A DIRECT DIGITAL PREPRESS PROOF SYSTEM

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Abstract: This paper describes a novel color prepress proofing system. The system consists of a high quality film recorder manufactured by MacDonald, Dettwiler, Ltd., Polaroid instant film and film processor, and a Polaroid color transformation that controls the red, green blue exposure at each pixel. The system reads a digital file for an image--such as those produced by page makeup systems. The system calculates the exposure for the instant film that will match ink on paper. Finally, the system exposes and processes the film so as to provide an instant print directly from the digital file.

In addition to describing the system, the paper will include the results of a comparison of the prepress proofs with actual ink on paper to test the accuracy of the color rendition.

Within TAGA, I assume that there is an appreciation for the appeal of an instant photographic prepress proof system which perfectly renders the colors obtained with ink on paper. Such a system would significantly reduce the turn-around time and labor involved with conventional prepress proofing methods. "Perfect color rendition" is a tall order and in a certain sense can never be attained. For many applications, however, if the color rendition in the proof is not of sufficient quality, the proof is not useful. Evaluating the quality we have attained is thus the central topic of this report.

First, I must start by saying that, in our quest for quality, we have not undervalued the considerations of cost and convenience which are also important in a working prepress proofing system. Polaroid has set a standard for convenience in instant photography. We pioneered the "point and shoot" approach whereby the camera automatically measured and responded to physical conditions like light level and subject distance. The photograph produced is available immediately in a dry format which develops before the photographer's eyes in about 60 seconds.

For industrial prepress proofing use, the cost of film can be substantially reduced by packaging it in large rolls to minimize factory preassembly. The film system consists of a roll of light-sensitive material, a roll of positive print material, and a tray of pods containing the developing reagent. The rolls are automatically cut inside the film processor so that the operator is ultimately presented with a peel-apart, two layer package which develops in about 60 seconds. Packaged this way, the cost of the material alone is quite competitive with conventional prepress proofing materials.

Until recently, the cost of a film recorder to make an image on film with the quality we demand could have been prohibitive. However, the recent development by MacDonald, Dettwiler Associates of the MDA COLOR FIRE 240 put the quality we needed in a reasonable price range. This device uses an inexpensive white light source and stationary film with rotating prism exposure to attain high resolution and precision in a rugged, servicable construction. It is capable of producing an image eight by ten inches with 8192 pixels on a side. There is no density microbanding visible at any magnification because the scanning is accomplished by an air-bearing supported spinning prism.

The film recorder/processor may be attached to a page makeup system or a general purpose computer. For an operator, creating a proof takes a one line command and five-ten minutes for exposure plus 60 seconds for instant film processing. Clearly this speed will allow the labor cost in prepress proofing to be considerably reduced.

The proof obtained is durable, permanent, and easy to handle. It is an excellent proof of what the printing press will produce. As you see, the topic of quality returns. Our solution to the problem of accurate proofing has been the construction of complete mathematical models of both the printing process and the film process. To estimate the many parameters of these models, we create and measure large, discrete subsets of the color space of each medium. These two models permit the calculation of a color transform which takes into account the important variables of each medium--scanner sensitivity, dye in film, pigments in ink, dot gain, film batch variability, etc.

The parameters of the color transform are used to program a special purpose data pre-processor residing in the film recorder. This processor transforms the stream of image digits that might have gone to a printing press into that stream of digits for the film recorder which produces on film an image which looks exactly like the image which could have been printed.

In evaluating the success of the procedure, the word "looks" in the last sentence should be underlined. In a real sense, the proof of the proof is in the viewing: the quality is really a psychophysical question. As a start, it is clear that the proof can only be metameric to ink on paper; therefore the viewing illumination will be important. We typically prepare proofs to be viewed under illumination with a color temperature of 5000 degrees. Although we show many examples comparing the instant photographic proofs with the ultimate ink on paper images, you should be cautioned that the proof is calculated to match the original when viewed by people, not when viewed by slide film. Therefore these examples must be considered to be simulations in which the color rendition is not as good as when the original and the photograph are viewed in person.

It is impractical to provide everyone with a side-by-side ink on paper/dye on film comparison example (which we regard as the ultimate test). Therefore we have performed a simple demonstration of the fidelity achieved in reproducing the Macbeth Color Checker chart. Starting with measurements of the spectral reflectance of each area of the chart, the parametric film model was used to calculate the RGB exposures necessary to create a synthetic copy of the chart on film..

To compare the two quantitatively, the measured reflectances of areas in both were transformed into a color appearance space in which Euclidean distance represents dissimilarity. The space we used was the Optical Society of America's Uniform Color Space. Figure 1 shows the original and reproduction plotted on two of the three coordinate axes of that space. The horizontal, "j", axis is roughly the yellow (positive) to blue (negative) dimension; and the vertical, "g", axis may be considered as a green (positive) to red (negative) dimension. In general, there is excellent agreement between the original and the reproduction. Deviations which do exist might be detectable in side-by-side presentation of the two colors but are not noticeable in the context of a complex image.

In Figure 2, these same 18 colored samples are plotted along the third dimension of the Uniform Color Space, lightness. The original lightness value is plotted on the horizontal axis and the photograph's is on the vertical axis. Perfection would be data points falling on a 45 degree line. Again, the photograph agrees quite closely with the original.

In conclusion, we hope that you feel convinced that the MDA COLOR FIRE 240 film recorder and Polaroid's color transform technique offer a combination that you should learn more about. More to the point, you should make your own side-by-side comparison to see if you do not agree that the photograph is an extremely good proof of the ink on paper image.

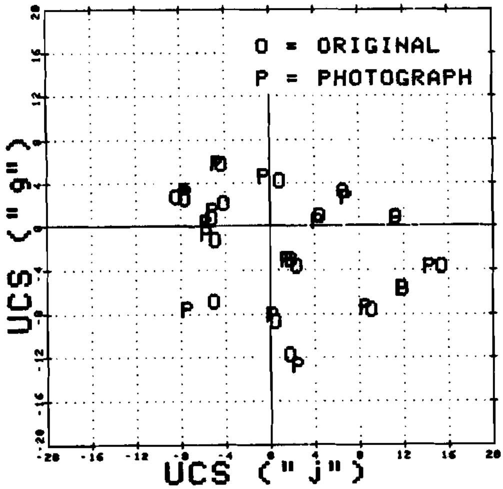

Figure 1

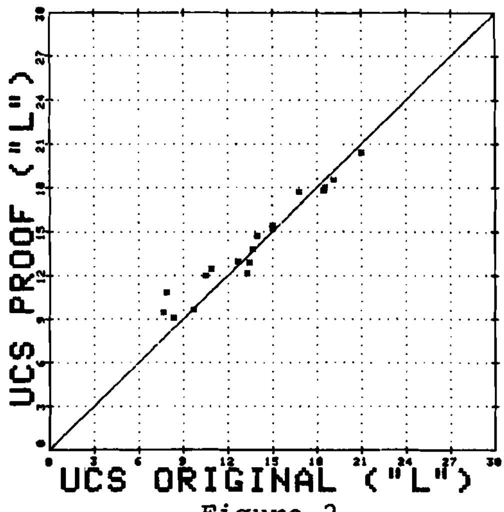

Figure 2