



AFP Color Management

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IBM Printing Systems
Boulder, Colorado



Agenda

- ☐ Two key messages!
- ☐ What colors can I print?
- ☐ How do I handle colors that I cannot print?
- ☐ How do you create a printer ICC profile?
- ☐ New AFP color implementation





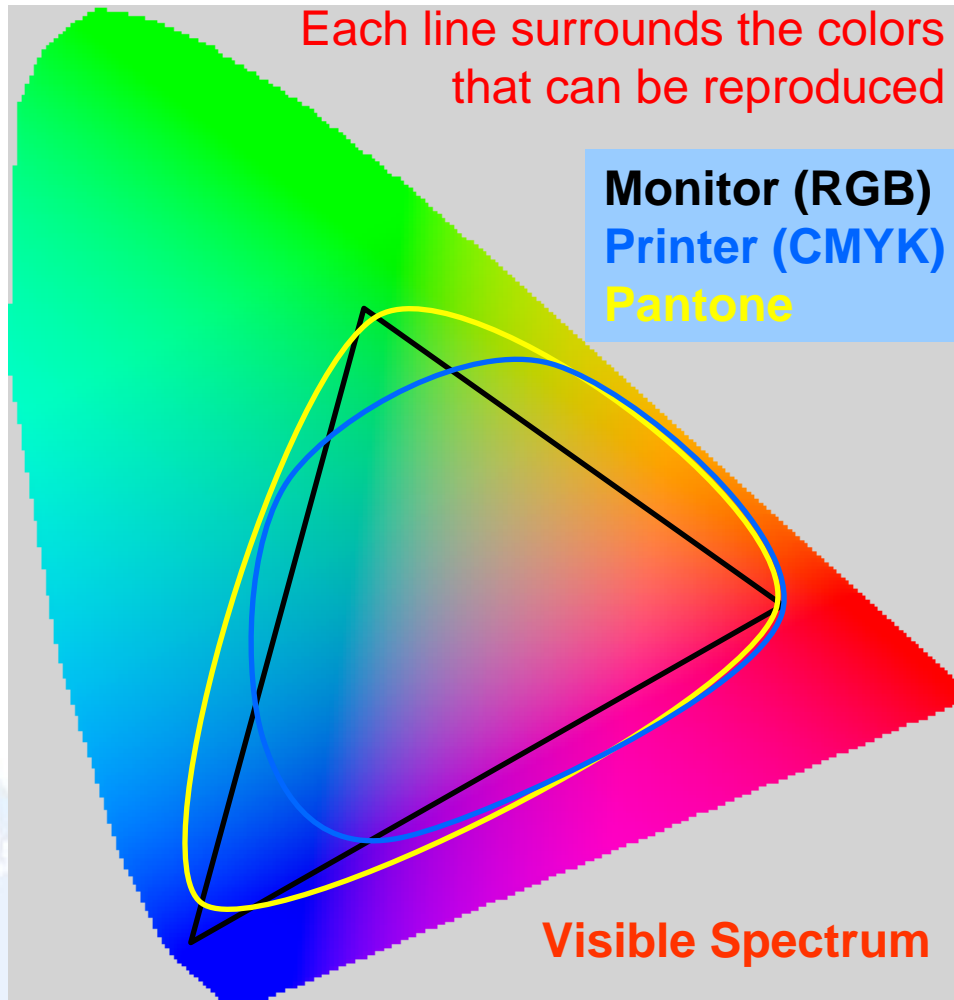
Two Key Messages

1. With the new AFP color architecture you will not get the same colors on different model printers! (But that's OK!)
2. Four-color, CMYK, printers can reproduce most, but not all, of the PANTONE® solid colors! (That's mostly OK.)





What Colors Can I Print?

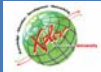


- ☐ Monitors, printers, and Pantone® all support different ranges/gamuts of colors
- ☐ Different model monitors and printers each have their own gamut
- ☐ Different paper types also affect gamut
- ☐ No CMYK printer can print all of the colors that can be reproduced by a monitor or Pantone



How important is it to get the exact color?

- ☐ In most cases, e.g. photographic images, visually “pleasing colors” are adequate
- ☐ In at least one case, corporate logos, we want the colors to be exactly correct, unfortunately this is rarely possible with printers that use a four-color, CMYK, process
- ☐ With CMYK printers compromises are required when attempting to reproduce specific colors
- ☐ Check to see if the printer you are considering can reproduce the colors you require!



Pantone Matching System®

- ❑ Colors, in corporate logos, are usually defined using the Pantone Matching System, e.g. IBM blue is Pantone 2718
- ❑ The Pantone Solid Color System contains over 1,400 solid (spot) colors that are created by mixing combinations of 14 base colors
- ❑ When using a four-color process (CMYK) printer Pantone provides simulations of the closest color that can be achieved

Sources: “PANTONE numbering systems explained,” and “what are other ways to define color?” under “articles of interest” at www.pantone.com



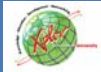
PANTONE COLOR BRIDGE®

- ❑ The Pantone Color Bridge reference tool provides color samples of both CMYK/Process and solid colors
- ❑ Samples, from an old set, are shown at right
- ❑ The closest CMYK simulation is shown in the left column, the correct solid in the right
- ❑ As you can see, in many cases, the difference is significant

PANTONE®	
4/C Process	Solid Color
PANTONE® IOEO-C C:34.0 M:0.0 Y:18.5 K:0.0	PANTONE 3245 C Y:18.5 K:0.0
PANTONE® LOHO-C C:47.0 M:0.0 Y:30.5 K:0.0	PANTONE 3255 C Y:30.5 K:0.0
PANTONE® ROKO-C C:69.0 M:0.0 Y:43.0 K:0.0	PANTONE 3265 C Y:43.0 K:0.0
PANTONE® XOMO-C C:91.0 M:0.0 Y:51.0 K:0.0	PANTONE 3275 C Y:51.0 K:0.0

PANTONE®	
4/C Process	Solid Color
PANTONE® GCOO-C C:27.5 M:11.5 Y:0.0 K:0.0	PANTONE 2707 C Y:0.0 K:0.0
PANTONE® JFOO-C C:38.0 M:23.5 Y:0.0 K:0.0	PANTONE 2717 C Y:0.0 K:0.0
PANTONE® XMOO-C C:91.0 M:51.0 Y:0.0 K:0.0	PANTONE 2727 C Y:0.0 K:0.0
PANTONE® ZUOO-C C:100.0 M:79.0 Y:0.0 K:0.0	PANTONE Blue 072 C Y:0.0 K:0.0
PANTONE® ZUOB-C C:100.0 M:79.0 Y:0.0 K:8.5	PANTONE 2747 C Y:0.0 K:8.5
PANTONE® ZUOG-C C:100.0 M:79.0 Y:0.0 K:27.5	PANTONE 2757 C Y:0.0 K:27.5

PANTONE®	
4/C Process	Solid Color
PANTONE® OFNO-C C:0.0 M:23.5 Y:56.0 K:0.0	PANTONE 1485 C Y:56.0 K:0.0
PANTONE® OHRO-C C:0.0 M:30.5 Y:69.0 K:0.0	PANTONE 1495 C Y:69.0 K:0.0
PANTONE® OJTO-C C:0.0 M:38.0 Y:76.0 K:0.0	PANTONE 1505 C Y:76.0 K:0.0
PANTONE® OMWO-C C:0.0 M:51.0 Y:87.0 K:0.0	PANTONE Orange 021 C Y:87.0 K:0.0
PANTONE® OQZC-C C:0.0 M:65.0 Y:100.0 K:11.5	PANTONE 1525 C Y:100.0 K:11.5
PANTONE® OMZJ-C C:0.0 M:51.0 Y:100.0 K:38.0	PANTONE 1535 C Y:100.0 K:38.0



How Do I Handle Colors That I Cannot Print?

- ☐ Different printers, monitors, cameras, and scanners generate unique ranges of colors, i.e. gamuts
- ☐ When you view an image on a PC, using Photoshop, how do you guarantee that you will get the desired colors when the image is printed on the target printer?
- ☐ Answer: Use a color management system based on ICC profiles





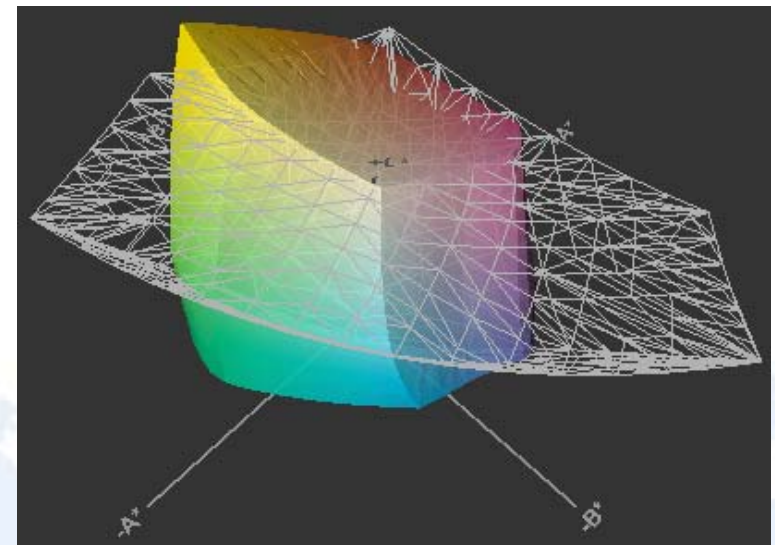
ICC Profiles

- ❑ File format defined by the International Color Consortium, ICC
- ❑ Describes the color characteristics of a particular device: digital camera, scanner, monitor, printer
- ❑ Used to intelligently-transform, device-unique, color information between devices
- ❑ For printers color characteristics change with type of paper used, e.g. coated and uncoated; worst case: separate ICC profile required for each paper type
- ❑ ICC profile is also called a Color Space, and in Photoshop it can be the Working Space which identifies the profile used for editing
- ❑ ICC profiles are provided by the device vendor and can also be created by the user using special hardware/software



ICC Profile 3D Colorspace Comparisons

- ❑ ICC profiles describe the color gamut supported by the device
- ❑ A three-dimensional representation allows exact comparison of the color capabilities of two devices
- ❑ The ICCView website builds a 3D model comparing any two ICC profiles and is available at: http://www.iccview.de/index_eng.htm
- ❑ Model depicts CIE L*a*b* colorspace
 - L* = Lightness
 - a* = green-magenta axis
 - b* = yellow-blue axis

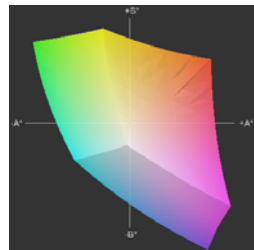


CIE = International Commission on Illumination,
or, Commission Internationale de l'Eclairage



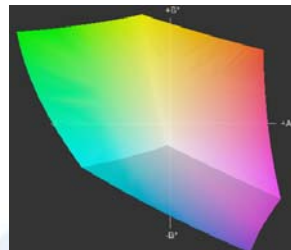
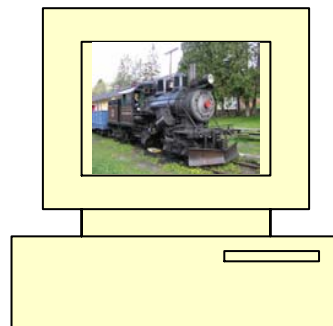
ICC Profile Effects: Each Image/Device has a Different Profile/Gamut

Original Image



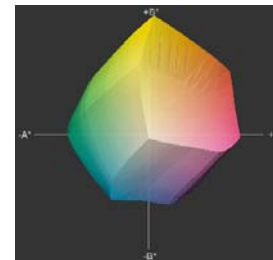
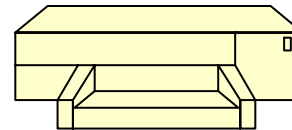
sRGB

Monitor



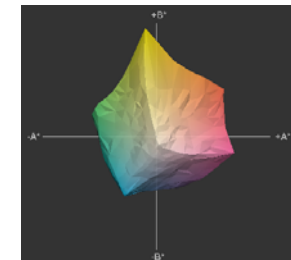
Adobe RGB (1998)

Proof Printer



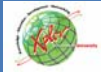
Proof

Production Printer



Production

4 Unique ICC Profiles



Color Management with ICC Profiles

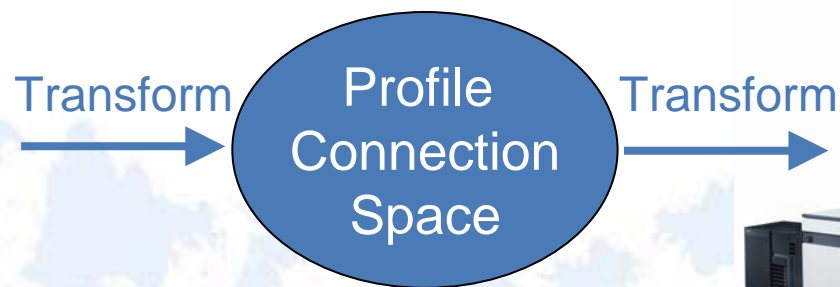
1. A Color Management System uses the input image's ICC profile to convert its colors to a device-independent format called the Profile Connection Space.
2. Then the target printer's ICC profile is used to convert the device-independent image to the printer-specific format.

Plus: Color objects can print correctly on any device that supports ICC profiles

Minus: Two transforms are required hurting performance



Image ICC Profile



Printer ICC Profile



Link Profile

- Converting from device-dependent to device-independent to device-dependent is flexible but hurts performance.
- Systems, using the new AFP Color Management Architecture, automatically build the equivalent of a Link Profile, from two device-specific profiles, using a single transform for optimum performance.



Image ICC Profile

Transform

Link
Profile



Printer ICC Profile



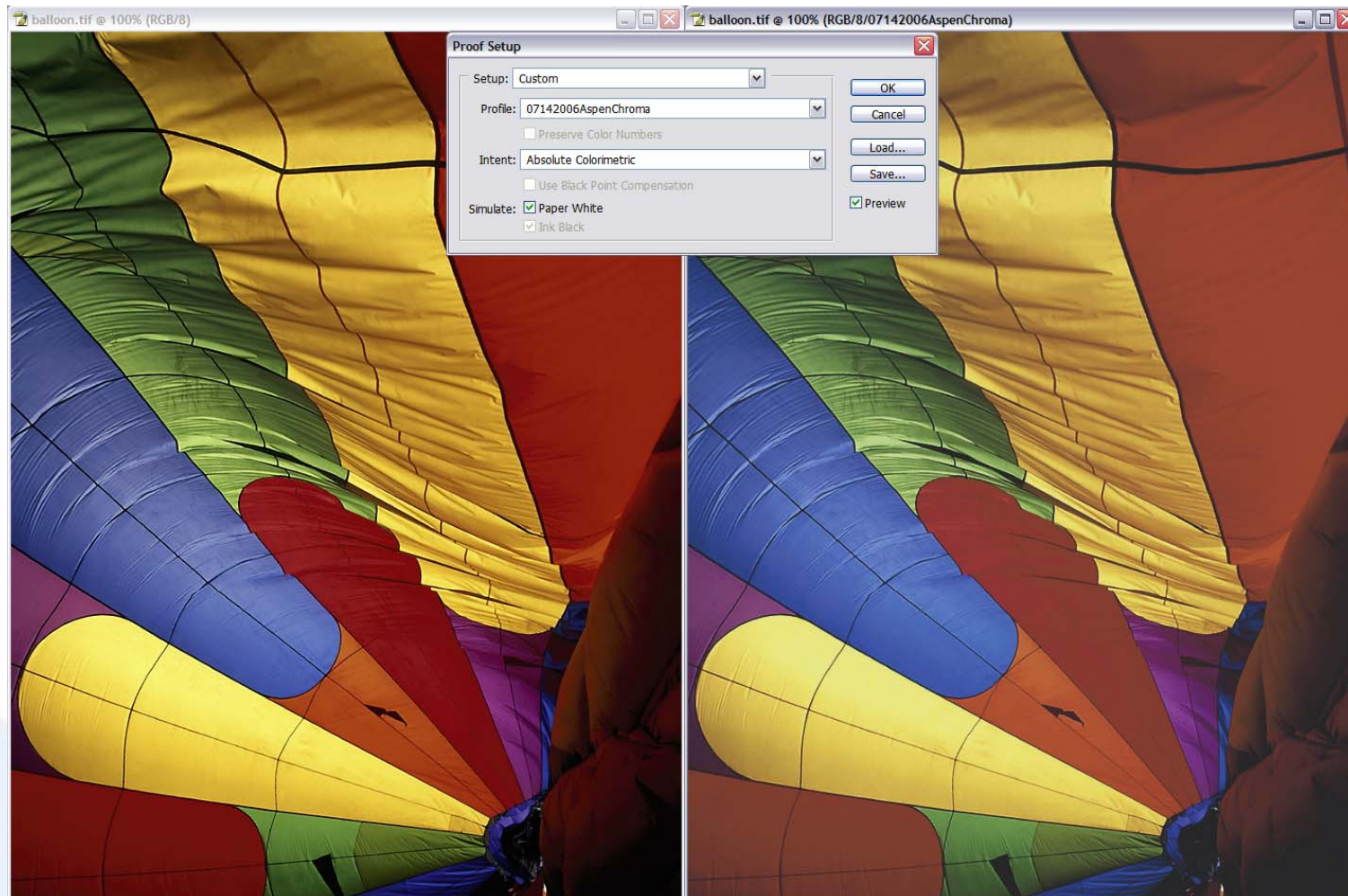
Rendering Intents

- ❑ Specifies color conversion when moving from one color space, (ICC profile), to another; i.e. how to handle colors, in an image, that cannot be reproduced exactly on a printer or monitor
- ❑ Perceptual:
 - Preserves visual relationships between colors,
 - Compresses image's gamut to fit within that of target device
 - Most pleasing for photographic images
- ❑ Saturation:
 - Produces vivid colors at expense of accuracy
 - Most suitable for business graphics
- ❑ Colorimetric (Relative and Absolute):
 - Match colors exactly and clip out-of-gamut colors
 - Used for logos and proofing
 - Relative maps source white to paper white (logos)
 - Absolute tries to preserve source white in destination (proofing)



Absolute Colorimetric Source Image

Colors Using Target Printer's ICC Profile



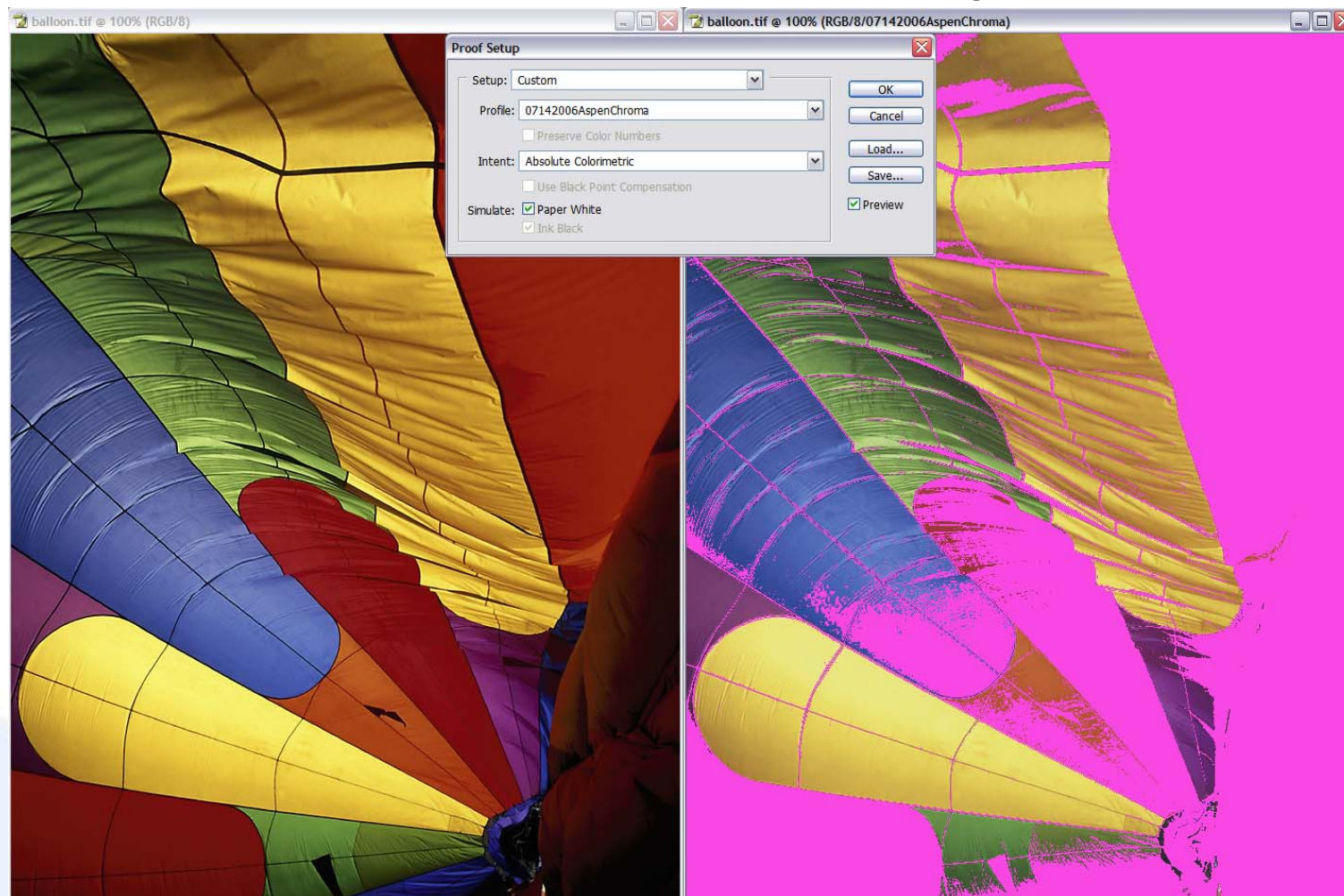


Absolute Colorimetric

Pink shows out of gamut colors

Source

Target

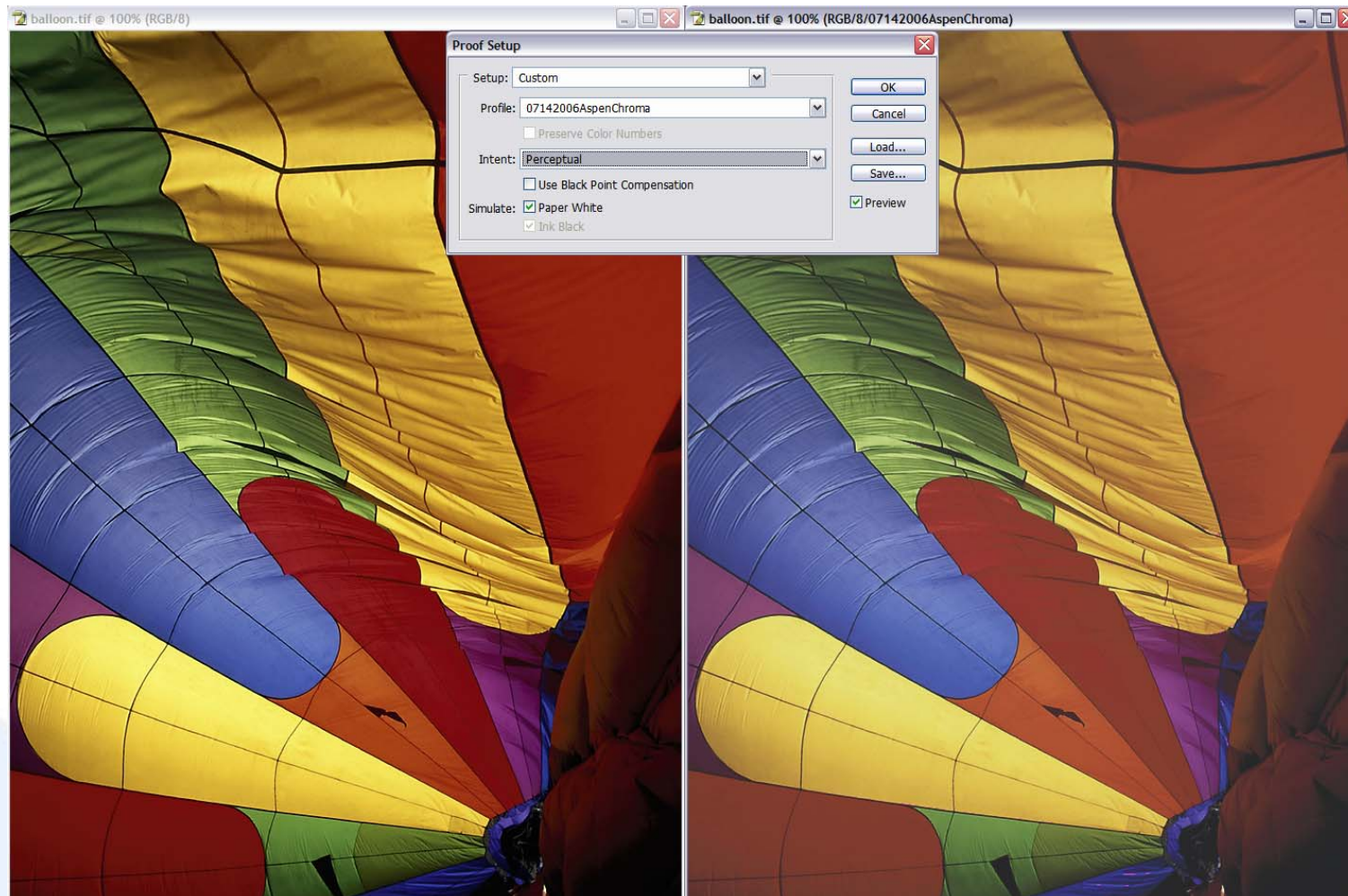




Perceptual

Source

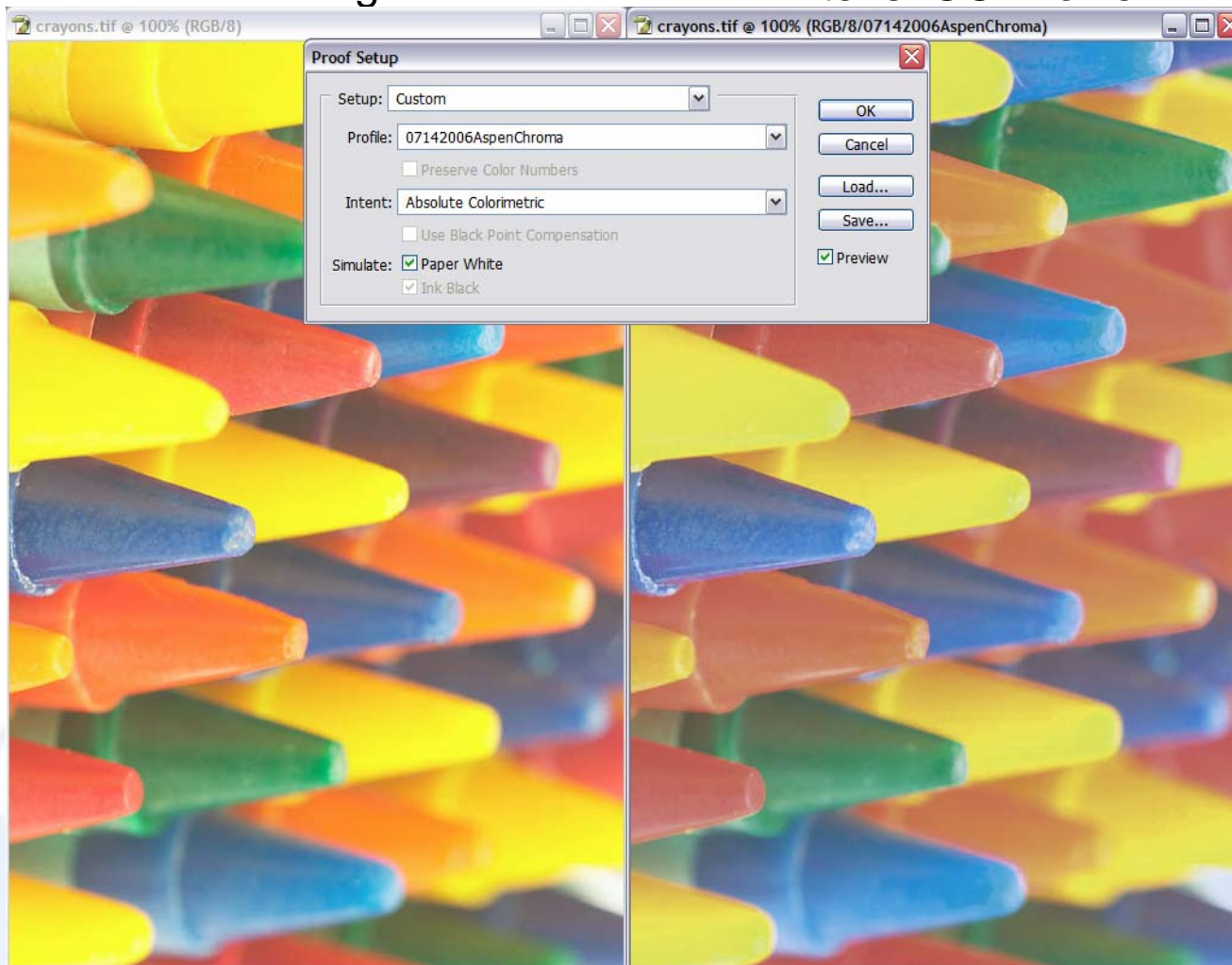
Target





Absolute Colorimetric Source Image

Colors Using Target Printer's ICC Profile



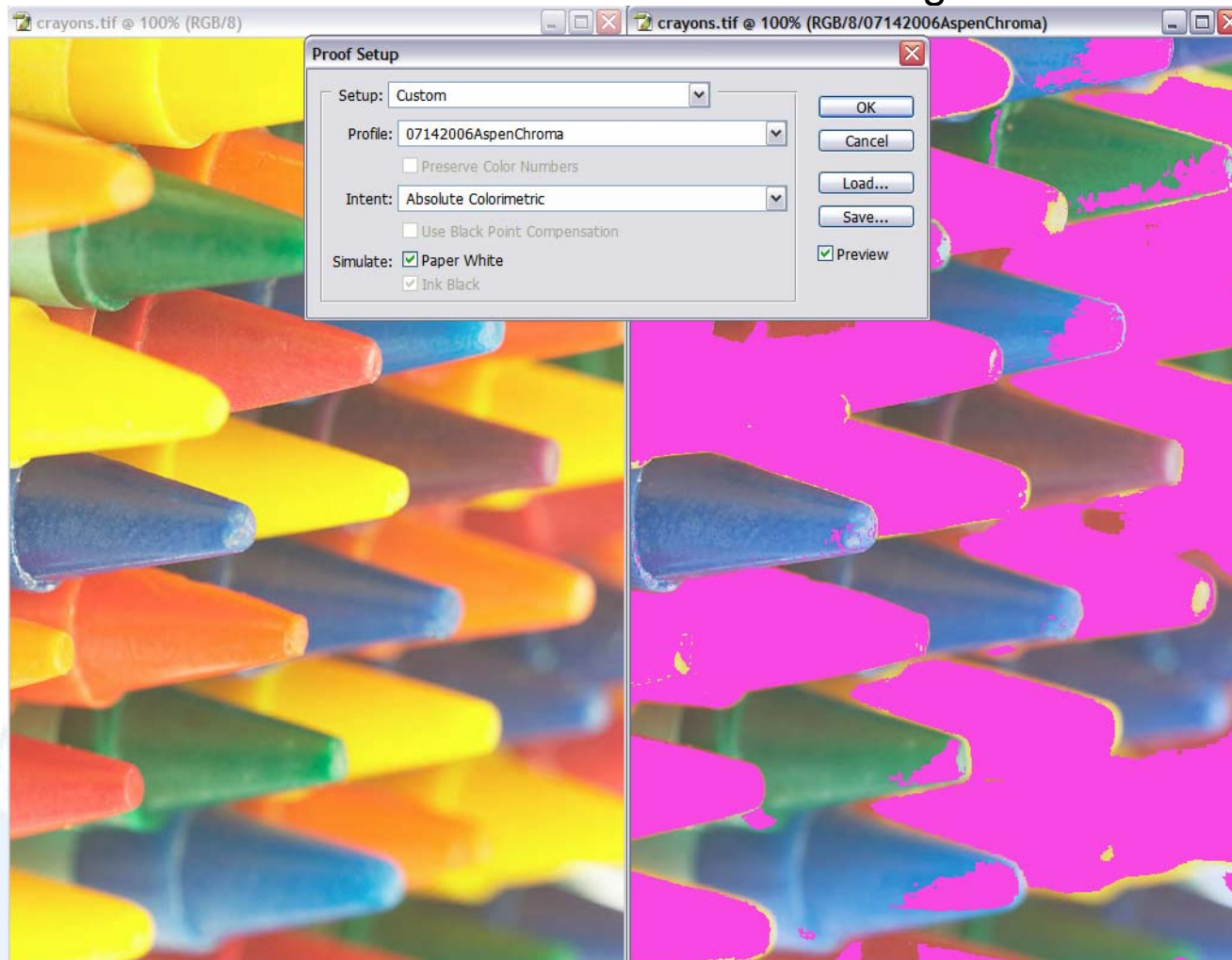


Absolute Colorimetric

Pink shows out of gamut colors

Source

Target

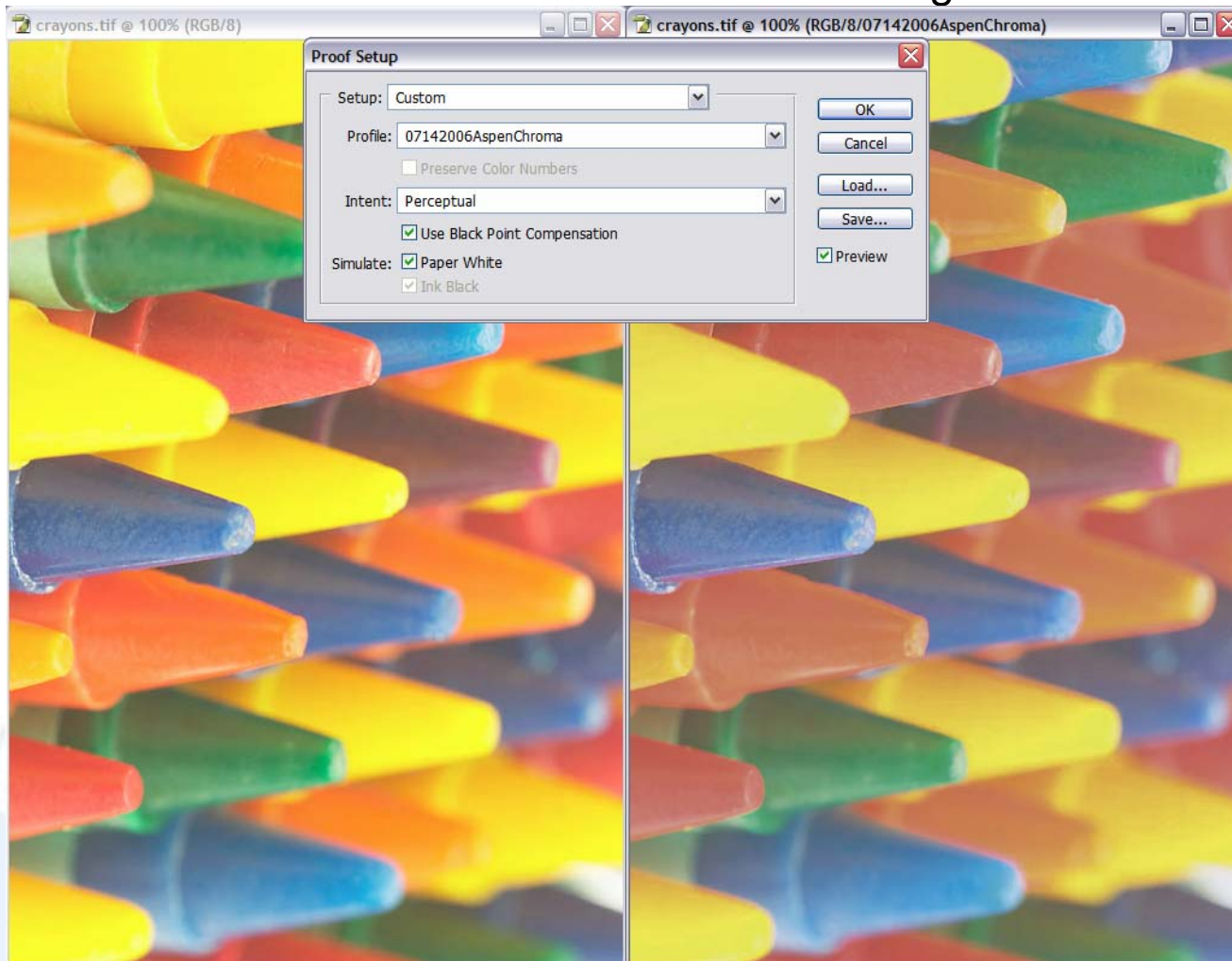




Perceptual

Source

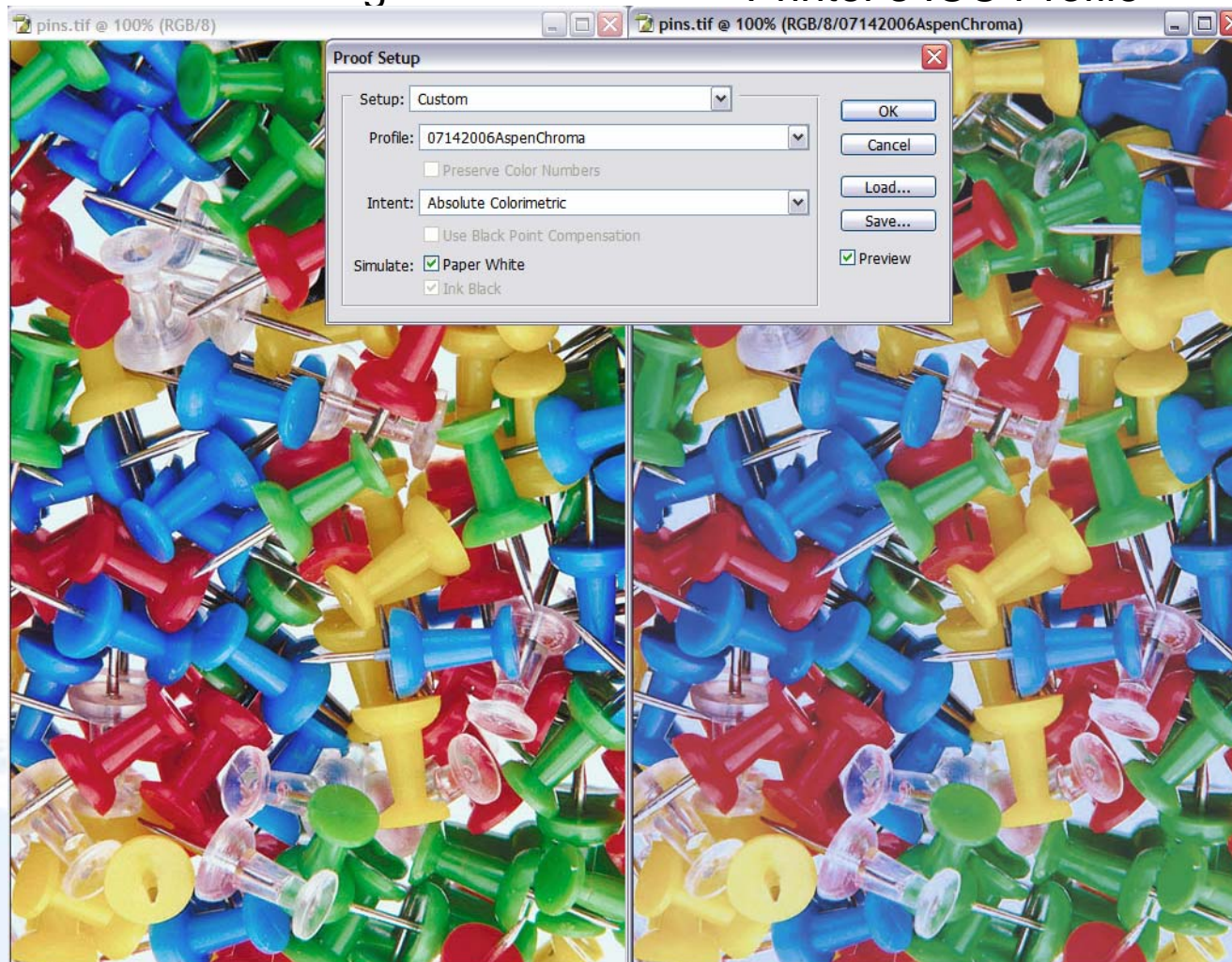
Target





Absolute Colorimetric Source Image

Colors Using Target Printer's ICC Profile



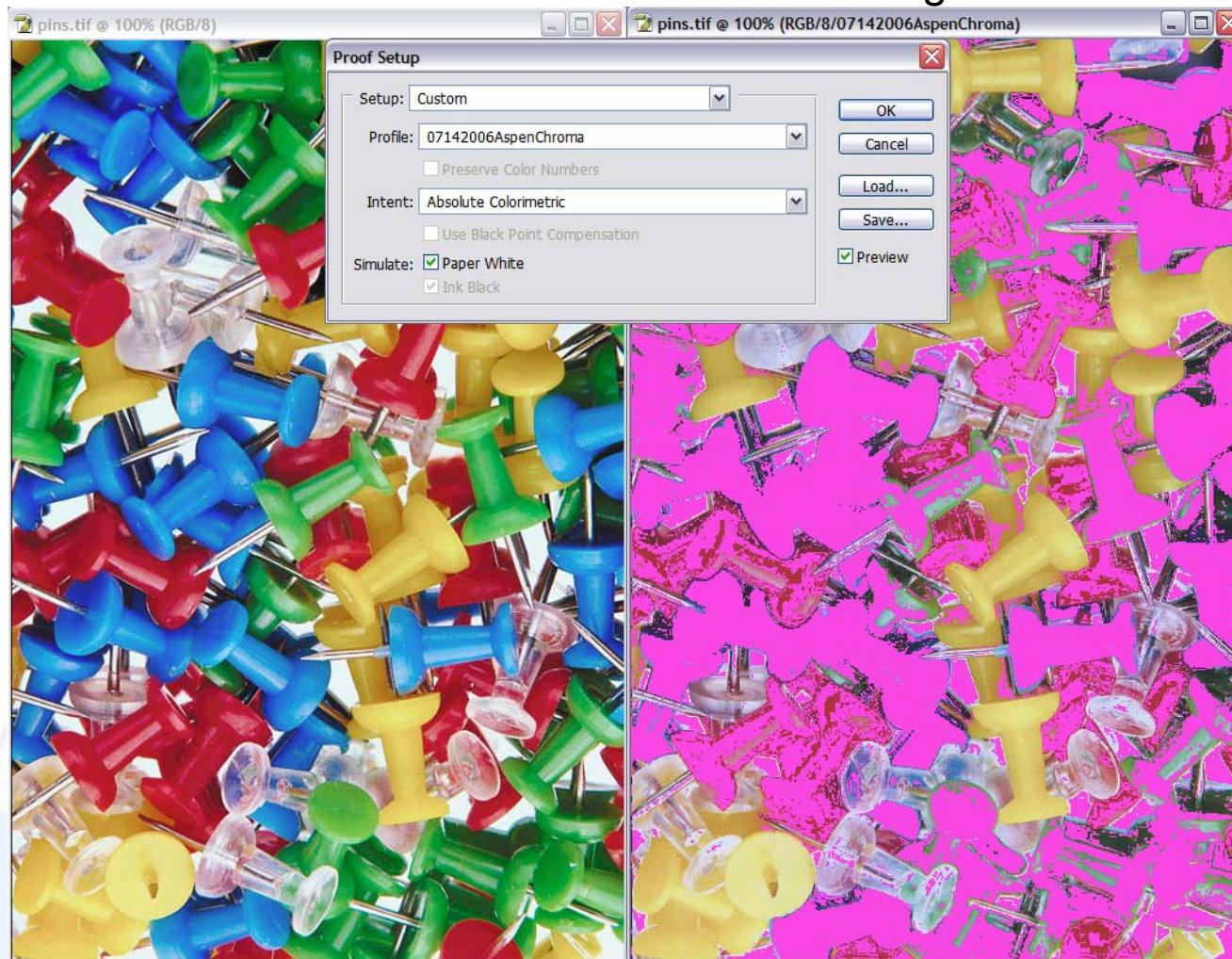


Absolute Colorimetric

Pink shows out of gamut colors

Source

Target

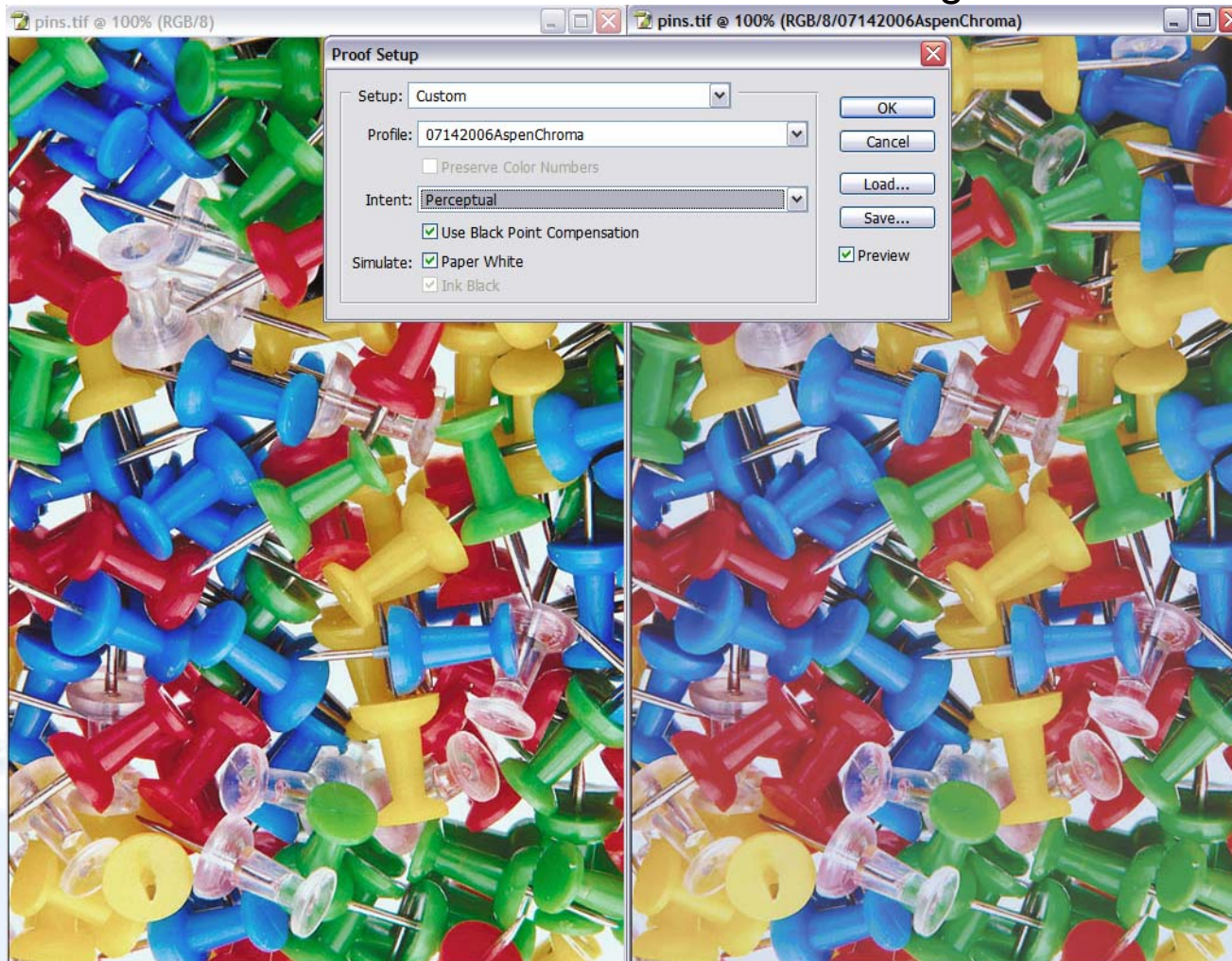




Perceptual

Source

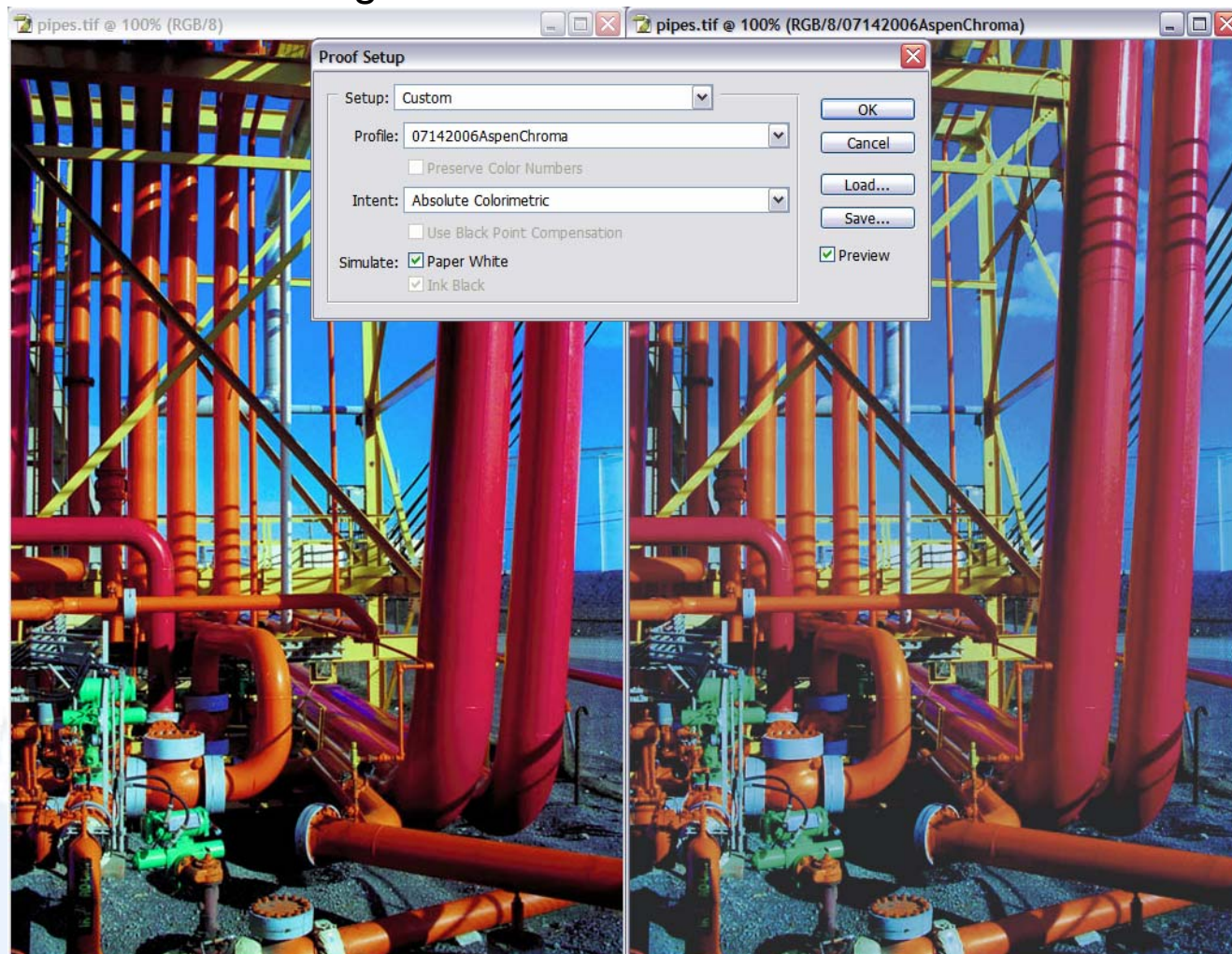
Target





Absolute Colorimetric Source Image

Colors Using Target Printer's ICC Profile



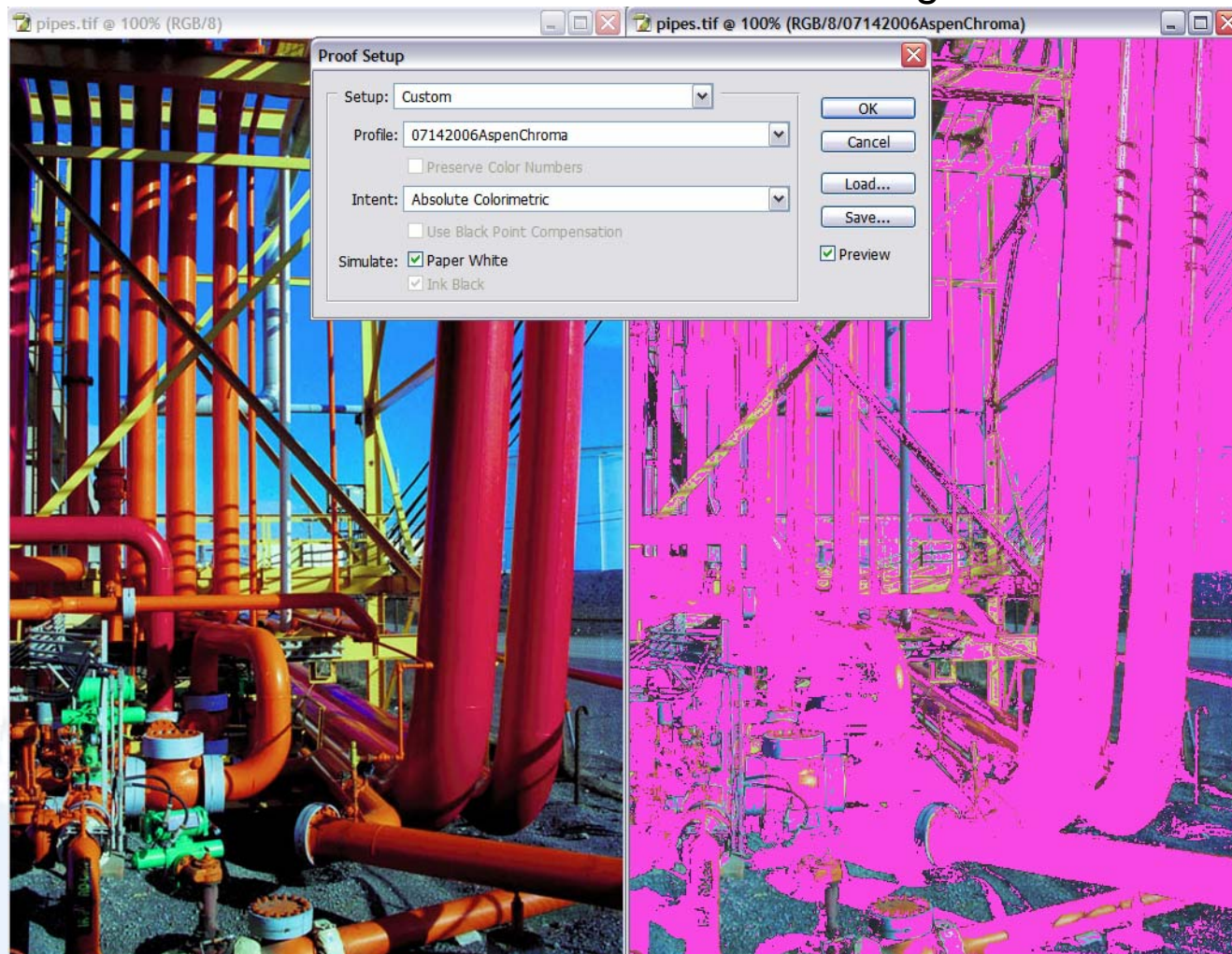


Absolute Colorimetric

Pink shows out of gamut colors

Source

Target

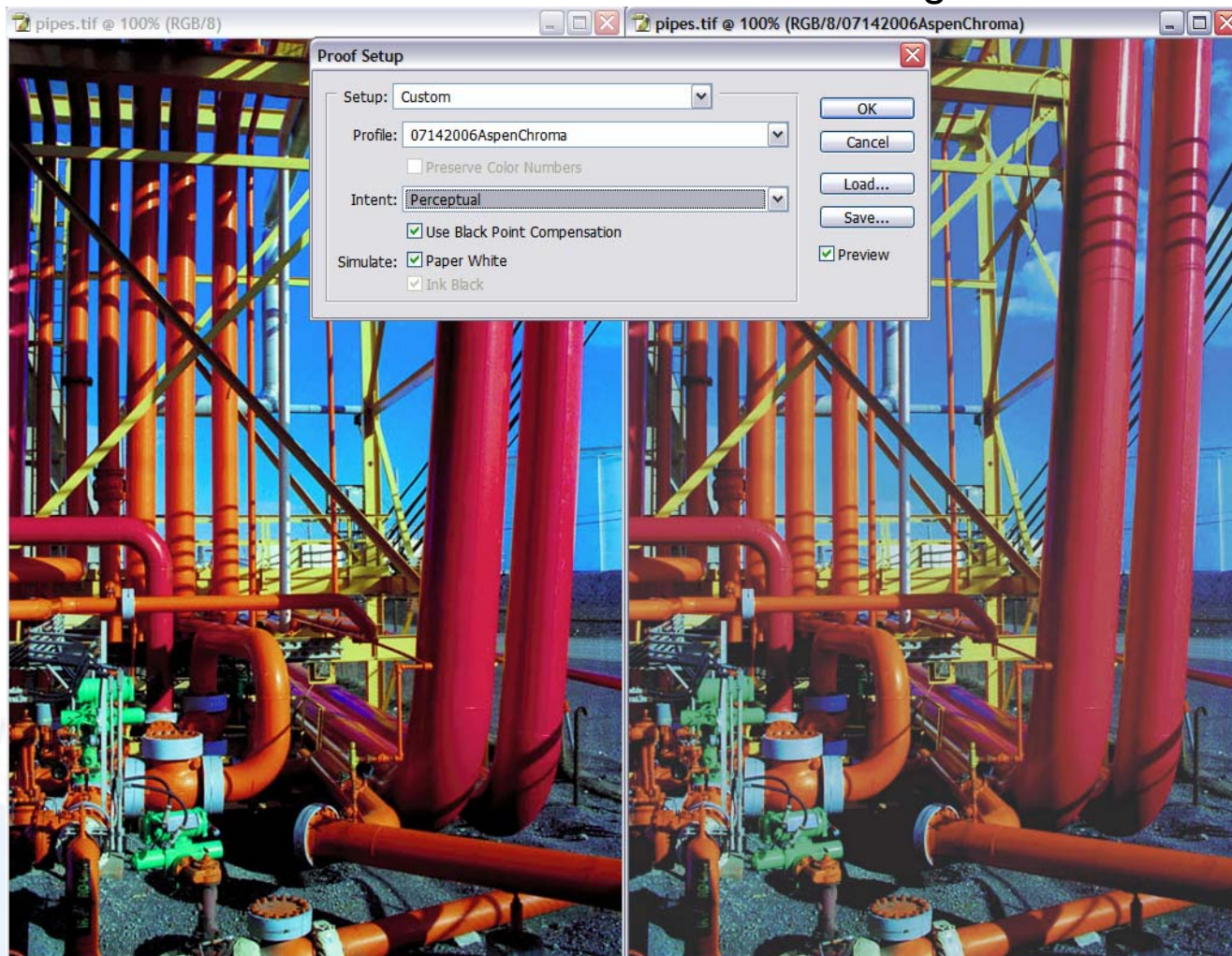




Perceptual

Source

Target





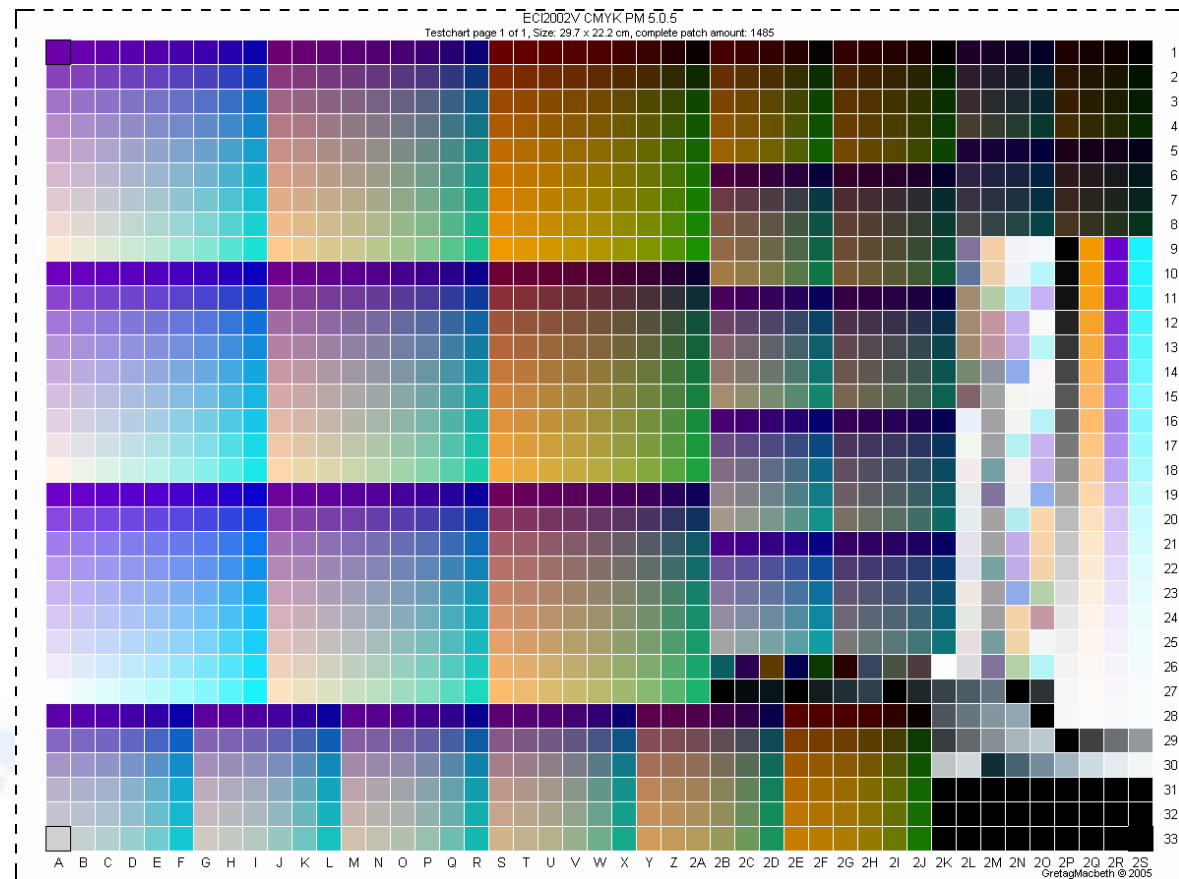
Create Printer ICC Profile





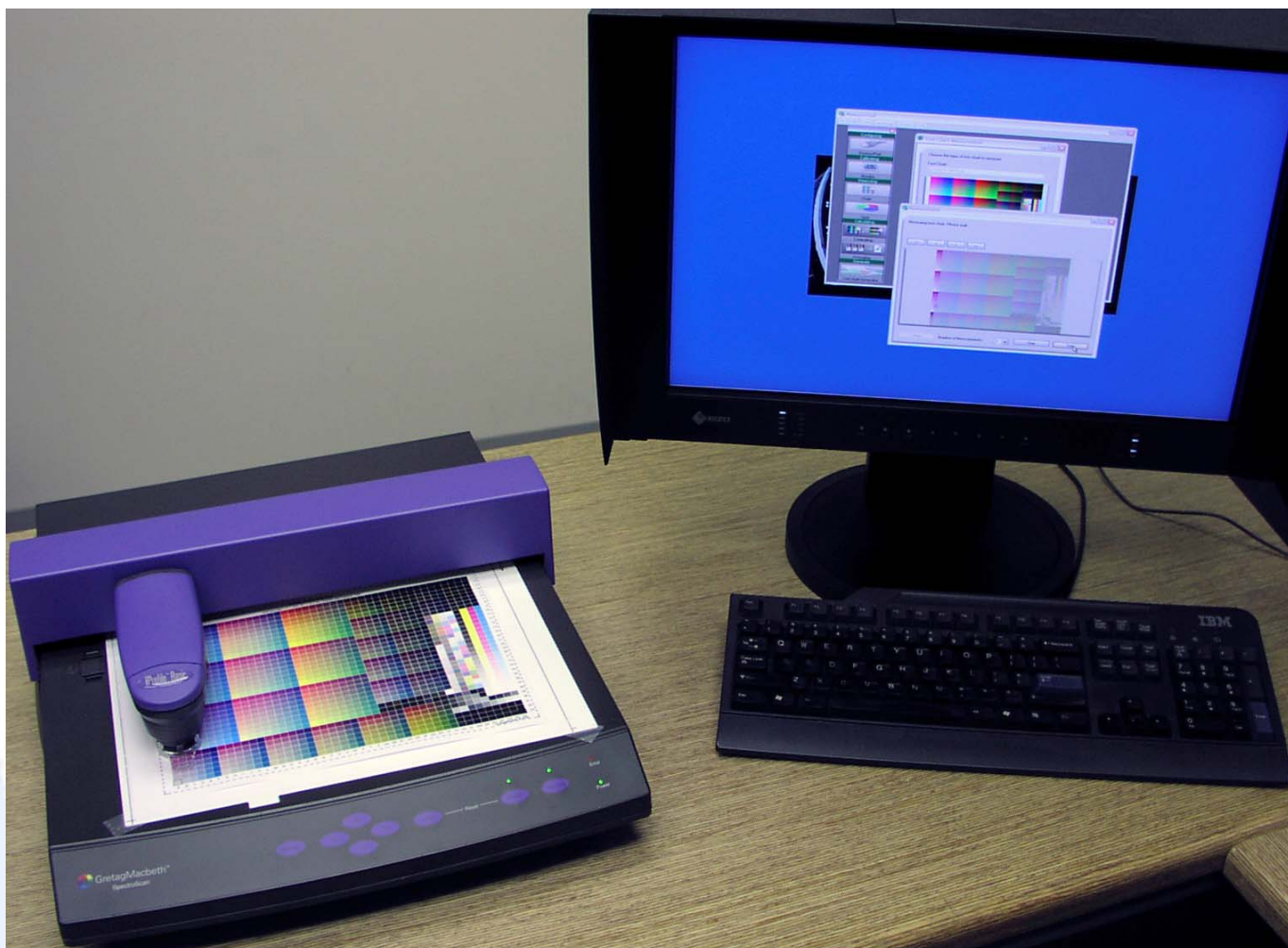
Create ICC Profile for CMYK Printer

- ❑ Print CMYK testchart on printer to be profiled
- ❑ Industry-standard ECI2002V testchart commonly used for printer profiling
- ❑ Contains 1485 patches





Reading Testchart, PC with Instrument Attached





Create Printer ICC Profile from Measurement Data



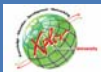
A reference file, containing the requested colors, is compared with the measurement file to produce the ICC Profile



Computing Profile, takes around 5 minutes



- ☐ Profile is either loaded into printer or print server resource library
- ☐ In AFP the profile is called a Color Conversion Color Management Resource, (CC CMR)
- ☐ At least one is needed for each printer model
- ☐ Different profiles may be needed for each paper type if the paper difference is enough to affect color gamut
- ☐ Printer vendors will likely provide profiles for standard papers



New AFP Color Implementation





AFP Color Consortium and AFP Color Management Architecture, (ACMA)



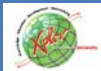
- ❑ Purpose: Create a comprehensive open standard for accurate and consistent full-color production print.
- ❑ Goals:
 - Accurate color rendering
 - Consistent color rendering across AFP output devices
 - Tunable colors and grayscales
 - High-speed color conversions



AFP Color Consortium and AFP Color Management Architecture, (ACMA)



- ☐ Established in October 2004
- ☐ 31 member companies published ACMA architecture March 2006
- ☐ Role expanded in 2006 to include the entire AFP architecture
- ☐ Consortium members provide AFP: application generators, print servers, printers, and consulting services
- ☐ Consortium will verify vendor to vendor interoperability and certify product compliancy
- ☐ Architecture requires compliant products to support a minimum function set to make certain each solution is useful and portable
- ☐ For architecture documentation and other information:
www.afpcolor.org



AFP Color Consortium Members



☐ Document Composition & Resource Creation

- Cincom
- COPI
- DocuCorp
- Document Sciences
- Elixir Technologies
- Exstream Software
- FormsPath SL
- GMC Software Technology
- Group 1
- Invaris
- Inventive Designers
- ISIS-Papyrus
- Metavante
- PrintSoft
- StreamServe

☐ Servers & Transforms

- CDP Communications
- Compart Systemhaus
- Crawford Technologies
- Emtex
- LRS
- MPI
- Solimar Systems
- Xenos Group

☐ Printers & Controllers

- IBM
- Intermate
- Kodak
- Lexmark
- Oce
- Ricoh
- Xeikon International
- Xerox



Data Objects

CMRs

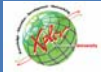
RATs





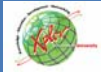
Data Object Resources

- ☐ Resource type to support data formats not-defined by AFP
- ☐ No conversion required!
- ☐ Examples:
 - TIFF
 - JPEG
 - GIF
 - EPS
 - PDF Single-Page Object
 - TrueType/OpenType Font

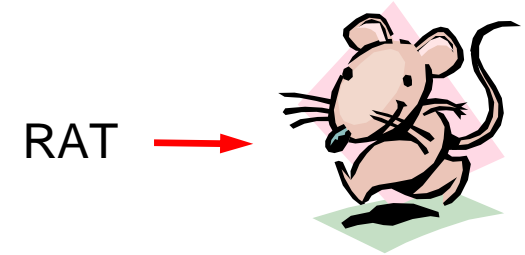


Color Management Resources, CMRs

- ❑ New AFP resource type to implement color management
- ❑ 5 Types:
 - **Color Conversion (CC):** Contains ICC Profile which describes the color characteristics of a Data Object, (e.g. TIFF/JPEG), or printer; used to convert color data between the two
 - **Tone Transfer Curve (TTC):** Specifies grayscale appearance:
 - Dark
 - Accutone
 - Highlight Midtone
 - Standard
 - **Halftone (HT):** Specifies halftone line screen
 - **Indexed (IX):** Extends highlight color support for colorant mixing
 - **Link Color Conversion (LK):** Look-up tables that convert colors directly from the input color space to the output color space; helps performance



Resource Access Table (RAT)



- ❑ When Data Objects and CMRs are installed in resource libraries, they are processed using a Resource Access Table (RAT)
- ❑ Maps a resource name, specified in the application print file, to the resource file name and other information needed to process it
- ❑ Allows resources to be referenced in data stream by their inherent, native name, not by a platform-specific file name
- ❑ RATs are located in same directory as the resources they map
- ❑ RATs were first introduced in AFP with TrueType/OpenType fonts
- ❑ There are three types of RATs, each with a hard-coded file name:
 - Data Object RAT: AFP_DataObjectResource.rat
 - Color Management Resource RAT: AFP_ColorManagementResource.rat
 - TrueType/OpenType Font RAT: IBM_DataObjectFont.rat



Data Objects Defined in Pagedef and Stored in Print Server Resource Library

1. Place unmodified TIFFs/JPEGs in print server directory or inline using original file names
2. Build pagedef using data objects with OBTYPE of IOCA and OBID of TIFF/JPEG

```
PAGEDEF TIFF REPLACE YES  
      WIDTH 8.5 in  
      HEIGHT 11.0 in;
```

How resources are retrieved is
described on the following pages.

```
FONT NORM  CS H200  CP V10037 HEIGHT  9 RATIO 70;
```

```
OBJECT CCBIG      OBXNAME CCBIG      OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;  
OBJECT CCSMALL    OBXNAME CCSMALL    OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;  
OBJECT IBMLOGO    OBXNAME IBMLOGO    OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;  
OBJECT BARB1      OBXNAME BARB1      OBKEEP PRELOAD OBTYPE OTHER OBID JPEG;  
OBJECT BARB2      OBXNAME BARB2      OBKEEP PRELOAD OBTYPE OTHER OBID JPEG;  
OBJECT BARB3      OBXNAME BARB3      OBKEEP PRELOAD OBTYPE OTHER OBID JPEG;  
OBJECT CHECKSUM   OBXNAME CHECKSUM   OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;  
OBJECT CKHEADER   OBXNAME CKHEADER   OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;  
OBJECT DBHEADER   OBXNAME DBHEADER   OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;
```



On z/OS the resources are stored in the
UNIX HFS, (Hierarchical File System).



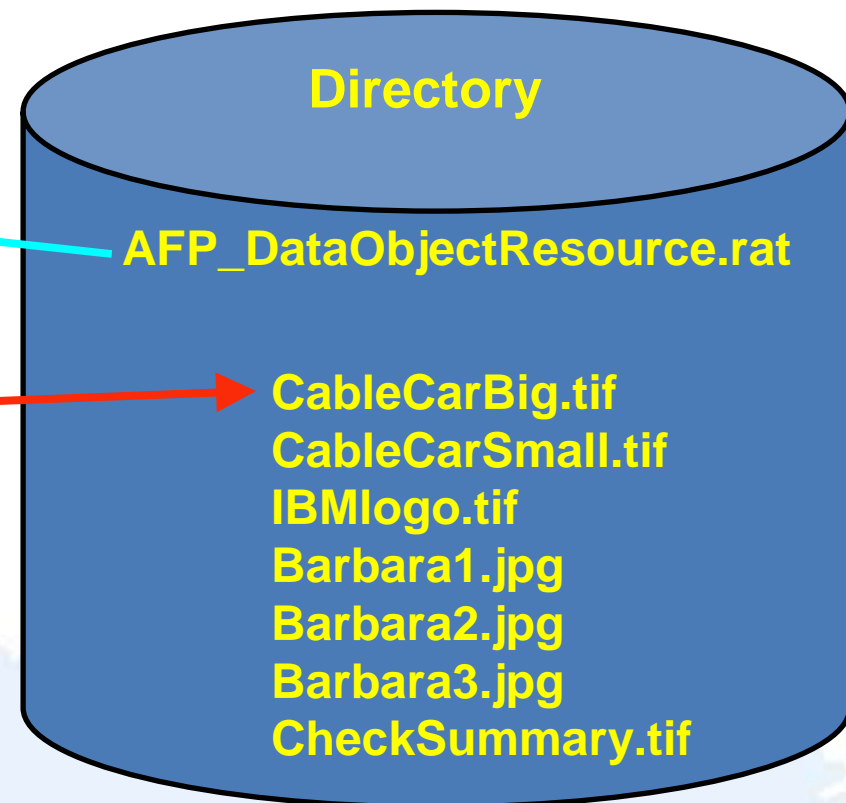
Data Object Resource RAT Maps Application Resource Name to Resource Filename

Application Pagedef

OBJECT CCBIG OBXNAME CCBIG OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;

Data Object Resource RAT

Object Name	Filename
CCBIG	CableCarBig.tif
CCSMALL	CableCarSmall.tif
IBMLOGO	IBMlogo.tif
BARB1	Barbara1.jpg





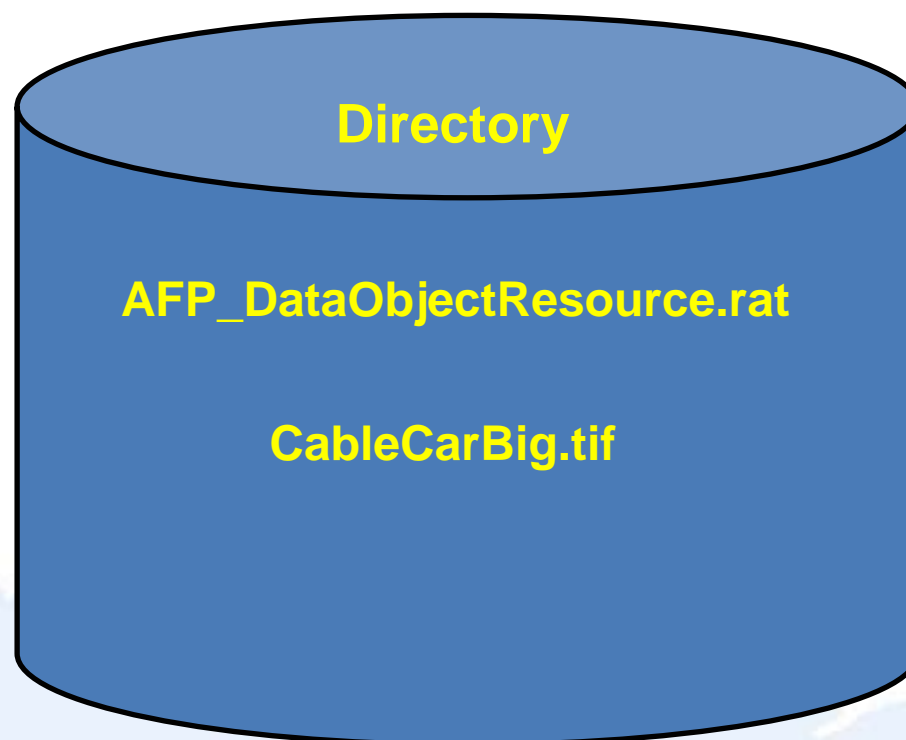
Data Object Resource RAT Also Identifies Color Management Resources (CMRs) Associated with the Data Object

Application Pagedef

OBJECT CCBIG OBXNAME CCBIG OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;

Data Object Resource RAT

Object Name	Filename	CC CMR Name
CCBIG	CableCarBig.tif	sRGB
CCSMALL	CableCarSmall.tif	sRGB





Another RAT, the Color Management Resource RAT, Maps CMR Name to CMR Filename

Application Pagedef

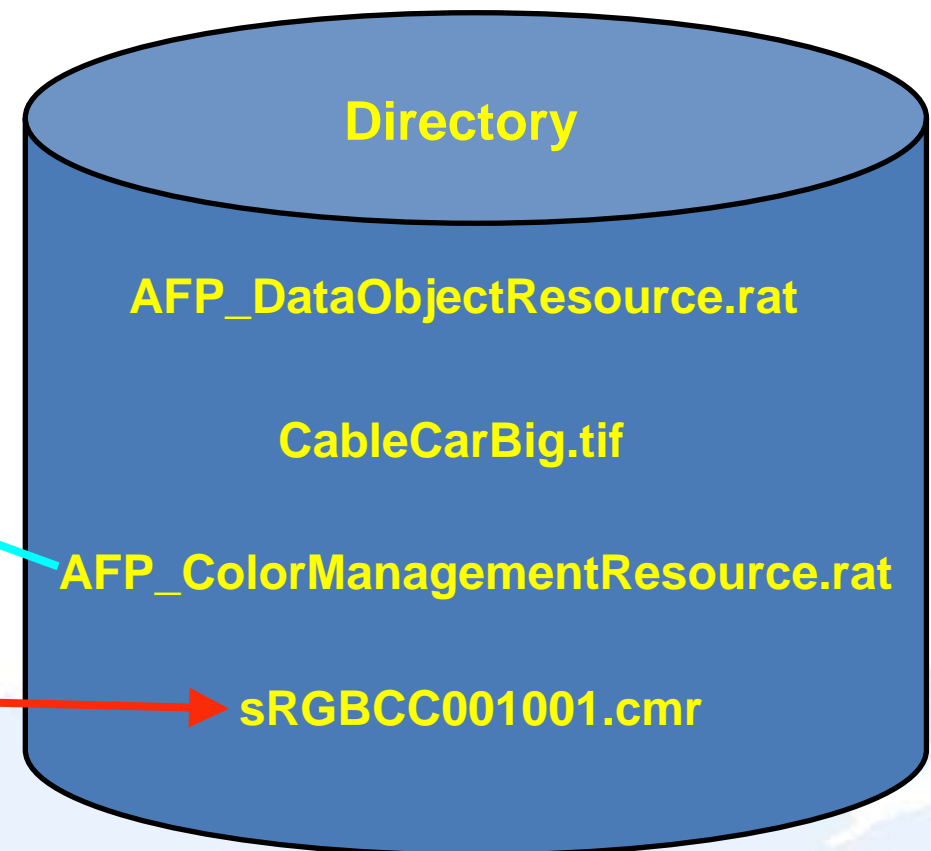
OBJECT CCBIG OBXNAME CCBIG OBKEEP PRELOAD OBTYPE OTHER OBID TIFF;

Data Object Resource RAT

Object Name	Filename	CC CMR Name
CCBIG	CableCarBig.tif	sRGB
CCSMALL	CableCarSmall.tif	sRGB

Color Management Resource RAT

CMR Name	Filename
sRGB	sRGBCC001001.cmr
Adobe_RGB	Adobe_RGBCC001001.cmr





Specifying Rendering Intent in an Application

Application Pagedef

```
OBJECT CCBIG      OBXNAME CCBIG      OBKEEP PRELOAD OBTYPE OTHER OBID TIFF
                  RENDER PERCP;
OBJECT CCSMALL    OBXNAME CCSMALL    OBKEEP PRELOAD OBTYPE OTHER OBID TIFF
                  RENDER SATUR;
OBJECT IBMLOGO    OBXNAME IBMLOGO    OBKEEP PRELOAD OBTYPE OTHER OBID TIFF
                  RENDER RELCM;
OBJECT BARB1      OBXNAME BARB1      OBKEEP PRELOAD OBTYPE OTHER OBID TIFF
                  RENDER ABSCM;
```

PERCP = Perceptual

SATUR = Saturation

RELCM = Relative Colorimetric

ABSCM = Absolute Colorimetric

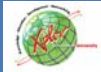


Specifying Line Screen and Appearance for Monochrome Printers that Support the Color Architecture

Application Pagedef

```
OBJECT CCBIG      OBXNAME CCBIG      OBKEEP PRELOAD OBTYPE OTHER OBID TIFF
                  OB2CMR  '106lpi'  OB2XNAME 'HTgeneric106' instr
                  OB2CMR  'hilitemidtone' OB2XNAME 'TCgenerichilmid' instr;
```

- ☐ The command above uses generic CMRs to request a line screening of 106lpi and an appearance of highlight midtones.
- ☐ Generic CMRs allow a device-independent specification, similar to Infoprint Submit, where the actual result may not exactly match the requested value. For example, when a line screen of 106lpi is requested on a 4100-HD3/4 the actual line screen generated is 96lpi.
- ☐ Specific CMRs can be used instead of generic however an error will occur if the device cannot provide the requested value.



AFP Application Enablers

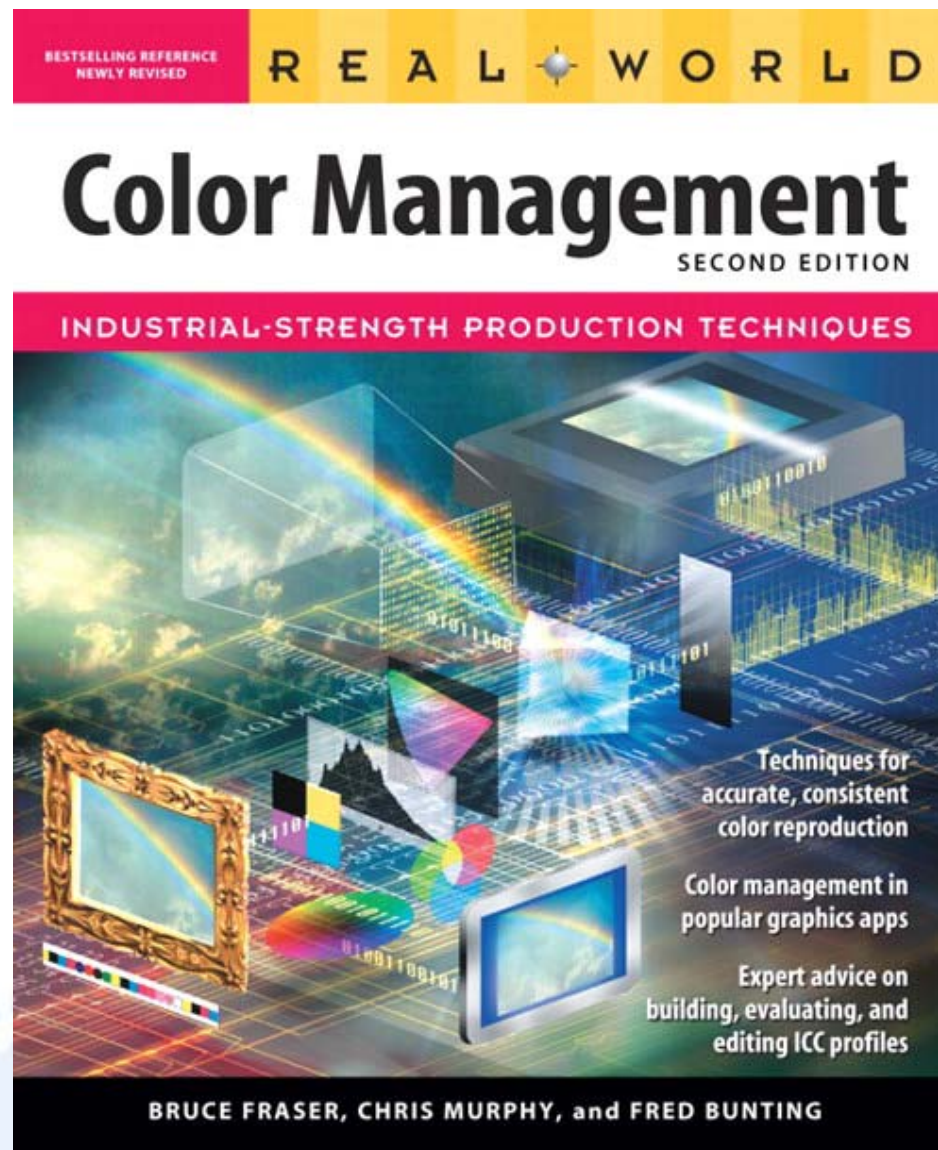
- ❑ AFP application enablers are the best choice for creating AFP color applications, see AFP Consortium member list for vendors
- ❑ They can create highly custom statements required to exploit the value of color
- ❑ The consortium members are working together to test the interoperability of applications, print servers, and printers

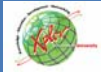




Recommended Reading

- ❑ *Real World Color Management* by Bruce Fraser, Chris Murphy, and Fred Bunting
- ❑ Explains how to use color management in your workflow





Remember: Two Key Messages

1. With the new AFP color architecture you will not get the same colors on different model printers!
2. Four-color, CMYK, printers can reproduce most, but not all, of the PANTONE® solid colors!





***Color is Coming,
Be Prepared!
Questions?***