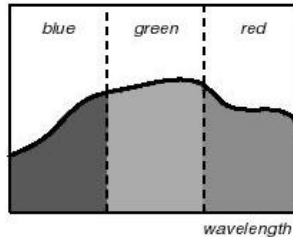


Color Reproduction



Principles

- Capture image as "RGB" components
- Reproduce each component
- Metameric match to the "original"

The Reproduction of Colour
R.W.G Hunt

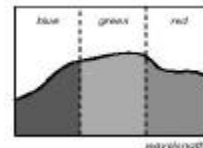
Image Capture

Process image through R, G, B filters

- Filters act as color matching functions
- Ideally, exact match to human vision
- Ideal is rarely practical

Encode the R, G, B components

- Primaries plus linearity
- Density, compressed intensity
- Digital data will be quantized

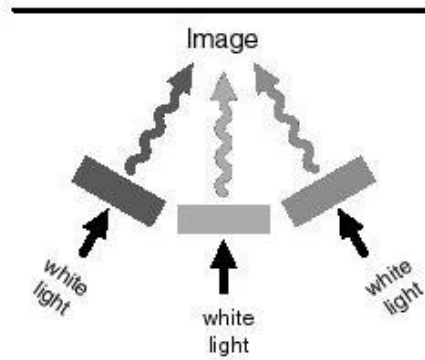
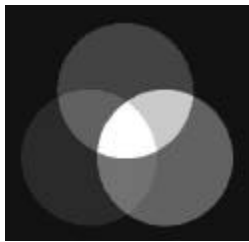


Additive Reproduction

Combine red, green, blue lights

Primaries

- red
- green
- blue



Additive Displays

CRT Displays

- RGB phosphor dots
- Electron gun

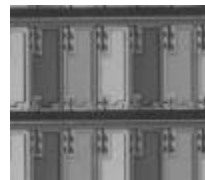


LCD Displays

- Backlight
- RGB filters

Video Projectors

- RGB separations
- Three lights



Television/Video

Camera captures separations

- Encode as standard RGB
- Encode as companded intensity (gamma)

Reproduced on RGB display

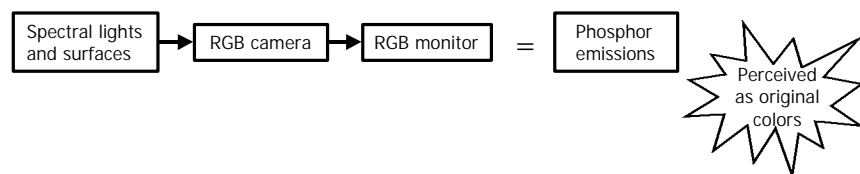
- Map RGB input to RGB pixels
- Decode linearity to give correct appearance

Digital photography

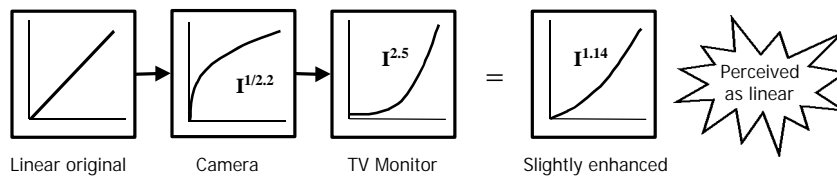
Digital Video
Charles Poynton

Television Pipeline

RGB Encoding



Intensity Encoding (I TF)



Monitors vs. LCDs

Monitors are similar

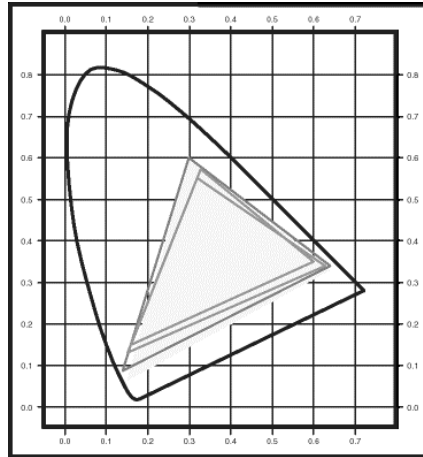
- ITU-R BT.707
- Yellow triangle

LCD's still evolving

- Filters, backlights
- Colored triangles

RGB₁ to RGB₂

- Linear transform
- 3x3 matrix



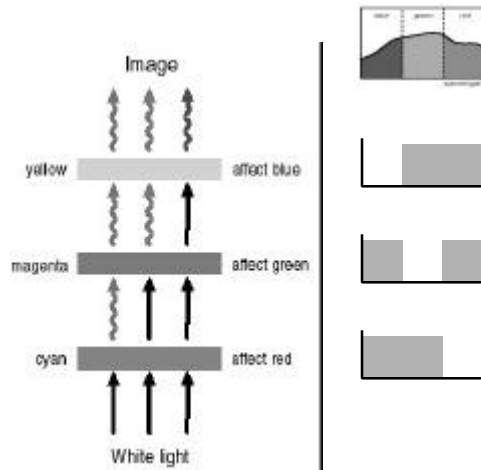
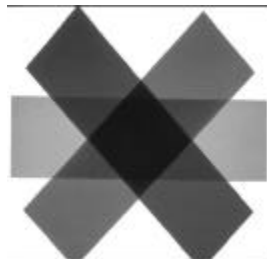
Data courtesy of Tom Fiske

Subtractive Reproduction

Filter white light to modulate R, G, B

Primaries

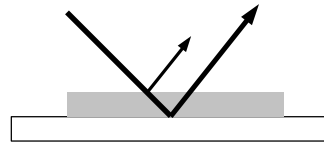
- cyan
- magenta
- yellow



Reflection Prints

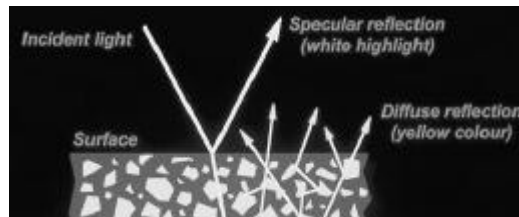
Subtractive process

- ❑ Layers of colors
- ❑ Ambient light
- ❑ Reflects off paper



Problems

- ❑ Contrast
- ❑ Saturation



I deal vs. Real CMY

I deal filters

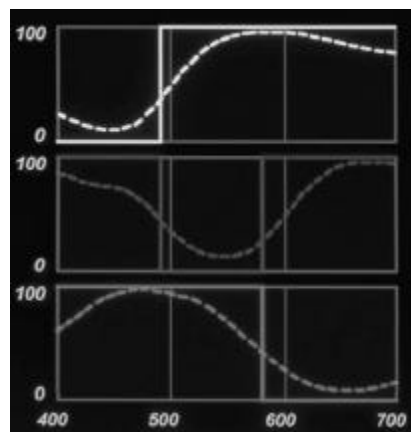
- ❑ Solid lines
- ❑ Block filters

Real filters

- ❑ Impurities
- ❑ Cross-talk

Result

- ❑ Non-linear
- ❑ Dark, muddy colors



Subtractive Media

Photographic slides and prints

- Film/emulsion layers encode separations
- Density encodes grayscale

Ink on paper printing technologies

- Standard CMY plus black (K)
- Patterns encode grayscale
- Halftone/dither, black algorithms

I S&T publications



CMYK Separations

red = magenta + yellow
green = yellow + cyan
blue = cyan + magenta
black for contrast



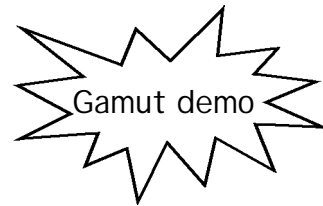
Issues

Specifics of media

- Each has its own science and art
- Make it work in its market

Limited gamut

- Brightness compression
- Color compression



Digital Media

Integrating traditional media

- Scanners, video cameras
- Monitors, video recorders
- Printers, film recorders

All computer controlled

How do we manage color across them?

Cross-media Color

Device-independent color

- Based on color psychophysics
- CIE standards and extensions

Color management systems

- Standard color specification
- Calibrated devices (media)
- Make colors/images "look the same"

Digital Color Management
Giorgianni & Madden