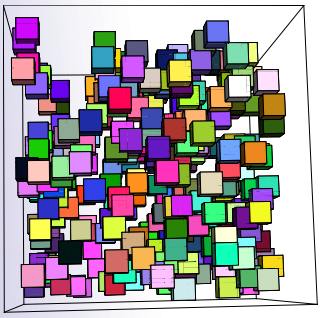
Stops, Steps, Looks, and LUTs: The Art of Digital Cinematography



Fall, 2010

Proposed for Berlin
[possibly Sep. 14–15]

In discussion for Oslo,
New York, and
Los Angeles

Cinematographers and their colleagues – camera operators and assistants, colourists, visual effects supervisors and artists, and others – are making the transition to digital acquisition. Digital imaging technicians (DITs), digital intermediate engineers, and digital intermediate technicians are also involved. All of these people are engaged in translating aspects of film into the equivalents in digital technology. Many questions arise. How many stops of exposure latitude does a digital camera offer? What exposure index should be used? What is the "film look" and where should it be imposed? Why does noise arise, and what can be done to minimize it? Should I record and process "log" or "linear"? Is there one kind of "log" and one kind of "linear," or are those terms ambiguous? Is it valuable to have an on-set display? Where do the LUTs go, and who should determine their content? Under what conditions is on-set colour grading useful?

In this 2-day seminar, Charles Poynton will introduce digital cinema acquisition in a manner that's accessible to cinematographers, colourists, and related craftspeople. He will introduce logarithmic coding, and relate that to conventional photography and to digital cinema. He will describe camera sensitivity and ISO/EI ratings. He will describe the zone system, and discuss what aspects of that system are valuable in connection with digital acquisition. He will discuss the tone scale and colour modifications that impart the "film look," and he will discuss the roles of camera controls (GAMMA, KNEE, SLOPE) and 1-D and 3-D lookup tables in achieving these modifications. See overleaf for a detailed Syllabus.

Who Should Attend: The attendee should be familiar with digital video, HDTV, and/or digital cinema. Knowledge of mathematics isn't required; nonetheless, we'll show some equations and graphs! The seminar will be suitable for people in positions such as these:

- Cinematographers, assistant cinematographers, and colourists
- HD engineers and Digital Imaging Technicians (DITs)
- Film scanner and film recorder engineers and technicians
- Post-production and visual effects supervisors, and post/VFX engineers
- Digital cinema, digital video, and CGI/VFX software developers

Registration: [[USD 450/EUR 375]], including refreshments. Lunch will be provided; you will have a chance to socialize with your colleagues. Detailed handout notes – some of which form portions of Mr. Poynton's forthcoming book – will be provided. For information, e-mail Charles Poynton, charles@poynton.com, or telephone +1 416 535 7187.

Charles Poynton specializes in the physics, mathematics, and engineering of digital colour imaging systems, including digital HDTV and digital cinema (D-cinema). He is the author of *Digital Video and HDTV Algorithms and Interfaces,* and a Fellow of both the Society of Motion Picture and Television Engineers (SMPTE) and the BKSTS. He was the founding chairman of the SMPTE committee that developed the DPX standard.

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Day 1

Introduction: Two views of imaging – the engineering view and the creative view; lightness terminology; contrast ratio and its measurement(s); the relative nature of lightness sensitivity; perceptual uniformity; logarithms and power functions; zone system; introduction to radiometry and photometry (lumens, lux, candelas, and $cd \cdot m^{-2}$ [nt]); picture rendering and image state.

Display: Studio reference displays (CRTs and emergent LCDs); emergent display standards; digital cinema projectors; projection primaries; colorimetric matching and appearance matching; gamut issues; display characterization and calibration; using profiles and LUTs.

Image coding for CGI, video, HDTV, and digital cinema: Linear-light (OpenEXR); log-light (log *RGB*); power function (BT.709) encoding and its variants (HyperGamma, *Film Rec,* Cine Gamma); log-neg (CPD) coding; gamma 1, 1.7, 1.8, 2.0, 2.2, 2.4, 2.6, 2.8, and 3 in video, HDTV, CGI, and film; code efficiency and its visual impact; gamut limitations; bit depths; sRGB; $Y'C_BC_R$; chroma subsampling; implications for compression.

Colour management and colour appearance: Workflow; choice of coding system and gamut; integration of CGI and visual effects; "Printer lights"; colour characterization and calibration; LUTs: 1-D and 3-D; "view" LUTs and "print" LUTs; ICC colour management and ICC profiles; DCI standards; concepts of DCDM, DCP, and the reference projector; $XYZ^{1/2.6}$ encoding.

Day 2

Camera characteristics: CCD and CMOS sensors; beamsplitter cameras; mosaic (Bayer) sensors and demosaicking; photosite and pixel counts; mosaic patterns and demosaicking algorithms; sensitivity, saturation, dynamic range, exposure latitude, and ISO/EI ratings; noise; highlight handling; histograms and "exposing to the right/top" (EttR/EttT).

Acquisition: Exposure; white balance; choice of data encoding; GAMMA, BLACK GAMMA, KNEE POINT, and KNEE SLOPE controls; on-set previsualization and look management; ASC color decision lists (CDLs). Characteristics of real cameras: ARRI Alexa, Sony F900/F950/F23, Panavision Genesis, Sony F35, Thomson Viper FilmStream, Phantom, SI-2K, RED ONE, others.

Digital intermediate: Traditional film workflow; emergent digital cinema workflows (including "raw" workflows and demosaicking); wavelet compression; timing/grading; choice of coding system and gamut; integration of CGI and visual effects; colour calibration and colour management.

Film scanning and recording: Sensitometry and film gamma (*D*-log *E* curves); optical density; behaviour, characterization, and calibration of film scanners and recorders; Cineon printing density (CPD); film scanning, film recording, colour grading and approval prior to film recording.