numerous projects dealing with standards work on new technologies in color imaging currently in process. Our Technology Committee on Essence (10E) has a project defining Dynamic Metadata for Color Volume Transformation of High Luminance and Wide Color Gamut Images. The document suite (ST 2094) is under way, currently consisting of six parts on core components, syntax, and carrier and four parts documenting individual application schemes. This suite of standards will specify the semantics and representation of content-dependent metadata needed for color volume transformation of HDR and WCG imagery to smaller color volumes (e.g., BT.709 or digital cinema) in mastering applications. A project proposal for signaling the carriage of HDR and/or WCG essence was presented at the March meeting round. Meeting outcome reports are published following each of our quarterly standards meetings and can be found on the SMPTE website (https://www.smpte.org/standards/meeting-reports). SMPTE

Reference

1. J. L. Forrest and F. M. Wing, "The new Agfacolor process," *J. SMPE*, 29 (3): 248–257, Sept. 1937.

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