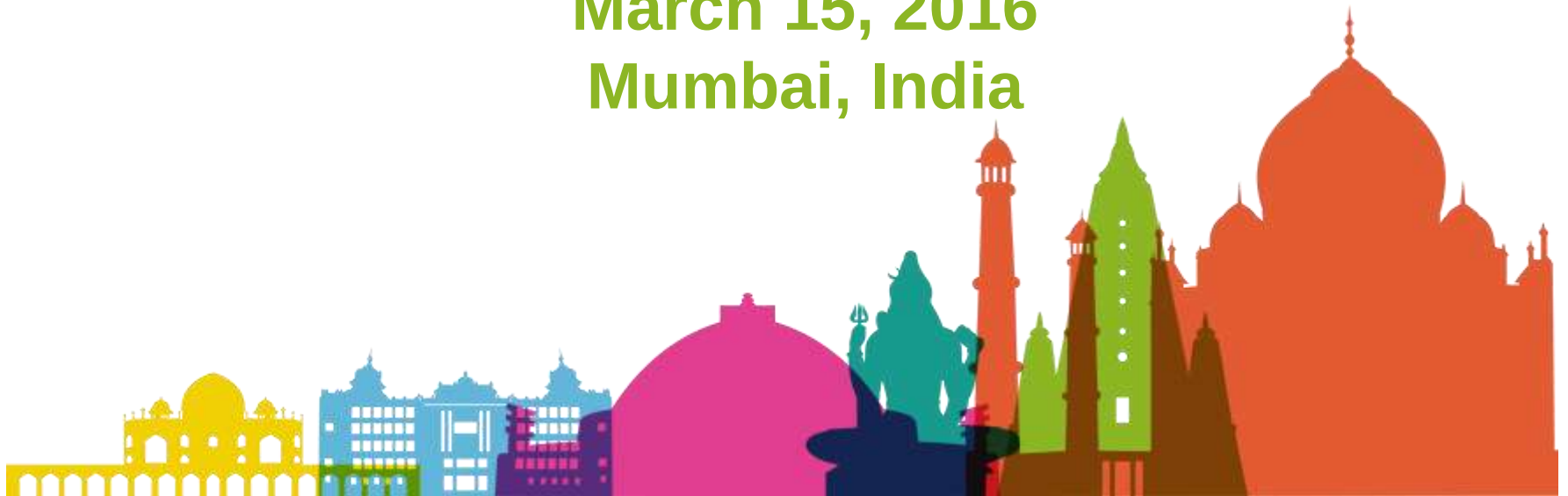


CREATING FUTURE PRINT THROUGH TECHNOLOGY AND INNOVATION



PRINT BUSINESS OUTLOOK CONFERENCE 2016

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ICCMAX: THE NEXT WAVE OF ICC COLOR MANAGEMENT

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PRINT BUSINESS OUTLOOK CONFERENCE 2016

Overview

- **Background and motivation for iccMAX**
- **Overview of some important iccMAX features**
- **iccMAX Workflows**
- **Current status of iccMAX**
- **Summary**



ICC Profile Specification

- **ISO 15076-1:**
 - v4 ICC profile
 - Defines data container format for colour management interchange.
 - Widely used around the world
 - Predominant in graphic arts workflows.
 - Widespread adoption in commercial and academic software.
 - First published as ISO standard in 2005.
 - Very successful at spreading colour management to many parts of the world.



What is v4 Good For?

- Enabling cross-platform, vendor-neutral consistent colour in graphic arts applications.
- Connecting any device or colour space through a well-defined Profile Connection Space (PCS)
- Viewing and colour matching under standard lighting conditions similar to D50.
- Enabling colour tuning in colour managed workflows.
- Providing standard container for specifying colour interchange.

So why change?



Motivations for Change

- **Basic assumptions of ICC v4 profiles limit applications**
 - D50/2° colorimetric PCS
 - No support for spectral data or transforms
 - Diffuse uniform illumination assumption
 - Simple transforms are effectively limited to low dimensionality
- **Structure of ICC v4 unsuitable for some lightweight workflows.**
- **Desire to open colour management platform and stimulate new development beyond ICC members.**



v4 can be too restricted

- **Example: package print, process + spot colours, with gloss and metallic inks**
 - V4 LUT structure not practical beyond 6-7 colours (profiles too large, too slow...)
 - Spot colour inks often defined spectrally, but no support for spectral data
 - Cannot define directional appearance of ink in profile
 - Cannot preview appearance of package on display or proof
 - Cannot predict under different viewing conditions



iccMAX key changes

- **Wider range of Profile Connection Spaces, e.g.**
 - Colorimetry
 - Spectra
 - Material
- **Wider range of transform elements**
 - Complete flexibility with multiProcessElement
 - Static and programmable transforms
- **Wider range of tag types, e.g.**
 - BRDF
 - CxF measurement data
 - Gamut boundary
 - Extended data types



iccMAX vs. v4

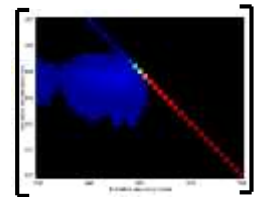
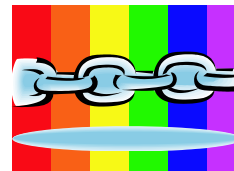
- **iccMAX profiles have same header + tag structure as v4 profiles, but:**
 - Different values possible in header.
 - Some retained tag types from v4, some new tag types.
 - Some v4 tag types deprecated.
 - New color space types, PCS types, data tags.
- **iccMAX CMMs generally intended to use v2 & v4 profiles, but earlier CMMs will not need to be compatible with iccMAX profiles**



iccMAX – High level overview (1)

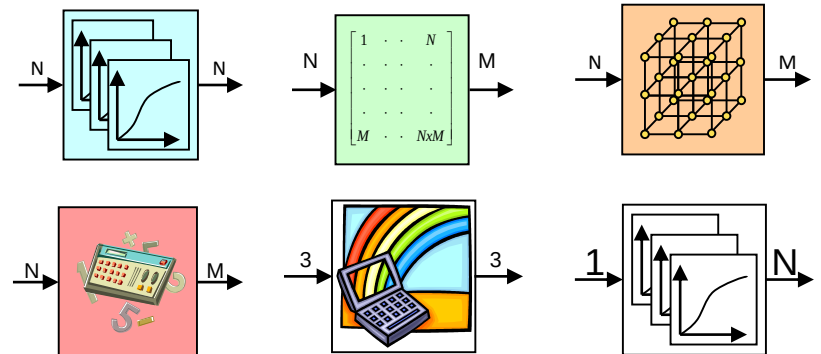
- **Connection Space Extensions**

- Spectral profile header extensions
- Profile Connection Condition tags
- PCS Transforms
- Sparse matrix encoding
- Material Connection Spaces



- **multiProcessingElements**

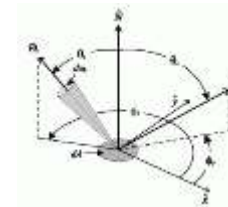
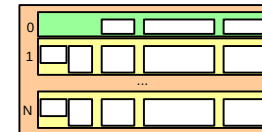
- 1-D Look Up Tables (LUTs)
- Matrices
- N-dimensional LUTs
- Calculator element
- ICC Color Appearance Model
- Tint Array element



iccMAX – High level overview (2)

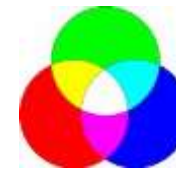
- **Hierarchical tag types**

- Named Color Tag Array
- Support for angular dependencies via Bidirectional Reflectance Distribution Functions (BRDF)
- Profile Sequence Information



- **Other Extensions**

- Color Space Encoding profiles
- Gamut Boundary Description encoding
- Color Measurement (CxF) tag encoding
- UTF8 text & UTF16 encoding
- Additional Numeric Array Types



CxF

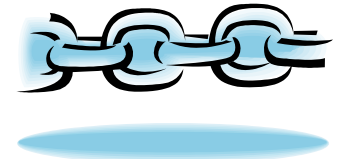


iccMAX Colour Spaces

- **Color space signatures as defined in ICC.1**
- **N-channel color space signatures supporting up to 2^{16} channels**
- **Colorimetric Profile Connection Spaces**
 - Same as defined in ICC.1 (XYZ and L*a*b*)
 - Observer and Illuminant can vary as defined by spectral viewing conditions tag
- **Spectral Profile Connection Space Signatures**
 - Reflectance, transmission, radiant/emission spectra, and bi-spectral (fluorescent) spectra (optionally compressed)
- **Material Connection Spaces**
 - Defines named “material” channels for connection and routing between profiles with default behavior for sub-set channel connection



iccMAX Profile Connections



1. Named Color connections

- Tint based colors using device, colorimetric, spectral, and/or Bi-directional Reflectance Distribution Functions (BRDF) values

2. Colorimetric Connections

- How does an observer see it?

3. Spectral Connections

- What is its relationship to light?

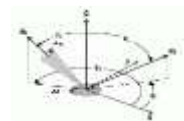
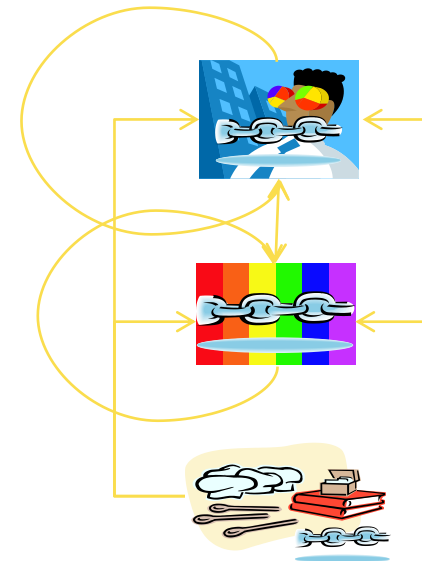
4. Material Connections

- What is it?

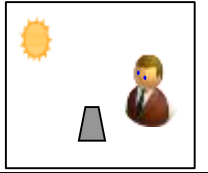
5. BRDF Connections

- Considering angular dependencies

- Both Colorimetric and/or Spectral PCS connection tags can be defined in the same profile



Profile Connection Conditions (PCC)



- **Profile Connection Condition (PCC) information is required whenever PCS is NOT standard D50 using 2-degree observer**
 - Provides for interoperability to connect with arbitrary observer / illuminant viewing conditions
 - Provides flexibility for when and how PCS conversions are made
 - Provides colorimetric conversion transforms for changes in observer and / or illuminant
- **Profile Connection Conditions (PCC) comprise of:**
 - Header color space and spectral PCS metadata
 - Three new tags:
 - **spectralViewingConditionsTag**
 - **customToStandardPcsTag**
 - **standardToCustomPcsTag**



Material Connection Workflows

- **A Material Connection Space defines a connection for workflows that defines what the colour channels *ARE* rather than *how they look* or are *how they are related to light***
 - New profile types are used to convert between device, MCS, and a PCS values
- **Examples include:**
 - N-Colour Ink Overprint Visualization
 - Visualizing overprinted ink channels with different ink orders or use of spot inks
 - Fine Art Pigment Identification
 - Going from Multi-spectral capture to Pigment identification to Visualization of pigments
 - Medical imaging
 - Scanning to RGB + extra channels that provide bio-marker information for visualization of slide scan with bio-markers



MCS Connection Workflows



MCS Connection Workflows



MID Channels

1. Process Cyan
2. Violet
3. White
4. Process Black
5. Blue
6. Gold



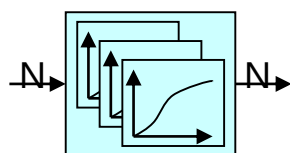
MVIS Channels

- | | | |
|--------------------|-----------------|---------------|
| 1. Process Cyan | 7. Gold | 13. White |
| 2. Process Magenta | 8. Blue-Green | 14. Silver |
| 3. Process Yellow | 9. Purple | 15. Red |
| 4. Process Black | 10. Blue | 16. Warm-Pink |
| 5. Orange-Yellow | 11. Bright-Red | 17. Violet |
| 6. Orange | 12. Pale Yellow | |

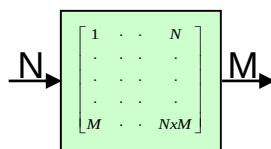


Processing with multiProcessElements

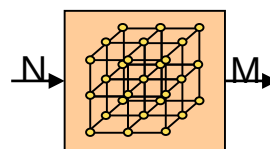
- multiProcessElements are a fundamental part of iccMAX
- They allow for processing workflows to be “programmed” using 32-bit floating point processing
- They completely define transformations from input to output
- Direct colour transformation modeling can reduce profile size and increase accuracy



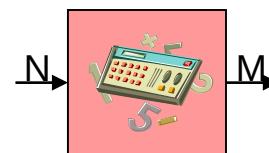
1-D LUTs



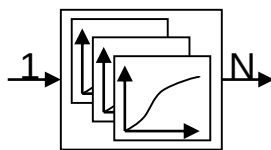
NxM Matrix



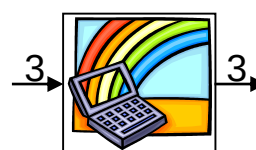
Multi-Dimensional
LUT



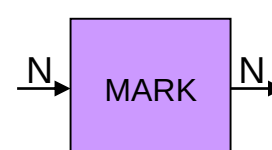
Programmable
Calculator



Tint Curves



Colour Appearance Model



Placeholder



The iccMAX Approach

- **Open source development**
 - Reduced risk for individual adopters
 - Improved access to leading research for level playing field
- **Flexible architecture**
 - Different application-specific form factors: not “one size fits all” but “many sizes fit all”
 - Reduced implementation cost for adopters, limited to solutions for particular industries



About iccMAX Workflows

- **iccMAX workflows are defined by iccMAX Interoperability Conformance Specification (ICS) documents separate from the iccMAX specification**
 - ICS documents define workflow specific requirements utilizing features of iccMAX specification
 - ICS documents will be registered with the ICC for defining various domain specific workflows
- **Not every feature of iccMAX specification needs to be implemented to support an iccMAX based workflow**
- **Allows for future iccMAX extensions**



Backwards compatibility with iccMAX

- **An iccMAX profile is identified as v5 in the header**
- **An iccMAX CMM will support v2 and v4 profiles**
- **An iccMAX CMM will support selected iccMAX features**
 - As defined by the workflow specific ICS that it supports
- **The Reference Implementation supports all iccMAX features**
 - Developers will use this as a starting point for CMMs and applications



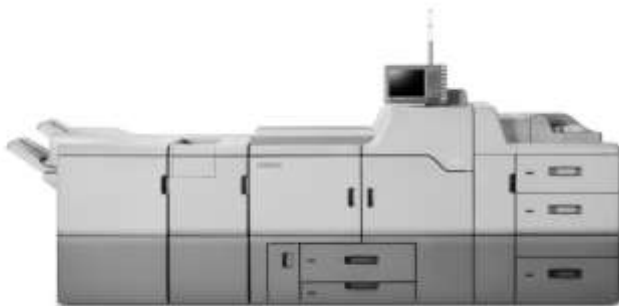
How does iccMAX solve our problem case?

- Spot colours defined spectrally in **Named Color** element using **CxF** data
- Any number of colorants can be supported by using an **MPE** sparse **LUT** or an **MPE calc element**
- Spot colour overprints calculated in profile by **MPE calc element**
- Preview of directional effects of gloss and metallic inks supported by **BRDF** transform
- Match under different viewing conditions supported by **Profile Connection Conditions**



Initial Target Markets

- Packaging
- Medical Imaging
- Digital Printing
- Fine Art



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Current status of iccMAX

- **Now available on the ICC Web Site**
 - Preliminary iccMAX specification document
 - Link to open source reference implementation source code on GitHub
 - Binary command line executables to compile, apply, and interact with iccMAX profiles
 - Example profiles and images for various use cases
 - (See: <http://www.color.org/iccmax/index.xalter>)
- **Various implementations are in development**
- **In process of ISO standardization**
 - Currently circulated in ISO TC130 for comment and future ballot



Summary - iccMAX for the Real World

- **Colour in the “Real World” is much more complex than can be communicated using ICC v4 profiles**
- **iccMAX provides the means to communicate about various approaches to colour**
 - Named Color and Material Connection Spaces (What is it?)
 - Spectral Connection Spaces and BRDF (How does it interact with light?)
 - Extended Colorimetric spaces (What does it look like?)
- **iccMAX provides a flexible platform for modeling and defining colour workflows based on the multiProcessElement**
- **iccMAX encompasses the complexities of colour in the Real World**



Thank You

Questions?

