Development of an Algorithm to Convert Colorimetric variables of ΔL*, ΔC* ΔH* to Dyers' Variables of Differences in Depth, Brightness and Hue

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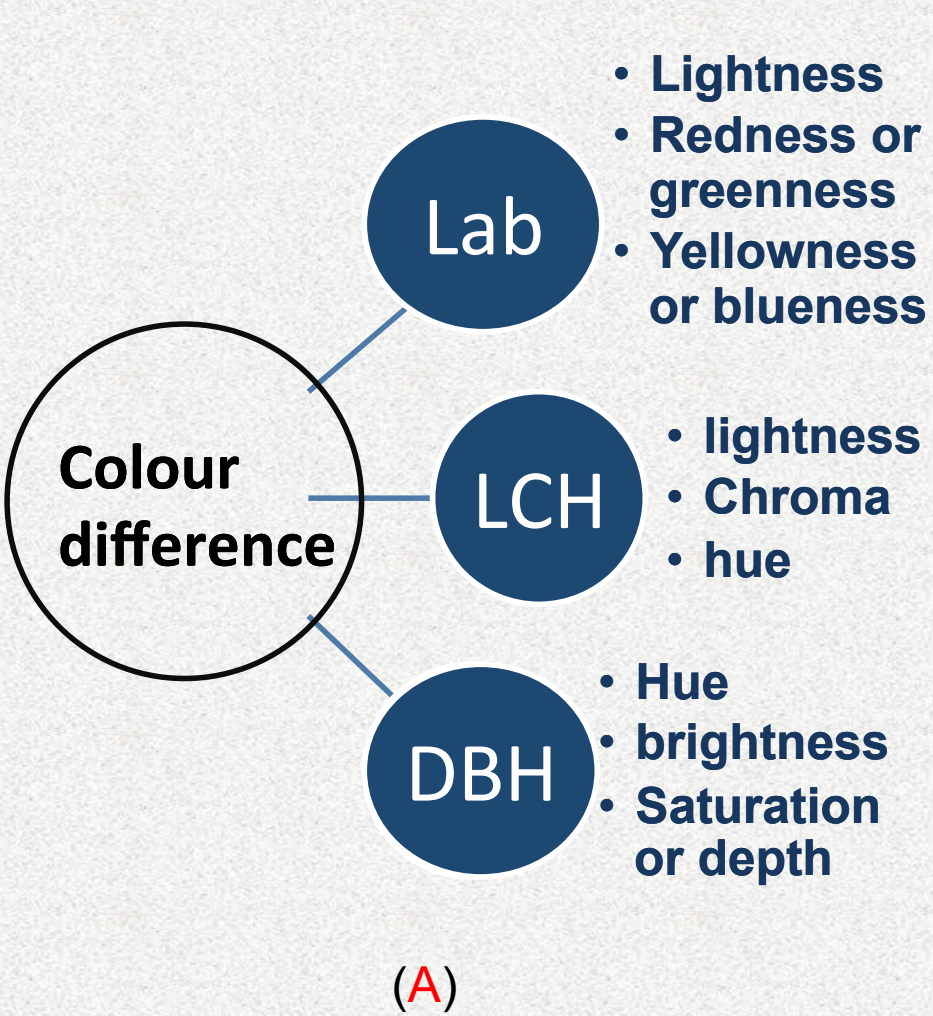
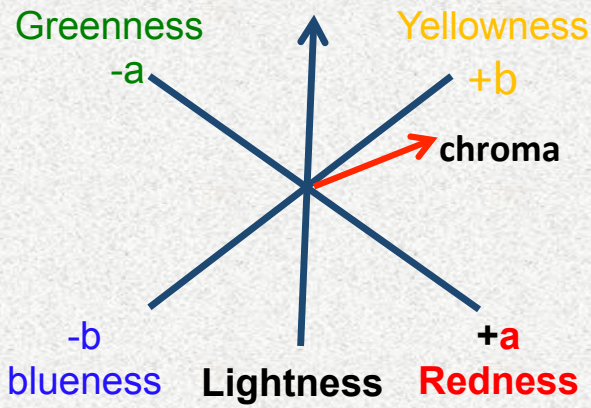
STRESA IAC TC 2010

Colour difference and its partitioning



(A)



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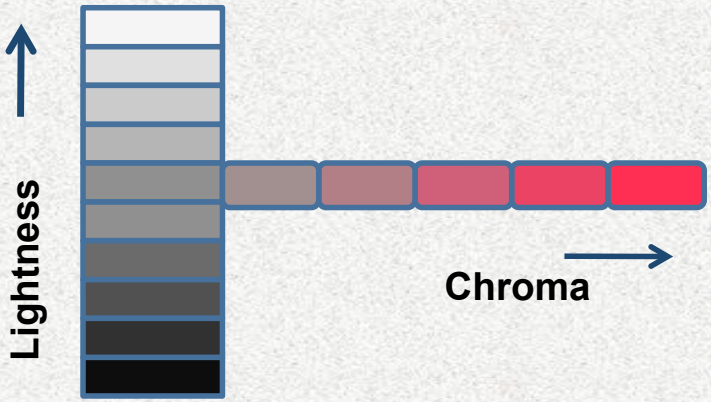

(C)

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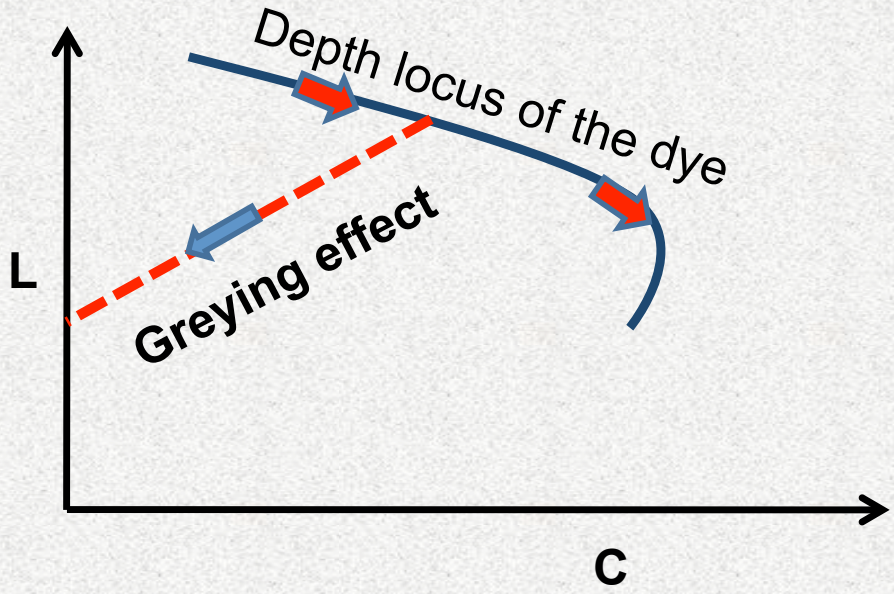
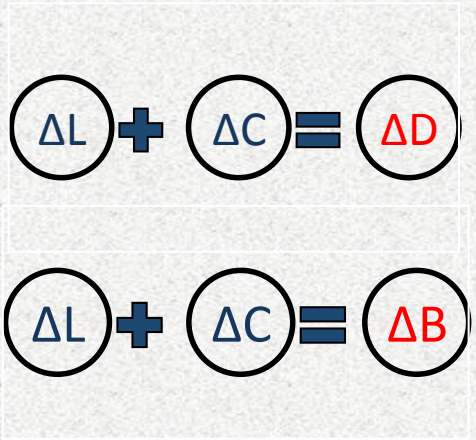
Relationship between dyers variables and colorimetric variables





- change in concentration of the dye is always accompanied with both the change in lightness and chroma.
- Addition of grey to the dyeing result in decrease of lightness and chroma.

Interpretation of LCh values. An Example

- Your target colour

L* = 63 C* = 24

h = 45°

- Your batch

L* = 65 C* = 25

h = 45° ΔE = 2.00

COLORIMETRIC OUTPUT

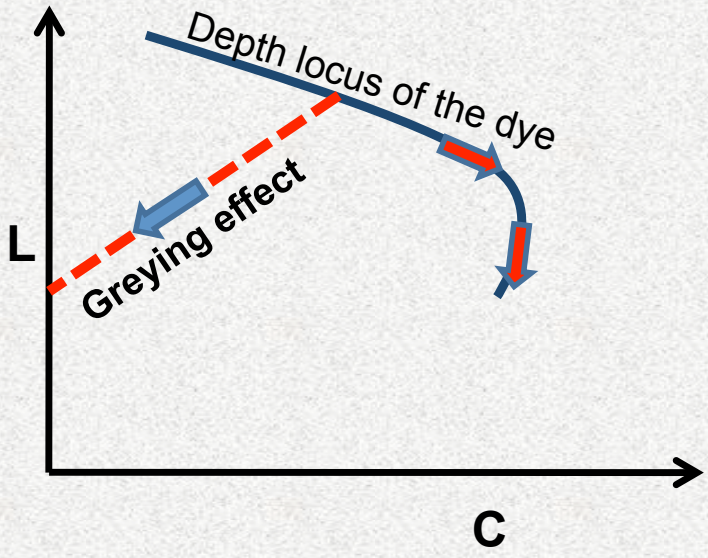
ΔL = 2 ΔC = 1

- Instruction is decrease L* and C* - but how?

DYERS' OUTPUT

Batch is thinner

- Instruction is decrease the concentration



- **It is therefore necessary to inter-relate the output of the colorimetric variables to the dyers' variables to get maximum advantages of colorimetry**

- **The WSF algorithm developed in this work defines a systematic way of predicting the change in depth and change in brightness by computing the variation in the colorimetric components of colour difference (ΔC, ΔL) throughout the colour space.**

WSF Algorithm

Generation of the equi-depth line passing through the standard

Adjustment of dye strength of batch till it intersects the equi-depth line of the standard

Computation of difference in depth, brightness and hue of standard and batch

WSF Algorithm- How to generate Equi-Depth line

- Six surfaces of constant visual depth (2/1, 1/1, 1/3, 1/6, 1/12, 1/25) defined numerically and mapped into CIELAB color space has been reported as WSI algorithm earlier.

- WSI algorithm was based upon predicting the lightness that colours of given chroma should have to be of equal depth, around the hue circle.

WSF Algorithm- How to generate Equi-Depth line

Conic equation was fitted to predict the lightness of the sample

$$k_1 L^{*2} + k_2 C^{*2} + k_3 L^{*} + k_4 L^{*} C^{*} + k_5 C^{*} + k_6 = 0$$

$$L^{*} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$a = k_1$$

$$b = k_3 + k_4 C^{*}$$

$$c = k_2 C^{*2} + k_5 C^{*} + k_6$$

WSF Algorithm- How to generate Equi-Depth line

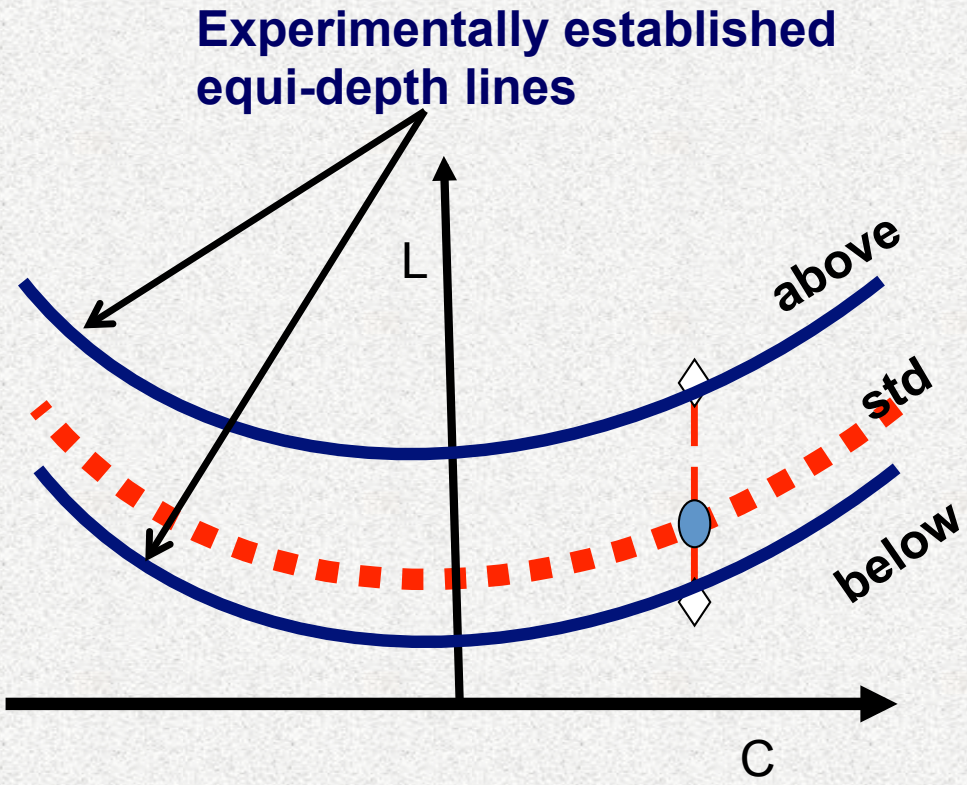
$$k_{1\,std} = k_{1\,below} + \Delta k_1$$

$$\Delta k_1 = \Delta L_1 / \Delta L_t * \Delta k_t$$

$$\Delta k_t = (k_{above} - k_{below})$$

$$\Delta L_t = (L_{above} - L_{below})$$

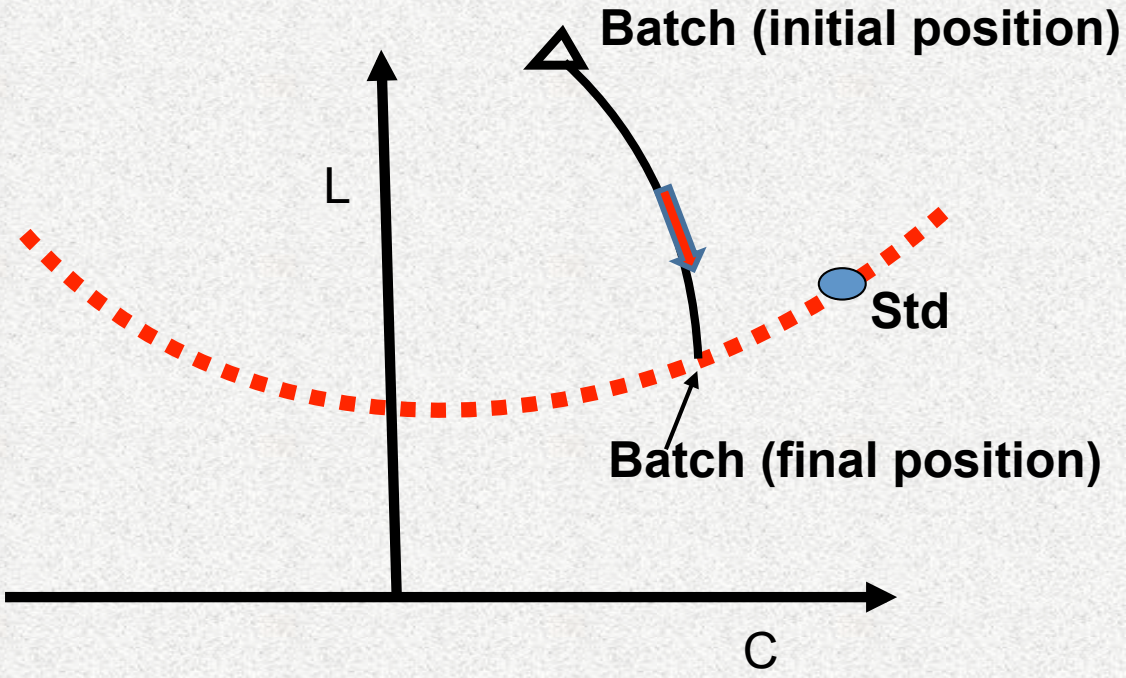
$$\Delta L_1 = (L_{std} - L_{below})$$



$$k_1 L^{*2} + k_2 C^{*2} + k_3 L^* + k_4 L^* C^* + k_5 C^* + k_6 = 0$$

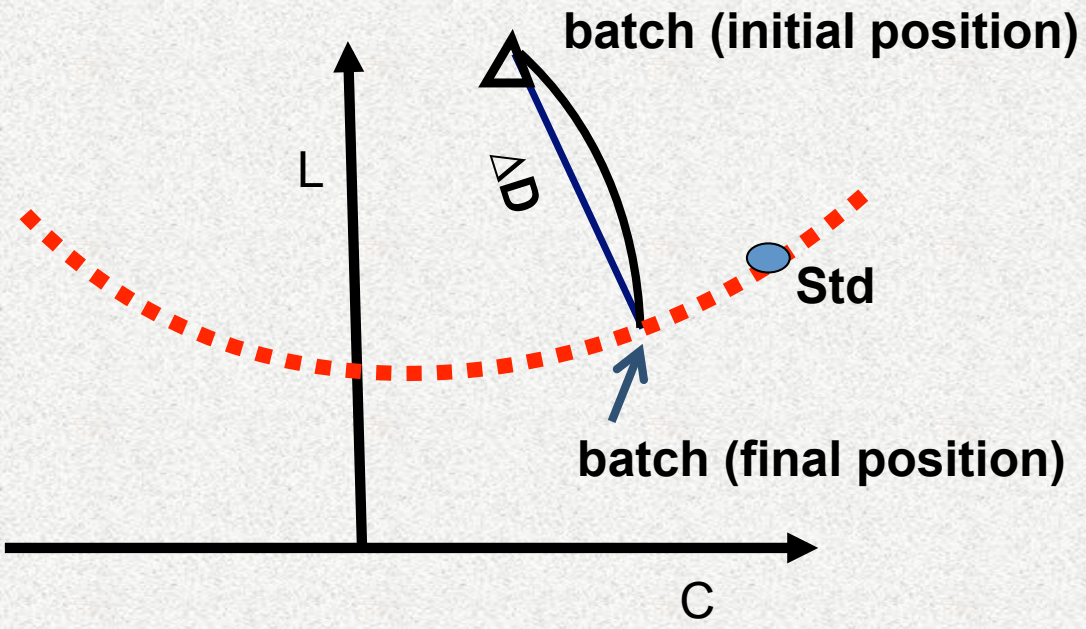
WSF Algorithm-prediction of batch strength relative to standard

- The K/S values of the batch are either increased or decreased, until its depth becomes equal to that of standard.



Computation Of Difference In Depth and its verbal description

- ∆D is the linear distance of the batch from its initial position to its final position
- Batch is **thinner** If the **concentration** of the batch **increases** to intersect the depth line of the standard, and vice versa



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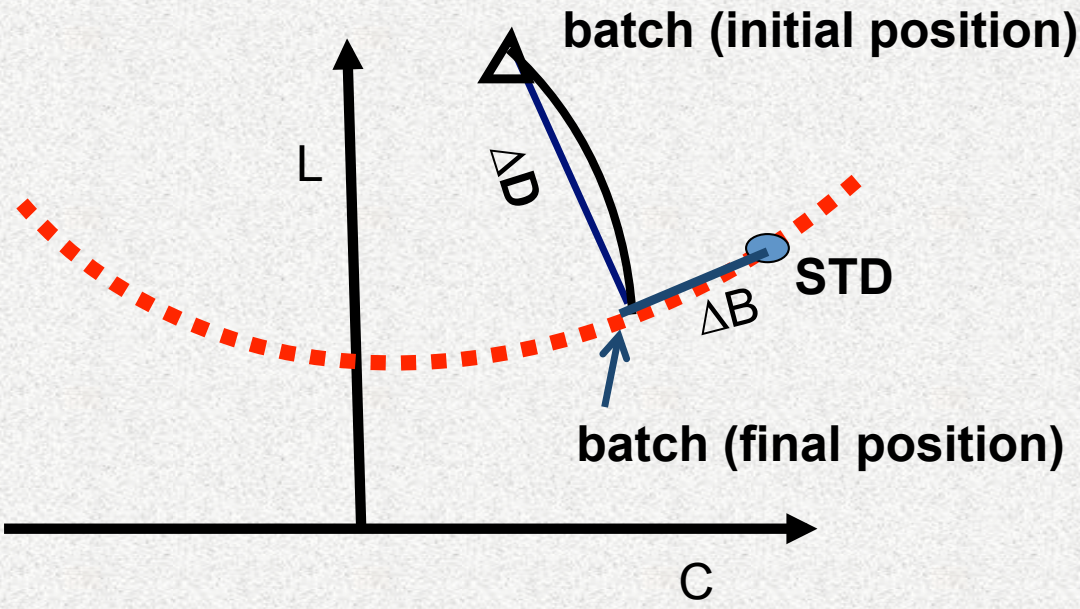
Computation Of Difference In Brightness and its verbal description

- ΔB is the linear distance between the location of the batch on the standard's equi-depth line and the location of the standard.
- The batch is **flatter** if its **chroma** on the equi - depth line of the standard is **lower** than the chroma of the standard, and vice versa



Statistical Analysis

- 39 pairs of samples showing small/medium colour differences of between 0.3 – 3.0 CIELAB units were prepared at different regions of the colour space.

- Each of the 39 sample pairs was assessed by a professional colourist. The colourist's decisions were made in terms of the percentage contribution of depth, brightness and hue to the overall colour difference seen.
- The differences in depth, brightness and hue of each of the pairs were computed using the WSF algorithm and also the DBH model

Statistical Analysis

Correlation with visual assessment and with DBH

	r (ΔD)	r (ΔB)
WSF VS DBH	0.964	0.595
DBH VS VISUAL	0.519	0.323
WSF VS VISUAL	0.5304	0.138

Thank you