
Letter to the Editor on Usage of the Word "Stereoscopic"

Re: "A 35mm Autostereoscopic System for Live-Action Imaging Using a Single Camera and Lens," by Christopher A. Mayhew, June 1993 *SMPTE Journal*, pp. 505-511

I have followed with great interest the articles by Christopher A. Mayhew on the development of camera systems that are reported to provide depth enhancement in a single film or video channel. My comments here apply especially to his latest article, "A 35mm Autostereoscopic System for Live-Action Imaging Using a Single Camera and Lens," published in the June 1993 issue of the *Journal*.

In the latest version of his Vision III process, the disparate right- and left-eye images (as well as image pairs with vertical displacement components) are produced alternately in time by moving the camera in orbits around its optical axis while keeping it pointed at the subject, which coincides with the optical axis. As Mr. Mayhew points out, Vision III, when "tuned" properly for convergence on the subject and judiciously for disparity (corresponding to the degree of separation of the right- and left-eye images in conventional systems), gives most viewers an impression of solidity and increased sharpness of the image not reported in the conventionally photographed control images. I share his interest in a system that provides depth enhancement without requiring the viewer to use special viewing apparatus, or even to have two eyes.

As I have implied above, Mr. Mayhew also makes clear that the Vision III process presents these alternately presented disparate image pairs to both eyes at all times, in marked contrast to other well-known systems, which present the left and right images only to the corresponding eyes. These latter systems have come to be known as "stereoscopic." Some stereoscopic processes, such as certain lenticular systems and holograms, do not require ancillary viewing equipment such as polarizing or optically shuttered viewing glasses to channel the right and left images to the respective eyes; they are said to be "autostereoscopic."

It is to be expected that one would want to use a term that is qualitatively familiar to the lay public, such as *stereoscopic*, in describing this novel system, since almost everyone knows what an old-fashioned stereoscope is, along with its various "3-D" descendants. As one who has urged caution in calling Vision III a stereoscopic process, I present here a description of the visual mechanism underlying the phenomenon of *stereopsis*, a term mentioned by Mr. Mayhew, but with no attempt by him to examine its workings, in the articles he has published in the *Journal*.

In supporting my contention that, according to presently accepted scientific terminology, his system does not qualify as stereoscopic, even though it may be impressive, scientifically significant, and worthy of further explanation as to its psychophysical basis, I cite here at some length a modern college textbook, *Physiology of Behavior*, Third Edition, 1986, (Chapter 6, "Vision; Perception of Depth: Disparity Detectors," pp. 197-200) by Neil R. Carlson, University of Massachusetts, by permission of Allyn and Bacon, Inc., Needham, Mass., publisher:

"The visual cortex of animals with good binocular vision, such as that of the rhesus monkey, contains cells whose response patterns appear to contribute to the perception of depth. These neurons exist in the striate cortex and also in level 1 of the visual association cortex." [He cites Poggio, G. F., and Poggio, T., "The Analysis of Stereopsis," *Annual Review of Neuroscience*, 1984, pp. 379-412.] "Some of them will respond only when both eyes are simultaneously stimulated and will not respond to stimulation of one eye alone. (Poggio and Fisher, 1977; Clarke and Whitteridge, 1978). In some cases, cells in corresponding locations on both retinas have identical receptive fields, but in most cases the cells respond most vigorously when each eye sees a stimulus in a slightly

different location. That is, neurons respond to *retinal disparity*, or a stimulus whose image falls on slightly different parts of each eye.

"We perceive depth by many means, most of which involve cues that can be detected monocularly, by one eye alone. For example, perspective, relative retinal size, loss of detail through the effects of atmospheric haze, relative apparent movement of retinal images as we move our heads, all contribute to depth perception and do not require binocular vision. However, binocular vision provides a vivid perception of depth through the process of *stereopsis*. If you have used a stereoscope (such as a View Master) or seen a three-dimensional movie, you know what I mean.

"Stereopsis (literally, 'solid appearance') requires binocular retinal disparity of some elements of a visual stimulus. When you fix your gaze on an object in the middle distance, the convergence of your eyes causes that point, and other points an equal distance away from you, to fall on identical portions of each retina. These points fall on the *fixation plane*. (Actually, because the equidistant points fall on a portion of a sphere, the term *plane* is a misnomer.) This phenomenon is easy to demonstrate." [He describes a standard fixation exercise.] "The cues for stereopsis are provided by stimuli located just off the fixation plane, which stimulate slightly different parts of the retina of each eye. As we saw, some neurons respond selectively to just this occurrence.

"Investigators have found that the visual cortex contains two classes of neurons that are sensitive to retinal disparity. The first class responds with an increase or decrease in firing rate to a limited range of retinal disparity (± 0.2 degrees for the excitatory cells and ± 0.4 degrees for the inhibitory cells)... The second class of neurons selectively responds to stimuli nearer or farther than the fixation plane...." [Dr. Carlson describes a second simi-

lar fixation exercise, demonstrating "crossed" (near) and "uncrossed" (far) images with respect to each eye when the eyes are alternately closed.] He continues, "Thus, some neurons detect relative 'nearness,' and others detect relative 'farness.'"

He concludes the section by describing classes of people with presumed neural deficiencies, who have difficulty in judging distance by means of binocular cues.

I believe that the discussion that I have excerpted above conveys a very important distinction in defining and providing knowledge on the mechanism of binocular vision, along with insight on the "merging" of the disparate images. It also acknowledges that there are many cues that are used in depth perception.

Whatever perceptual mechanism underlies Vision III's effect, it is clearly not stereopsis, since the

above-described sensing of retinal disparity does not take place when both left and right retinal images are simultaneously identical. It appears that all classes of imaging devices for visual purposes that heretofore have been classed as stereoscopic since Charles Wheatstone's invention of the stereoscope in 1832 have made use of stereopsis, even though the visual mechanism of stereopsis was not realized until considerably after the day in 1904 that Theodore Brown spoke before the Optical Society of Great Britain, when he said to the contrary, in effect, that any object seen in relief of its surroundings and with solidity can be said to be seen stereoscopically. (I am indebted to Mr. Mayhew for his reporting of these two historical events, in addition to his generally excellent historical coverage.) I agree with his observation that "concepts grow along with knowledge." Thus, I

believe that scientific knowledge on the subject of stereopsis and hence, the previously established usage of the word "stereoscopy," which still prevails in technical parlance to connote the utilization of stereopsis, has increased since the time of Theodore Brown's statement, and evidently without general knowledge of his statement or regard for it.

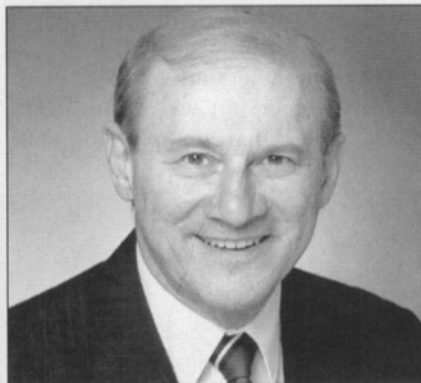
An alternative term used by the author, *depth enhancement*, is, to my thinking, a very complimentary general descriptor for Vision III. Stereoscopy is the accepted technical usage for binocular vision with retinal disparity that I strive to preserve. In future discussions of stereoscopy, will the technical community have to ask, "With, or without, retinal disparity?"

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June 17, 1993

1993 Progress Report to Appear in April 1994 Journal SMPTE Executive Vice-President Stan Baron Named Chairman

The 1993 Progress Report will be published in the April 1994 issue of the *SMPTE Journal*, according to Editorial Vice-President David L. George, Imagineering Ltd. The Progress Report is a summary of technological advances in the motion-picture and television industries. The report will be international in scope, with information contributed by SMPTE members from around the world.

SMPTE Executive Vice-President Stanley N. Baron, NBC, is the Chairman of the 1993 Progress Report Committee. Editorial Director, Motion Pictures, Frank Ricotta, Technicolor, Inc.; Editorial Director, Television, Paul Berger, CBS; and the Progress Committee members will contribute to the report under Baron's supervision. SMPTE Engineering Vice-President Kenneth Davies, Canadian Broadcasting Corp., will



Stanley N. Baron

cover developments from SMPTE engineering committees, many of which have worldwide significance. In addition, a report on the Society's educational activities will be provided.

All companies are invited to submit information on new equipment and new facilities that were introduced in 1993. Information should be submitted on the forms supplied by the SMPTE, which are being sent to all

Sustaining Members. These forms can be obtained by writing to the SMPTE at the address below. Glossy black-and-white photographs are preferred; some color photographs will be published if they are of special interest.

The basic criteria for acceptance of material is that the information be factual (no opinions or editorializing), that the new developments occurred in 1993, and that the material be relevant to motion pictures, television, or related fields. All submissions must be received by December 1, 1993. The SMPTE reserves the right to determine the suitability of all material submitted for the report.

Send your information to the Editor, *SMPTE Journal*, 595 W. Hartsdale Ave., White Plains, NY 10607. The material can be faxed to (914) 761-3115. Please note that no material will be accepted after the December 1 deadline.