# CIE TC 8-16
# Consistent Colour Appearance (CCA) in a Single Reproduction Medium

Informal Workshop at RIT

1st June 2017

W Craig Revie

# Overview

Increasing gamut size

**Q1:** why do images in set B have a similar appearance whereas the images in set A do not?

**Q2:** is the degree of similarity of a set of images something that could be measured?

**Q3:** are all observers in agreement as to when Consistent Colour Appearance is achieved?

# Why would such a metric be useful?

# Flexible print (RGB) workflow



Print contract is agreed based on a **reference display image** or **prototype print** from a standard digital printing system
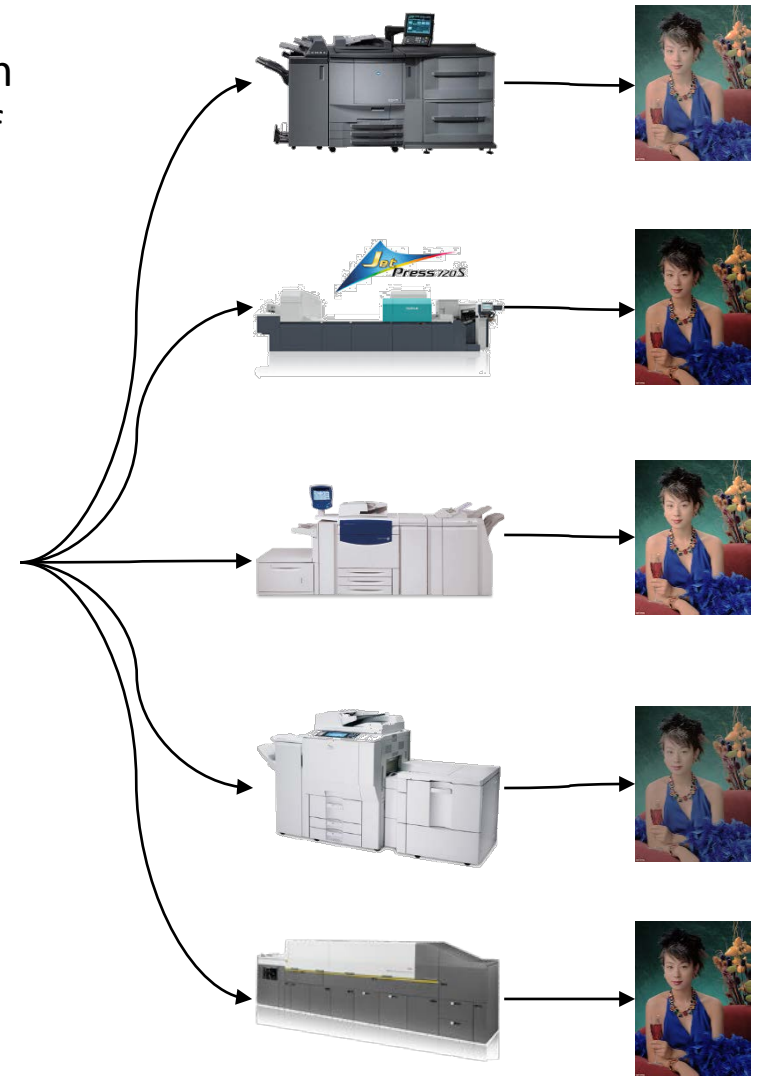
RGB

Printing should use all of the available printing gamut but must retain colour appearance of agreed reference



RGB → **Colour conversion** →

Consistent colour appearance?

## Initial target for CIE TC8-16

# Brand management



Product packaging



Magazine advert
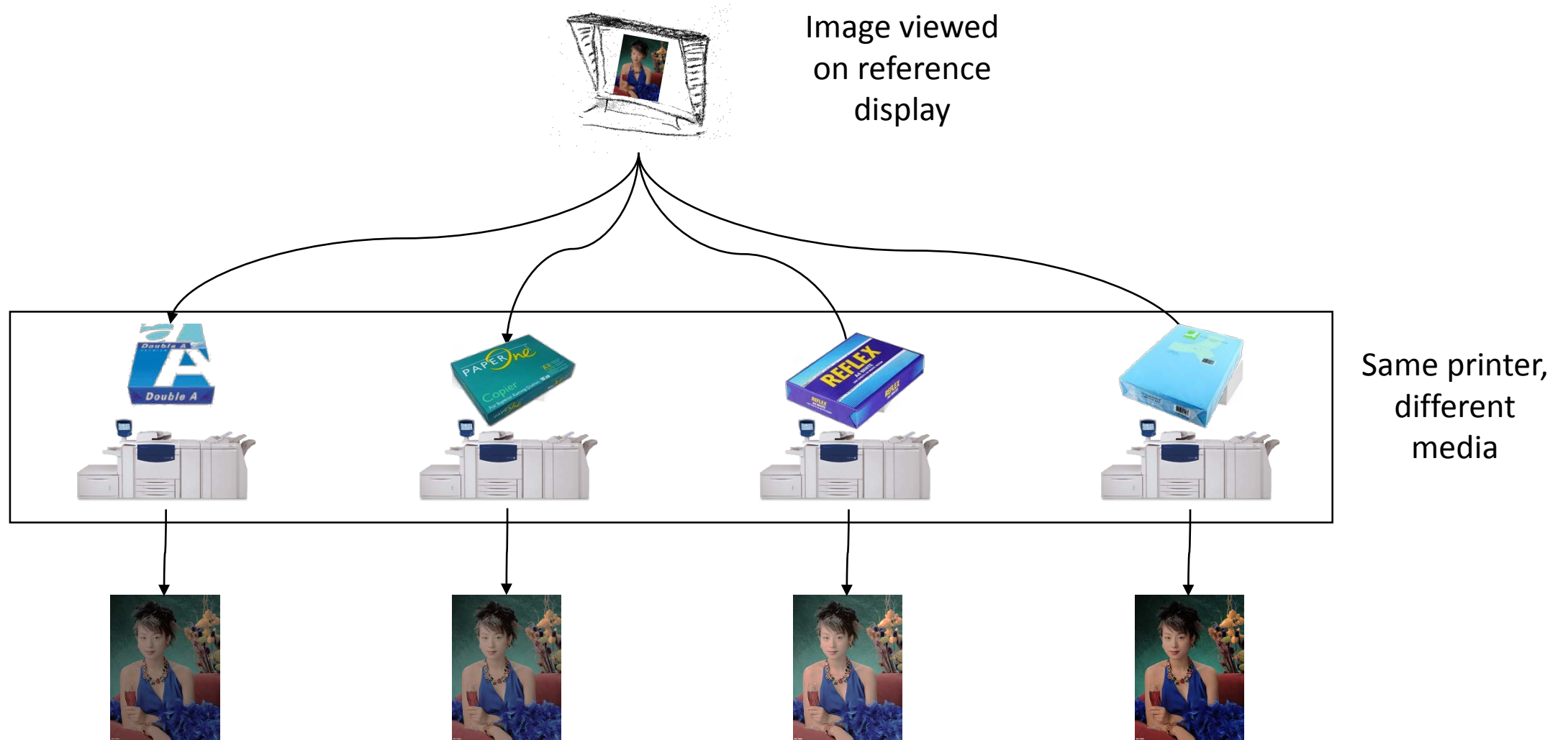


Newspaper advert
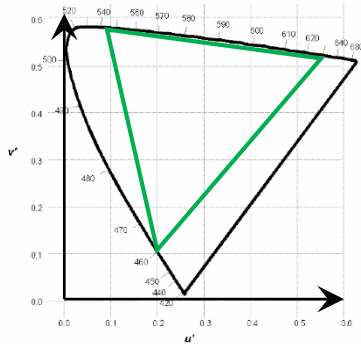


Billboard advert



Vehicle wrap



Television / internet

# Consistency across different print media



Image viewed on reference display

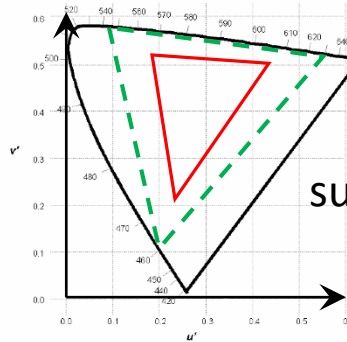Same printer, different media

Consistent colour appearance between prints and with display image?

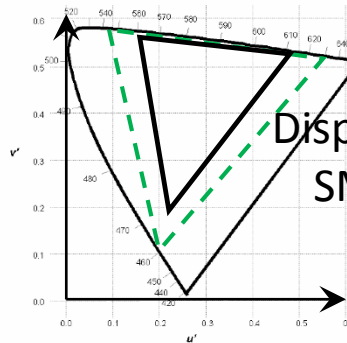# Consistency across displays (UHDTV)



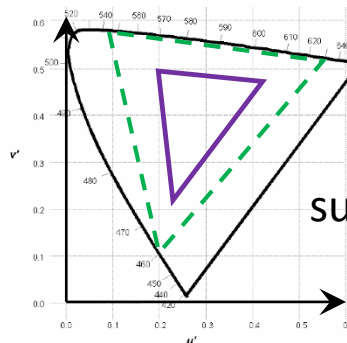Transmitter uses BT.2020 encoding with very large colour gamut

What is needed to achieve consistent colour appearance?

Display A supports BT.709

Display B supports SMPTE DCI-P3

Display C supports sRGB

# **Conventional printing:** Characterised Reference Printing Conditions (ISO/PAS 15339)
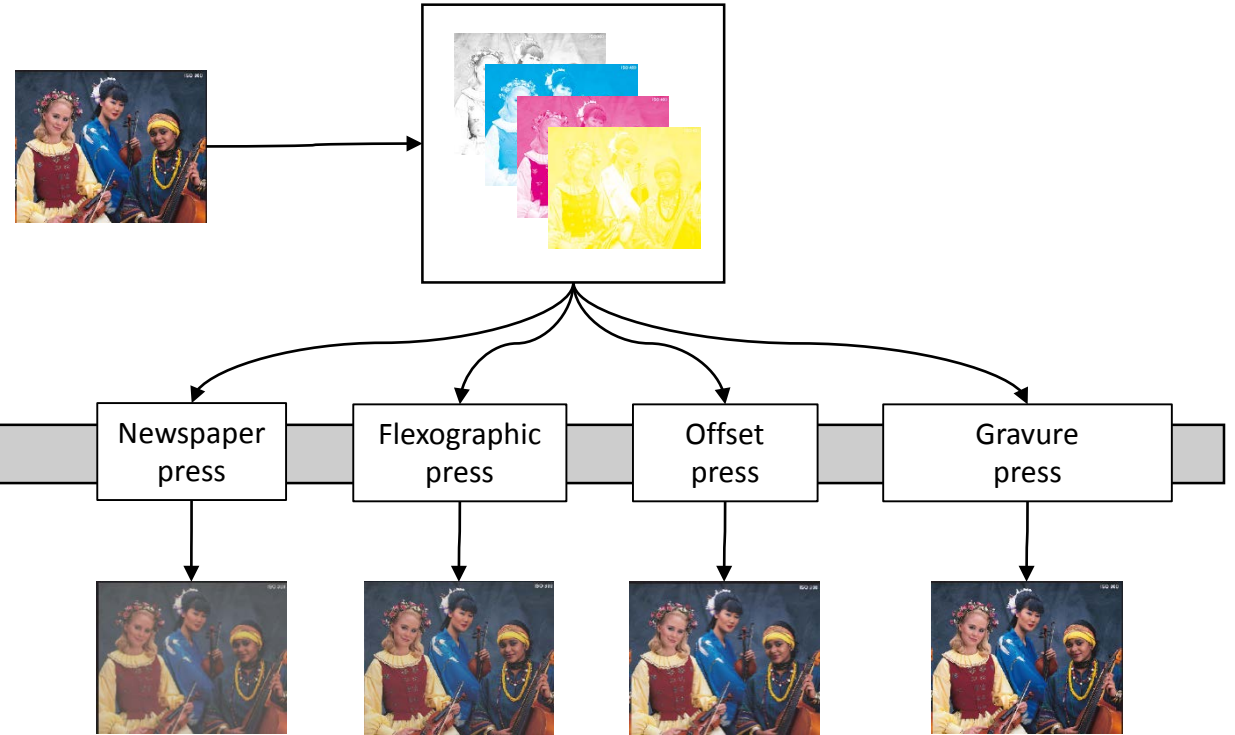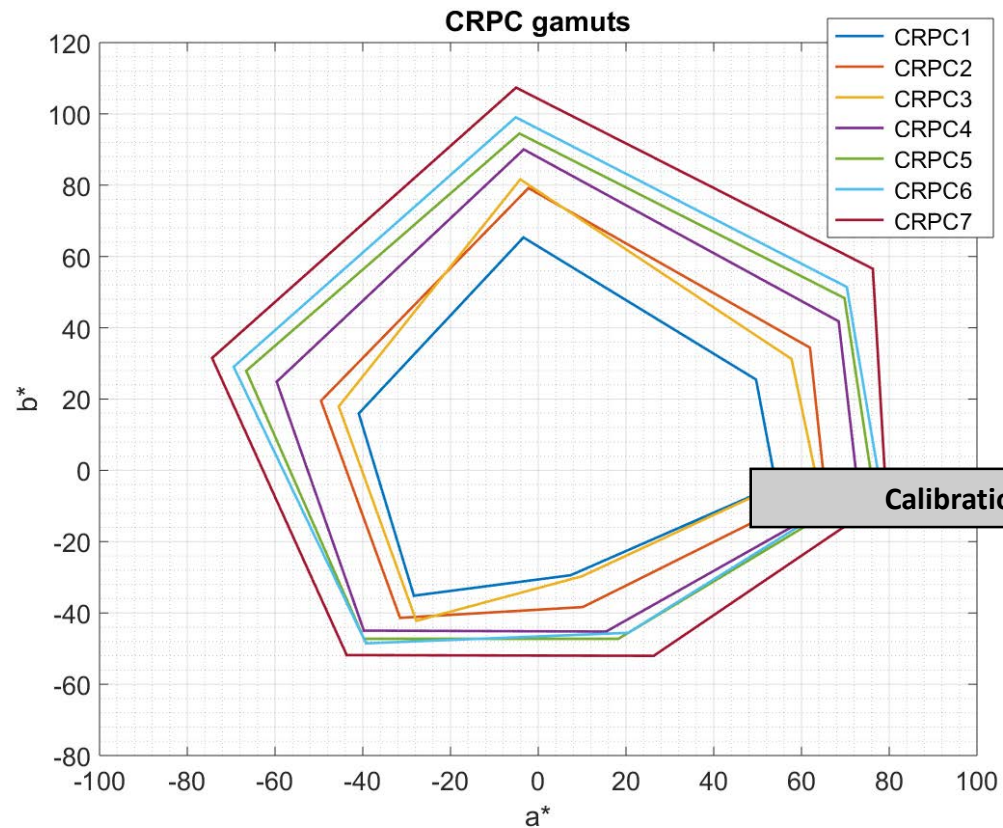


Consistent colour appearance?

# Assessment method

# Objective: CCA of printed images



Reference Images

Production Printers
Includes media, inks and printer configuration

Reference Printer
Includes media, inks and printer configuration

Production Prints

Reference Prints

Print Visual Assessment

Print Viewing Environment
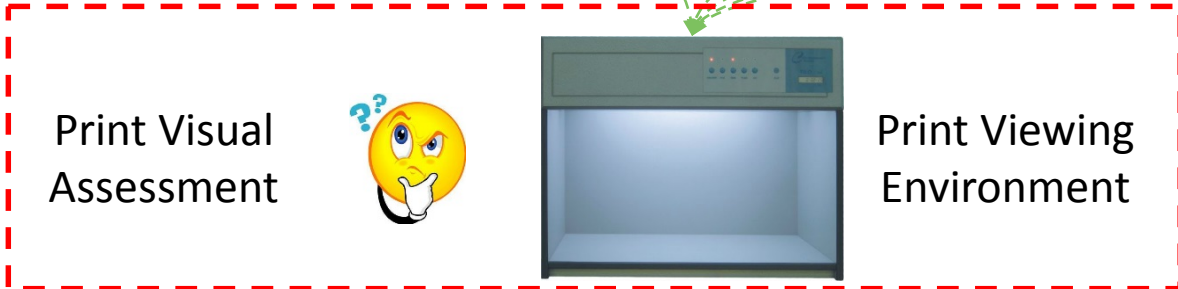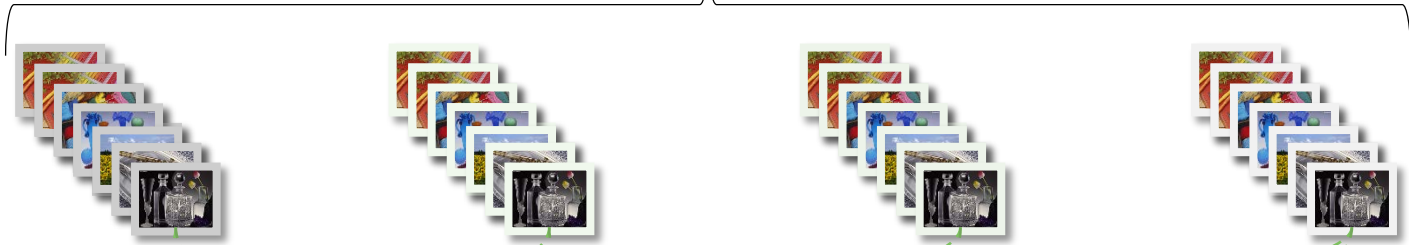
Print measurement and assessment

Consistent Colour Appearance Metric

# Use of print gamuts (hard copy)



Each set of images is rendered using the same algorithm

Rendering algorithm → Reference print gamut → ICC Absolute colorimetric

Rendering algorithm → Print Gamut 1 → ICC Absolute colorimetric

Rendering algorithm → Print Gamut 2 → ICC Absolute colorimetric

• • •

Rendering algorithm → Print Gamut n → ICC Absolute colorimetric

Image colorimetry defined by ISO 12640

Proofing substrate suitable for accurate proofing all print gamuts as required by ISO 12647-7

# Use of print gamuts (soft copy)

Each set of images is rendered using the same algorithm

Image colorimetry defined by ISO 12640

Rendering algorithm → Reference print gamut → ICC Absolute colorimetric

Rendering algorithm → Print Gamut 1 → ICC Absolute colorimetric

Rendering algorithm → Print Gamut 2 → ICC Absolute colorimetric

• • •

Rendering algorithm → Print Gamut n → ICC Absolute colorimetric

Proofing display colour gamut suitable for accurate proofing all print gamuts as required by ISO 14861

# Resources

# Candidate images (ISO 12640 SCID)

Border showing
unprinted substrate

10 mm

128 mm

96 mm
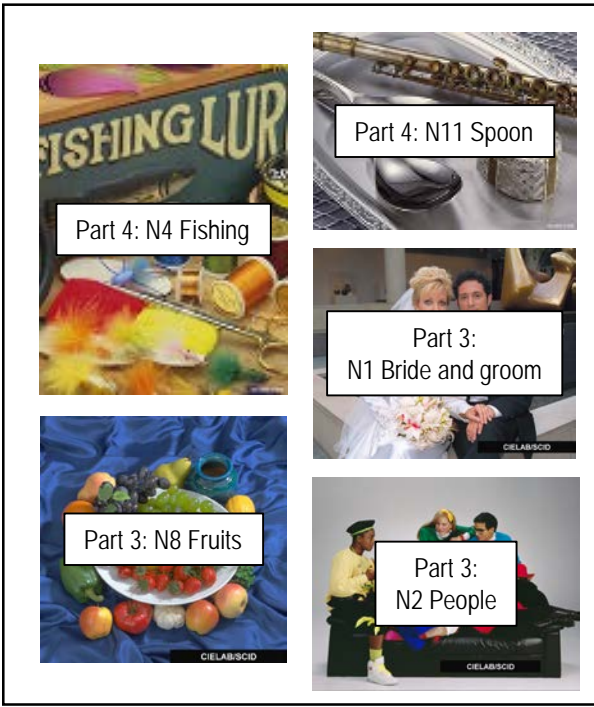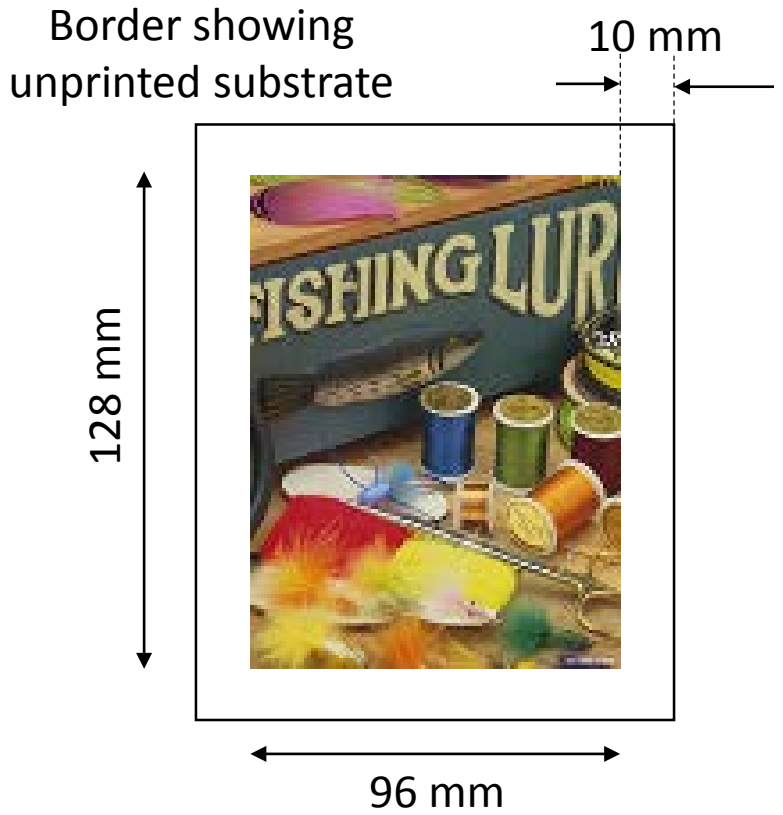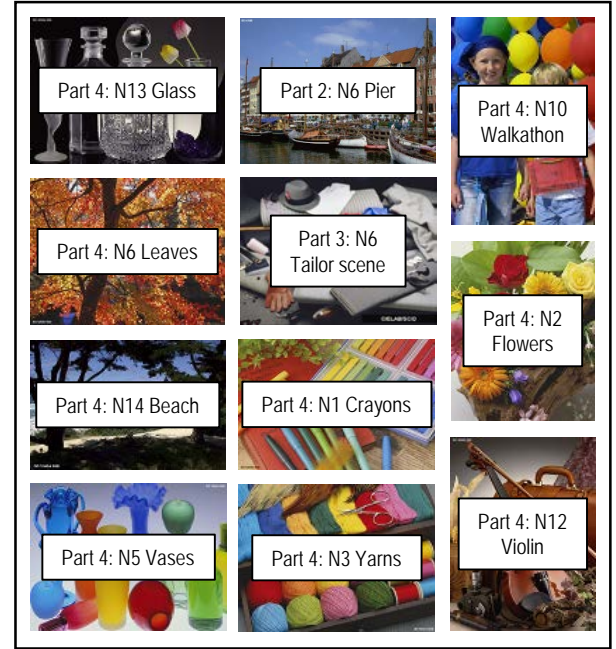
Images should be printed at
approximately the same size

Primary image set

- Part 4: N4 Fishing
- Part 4: N11 Spoon
- Part 3: N1 Bride and groom
- Part 3: N8 Fruits
- Part 3: N2 People

Secondary set

- Part 4: N13 Glass
- Part 2: N6 Pier
- Part 4: N10 Walkathon
- Part 4: N6 Leaves
- Part 3: N6 Tailor scene
- Part 4: N2 Flowers
- Part 4: N14 Beach
- Part 4: N1 Crayons
- Part 4: N5 Vases
- Part 4: N3 Yarns
- Part 4: N12 Violin

See http://www.color.org/resources/r8-13/CCA_test.xalter

# Proposed additional / replacement images (Roman16)

Additions to primary set
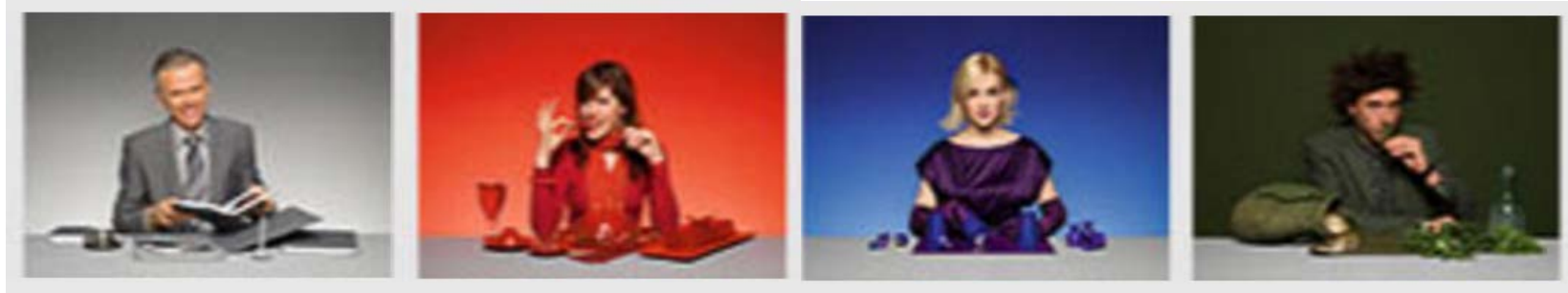


Additions to secondary set
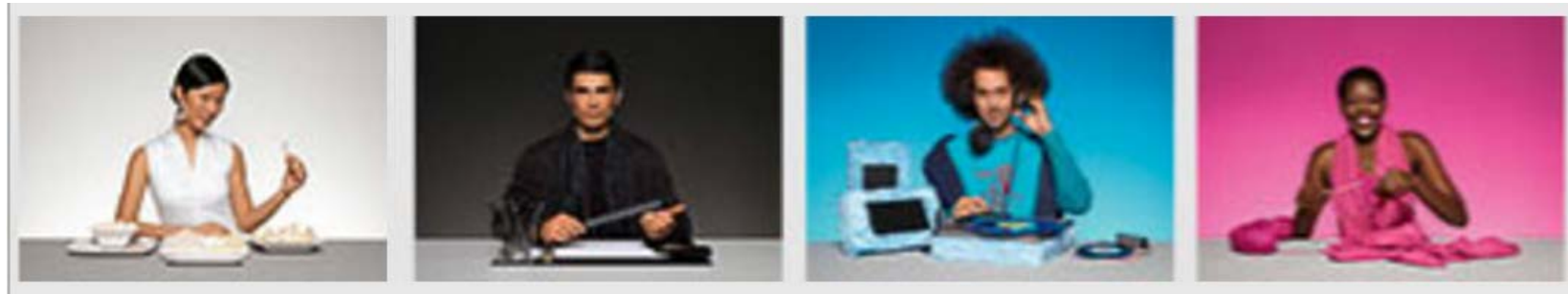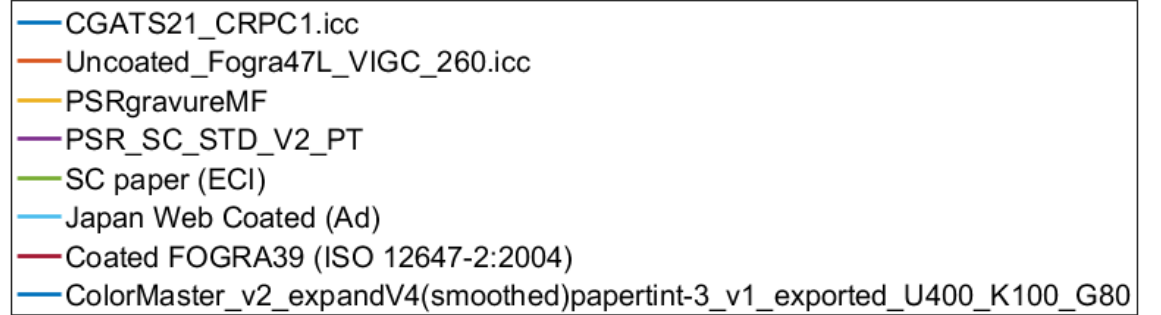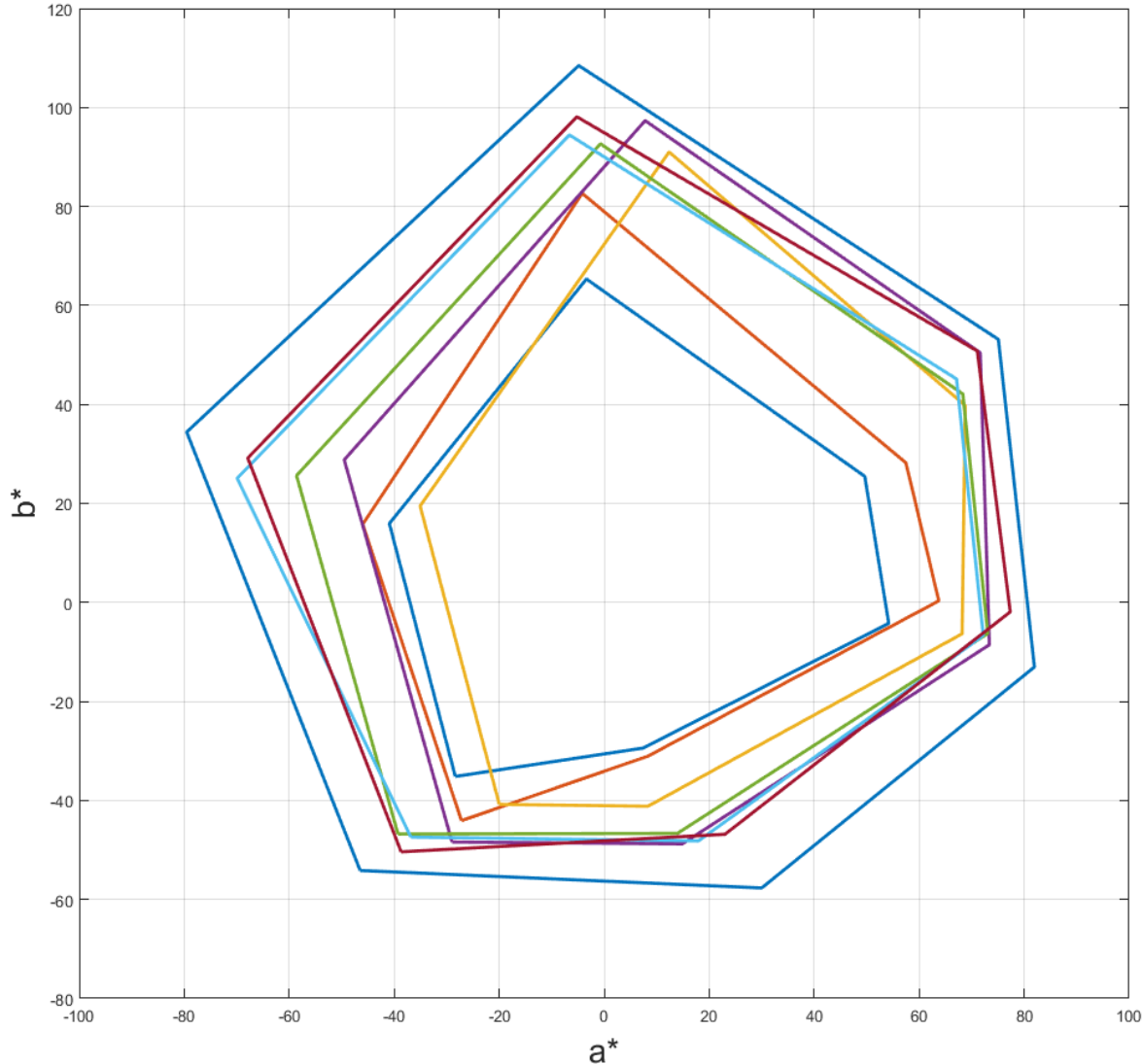
# Candidate print gamuts



**Candidate profiles for Consistent Colour Appearance assessment**

Legend:
- CGATS21_CRPC1.icc
- Uncoated_Fogra47L_VIGC_260.icc
- PSRgravureMF
- PSR_SC_STD_V2_PT
- SC paper (ECI)
- Japan Web Coated (Ad)
- Coated FOGRA39 (ISO 12647-2:2004)
- ColorMaster_v2_expandV4(smoothed)papertint-3_v1_exported_U400_K100_G80

CGATS21 CRPC1: ICC profile registry
Uncoated Fogra47L: ICC profile registry
PSR Gravure MF: ECI web site
PSR SC STD V2 PT: ECI web site
SC paper (ECI): ICC profile registry
Japan Web Coated (Ad): Adobe web site
Coated FOGRA39: Adobe web site
ColorMaster / Fogra53-5: Fogra web site

**Note:** it is not intended that these profiles should be used for rendering directly to CMYK. The associated characterisation data may be used directly but with some care the A2B1 tables (Absolute Intent) can be used to determine the colour produced by each CMYK combination

# Viewing conditions

# Viewing environment
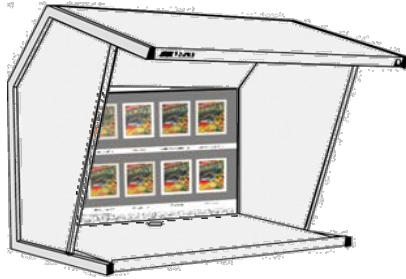


- ISO 3664:2009 Viewing conditions
- P2 viewing condition
- CIE Illuminant D50
- 500 lx +- 125 lx (same as ICC PCS)



- ISO 12646:2008 Display characteristics and viewing conditions
- ISO 14861:2015 Requirements for colour soft proofing systems
- Display colour gamut must be large enough to simulate all reference print gamuts

## Hard copy proof
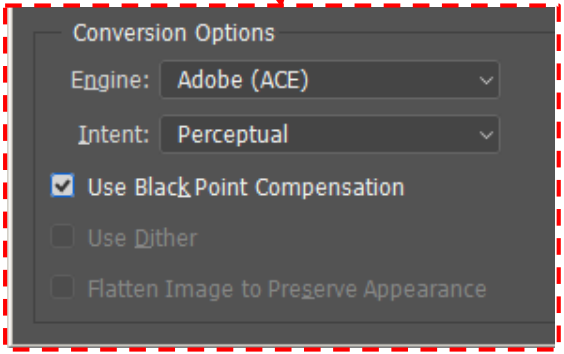
## Soft copy proof

# Conceptual tests

These tests may be too complex and it may be better
to consider a number of simpler tests for different aspects of
Consistent Colour Appearance

# Example document preparation
## - tests default ICC Perceptual reproduction



Image prepared by adding white border and assigning appropriate ICC Profile - in this case AdobeRGB (1998)
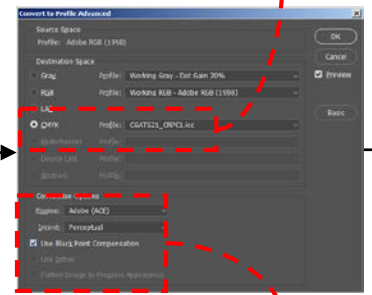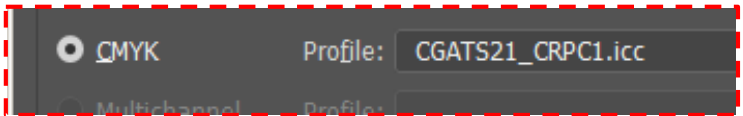
Adobe Photoshop 'Convert to profile' used to convert to reference print ICC Profile, in this case CGATS21_CRPC1

Munsell N5 grey background at least 2x white margin
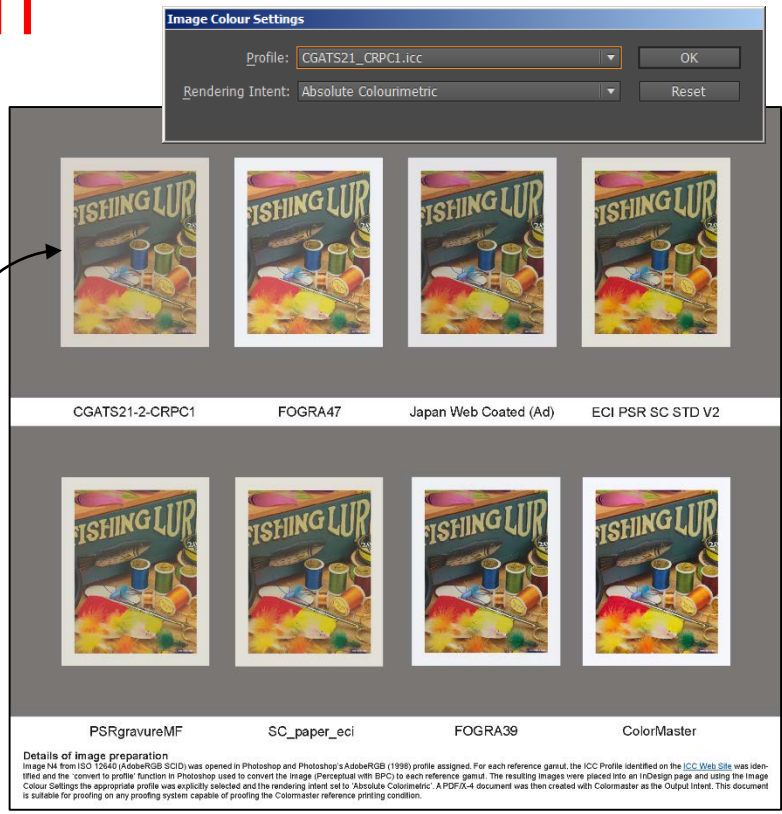
Image placed in InDesign document with the appropriate ICC Profile and 'Absolute Colorimetric' rendering intent explicitly selected for each image

A PDF/X document was created which uses ColorMaster as its OutputIntent profile. This PDF document may be printed on any proofing system which is capable of proofing ColorMaster

Example document at https://goo.gl/aBO2Cb

# ICC-based testing using more complex rendering algorithms



AdobeRGB test image

My example (very basic)

**Perceptual Rendering Intent**

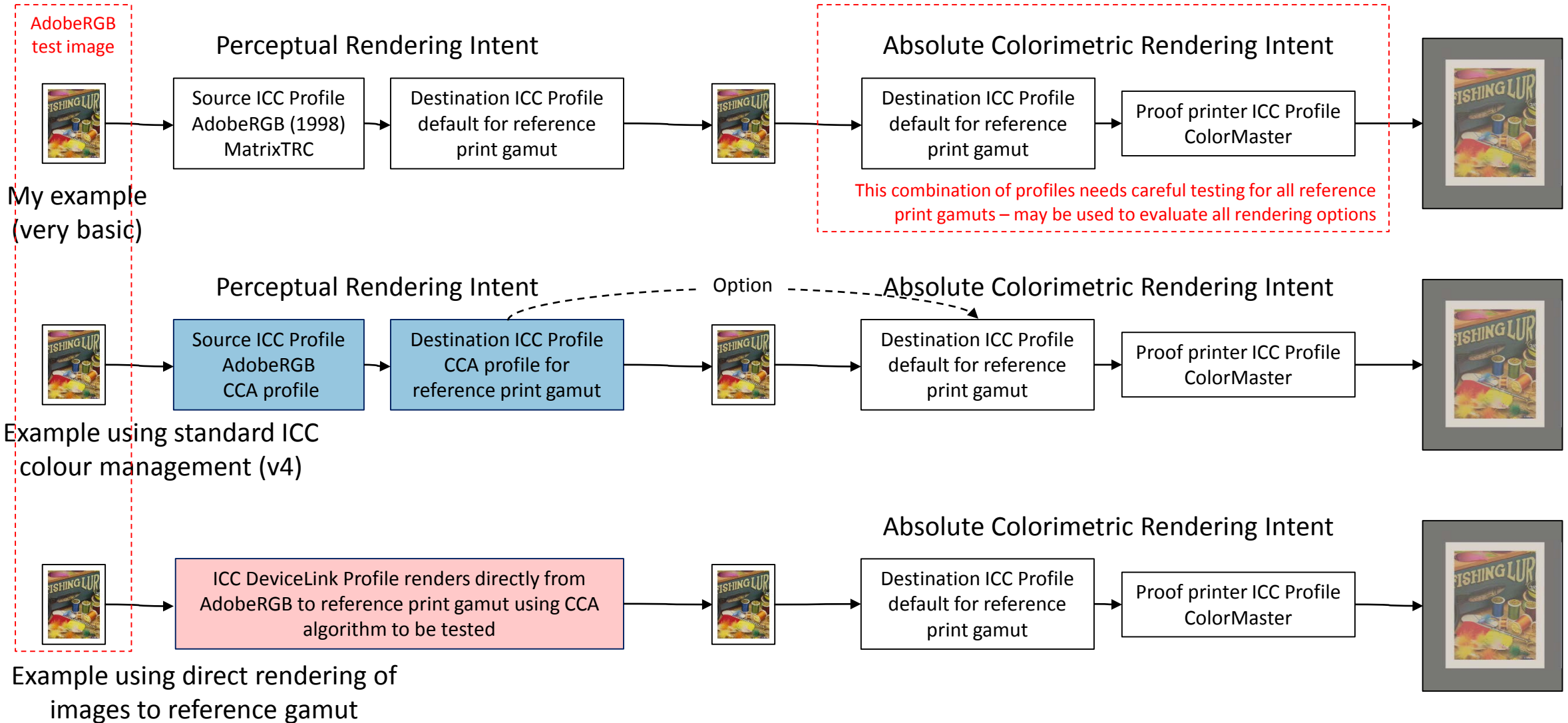Source ICC Profile AdobeRGB (1998) MatrixTRC → Destination ICC Profile default for reference print gamut →

**Absolute Colorimetric Rendering Intent**

Destination ICC Profile default for reference print gamut → Proof printer ICC Profile ColorMaster →

This combination of profiles needs careful testing for all reference print gamuts – may be used to evaluate all rendering options

Example using standard ICC colour management (v4)

**Perceptual Rendering Intent**

Source ICC Profile AdobeRGB CCA profile → Destination ICC Profile CCA profile for reference print gamut →

Option

**Absolute Colorimetric Rendering Intent**

Destination ICC Profile default for reference print gamut → Proof printer ICC Profile ColorMaster →

Example using direct rendering of images to reference gamut

ICC DeviceLink Profile renders directly from AdobeRGB to reference print gamut using CCA algorithm to be tested →

**Absolute Colorimetric Rendering Intent**

Destination ICC Profile default for reference print gamut → Proof printer ICC Profile ColorMaster →

# Metric development ideas

# Possible approach to metric development (Max Derhak)



Reference

Reproductions

Normalisation transform based on consistent colour appearance variables

Likely variables
*Tone, Saturation, Hue*

CCA-normalised reference

CCA-normalised reproductions emphasising non-CCA aspects

CCA metric calculation → CCA metric

CCA metric calculation → CCA metric

CCA metric calculation → CCA metric

# Discussion