Large-Gamut Digital CMYK Exchange Space

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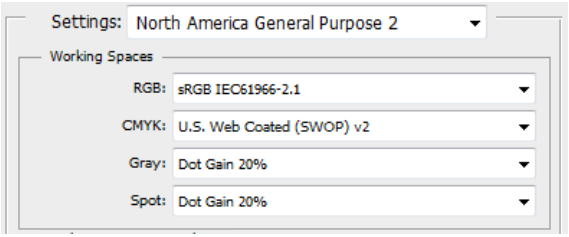
Overview

- **Motivation**
- **Scope**
- **Methodology**
- **Current Status**
- **Evaluation**
- **Next Steps**

Motivation 1: Predictability

- **Consider content created for digital hard-copy output.**
- **Designers create content for print effectively targeted for a particular printing condition. For example:**
  - CMYK profile for tagging to CMYK image
  - CMYK profile for print simulation of RGB image (eg, can become OutputIntent for PDF/X-4)
- **Targets are effectively chosen in the workflow whether the user explicitly defines them or not.**



- **Question: Does target choice affect result?**
- **Motivation: Reduce choices, but no less than necessary.**

Motivation 2: Consistency

- **Multiple printer types:**
  - A single site may have multiple different types of digital printer.
  - A single print buyer may send the same file to different sites with different printers.

- **Motivation: Improve consistency of experience between different printers: better for users, better for digital industry.**

Motivation 3: Blind Exchange

- **In case of blind exchange (eg, for PDF/X), not practical to use actual digital printer profile.**

- **Motivation: Enable designer to create file before knowing exactly which digital printer work will go to, and avoid having to ship printer profile upstream to each designer.**

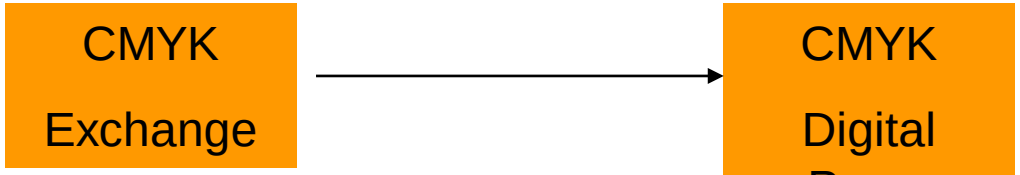
Color Workflow from RGB

- **Color separate from RGB (AdobeRGB, sRGB, etc.) to CMYK exchange space via perceptual or RC+BPC or…**
- **Designer adjusts content in light of product of first-stage transform (in CMYK exchange space).**
- **Re-separate from CMYK exchange to final CMYK (digital press) via RC+BPC with or without channel constraints.**
- **Channel constraints only required for some devices. Some devices only require black constraint.**

Target = SWOP?
Fogra39?
Etc?

Color Workflow from CMYK

- **Design in CMYK exchange space as assigned profile.**
- **Re-separate from CMYK exchange to final CMYK (digital press) via RC+BPC with or without channel constraints.**
- **Channel constraints only required for some devices. Some devices only require black constraint.**



Target = SWOP?
Fogra39?
Etc?

Scope

- **What does “digital printer” mean?**

- **For purposes of this work, considering market as main attribute, there are 2 major practical groupings:**
  1. Document/publication printers (toner, inkjet) aimed at producing print resembling traditional offset and gravure.
  2. Sign printers (mostly inkjet) competing predominantly against vibrant work produced by flexo, gravure, screen print.

  — Constraints on and purpose of substrates, primaries (ink/toner) are different in these markets (eg, UV light-fastness)
  — Question: Does the distinction matter?

Objective

- **Develop and evaluate CMYK exchange space and associated ICC profile suitable for use as design target in creative applications for work targeted at digital printers.**

- **Resulting CMYK exchange space:**
  - Shall be reasonably proof-able.
  - Shall not cause undue artifacts.

Methodology

- **Two types of approach depending on use case:**
  1. Identical reproduction across all digital printers.
  2. Common colour appearance across all digital printers.

- **Fitness evaluation:**
  - Examine gamut size/shape using L* plane slices.
  - Examine results of running test images through RGB->CMYK→CMYK color workflow.

- **Note: tone reproduction is less critical for digital printers vs. offset press usage, as digital printers are assumed to always use ICC color management.**

Colorimetric Reproduction

- **Implies intersection gamut common to all digital printers.**

- **Pro:**
  - “guaranteed” colorimetric match among printers – all colours in gamut

- **Con:**
  - Resulting intersection has tiny volume (RPC-3/4)
  - Approach cuts off competitive distinctiveness of individual printers.
  - Use guarantees gamut mapping and/or clipping at first step in colour workflow (RGB→CMYK)

Appearance Reproduction

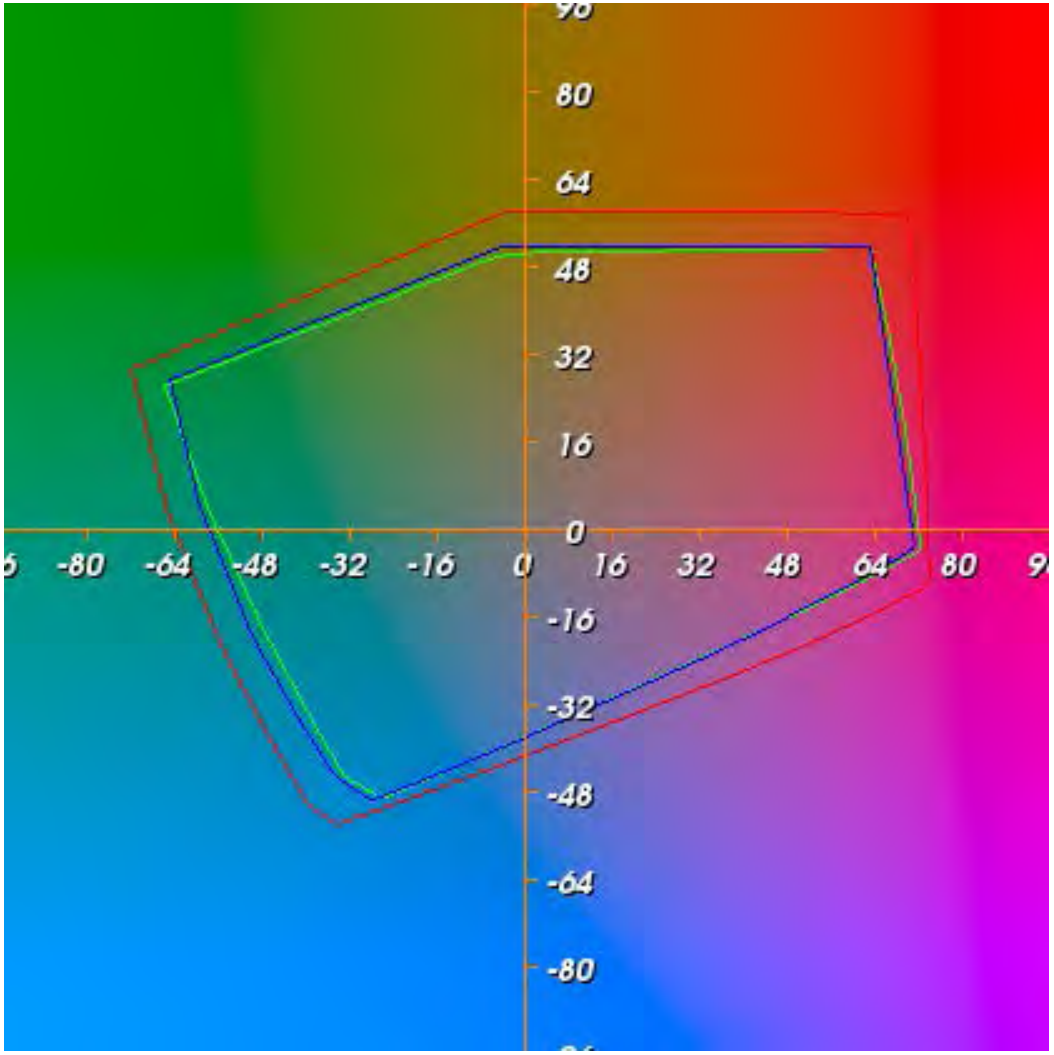
- **Implies larger gamut either similar size to average gamut of digital printers, or completely enclosing all digital printer gamuts.**

- **Pro:**
  - Second-stage transformation consistently mapping down from similar CMYK shape – all colours observed in design stage can be retained.
  - Less possibility of gamut clipping in first-stage transformation.

Candidate 1: RPC-7

- **Start with ISO 15339-1 RPC-7 (bigger than Fogra39).**
- **RPC-7 is stated as intended for large-gamut and digital devices.**

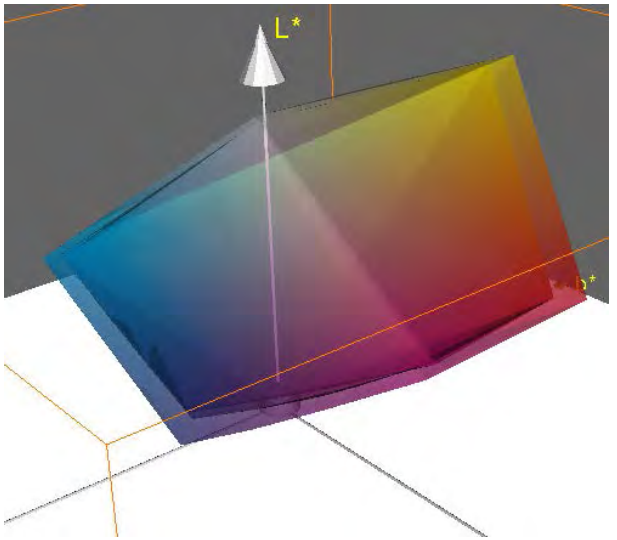
RPC-7 vs. RPC-6 & Fogra39



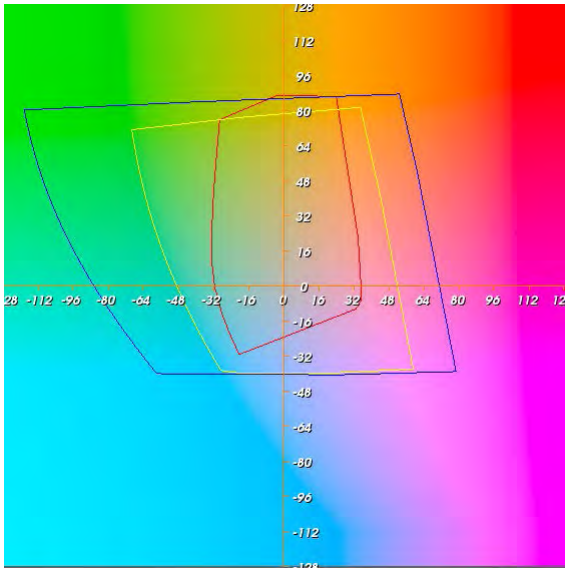
RPC-7

RPC-6

Fogra39

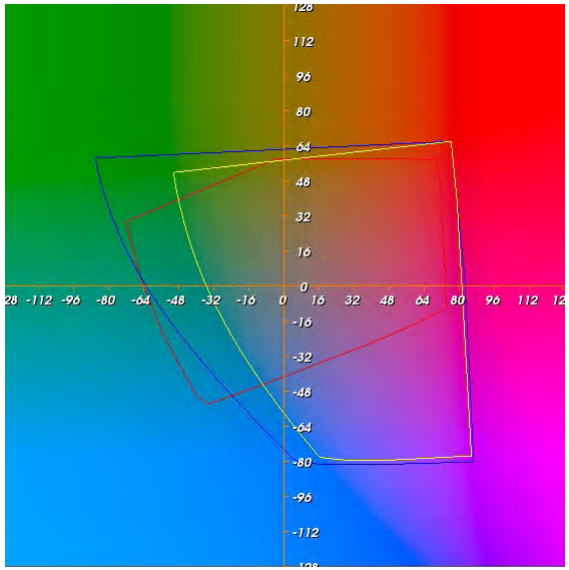


RPC-7 vs. AdobeRGB & sRGB



L*=75

L*=50

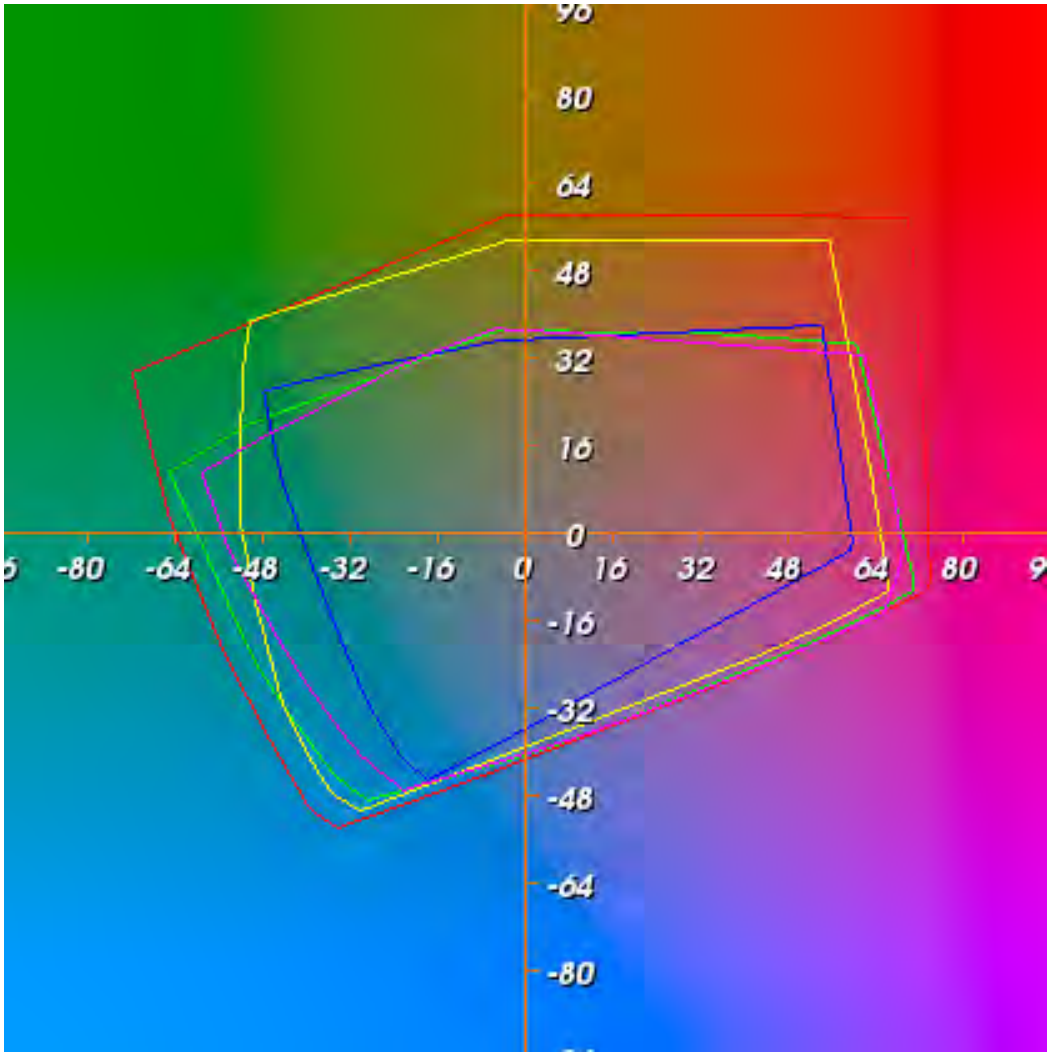


RPC-7

AdobeRGB1998

sRGB

Comparison vs. RPC-7: SC6 TF2



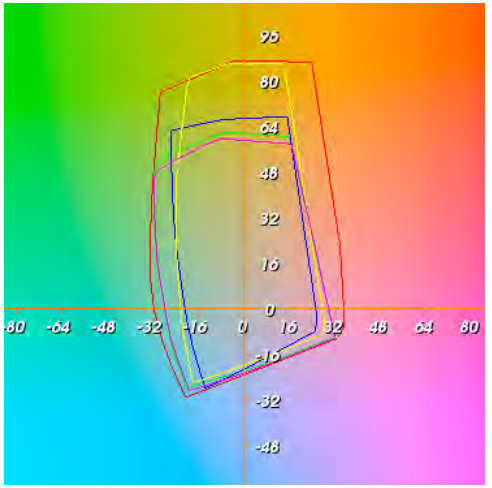
RPC-7

Sample-E

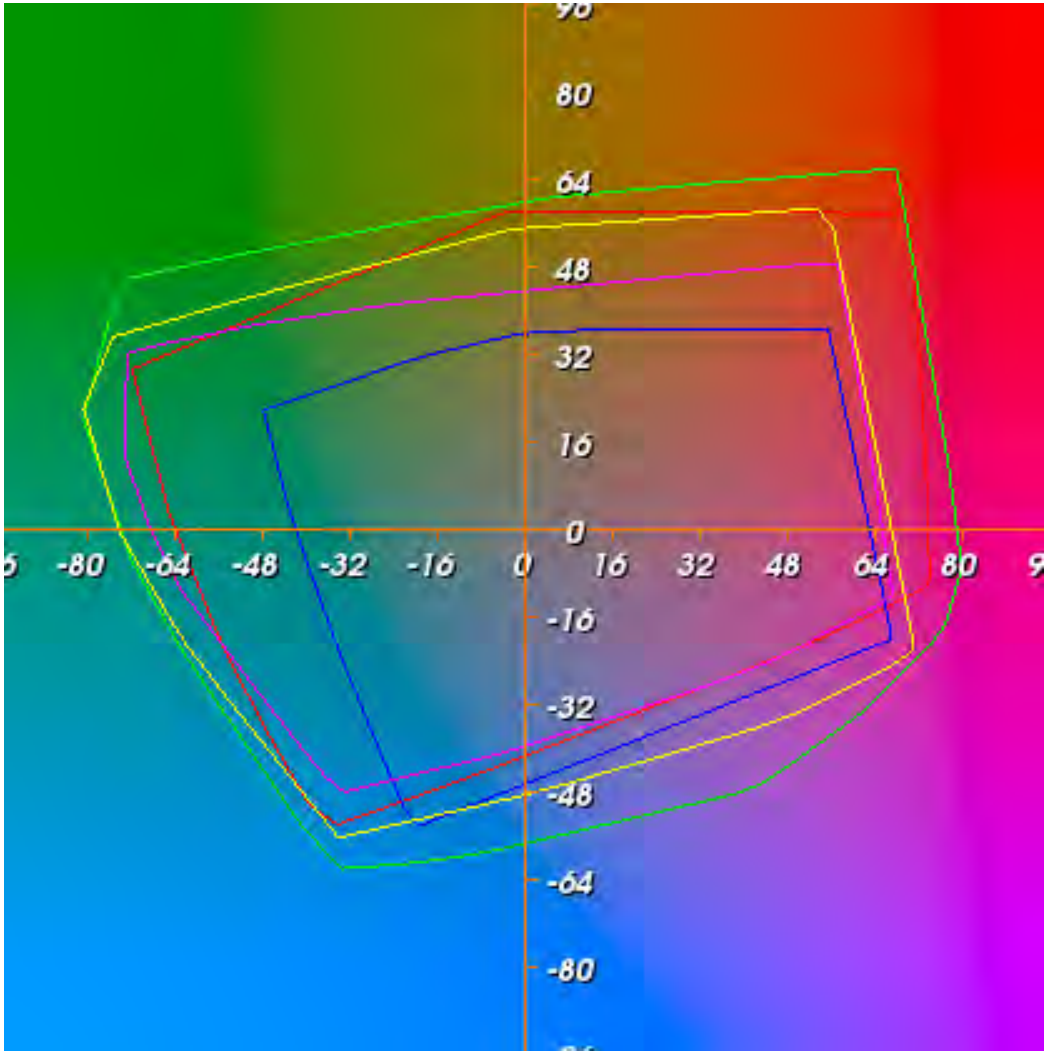
Sample-F

Sample-G

Sample-H



Comparison vs. RPC-7: 4 Printers



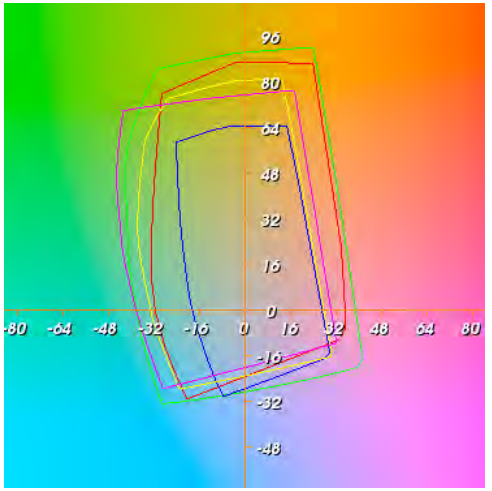
RPC-7

E-Satin

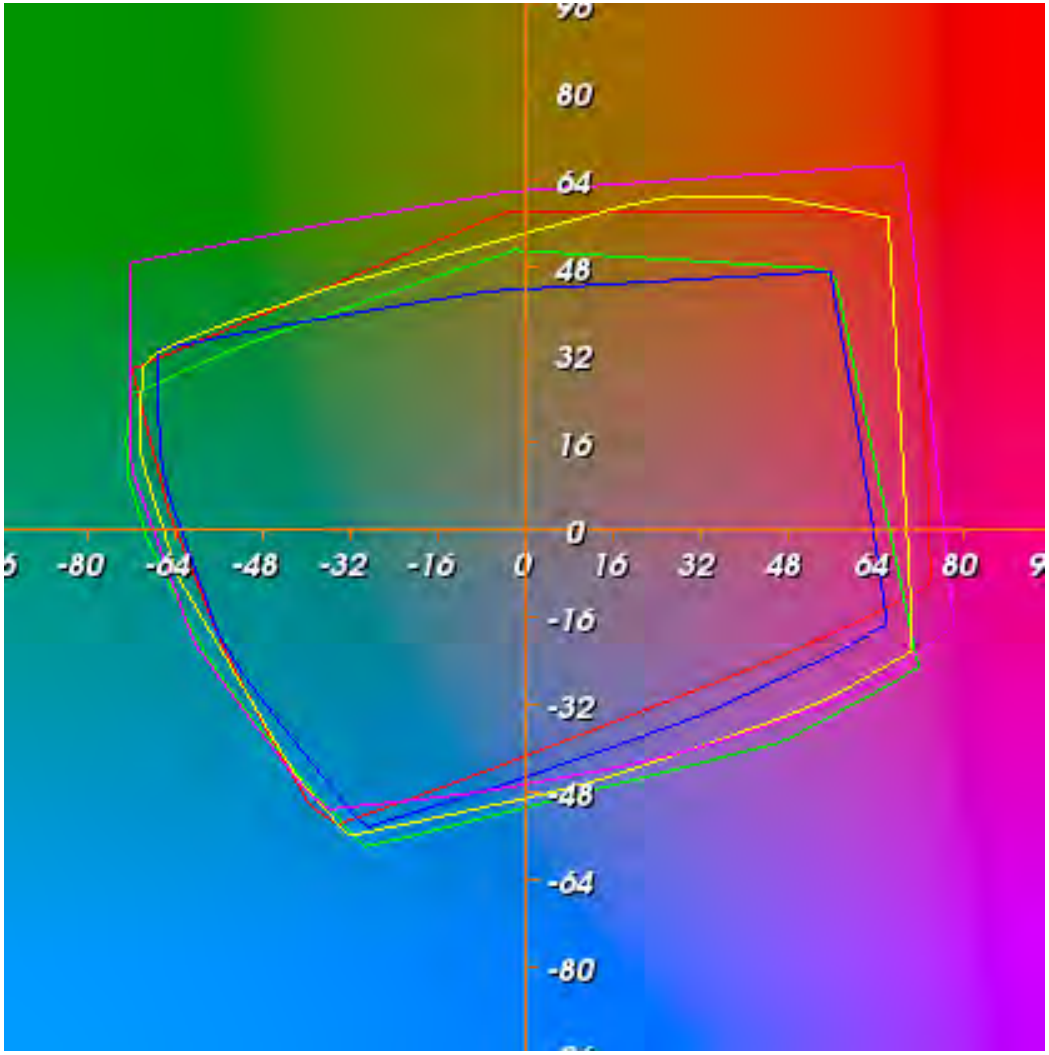
KC80

R5-PGls

P2-600S



Comparison vs. RPC-7: 4 More Printers



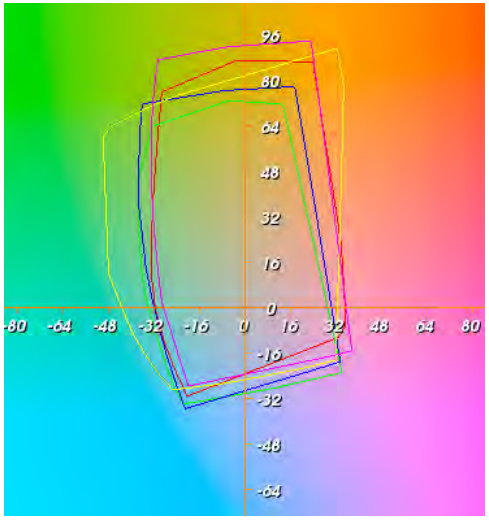
RPC-7

F-004

P2-300

PVC

NP240



Observations on RPC-7

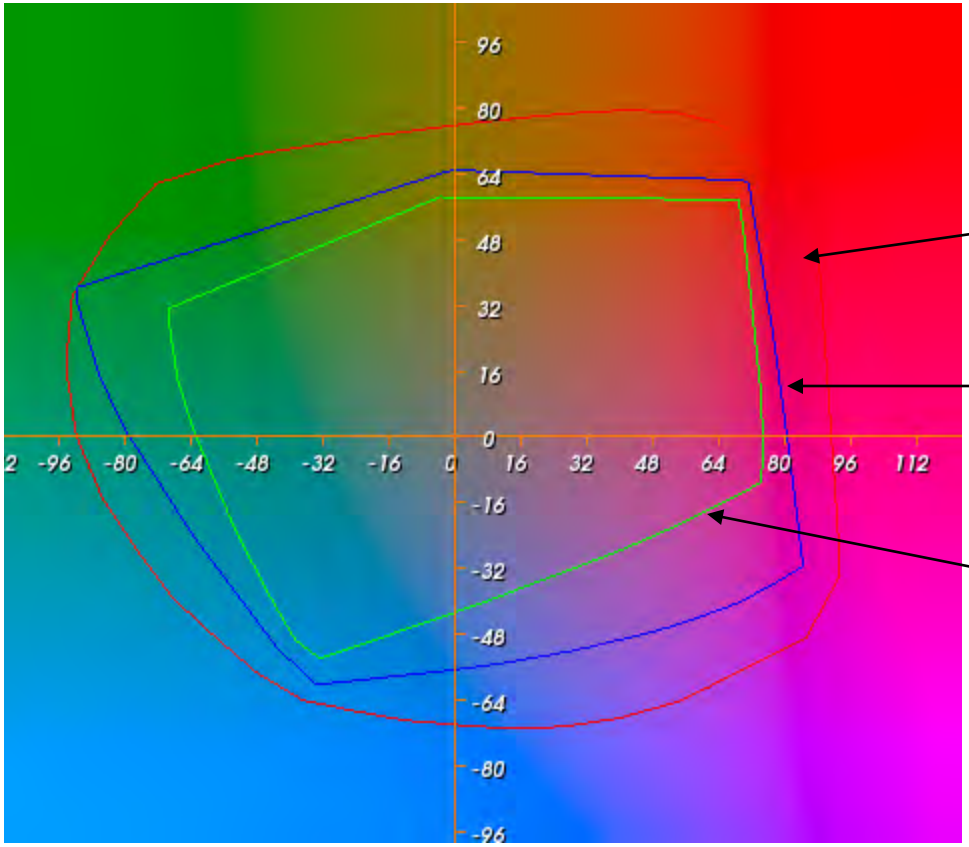
- **Does well enclosing SC6 TF2 (largely toner-based) digital printers (by design).**
- **Does not do so well with some newer, especially inkjet devices.**
- **At least one document printer has grossly larger gamut than RPC-7.**

- **Conclusion: RPC-7 is reasonable, but insufficient.**

Candidate 2: PRMG Shell

- **ICC v4.3 defines shell of Perceptual Reference Medium Gamut.**
- **Design of PRMG is intended to be superset of all graphic arts output devices.**
- **Colour space created based on PRMG coordinates (primaries, secondaries, white/dark points).**
- **On review, green secondary moved to align hue angle with ISO 15339-1 RPC.**
- **Profile posted on ICC web site on GASIG Color Experts' Day page.**

Gamut comparisons, Slice through L*=50

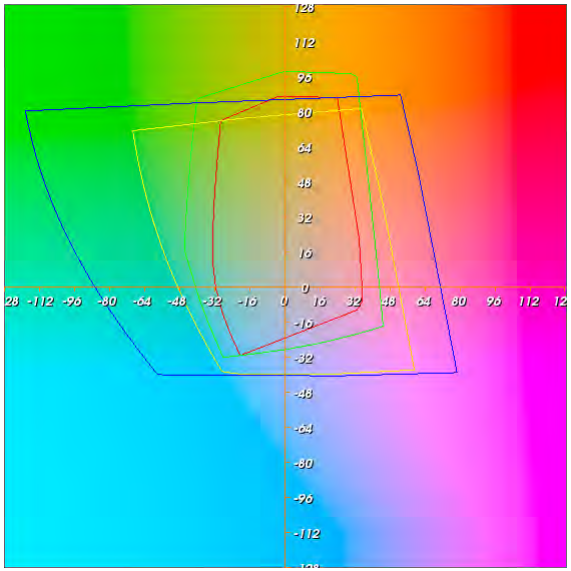


PRMG Shell

PRMG-based profile

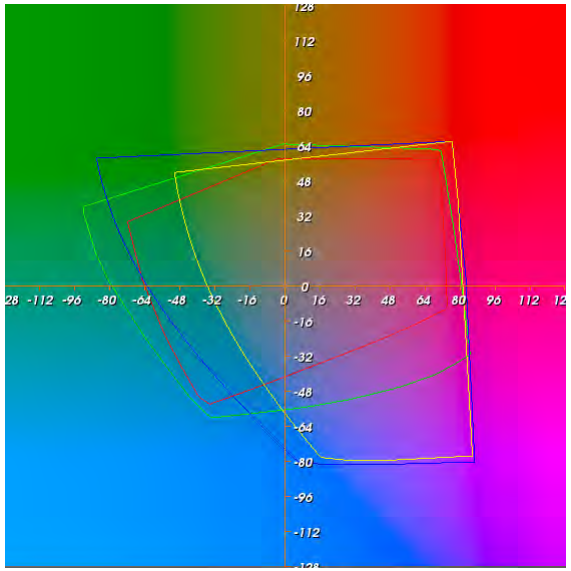
RPC-7

PRMG-MR vs. RPC-7 & RGB



L*=75

L*=50



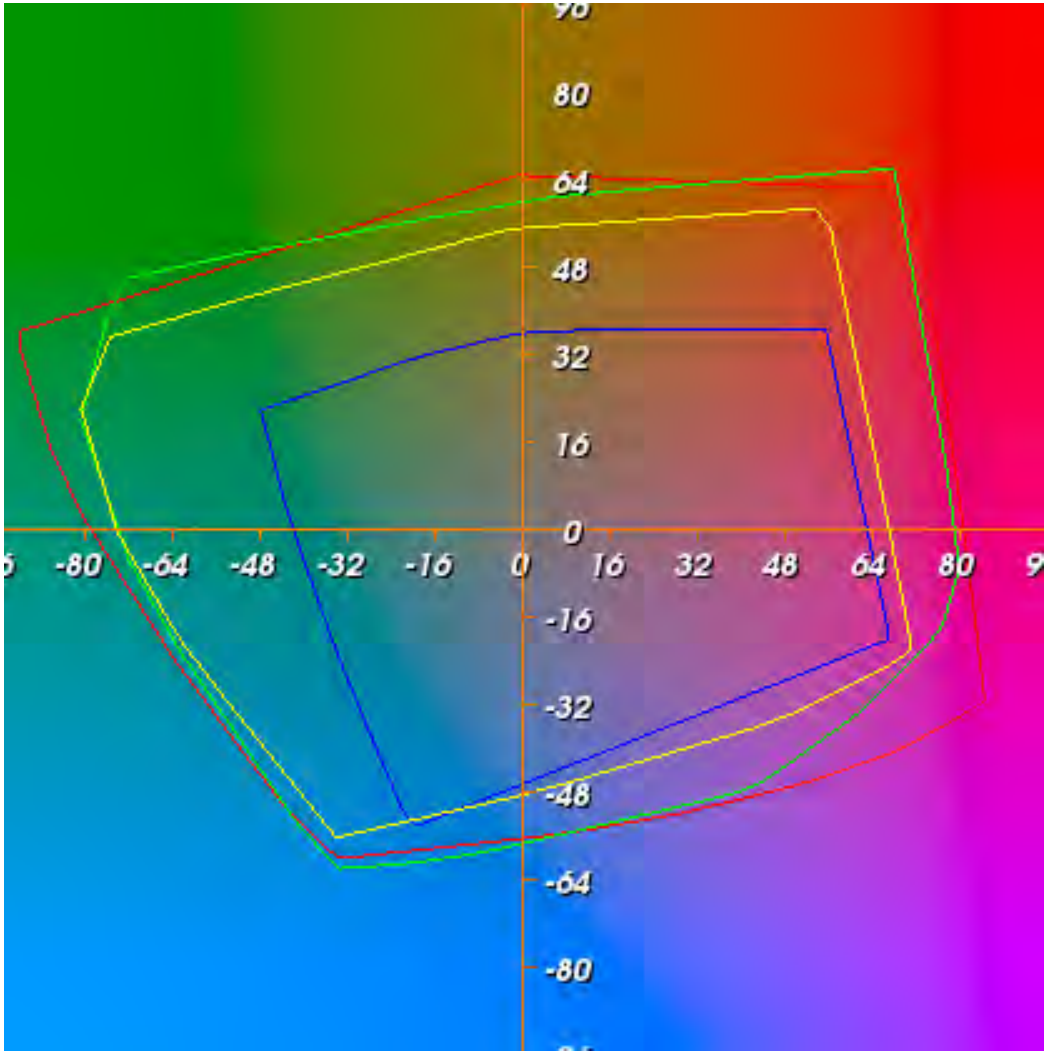
RPC-7

PRMG-MR

AdobeRGB1998

sRGB

Comparison vs. PRMG-MR: 4 Printers



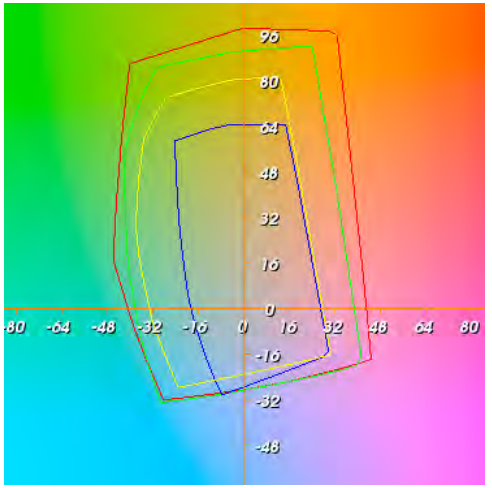
PRMG-MR

F-004

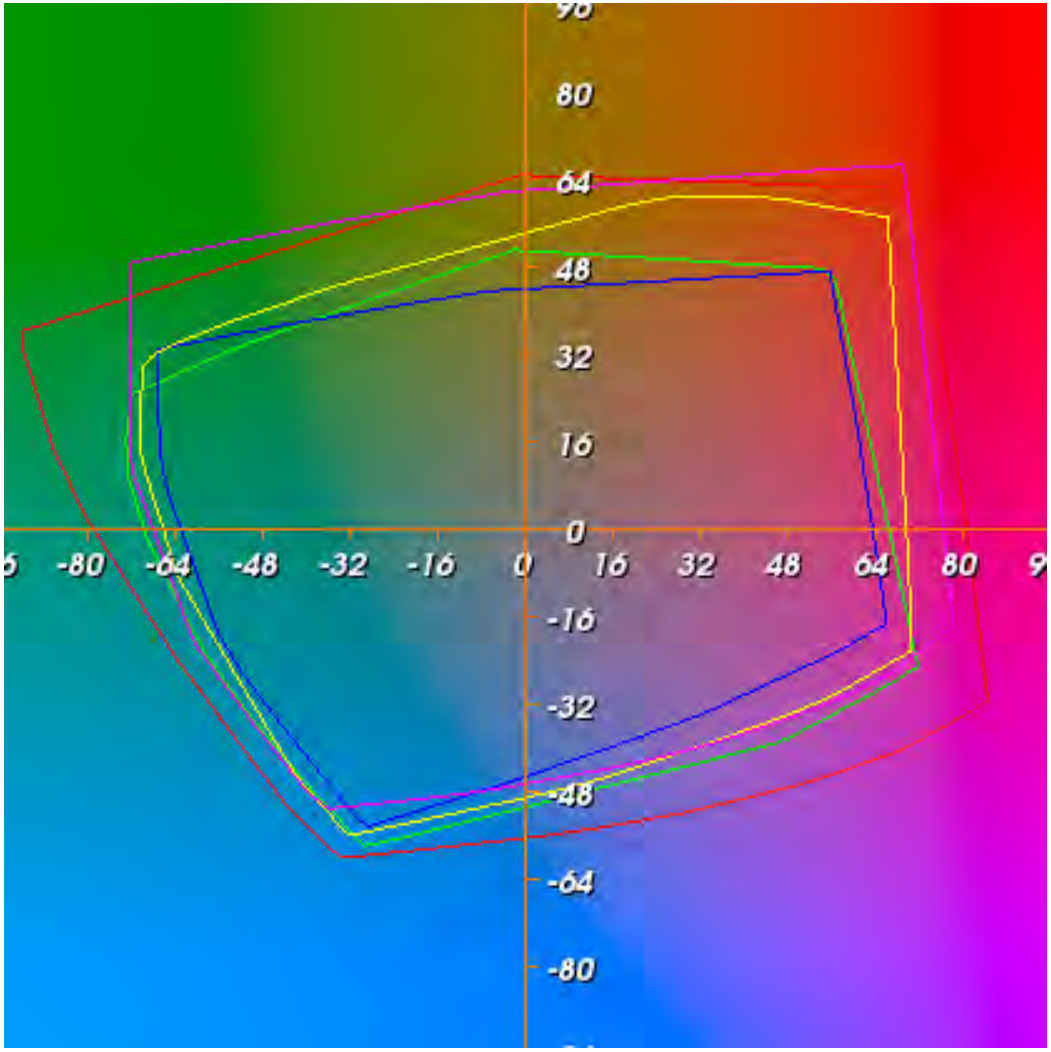
P2-300

PVC

NP240



Comparison vs. PRMG-MR: 4 More Printers



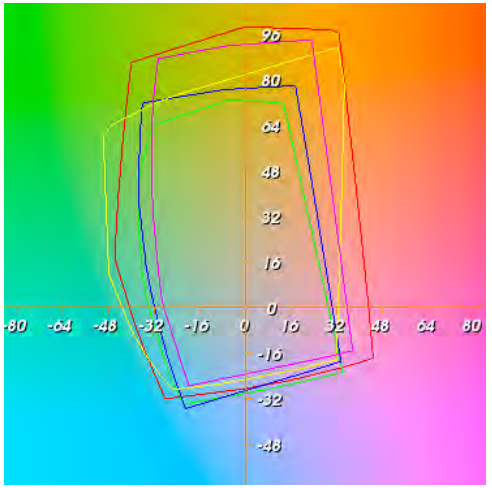
PRMG-MR

F-004

P2-300

PVC

NP240



Observations on PRMG-MR

- **Mostly encloses all tested digital printer color gamuts.**
- **Possibly too large compared with older SWOP-referenced toner devices (part of SC6 TF2 set).**

- **Discussion:**
  - PRMG-MR as the only large-gamut digital printer gamut, or as an RPC-8 as part of series RPC-1 through 7?

Via SWOP to NP240











Via RPC-7 to NP240











Via PRMG-MR to NP240











Image Evaluation

- **General observations:**
  - Converting through US Web Coated SWOP results in somewhat worse results than through the other paths, especially when outputting to larger-gamut digital devices.

Next Steps

- **Adjustments to PRMG-based exchange space to have:**
  - **TR015 neutral scale**
  - **Primary TVI curves aligned to 12647-2 Curve A for CMY, Curve B for K**
- **Consideration for moving magenta and yellow primaries.**
- **Further image evaluations in workflow, and on real-world printers.**

Thank you for your attention

Questions?