White paper on predicting the colorimetry of spot colour overprints

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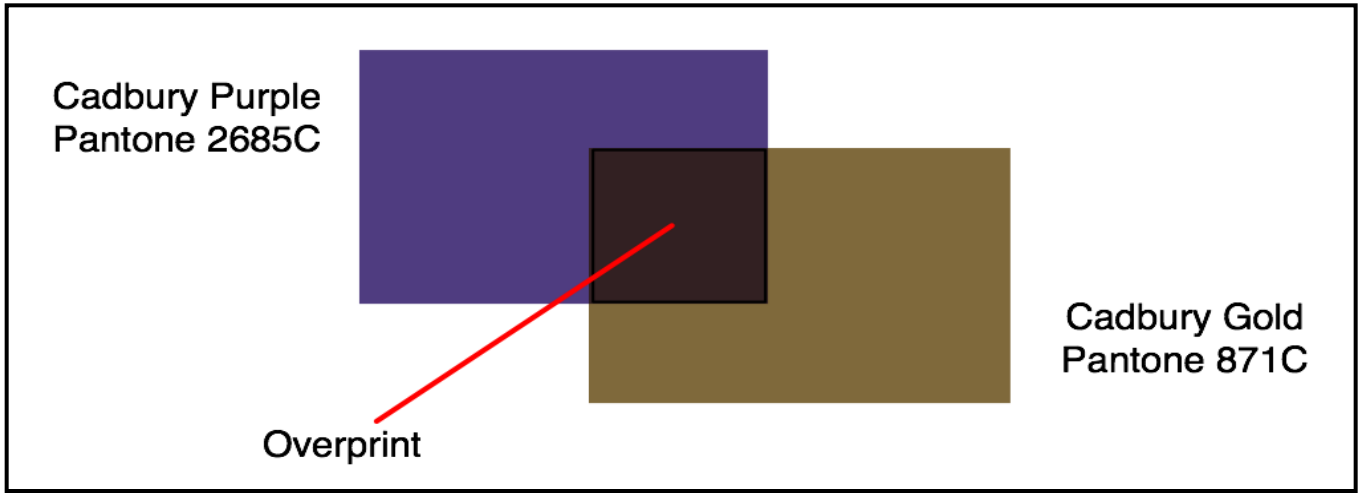
Outline

- Introduction
- Proposed overprint model
- Implementation
  - *One spot colour over another*
  - *Multiple spot colours*
  - *Spot colour over CMYK*
- Summary

Introduction

- Spot colour overprints - widely used in packaging
- Challenges - **communicating spot colours** across workflow, **preview of spot colour overprints** not accurate, colour management gap in pre-media software (*Chung, 2008*) (*Viggiano, 2008*)



Introduction

- Spot colour overprints with tints

Pantone 485C

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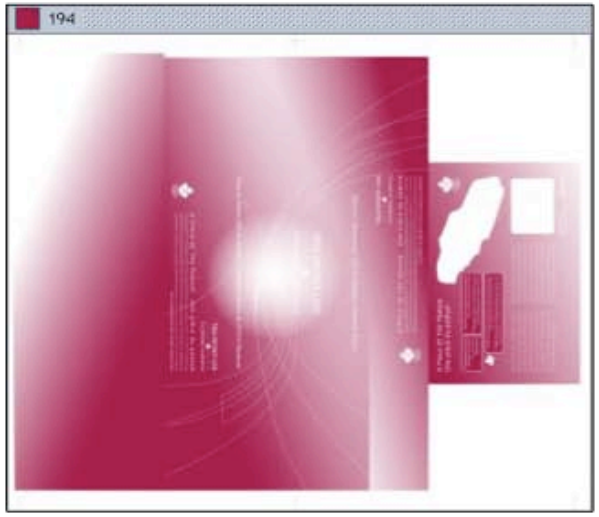

Pantone 194C

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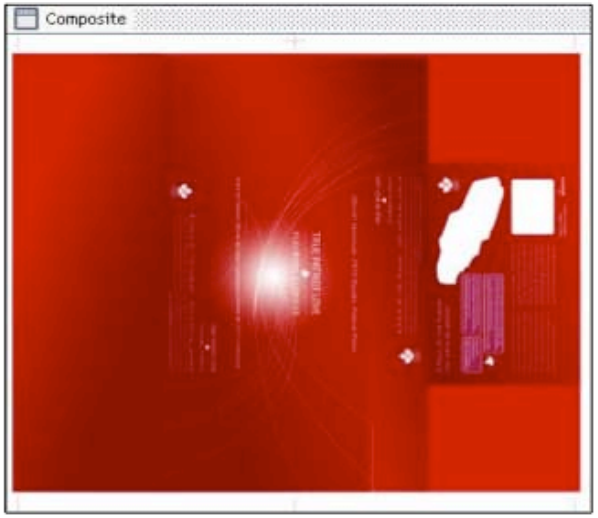
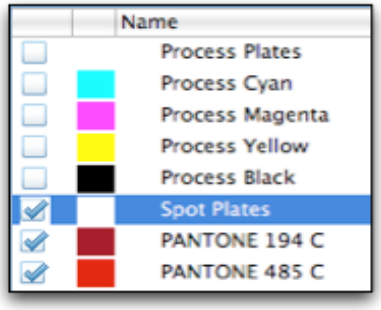


Overprint



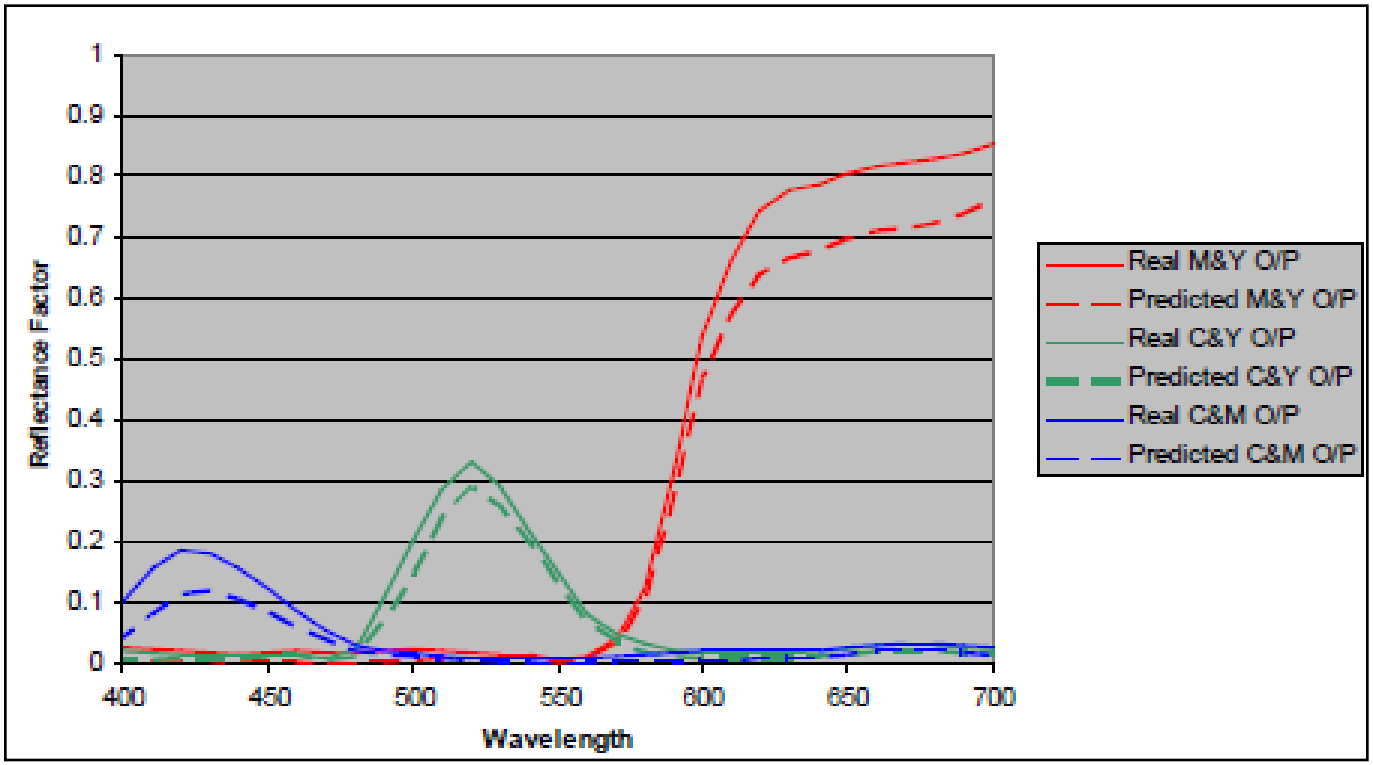
Objectives

- Predict the colorimetry of spot colour overprints
- Simple numerical method - **easy to implement** within ICC or PDF/X workflow
- Application - previewing overprints of spot colours on-the-fly using pre-media software

Proposed overprint model

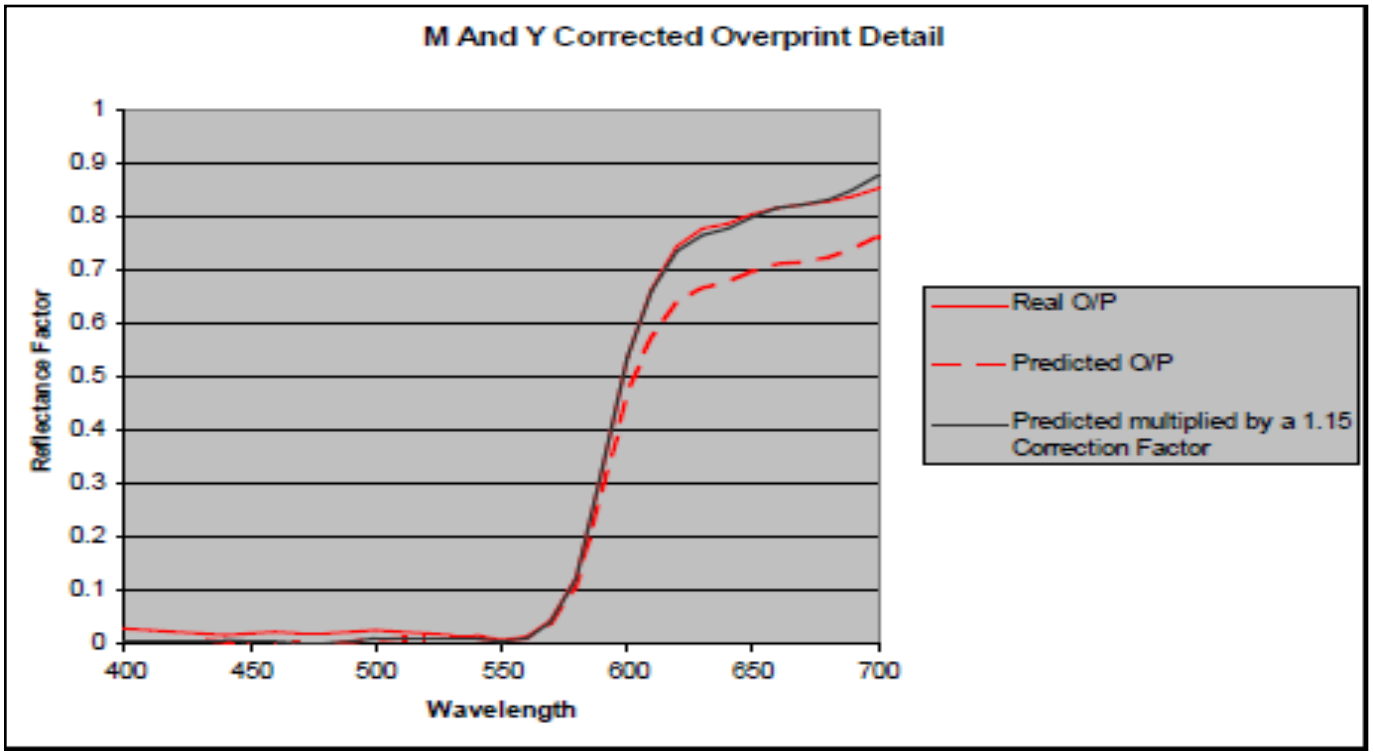
- Reflectance of overprint – product of the reflectances of two inks measured independently

- Error is typically a linear underestimate of the reflectance



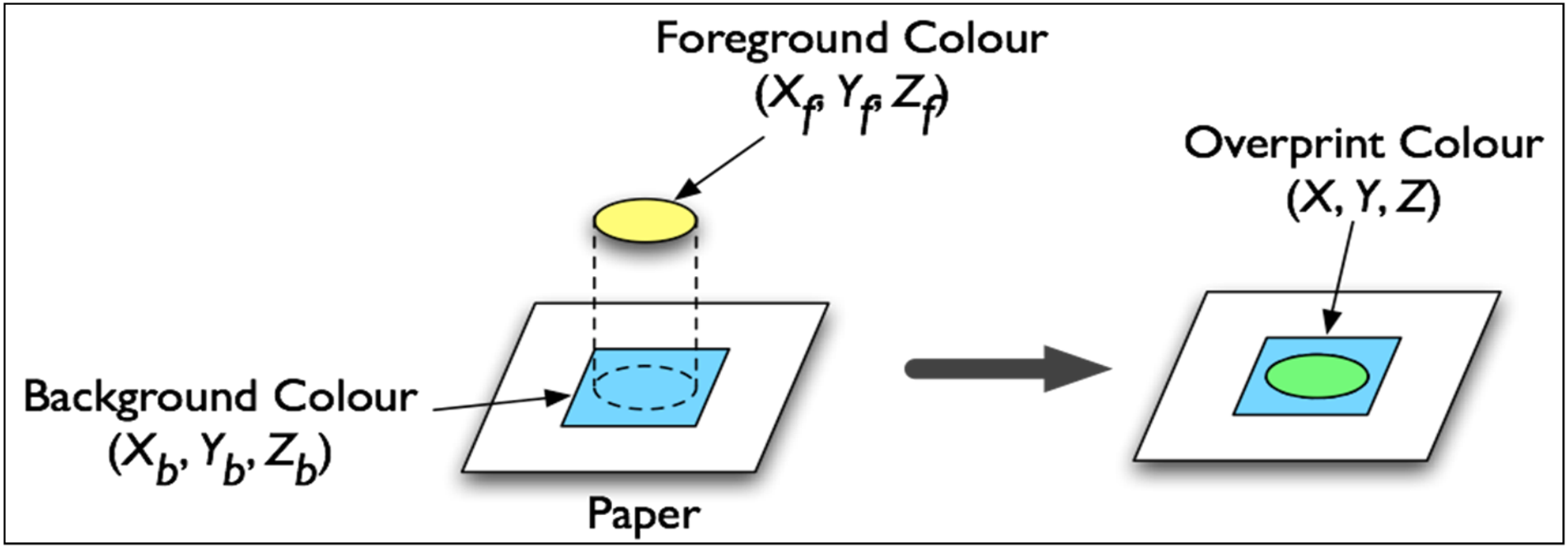
Proposed overprint model

- Reflectance product is modified numerically by coefficients
- Coefficients depend on **colorant opacity**, **ink sequence** and **dot area**



Proposed overprint model

- Underlying colour = Background colour
- Overprinted colour = Foreground colour



Proposed overprint model

- Overprint colour correlated to the product of background and foreground colours using regression analysis (*Deshpande, 2010*)

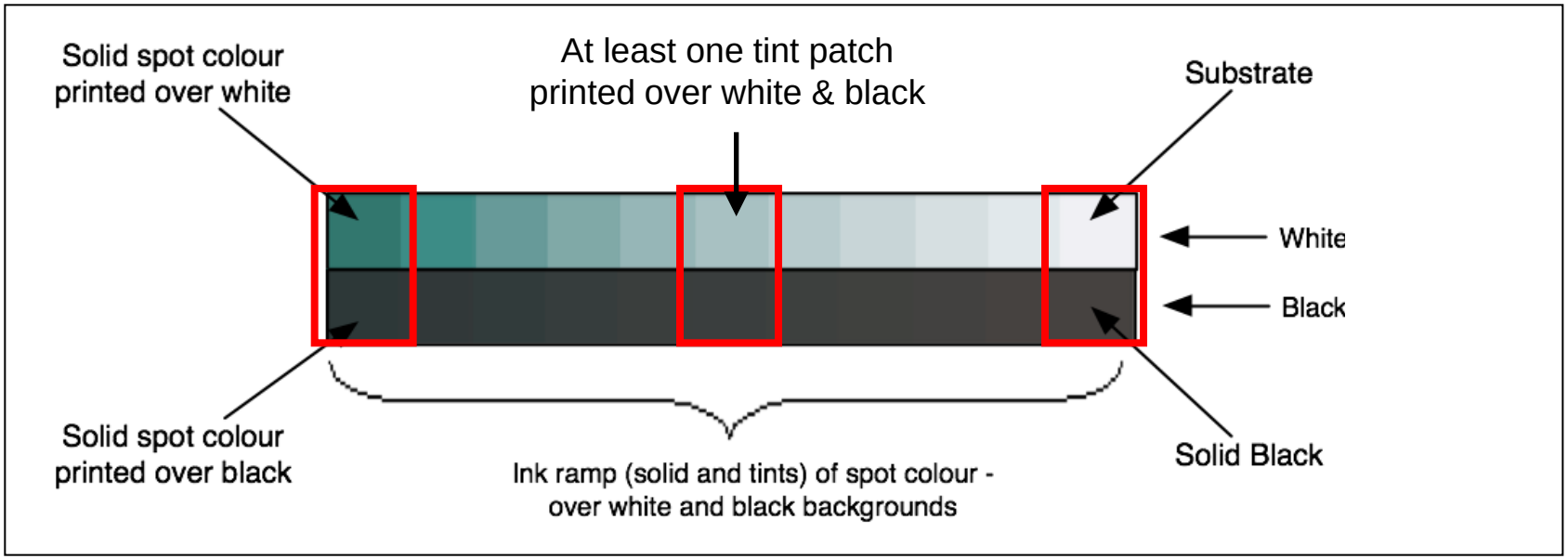
$$X = j_x \times (X_b \times X_f) + k_x$$
$$Y = j_y \times (Y_b \times Y_f) + k_y$$
$$Z = j_z \times (Z_b \times Z_f) + k_z$$

...Equation 1

X, Y, Z : predicted tristimulus values of the overprint colour
X_b, Y_b, Z_b : measured tristimulus values of the background colour
X_f, Y_f, Z_f : measured tristimulus values of the foreground colour
j_x, j_y, j_z : scaling factors of the foreground colour depending on dot area
k_x, k_y, k_z : constants of the foreground colour depending on dot area

How to obtain coefficients?

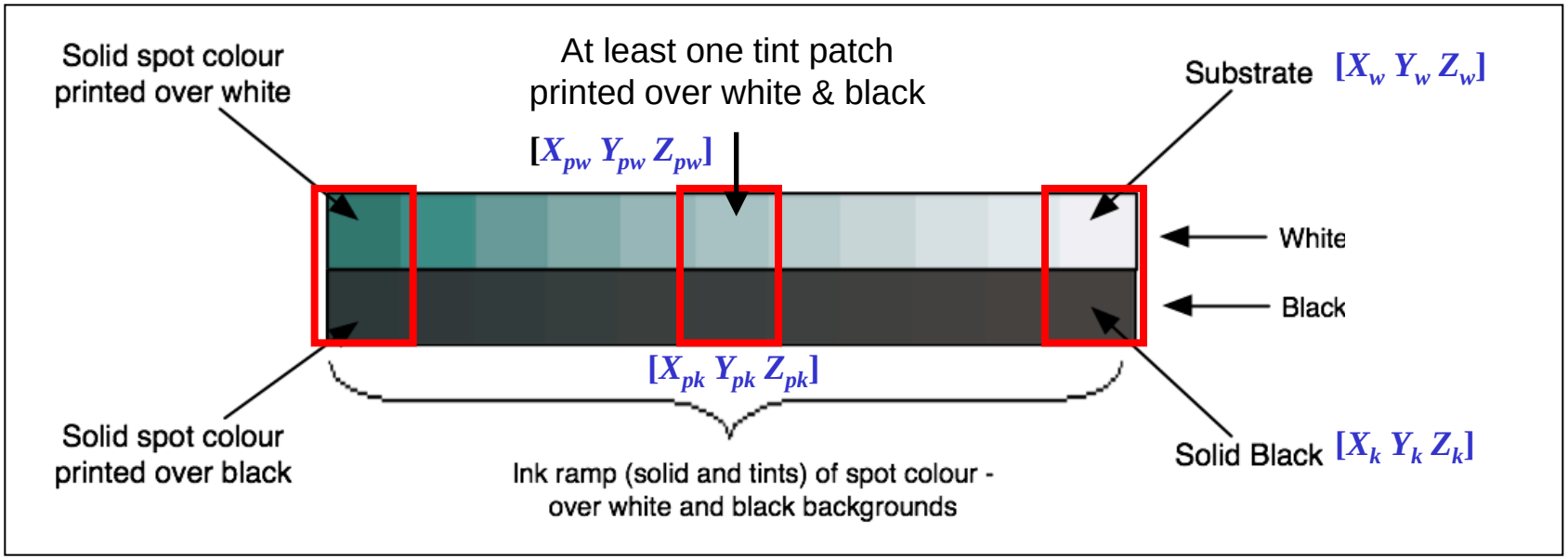
- Two unknowns – *j* and *k*
- Print and measure a solid ink and **at least one tint patch** on two overprint configurations – on white and on black



How to obtain coefficients?

- Apply model equations to: *pw* as overprint (background w, foreground *pw*) and *pk* as overprint (background *k*, foreground *pw*)

- Solve two equations for *j* and *k*



How to obtain coefficients?

- Solve two equations to obtain the coefficients

$$k_x = (X_{pk} \times X_w - X_{pw} \times X_k) / (X_w - X_k)$$

$$j_x = (X_{pw} - k_x) / (X_w \times X_{pw})$$

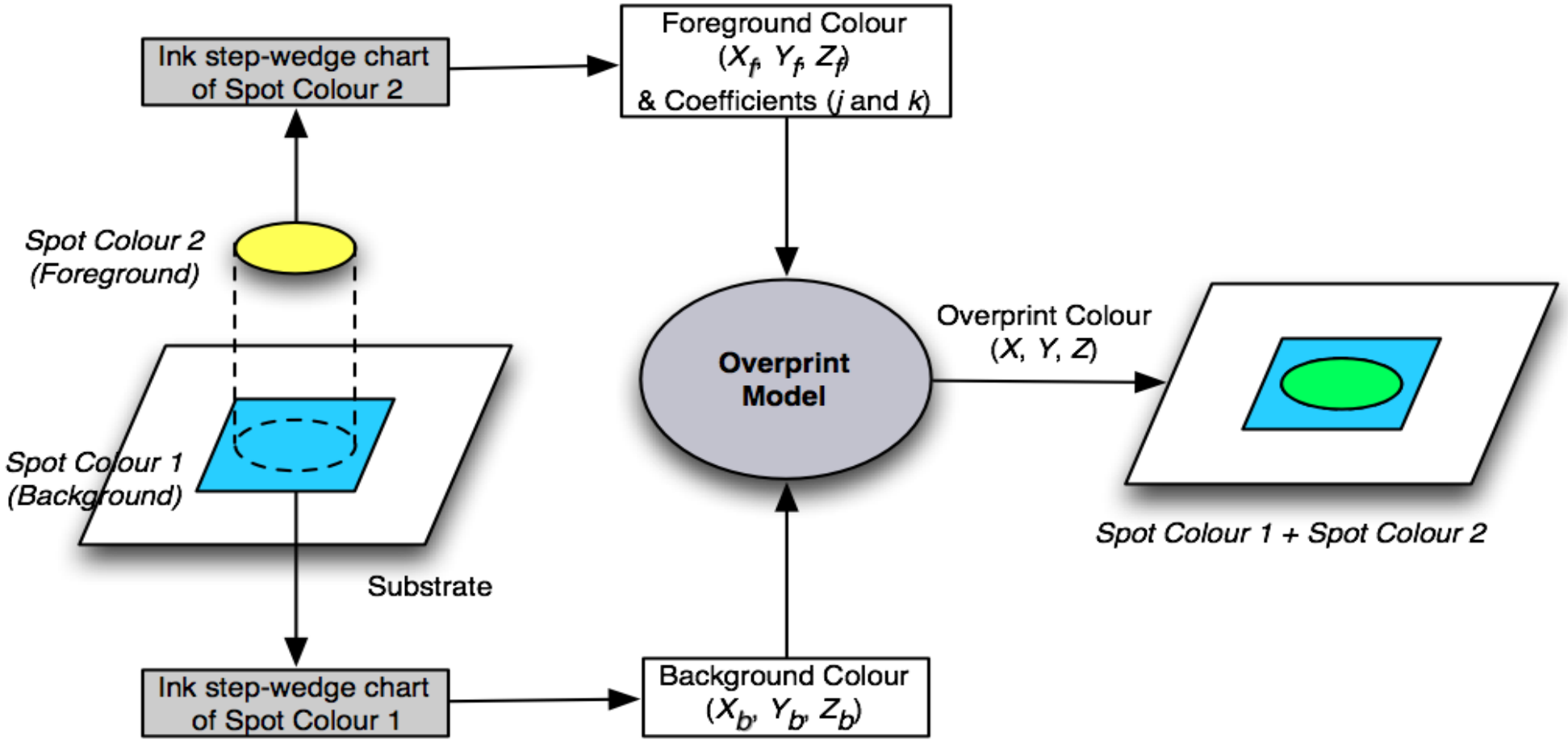
...Equation 2

X_{pw}, Y_{pw}, Z_{pw} : the tint percentage printed on white (substrate)
X_{pk}, Y_{pk}, Z_{pk} : the same tint percentage printed on black
X_w, Y_w, Z_w : the white (substrate) without overprint
X_k, Y_k, Z_k : the solid black without overprint

- Coefficients are relevant to the foreground colour

Implementation – *two spot colors*

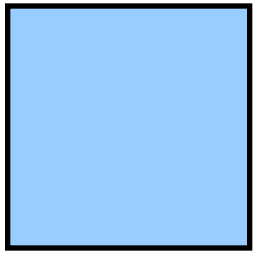
- 2-inks combination



Implementation – *two spot colors*

- 2-inks combination

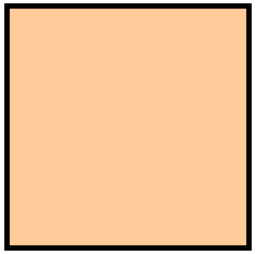
40% *Spot1*



X_b, Y_b, Z_b

+

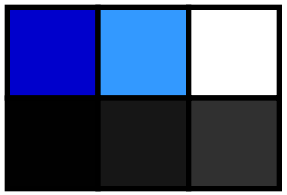
60% *Spot2*



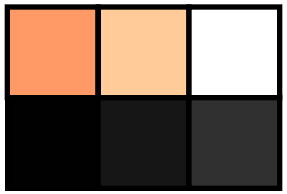
X_f, Y_f, Z_f

Implementation – Step 1

- Obtain the required tristimulus values of the ink step-wedge chart for each ink
  - Print and measure the step-wedge charts
  - Or find another data source matching to your printing conditions
  - Say if we have data available for 0%, 50% and 100% on white & black



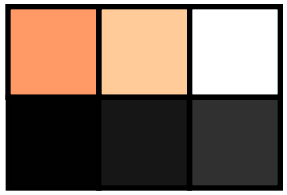
Spot 1



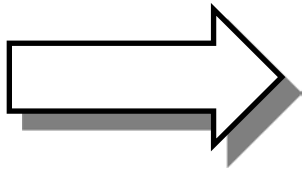
Spot 2

Implementation – Step 2

- Calculate the coefficients for foreground colour
  - First calculate the coefficients for *Spot 2* at 50% and 100% using *Eq. 2*
  - Interpolate the coefficients for 60% *Spot 2*



Spot 2

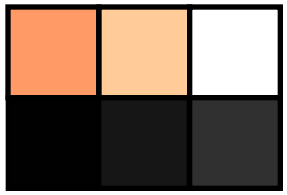


j_x, j_y, j_z for 60% *Spot 2*

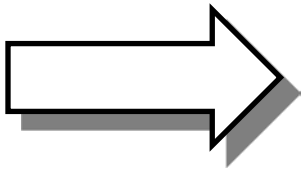
k_x, k_y, k_z for 60% *Spot 2*

Implementation – Step 3

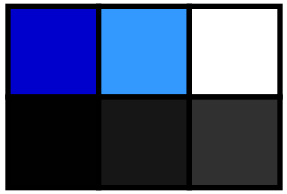
- Calculate the background & foreground colours
  - X_b, Y_b, Z_b for 40% *Spot 1* – interpolate the measurements of ink step-wedge chart for *Spot 1*
  - X_f, Y_f, Z_f for 60% *Spot 2* – interpolate the measurements of ink step-wedge chart for *Spot 2*



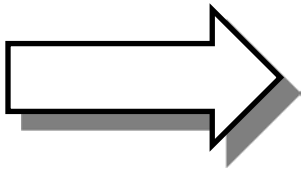
Spot 2



X_f, Y_f, Z_f for 60% *Spot 2*



Spot 1



X_b, Y_b, Z_b for 40% *Spot 1*

Implementation – Step 4

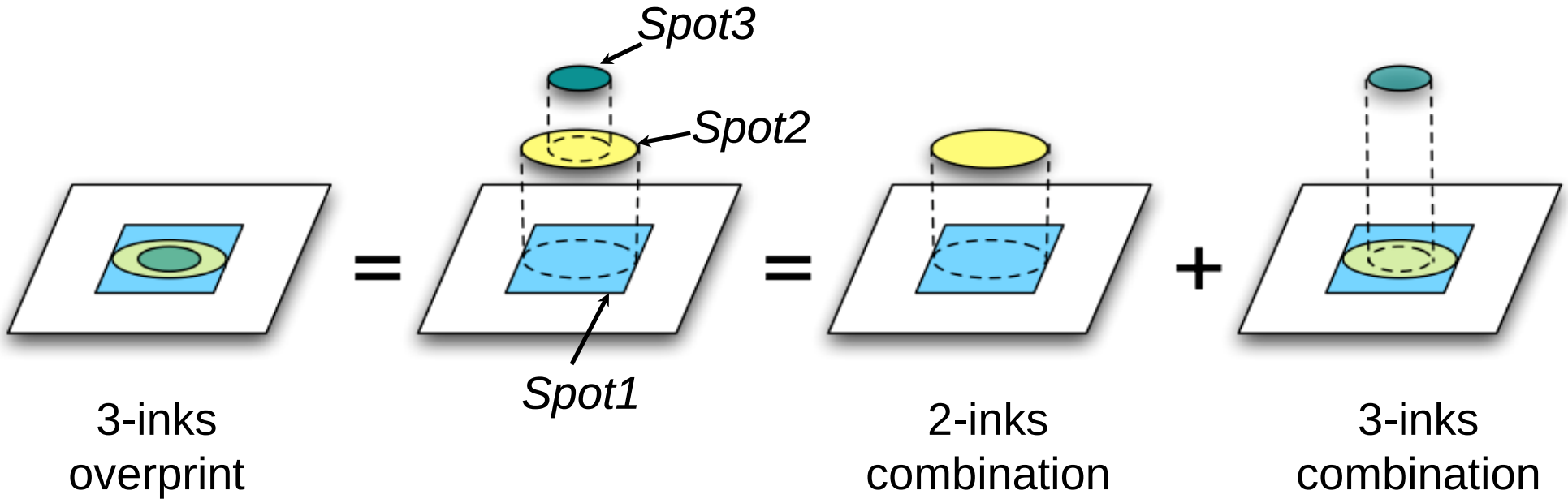
- Apply the overprint model to calculate the resulting colour
  - Calculate the product (***Xb*** × ***Xf***), (***Yb*** × ***Yf***), (***Zb*** × ***Zf***)
  - Apply *Eq. 1* to calculate the overprint colour using the interpolated coefficients for 60% *Spot 2*

$$X = j_x \times (X_b \times X_f) + k_x$$
$$Y = j_y \times (Y_b \times Y_f) + k_y$$
$$Z = j_z \times (Z_b \times Z_f) + k_z$$

...Equation 1

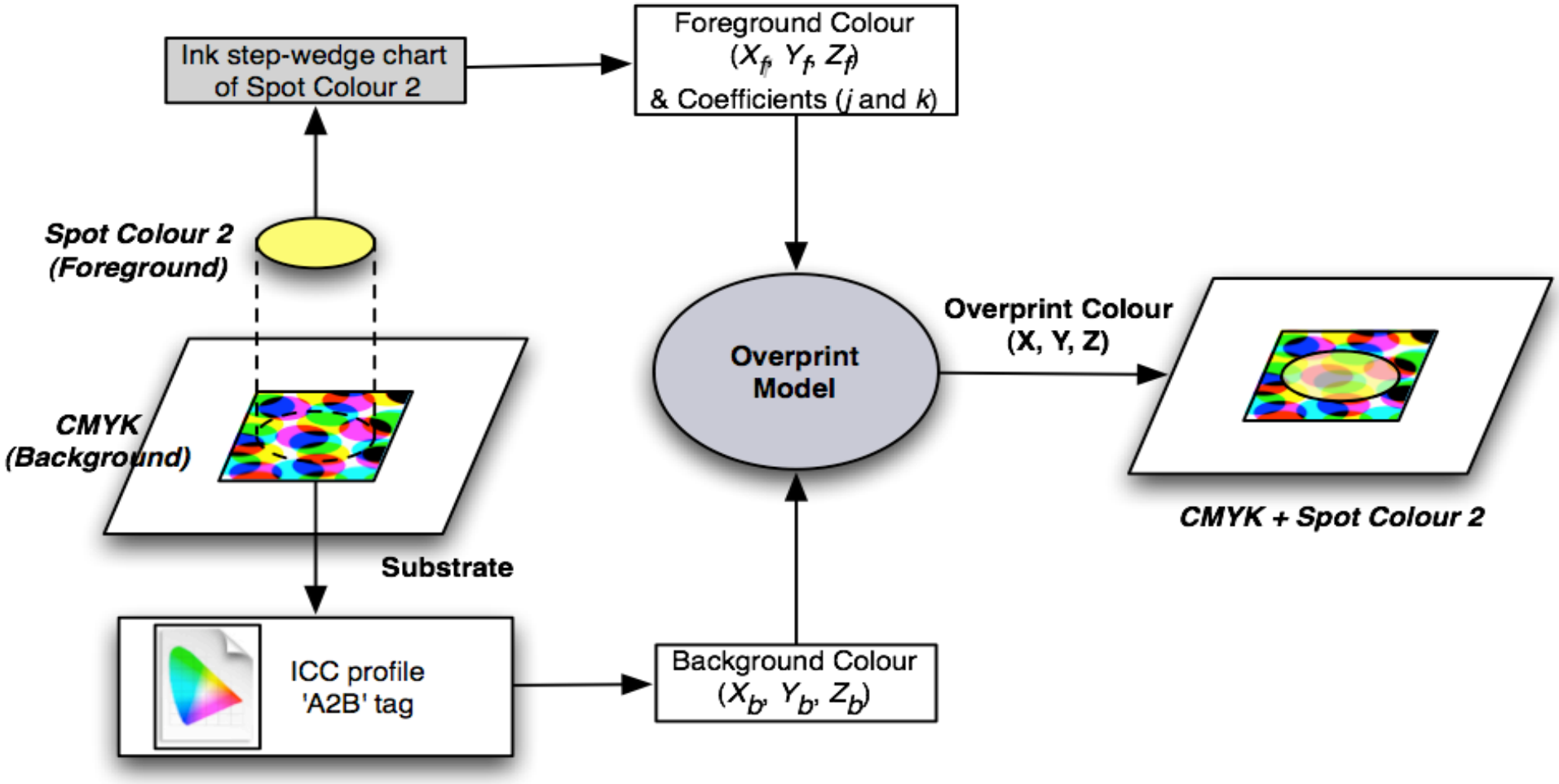
Implementation – *multiple spot colours*

- Multiple-inks combination: 3-inks, 4-inks and more
- Apply the model recursively by repeating steps 2 to 4: lay-down order is important



Implementation – *spot colour over CMYK*

- Process inks (*CMYK*) + Spot colour combination



Implementation – *spot colour over CMYK*

- **Lay-down order (ink sequence)** is important: process inks first and then spot colour
- If the sequence of process inks is known, the model can give consistent results
- Example: [*K – Spot – C – M – Y*]
- ICC profile provides the ink step-wedge data on white (substrate) and on black for C, M, Y
- Overprint combinations can be calculated by adding inks on top with the help of overprint model

Summary

- Proposed model - predicts ***solid and halftone overprints***
- ***Simple*** and computationally inexpensive - based on CIEXYZ
- Implementation for different use-cases
- Applications
  - *previewing overprints in pre-media software*
  - *matching spot colour overprints on digital printing systems*
  - *implement within ICC or PDF/X workflow*

References

- Chung, R., Riordan, M. and Prakhya S. (2008) *Predictability of spot colour overprints*, Advances in Printing and Media Technology, Vl. XXXV, p. 373-380

- Deshpande, K. and Green, P. (2010) *A simplified method of predicting the colorimetry of sot colour overprints*, Proc. 18th Color Imaging Conference: Color Science and Engineering Systems, Technologies, and Applications, p 213-216, San Antonio, Texas

- Viggiano, J.A.S. and Prakhya, S. (2008) *Prediction of overprint spectra using trapping models: A feasibility study*, TAGA 2008, Rochester, NY:2008 TAGA student chapter.

Thank You!