Desktop Color Photo Printing Example

Professional ICC solution for everyone

Case study of Mac OS X color management

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ICC Color Management Overview

- **Problem:**
  - Devices represent color in different spaces and different gamuts

- **Goal:**
  - Provide consistent and predictable color across devices

- **Solution:**
  - ICC profiles
  - Color Management Modules (CMMs)
ICC Profiles

• Describe how to transform colors between device color space and interchange space (PCS)
• Enable Color Communication
  — i.e. ability to predict color
  — creation of device specific color
  — device simulation (soft-proofing)
CMMs

• Provide the mathematical engine to perform color transformations
ICC Color Management System

Application

CMS Framework

Smart Profiles
Dumb Profiles
Smart CMM
Dumb CMM

CMS Framework Application

Descriptive text

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Color Management in Mac OS X

- Functionality provided by ColorSync
  - Color defined by ICC profiles
  - Color conversions performed by CMM
  - ColorSync Device Integration database contains ICC profiles registered for color devices known to the system
Color Management in Mac OS X

- Integrated automatic color management
  - ICC profiles embedded in color data are used by the system for reading, displaying, printing and saving to files
ColorSync Device Integration

• Mac OS X has Device Managers for input, display and printing

• Device Managers are integrated with ColorSync
  — Provide awareness of devices and access to their profiles

• Device Integration services include:
  — Device and profile registration
  — Device profile access
  — Notifications
ColorSync Device Integration

• Device and Profile Registration
  — Device Managers detect presence of devices
  — Register profiles provided by device drivers
  — Can also build device (factory) profiles
    — e.g. based on EDID
ColorSync Device Integration

- API to access device info & profiles
  - used by application for custom color management
  - used by the system for automatic color management
ColorSync Device Integration

• Notifications:
  — Can be received by any process
  — Notifications for:
    – Changes to the default device for a device class
    – Changes to a device factory or custom profiles
    – Changes to a device’s default profile
    – Device registration/unregistration
ColorSync Device Integration

- User can access ColorSync Device Integration database and assign custom profiles to color devices
Architectural overview

Carbon + Cocoa

CoreGraphics  Image Capture  ImageIO  QuickTime  Printing

ColorSync

Profiles  Device Integration  CMMs

Darwin
Sample Image Processing Application

- Sample code illustrating color image processing on Mac OS X
  — opening, displaying, color matching, correcting, saving and printing images

Visit:
Color Management in Printing

- Main goals:
  - Reliable, consistent color
  - Printing to be a part of Color Communication
    - Ability to predict and preview color
    - Application and the system control color matching
    - Driver assures color consistency
Color Communication in Printing
Color Communication in Printing

Image of a mountain with its reflection in the water.
Color Communication in Printing
Mac OS X Printing Architecture

- Application
- Printing Front-End
- ColorSync
- Device Integration
- Printing Back-End
- Printer
Mac OS X Printing Architecture

- Two main driver classes:
  - CUPS (PostScript and raster)
    - print options controlled by PPD
      - can specify ICC profiles linked to different printing conditions
  - Tioga (legacy, raster only)
    - print options controlled by the driver code
      - ICC profiles for different printing conditions are specified by a profile ID and stored in the job ticket
CUPS printer profile registration

• New keyword in PPD:

*<code>cupsICCCProfile</code> ColorModel.MediaType.Resolution “profilename”
or
*<code>cupsICCCProfile</code> ColorModel.XXXX.YYYY “profilename”

where XXXX and YYY are custom qualifiers.

Color Management in Printing

• Legacy:
  — Driver performs “last minute” color correction when the print job is handed off to the driver
    — driver color changes are not communicated back to the system or application
Application vs Driver Color Management

• Application (ColorSync) mode
  — Printing is a part of Color Communication
  — Color data is matched to the printer profile known to the system
  — Driver does not make any color adjustments

• Driver (Vendor) mode
  — Printing is excluded from Color Communication
  — Color data is matched to a known generic profile and handed off to the driver
  — Driver makes color adjustment based on custom color controls (color not communicated back to the system)
How should device drivers use ICC profiles?

• Provide factory profiles for their devices
  — Create basis for Color Communication in the system
  — Profiles should reliably and consistently represent device color capabilities

• Don’t perform any additional color tweaking beyond that described by the profiles
  — critical for Application (ColorSync) mode

• Allow factory profiles to be replaced by user’s custom profiles
Questions / Comments

Thank You!

http://www.color.org/tokyomeeting2006.html