ITT

Image Chain Overview:

From Collection to End User Display

December 7, 2006

Tracey Bjick (585) 269-5048

Sharon Lunt (585) 269-5089

Engineered for life

The Imaging Chain

- Image Chain refers to the links in the system, or everything that is used to collect, view, disseminate, or transform image data from beginning to end
- An image chain is calibrated when an image appears identical at all points through the work stream
- Attributes of an optimized and calibrated image chain
  - Camera: best representation of actual ground cover at time of capture, without glare, shadows, haze, etc
  - Scanner: captures all information in an image
  - Film/Digital Image: proper tonal balance & color reproduction
  - Ambient Environment: removes glare, & prevents images from washing out while viewing
  - Monitor: ensures monitor accurately displays collected data

When is the best time to collect imagery?

- From 10 am to 2 pm, Locally
  - Not before, or after
- A “Photographic Day” is…
  - 10% cloud cover or less, When the sky is blue
- NO Haze
  - Use a light meter to set proper exposure
- Minimal Aircraft Roll
  - Standard practice requires less than 3 degrees of roll or pitch in any direction

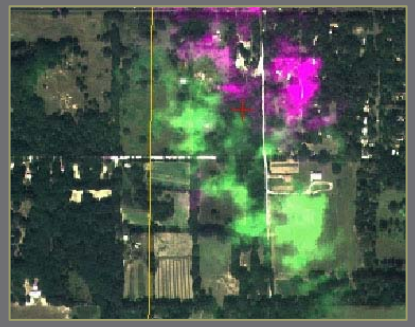
Sensor Issues:

Capture

- Exposure: contrast/dynamic range
- Frame rate: poor overlap/missing data

Film

- Noise
- Scratches, dust and debris



Digital

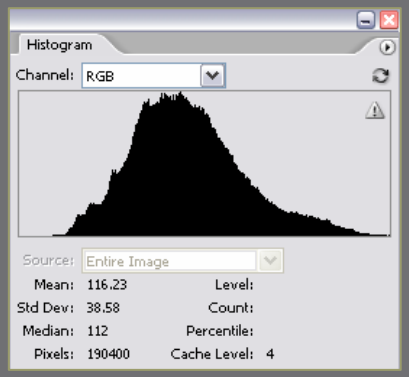
- Misregistration: channels and chips
- Dead pixels: missing data
- Striping or Banding: missing data

Photogrammetric Film Scanning

Matching Scanning System Response to Film Response:

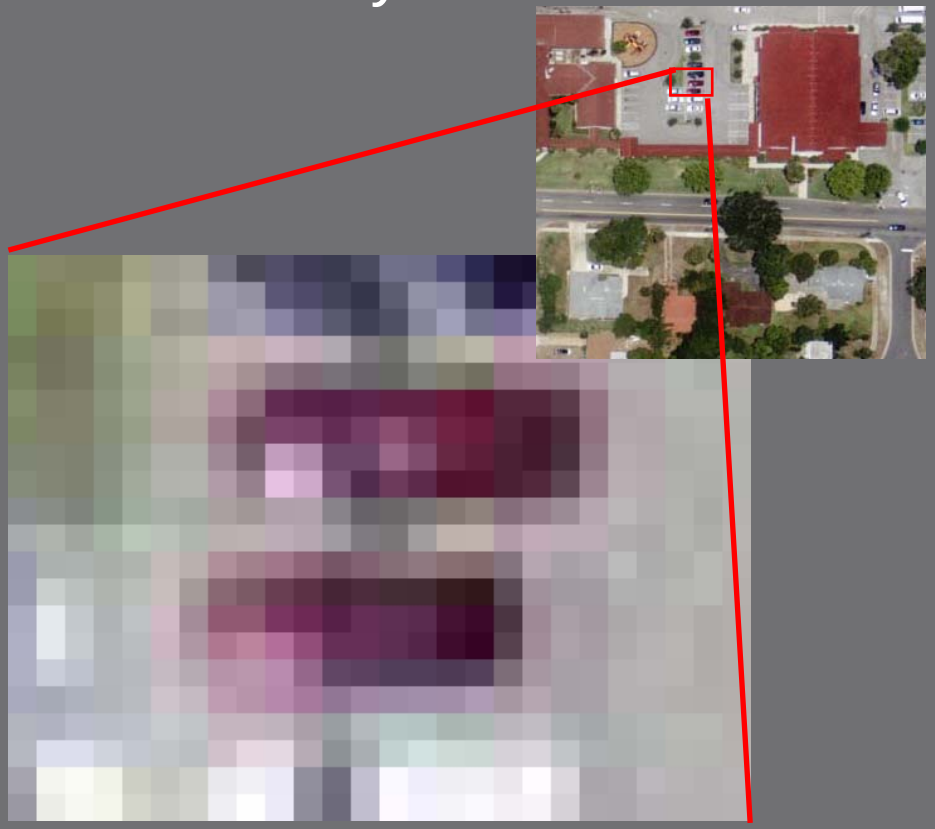
Compensates for system response, providing the following benefits

- Optimized tonal balance
- Optimized dynamic range
- Consistent, high quality output
- Reduced post processing



What Does a Scanner (Digitizer) Do?

- Creates a matrix of digital values (Pixels) where each pixel represents the density or color of the sampled image area



Scanning Steps

- Light intensity
- Aperture
- Exposure
  - May be adjustable per channel
- Processing controls (LUT)
  - Histogram shape
  - Dynamic range
  - Tonal transfer curve / color balance

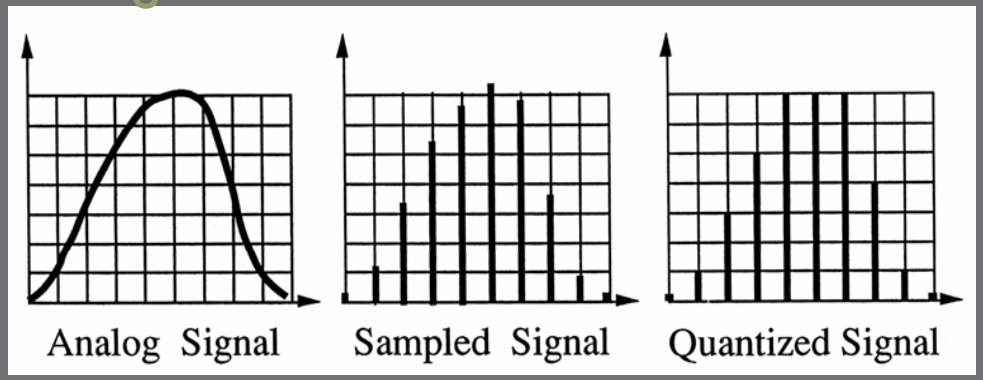
Note: Parameter names and availability vary per digitizer

How Does It Work?

- Light passing through the film is focused on to a Charged Coupled Device (CCD) array
- The CCD converts illuminated energy to a matrix of digital values where each digital count value represents the amount of captured light from a specific image area
- Image digitization is an analog to digital (A/D) conversion which involves sampling, quantization and binary encoding

Light

Dark



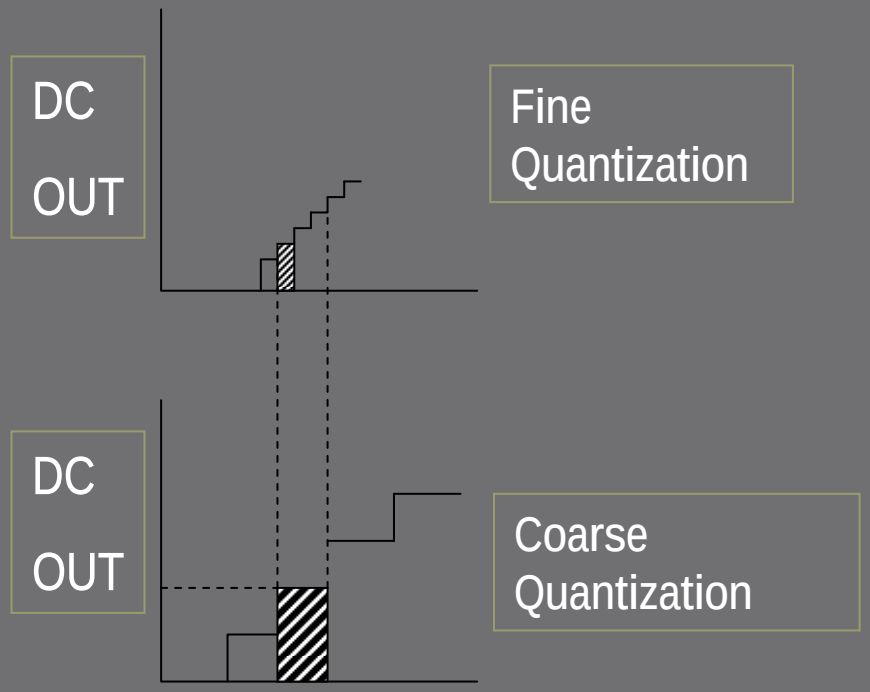
→ 0135777410

Digital Image Development

- Unpack Raw Imagery: retain max bit depth
- Lens Falloff/ Anti-vignetting
  - May be adjustable per channel
- Color Balance: choose midtone
- Processing (LUT) controls
  - Histogram
  - Dynamic range
  - Tonal transfer curve / color balance

Bit Depth

- The light amplitude is converted to a number, and is truncated to the nearest allowed level
- The higher the bit depth, the more levels available
  - 8 bits = 256
  - 10 bits = 1024 levels

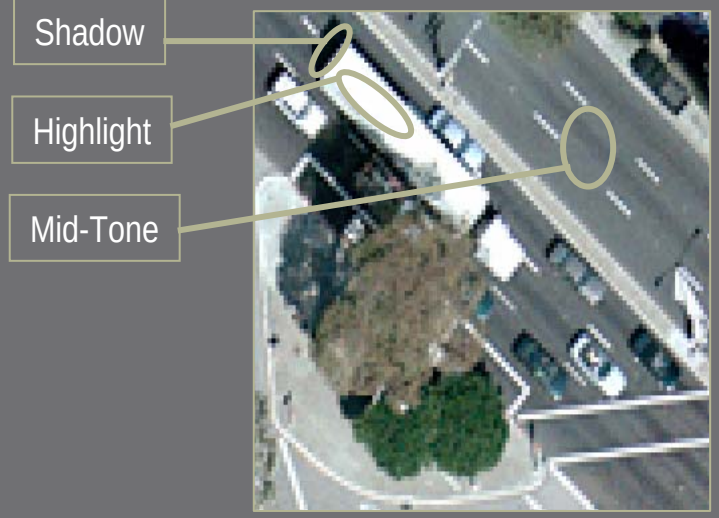


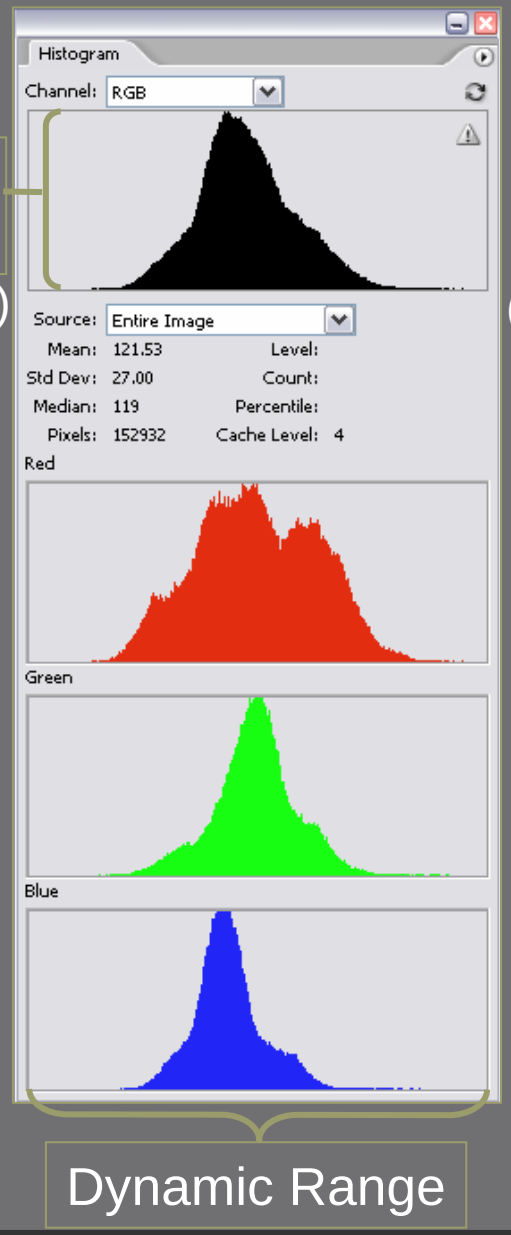
1 0 0 0 0 0 0 1 0 0 = 516	10-bit Binary value
1 0 0 0 0 0 0 1 = 129	8-bit Binary value

Histograms

Graphical representation of digital count distribution:

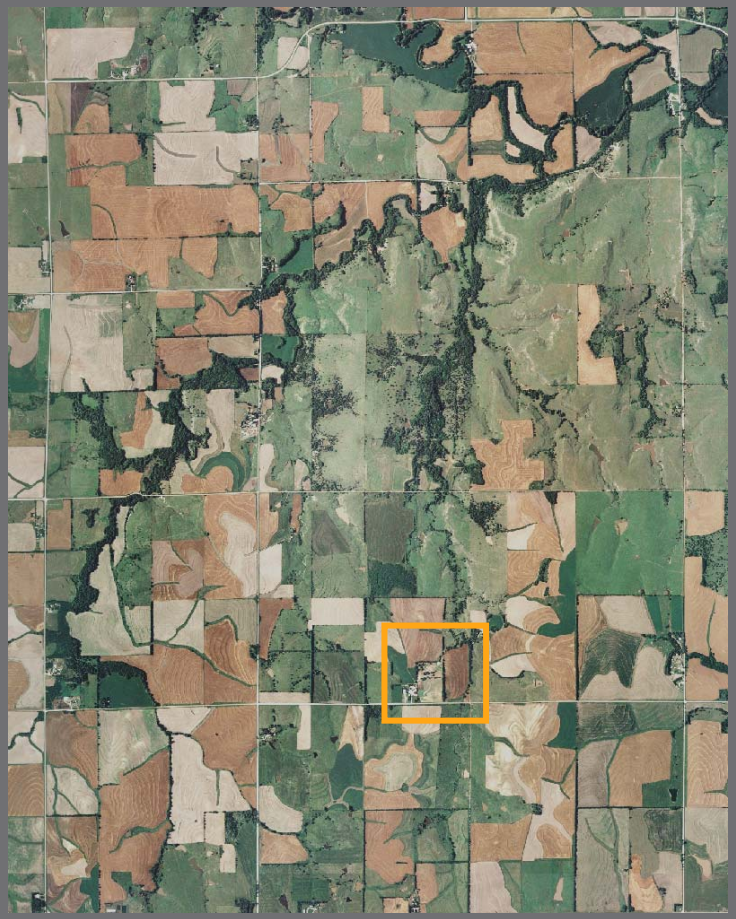
- Low digital values = shadows
- Middle digital values = midtones
- High digital values = highlights

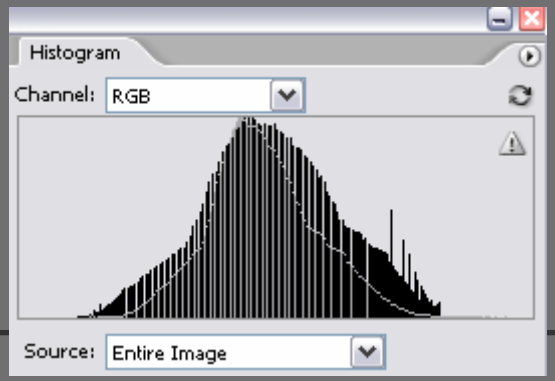




Histograms: Binning

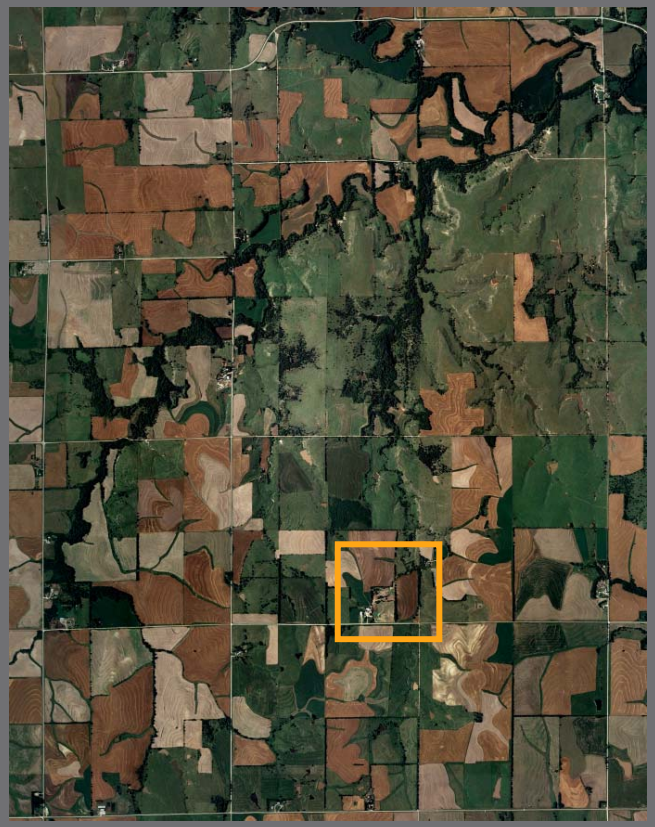
- Binning, quantizing: Quantization causes contouring and loss of low contrast detail

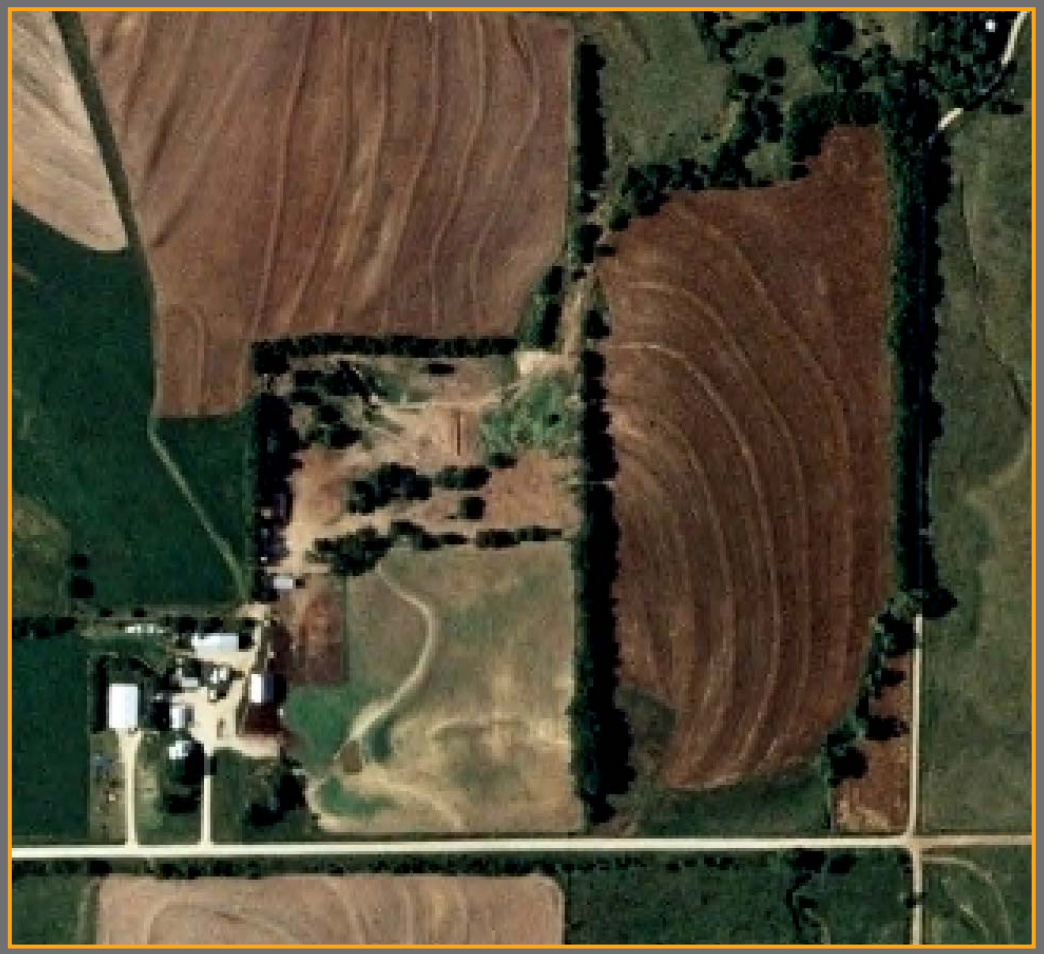


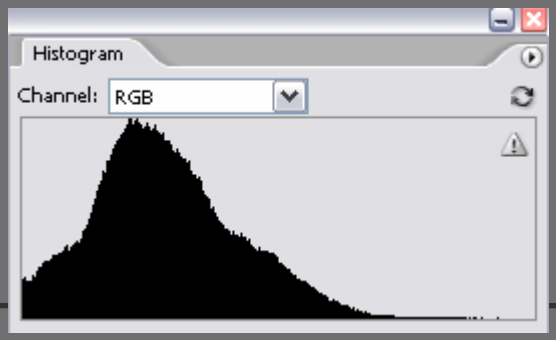


Histograms: Clipping

- Both High and low clipping increases contrast but yields data loss





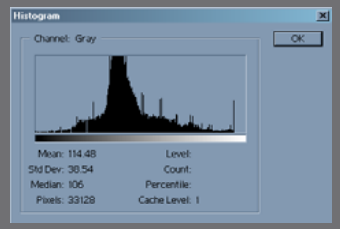


Dynamic Range

Distribution of the image data across digital counts

Range

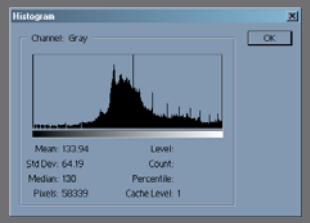
GOOD



Shadow clipping

Highlight clipping

Range too low



Building the Optimal Environment

- Match lighting with monitor
  - Retain detail on computer display, shadow and highlight
  - Easiest on operator's eyes
- D6500K: Light Bulbs' color temperature, all fixtures
- Lower light levels
- No windows, or else shades drawn
- If possible, neutral colors around image viewing monitor

Diffuse Ambient Flare

Diffuse flare caused by high ambient light

- Reduces monitor contrast
- Masks shadow detail

Results:

- Incorrect scanner adjustment
- Causes user fatigue

Solution: reduce amount of ambient light in room

  - Block windows
  - Dim and / or remove some lights

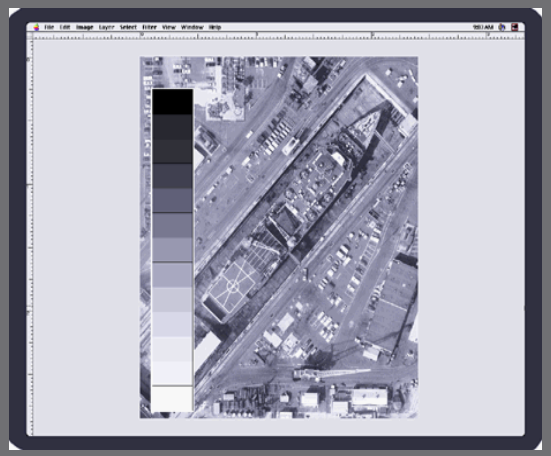
High ambient light

Low ambient light

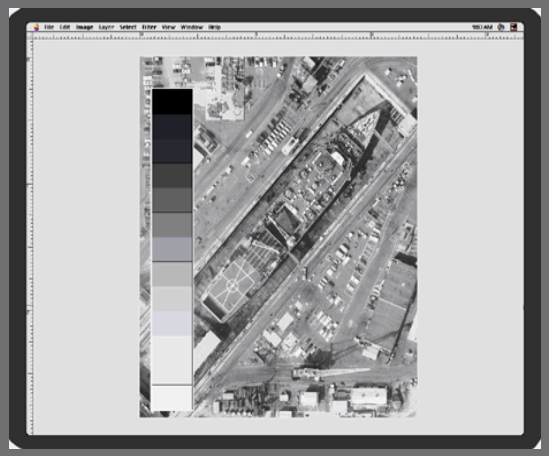
Influence of Monitor Setup

- The display is the last step in the image chain for most users
- How the image looks is dependent on display properties
  - Color temperature
  - Resolution
  - Color bit depth
  - Dynamic Range

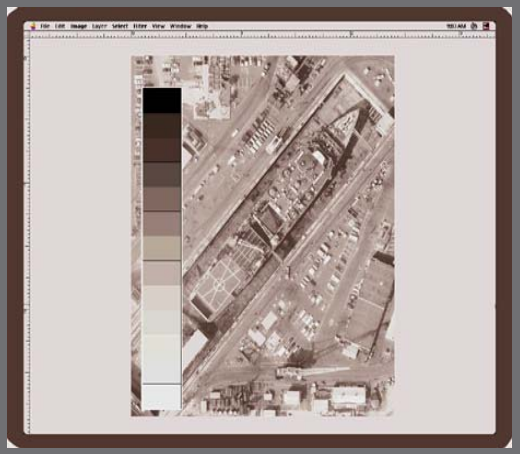
Monitor Color Temperature



9300K



6500K

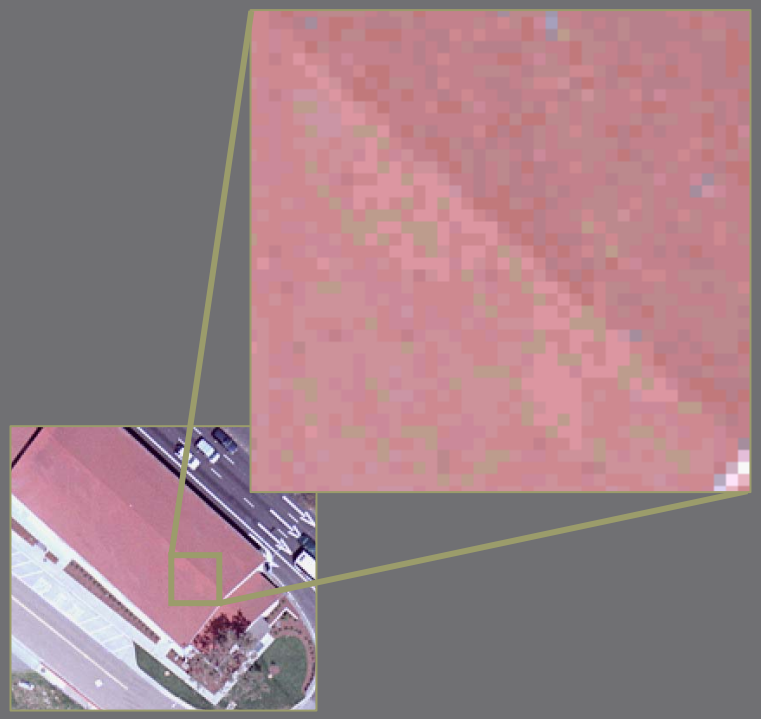


5000K

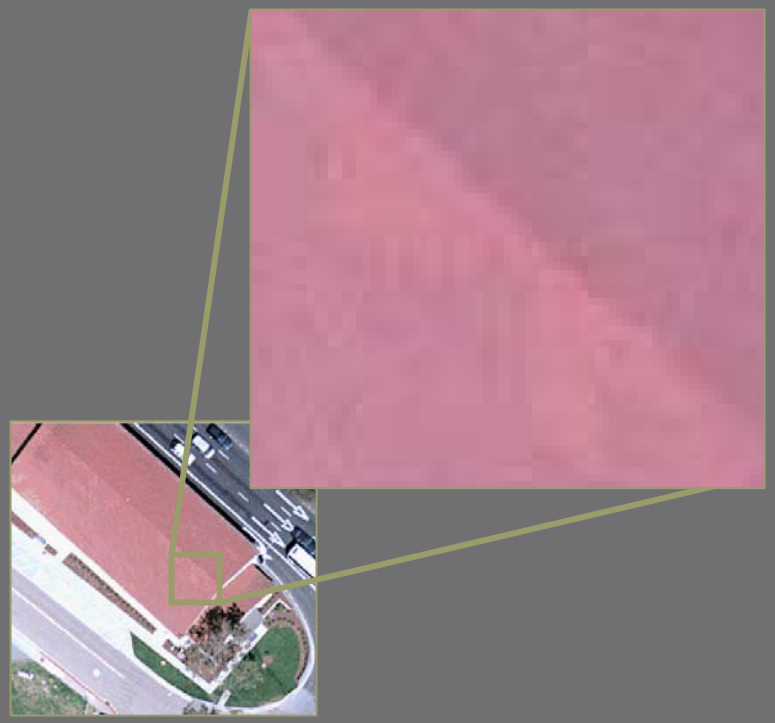
- Monitors from factory often have color temperature = 9300K. This is much too blue, creating a color cast on images
- 6500K is recommended, and visually more appealing

Importance of True-Color Display Property Setting

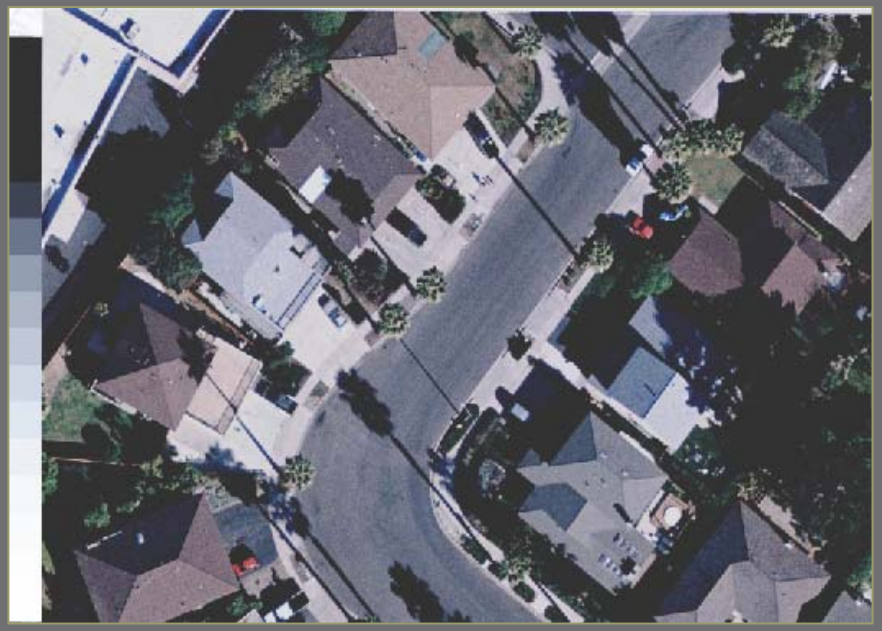
16 - Bit



24 - Bit



Effect of Monitor Setup



Poor

Good

Summary

- All images go through a chain of systems and processing
  - An image is only as good as the lowest quality link
- Image chain includes camera, scanner (film), image processing steps, viewing environment, and monitor display
  - All steps can be optimized and standardized or calibrated

Multi Sensor Acquisition

Map implementation approaches across multi-contractor acquisition to ensure consistent results

- Camera systems: Film/Digital
- Collection methodologies
- Image processing tools, corrections, standard procedures
- Viewing systems