

An Engineering Approach to Television Film

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INTRODUCTION

IN A PAPER* PRESENTED at a meeting of the Canadian Section of the Society in September 1957, and subsequently published in the *Journal*, it was stated that in the production of television film the mere adaptation of conventional motion-picture techniques has failed to produce the desired results. An entirely different approach to the problem was proposed — namely, that it is necessary to commence with the telecine reproducer and work backwards through the film process to the taking camera, in order to produce film images which will generate predictable video waveforms.

It was recognized then that a number of serious obstacles stood in the way of the practical application of such a scheme, particularly the lack of industry standardization in areas such as telecine set-up, film exposure techniques and film processing.

The reproduction of film material by means of a television system has always been extremely variable in tone or gray-scale quality. Attempts to improve this situation have usually failed because of the large number of variables involved between the original scene and the final viewing device. There are very few situations where one person or group of persons has control of all of these variables.

The largest differences in quality of film generally have been observed between film exposed under different conditions and processed by different laboratories, etc.

There is usually a significant difference also in the quality of the reproduction of the same film on different occasions even when reproduced on each occasion with the same equipment.

The broadcaster has been unable to establish a standard reproducing characteristic because his equipment has had to retain sufficient flexibility to handle the wide variations in density encountered in film presented for television reproduction. For example one conclusion reached after a study of television film was that telecine equipment should be able to reproduce film with a highlight transmission ranging from 80% to 3%, or with minimum densities varying from 0.10 to 1.52.

The producer of the film, therefore, not having available telecine equipment with a fixed reproducing characteristic has had to produce his film for a satisfactory subjective result when viewed by direct projection. It is unfortunate that so many people believe that all film suitable for direct viewing should also be suitable for telecine reproduction.

When the quality of film is being judged subjectively by direct projection, the brightness distribution on the screen is determined only by the density of the film in conjunction with the intensity of the projector lamp and the reflectance of the screen. The brightness of the television screen, on the other hand, is determined by the output voltage from the telecine equipment; hence the density distribution of the film must be such as to produce the correct voltages from the telecine equipment in order to produce a satisfactory subjective result on the television screen.

If the particular density distribution required to produce these output voltages happens to produce a good subjective picture when viewed directly, this is of no consequence whatever, since the only purpose of the film is to store information which will produce the correct voltages from the telecine equipment.

Apart from the convenience of using standard film equipment, there is no reason why film produced for television should not be of such a form as to be completely unrecognizable by direct viewing if this were found to enhance the broadcast quality via telecine equipment. Such a system has not been developed however. The fact that the images on film have a recognizable form has delayed by several years the progress of television film quality since it has led to complete misunderstanding of the requirements of the television system.

It was thought necessary to make a study of the telecine characteristic and to decide on the optimum adjustment of each variable, taking into consideration the film characteristic and aiming for a linear overall transfer. It was thought also that once the optimum adjustment of the telecine equipment was decided upon, the transfer characteristic could be calculated and used to construct test material for maintaining this adjustment. The standard characteristic could then be used (a) to evaluate the suitability of film presently produced for television, and (b) to calculate the correct exposure and processing for television film to meet the standard reproducing characteristic.

If the principle is accepted that the production of television film footage must be based on the accurate control of density formation in the film, then the concept of significant image areas becomes obsolete and the subjective adjustment of printer exposure level must be abandoned. With a constant-density film system, factors formerly of little consequence become critical. Accurate measuring equipment and techniques and the standardization of sensitometers, densitometers, printers and processing is implied. A high degree of camera exposure accuracy is required. Integrating exposure meters working against exposure indices will not be good enough, because they will produce widely different densities and density ranges in the negative for the same meter reading, depending on the ratio and area of highlights and shadows in the scene.

The tolerances normally allowed in conventional motion-picture practice are much too wide for successful application of the constant-density principle, because adequate quality control from a motion-picture industry standpoint does not imply accurate control of densities. This is particularly true of the film processing operation, in which adjustments are normally made to improve subjective appearance of picture images. In the application of the constant-density principle, image formation in processing must be maintained constant within specified tolerance limits and every effort must be made to ensure that the printer exposure level remains constant.

With a film system set up in this manner, it becomes possible by the use of a spot photometer to measure and adjust the luminance of selected scene elements, with the object of generating a video signal in the telecine reproducing equipment which will have predictable voltage amplitudes. Essential television peak-white and peak-black conditions may be established in the film at the time the negative is being exposed in the camera, and areas of particular interest such as faces may be located in the picture gray scale in any desired relation to black and white end points by measurement and calculation on the set.

The three papers which follow describe the results of detailed investigations which have been undertaken with the object of formulating specific proposals for industry standardization in regard to telecine reproduction, film exposure and processing.

* R. J. Ross, "Film in television," *Jour. SMPTE*, 67: 374-378, June 1958.