

COLOR MANAGEMENT WITH OPTICAL BRIGHTENING AGENTS

A Practical Approach

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SUMMARY

- Optical Brightening Agents (OBAs) in Paper
- Color Management **Problems** With OBAs
- ISO Measurement and Viewing **Standards** 2009
- Improved **Instruments** (M1 and M2 Measures)
- **Practical Color Management** With OBAs
- **Conclusions and Recommendations** For Future Standards

OBA IN PAPER

- OBAs Are **Fluorescent**
- Convert **UV** into **visible Blue** 400nm – 460nm (Peak 430nm)
- **Blue** Counters Normal **Yellowness**
- CIE **Whiteness Increase** from 90's into the 130's
- **Distorts Measurements** In CM Instruments

PROBLEMS WITH OBA

- **Measuring Instrument and Viewing Illuminant**

Must Match UV Content

- **Color Management Instruments**

Cannot Discern Fluorescence with a single measure

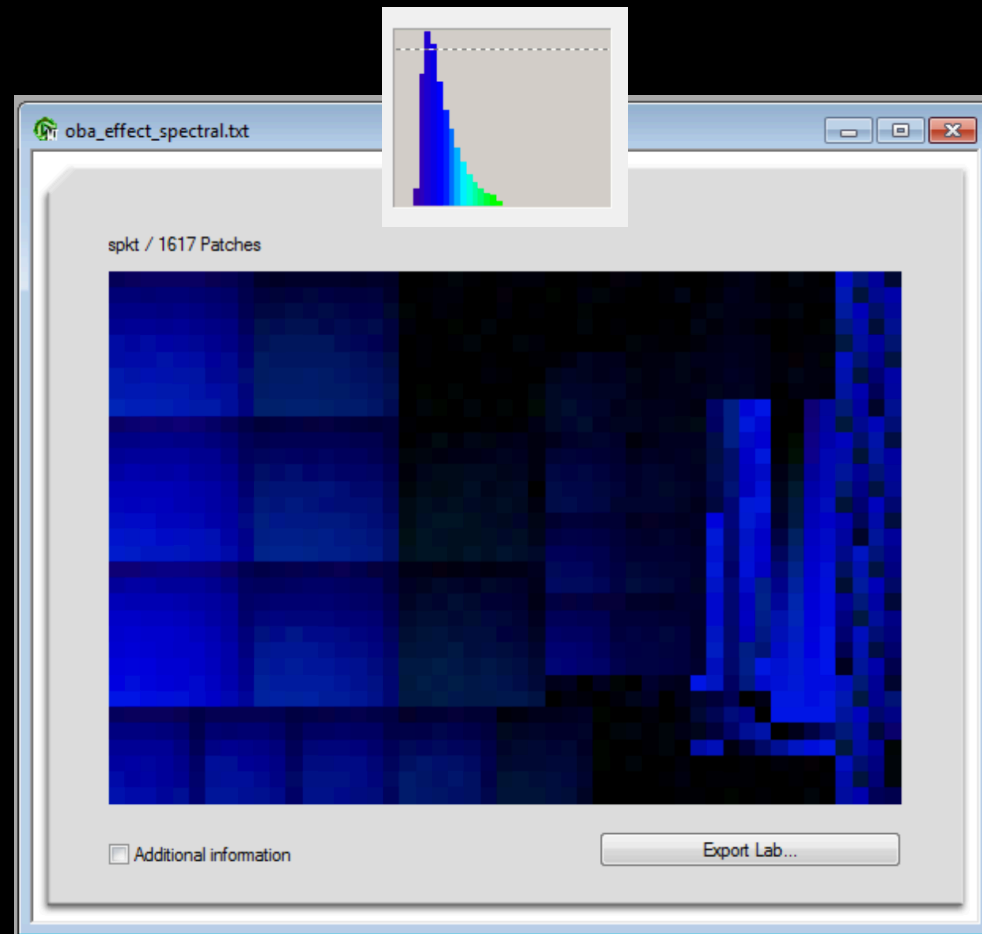
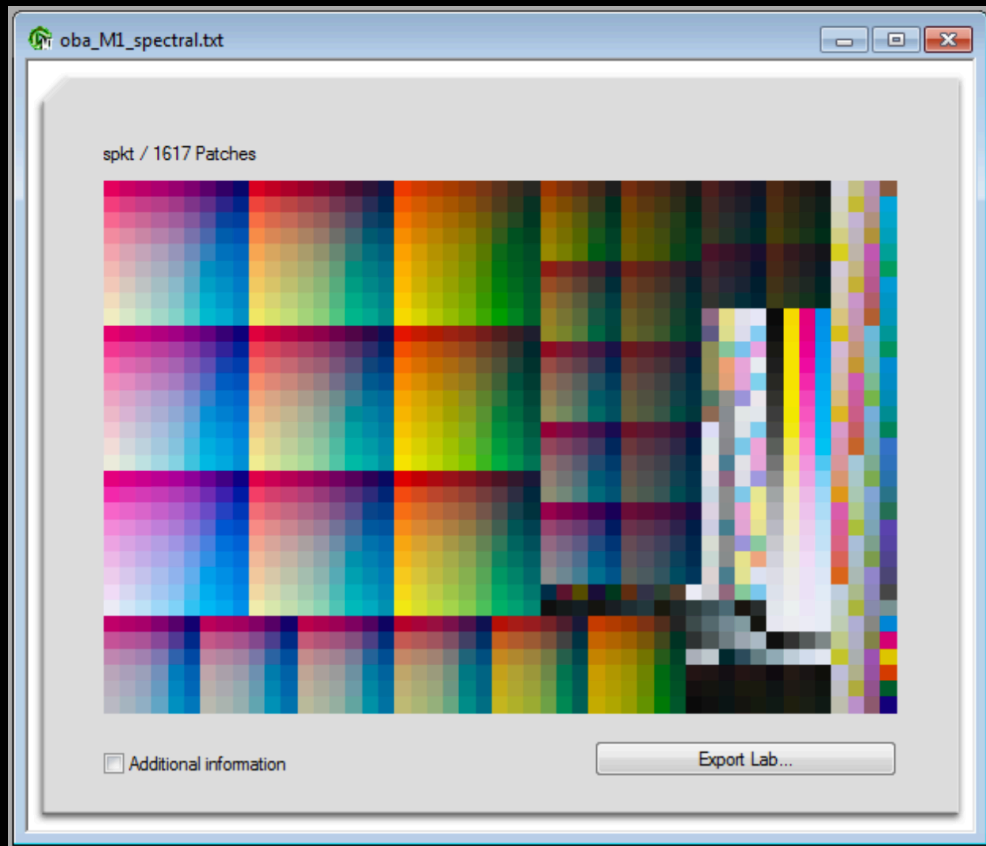
PROBLEMS WITH OBA

- **More OBAs** in contemporary papers
- **More UV** in present-day instruments (ISO 13655:2009)
- **More UV** in present-day viewing illumination (ISO 3664:2009)
- **BIGGER color management errors**

MEASUREMENT

- **Bi-Spectral Measurement** (R. Donaldson, 1954) (ASTM 2001)
 - Accurate measure of fluorescent samples
 - Impractical (Slow and Expensive)
- **M1 (with UV) / M2 (no UV)** - ISO 3664 : 2009
 - **Serendipity**– sets apart the blue OBA emission
 - **OBA effect(λ)** = $(M1(\lambda) - M2(\lambda)) * D50(\lambda)$
(SPD)

OBA EFFECT



ILLUMINATION

- **Measurement & Viewing Illuminants Must Match**
 - A primary **goal of ISO Standards 13655 and 3664**
 - **D50 SPD** is the reference standard **(including the UV portion)**
 - **M1 increases fluorescence 40% over M0 (i1Pro2)**
- **Increased UV = Increased Fluorescence**
Greater Management Error with OBAs

ILLUMINATION

- Survey of M1-capable instruments found **“large colorimetric errors”** (Wyble & Seymour, 2015) with fluorescent samples
 - **“should** match CIE illuminant D50.” (ISO 13655 : 2009)
- **Ratio of UV to Visible Light** between measuring and viewing
 - Same ratio for **Measuring and Viewing**
 - **Goal of ISO Standards**
 - **Mismatch** results in **color management errors**

VIEWING ILLUMINANT

- Hypothesis: Viewing **UV content** was **lower** than D50

- **80.3% UV** of D50
New ISO Compliant Tubes
- **65.5% UV** of D50
Legacy Tubes
- **59.2% UV** of D50
Philips TL 950
Macbeth Luminaires



PROBLEMS

- Higher OBA content in paper/media
- D50 problematic – different implementations
- Mismatch of UV content
between measure and viewing illuminants

Direct M1 measures may not yield acceptable results for color management of OBA-rich media.

PRACTICAL COLOR MANAGEMENT

- Example – Match Reference Data Set (M1 only)

M1 Data Set white point (L*a*b*): 95.0 1.0 - 4.0

M1 Media white point (L*a*b*): 95.6 2.7 -10.4

M2 Media white point (XYZ): 95.1 - .02 1.3



M1



M2

PRACTICAL COLOR MANAGEMENT

- Building Media Profiles
 - **M1** – if the viewing is D50
 - **M2** – if the viewing is absent of UV

PRACTICAL COLOR MANAGEMENT

- Building Media Profiles

- **Blend M1/M2** measures (Practical, Real World)

- Measure **UV to visible ratio** of the viewing source relative to D50
 - **Blend the M1 and M2** measures in the same proportions
 - Technically correct if D50 illumination (in the visual range)

PRACTICAL COLOR MANAGEMENT

- For Example – Viewing UV 60% of D50

M1 media white point (L*a*b*): 95.6 2.7 -10.4

M2 media white point (L*a*b*): 95.1 -0.2 1.3

M1 media white point (XYZ): 87.4 89.1 86.0

M2 media white point (XYZ): 84.5 87.8 70.9

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0.4 * M2 + 0.6 M1 (XYZ): 86.2 88.6 80.0 New Blended XYZ

0.4 * M2 + 0.6 M1 (L*a*b*): **95.4 1.6 -5.9** New Blended White Point



MI



BLENDED

CONCLUSIONS

- Color management **problems with OBA persist** after 2009 revisions to ISO 13655 and 3664
- ISO standards lead to new instruments – M1 and M2 from a single session
- **Serendipity** – OBA Effect (OBA fluorescence separated from normal reflectance)
- Correct colorimetry for D50 and non-D50 illuminants (see Appendix A of paper)
- Viewing – Measuring **UV to Luminance light ratio**
- **Aligning White Points** – more refined with M1 and M2 data

RECOMMENDATIONS

- **Standard data sets (e.g. GRACoL, FOGRA) should include M1 & M2 data**
- **Permits proper substrate correction for OBA content of printing papers**
- **Color matching under actual illuminants**

RECOMMENDATIONS

- Problems from defining UV content of sources as **equivalent to D50**
 - **D50** is not easily implemented in the UV region
 - Approximations are permitted, with **dubious guidelines**
 - **Inaccurate, inconsistent measurements** (Wyble, Seymour 2015)
 - M1 and M2 are approximated with **proprietary algorithms**

RECOMMENDATIONS

- Revised ISO Measurement and Viewing Standards
- ADD two new measuring conditions (ISO 13655)
 - **Illuminant 'A'** – Quartz Bulb (CIE-15, 2004)
 - **Illuminant UV365** – LED – Peak 365nm and Narrow Bandwidth
- Revise UV content of viewing illuminant (ISO 3664)
 - Fluorescent lighting – Mercury Vapor I-line at 365nm
 - LED Lighting – Peak 365nm and Narrow Bandwidth

THANK YOU

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ALGORITHM (XYZ) – Align white points (minimum ΔE)

M1 Coefficient 0.436 M2 Coefficient 0.564

0.436 M1 + 0.564 * M2 (L*a*b*) 95.3 1.1 -4.0 Blended White

Point