Optimal Method
Print Calibration

Charles Spontelli – Graphic Arts Consulting, LLC / BGSU

William Birkett – Doppelgänger, LLC

FTA Membernar – December 15, 2022

OPTIMAL METHOD

PRINT Experience

- **Charles (Chuck) Spontelli**
  Professor Emeritus BGSU, RIT School of Printing
  Taught print and color for 35 years
  Print color consultant for 5 years

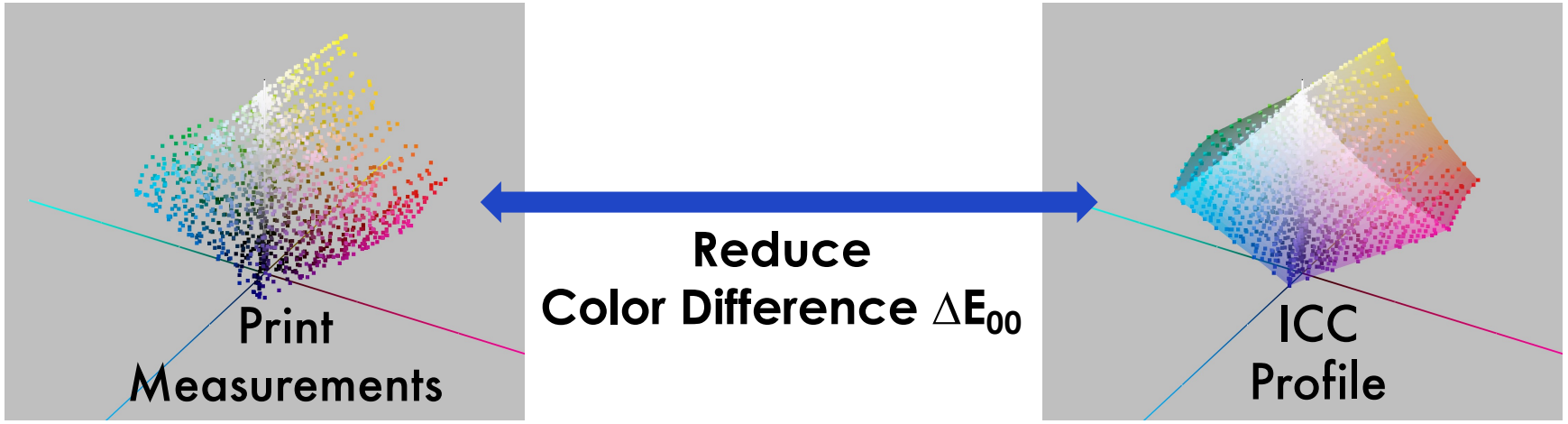
- **William (Bill) Birkett**
  Engineer, University of Michigan
  Owned a prepress company for 32 years
  Print color consultant for 17 years

Calibration Methods

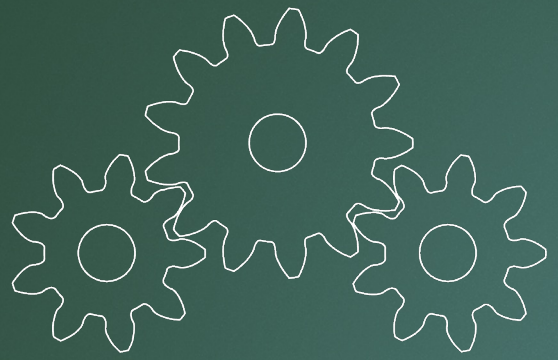
- **TVI/SCTV**
  Use **Curves** to match **prescribed tonality of process colors**
- **Near Neutral**
  Use **Curves** to match **prescribed gray balance and tonality**
- **Color Management**
  Use **Color Transforms** to match an **ICC Profile**
- **Optimal Method**
  Use **Curves** to match an **ICC Profile**

How It Works

- Reduce overall **color difference (ΔE)**
  Between Print Process and Reference

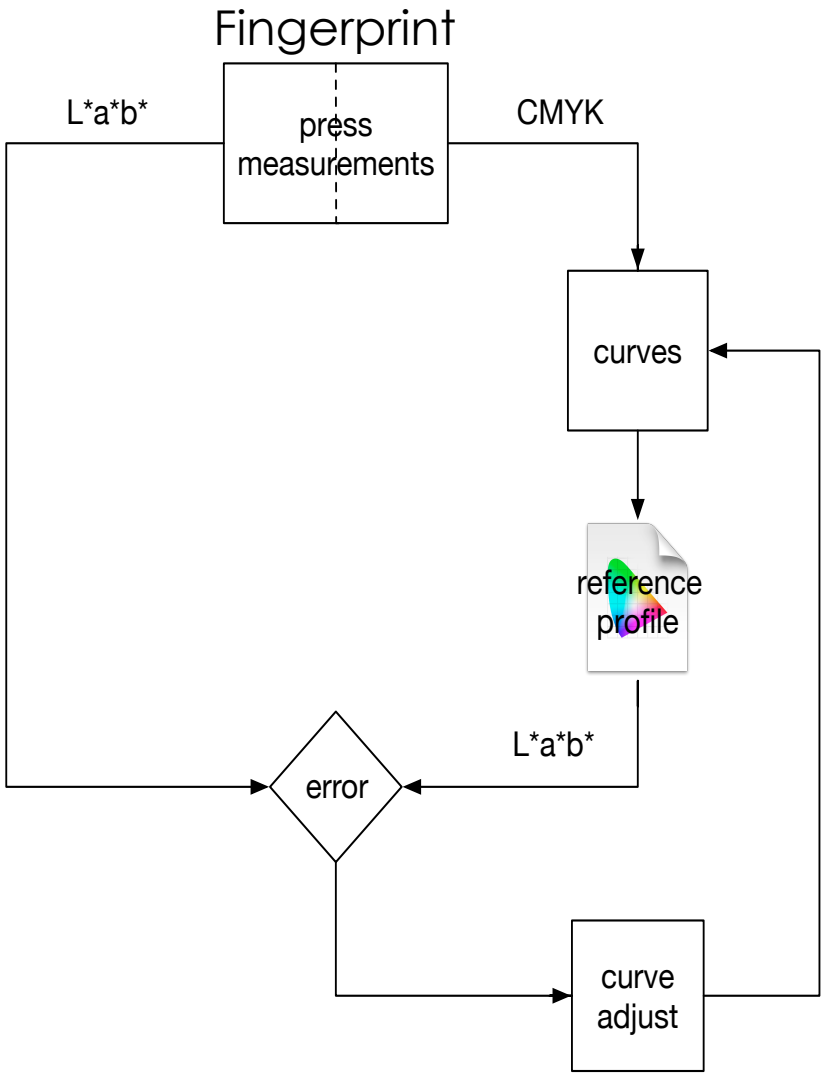


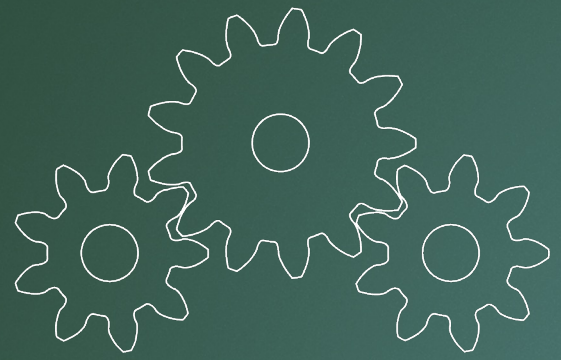
OPTIMAL METHOD



How It Works

- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

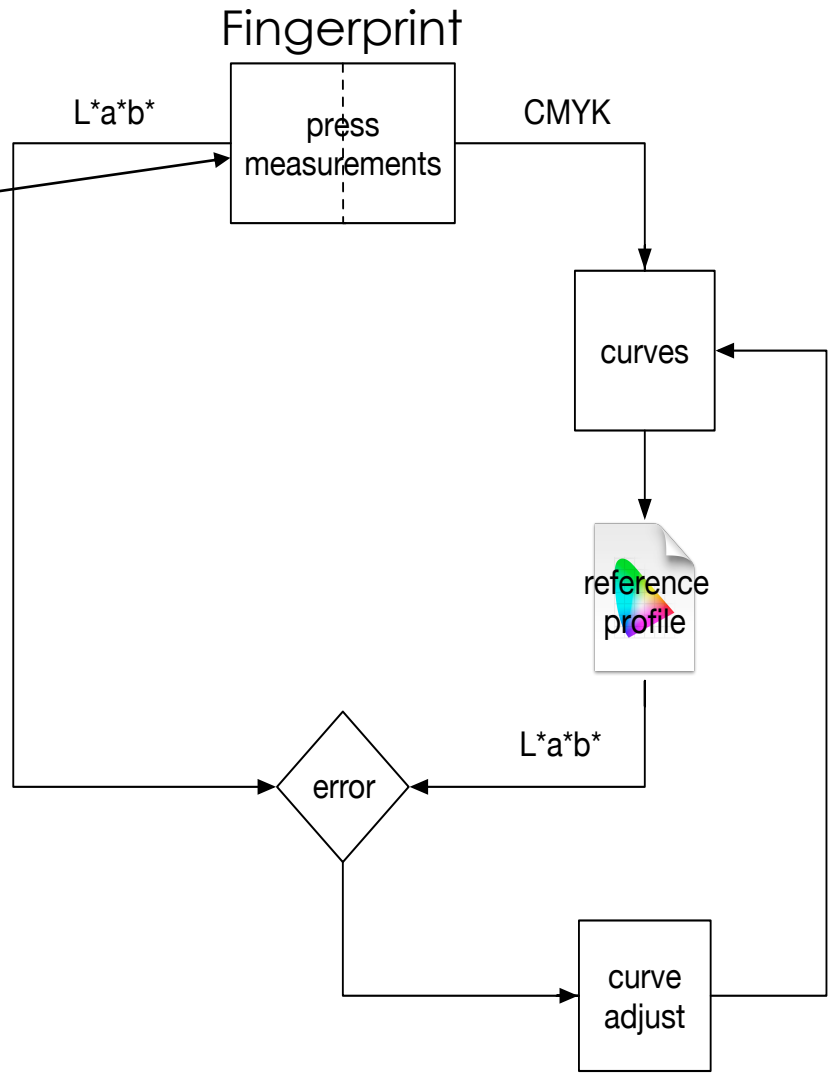




How It Works

- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

Print a test chart with standard inks and color gamut.
Measure the samples.



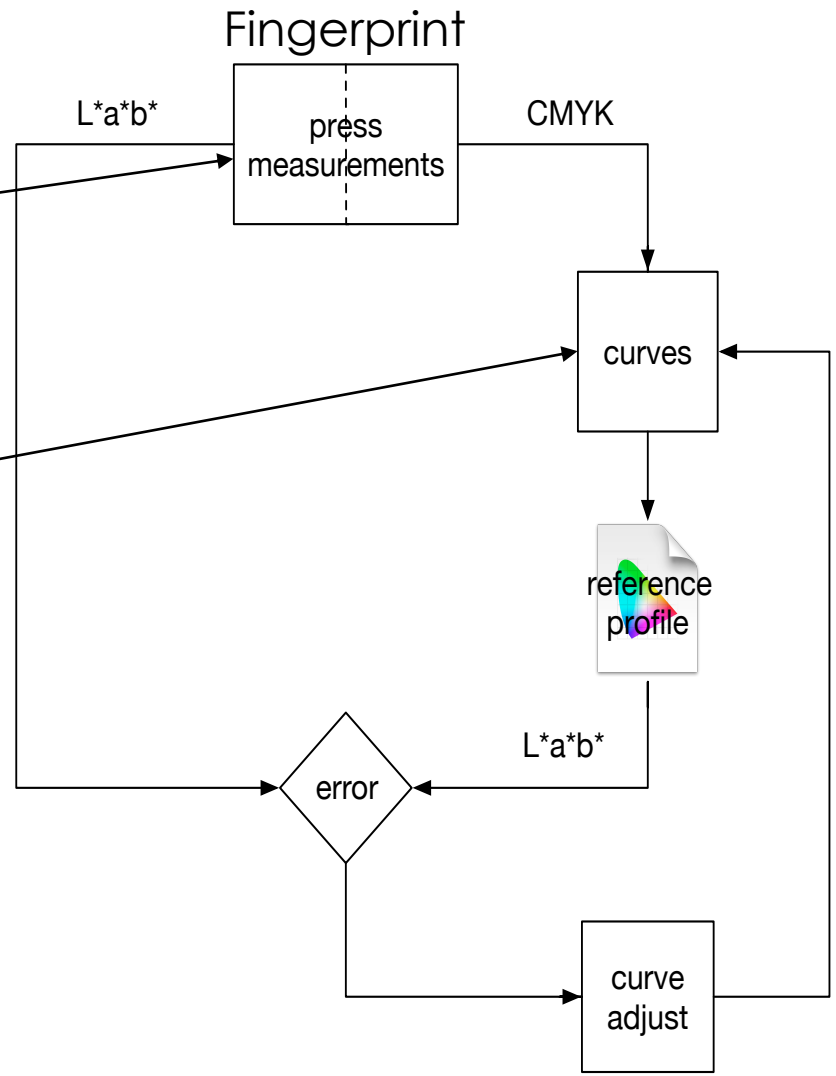
OPTIMAL METHOD

How It Works

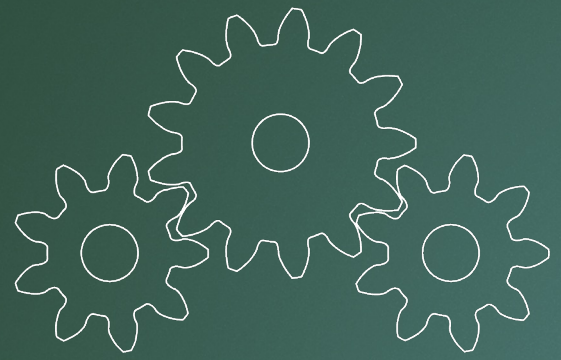
- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

Print a test chart with standard inks and color gamut. Measure the samples.

Begin with Linear Curves (identity function).



OPTIMAL METHOD



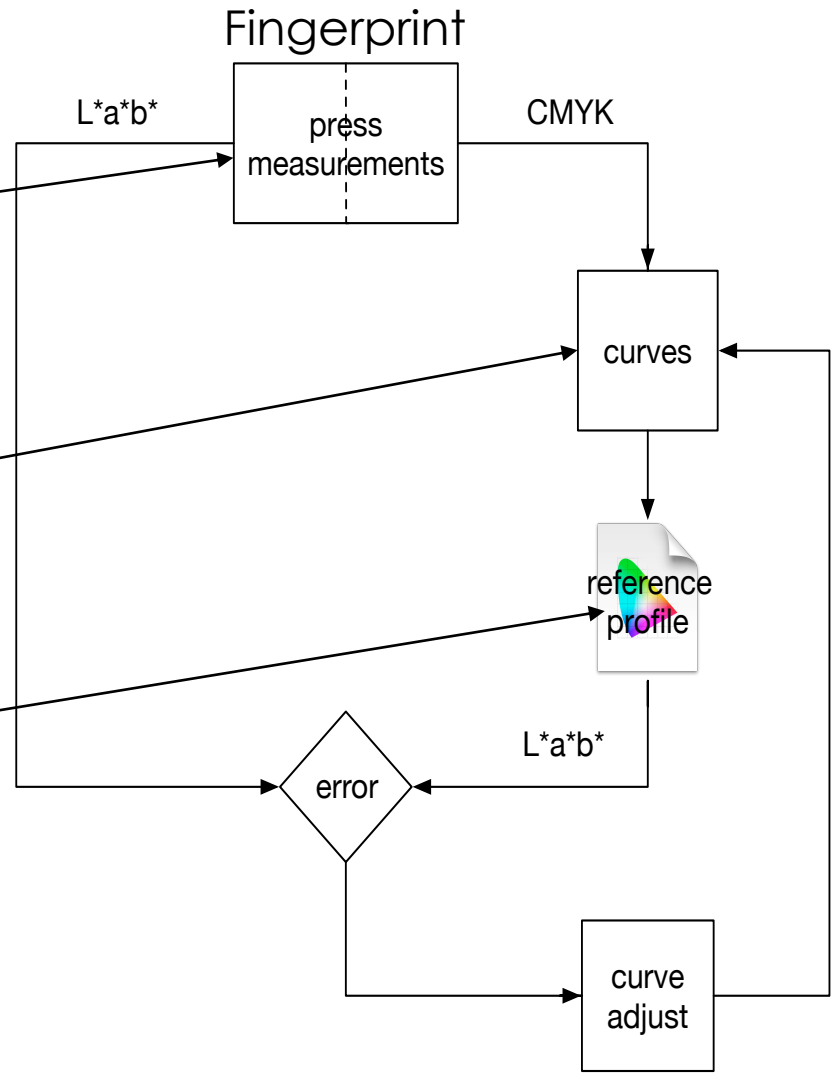
How It Works

- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

Print a test chart with standard inks and color gamut. Measure the samples.

Begin with Linear Curves (identity function).

Calculate reference L*a*b* values using the reference profile.



OPTIMAL METHOD

How It Works

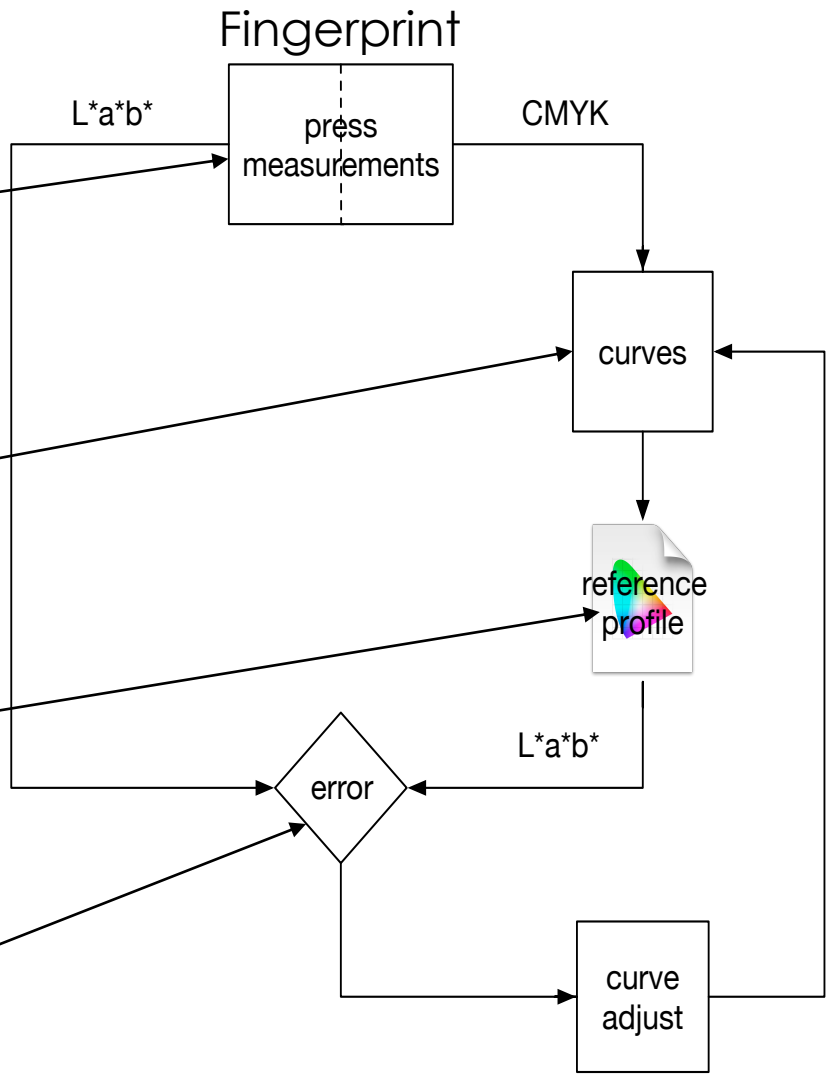
- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

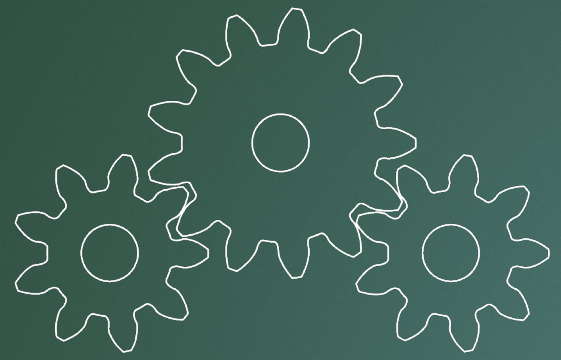
Print a test chart with standard inks and color gamut. Measure the samples.

Begin with Linear Curves (identity function).

Calculate reference L*a*b* values using the reference profile.

Calculate the color difference for each sample.





How It Works

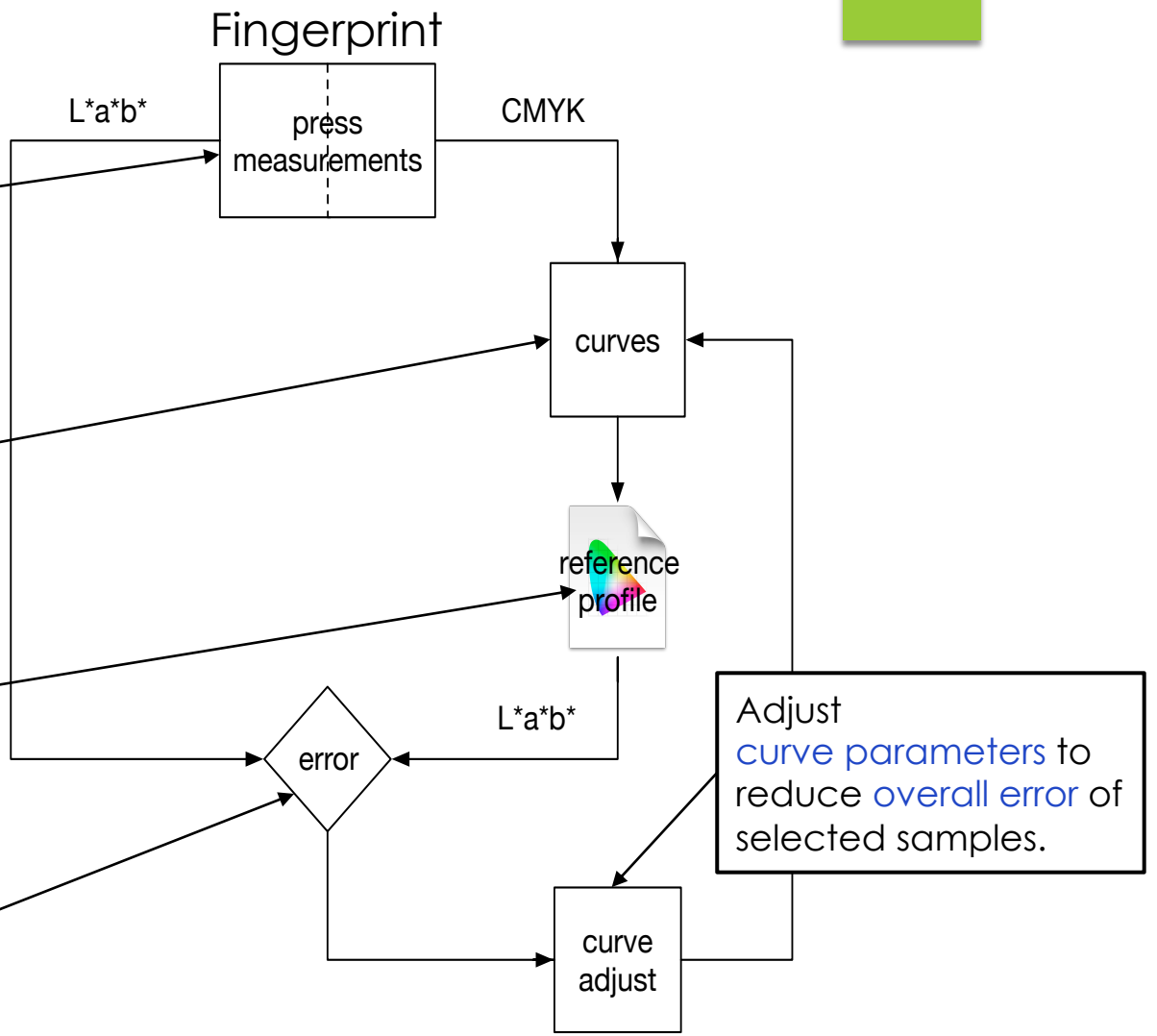
- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

Print a test chart with standard inks and color gamut. Measure the samples.

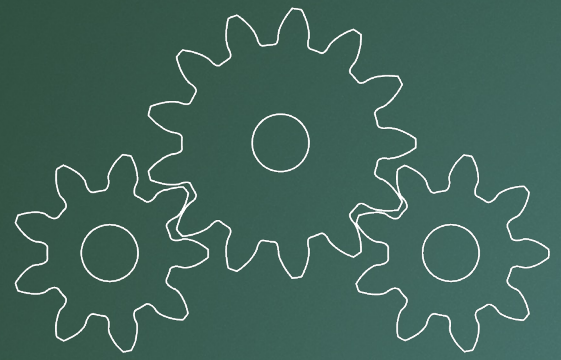
Begin with Linear Curves (identity function).

Calculate reference L*a*b* values using the reference profile.

Calculate the color difference for each sample.



OPTIMAL METHOD



How It Works

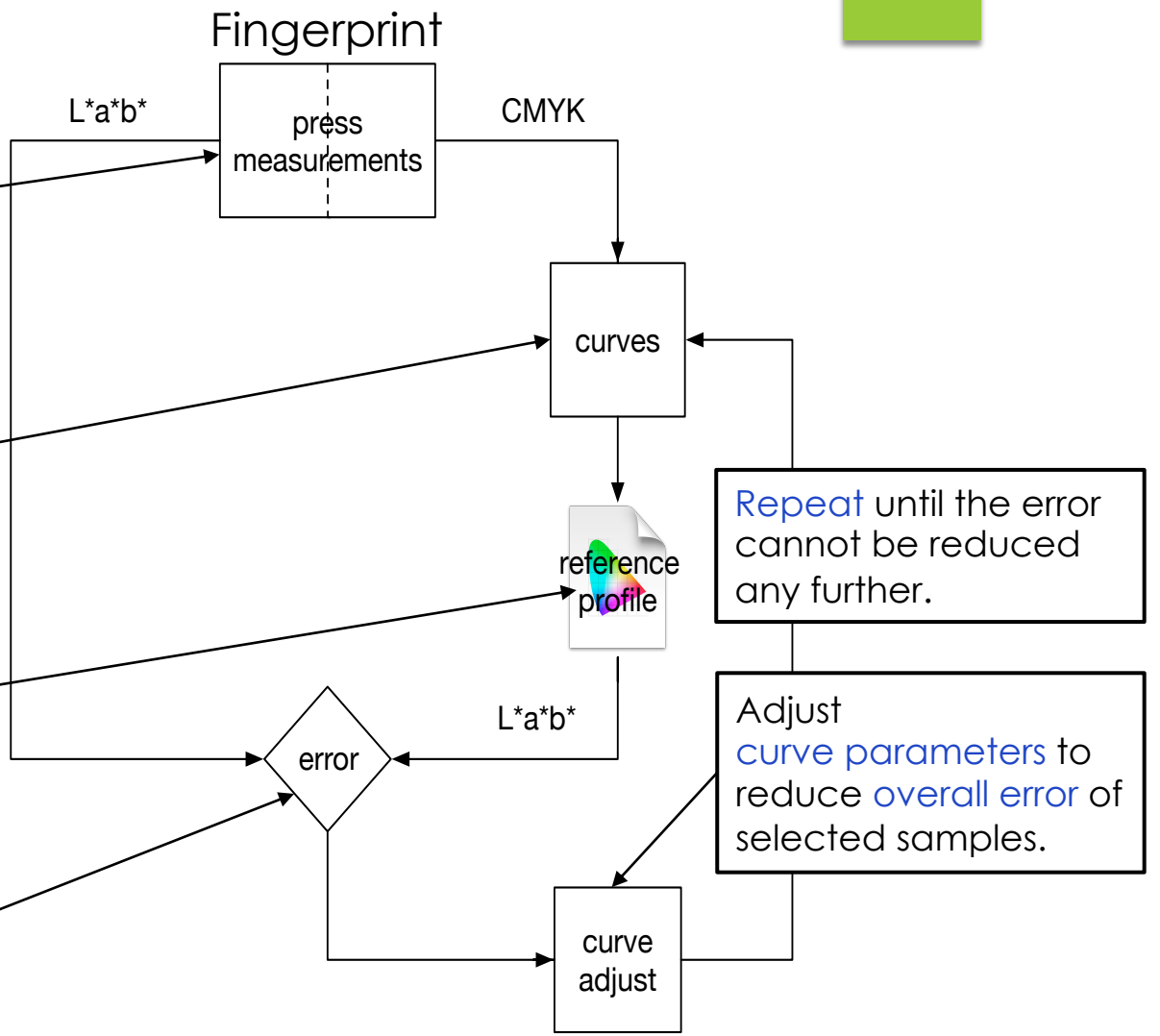
- **Iterative** software loop
- **Stops** when the overall color difference (ΔE) can't be reduced any further

Print a test chart with standard inks and color gamut. Measure the samples.

Begin with Linear Curves (identity function).

Calculate reference L*a*b* values using the reference profile.

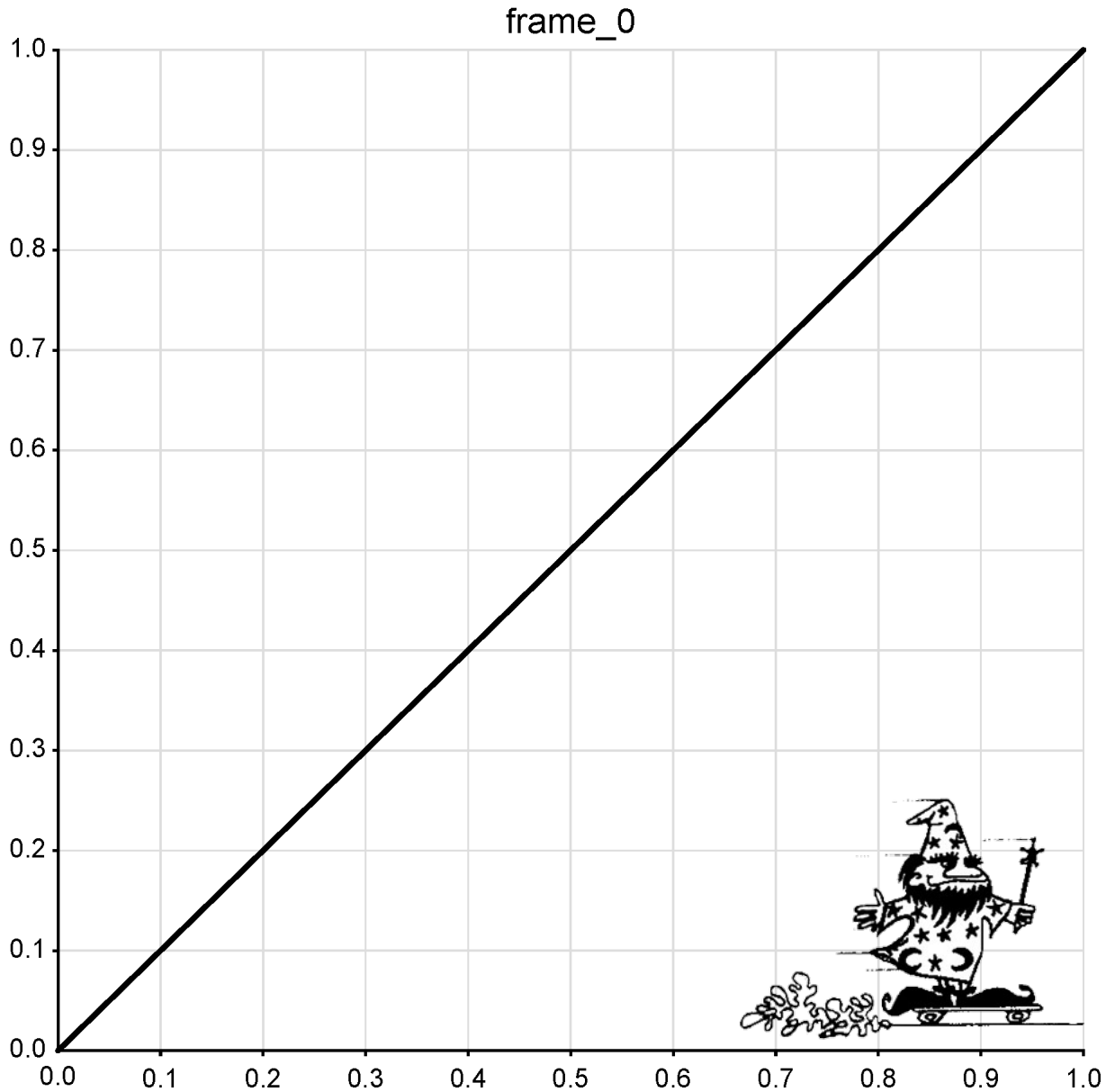
Calculate the color difference for each sample.



OPTIMAL METHOD

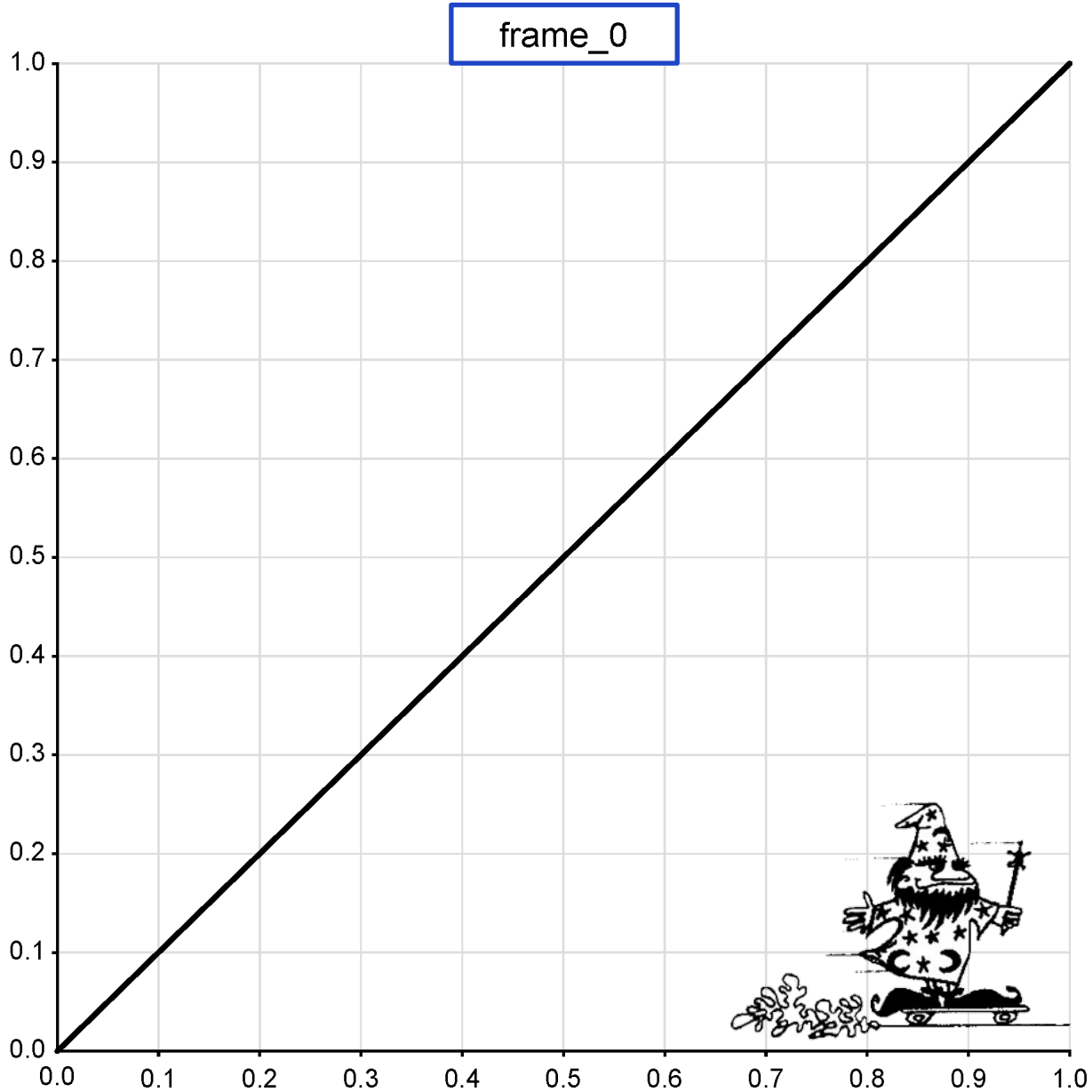
Visualization

- **Animation** shows the optimization process at work
- The initial curves are **linear**
- In this example, optimization required **145** iterations



Visualization

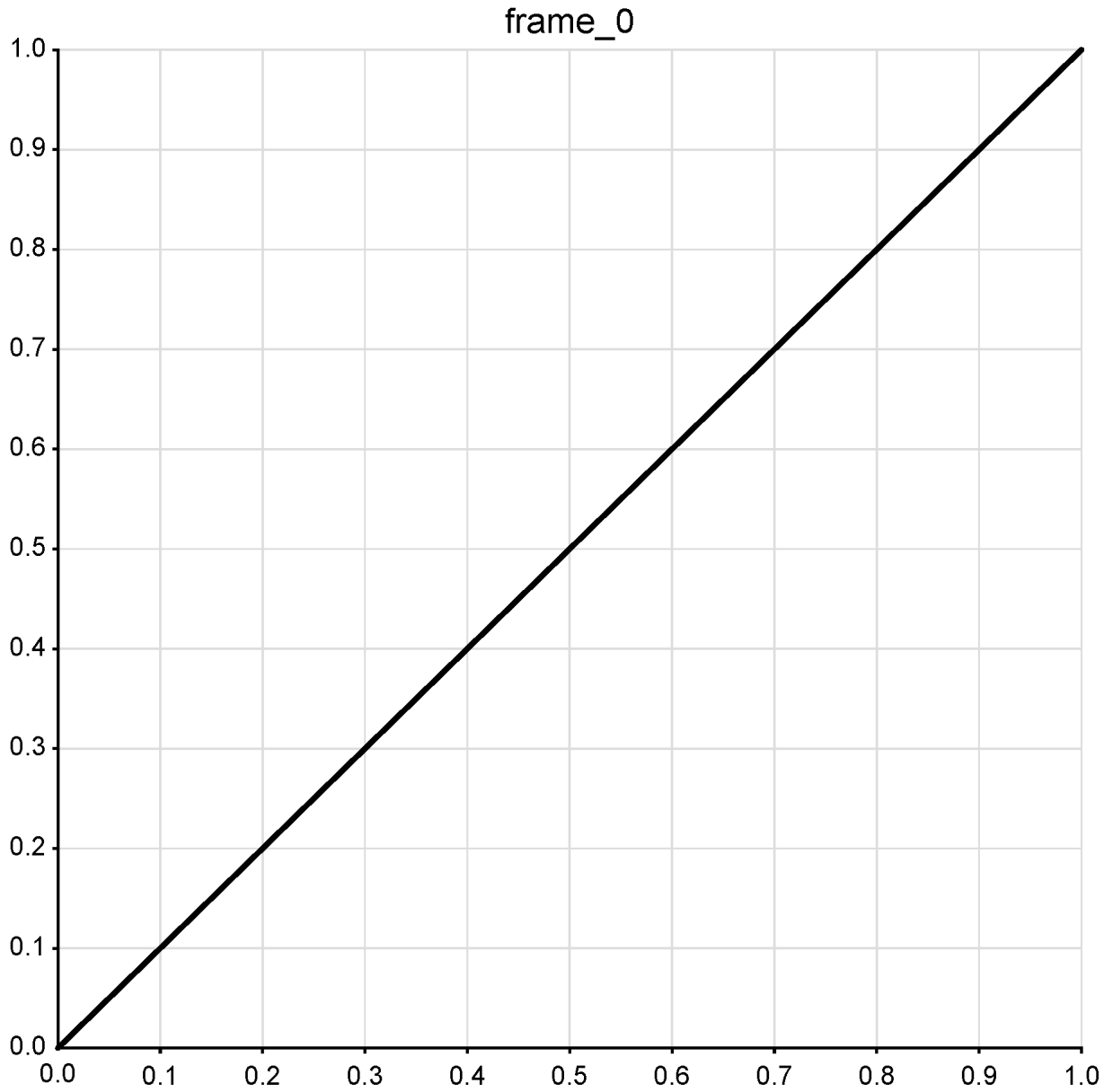
- **Animation** shows the optimization process at work
- The initial curves are **linear**
- In this example, optimization required **145** iterations



OPTIMAL METHOD

Visualization

- **Animation** shows the optimization process at work
- The initial curves are **linear**
- In this example, optimization required **145** iterations



OPTIMAL METHOD

Properties

- **Any** printing process
- **Any** number of inks
- **Any** gray balance
- **Any** tonality

Flexibility

Properties

- **Any** printing process
- **Any** number of inks
- **Any** gray balance
- **Any** tonality

Digital

Offset

Flexo

Gravure

Properties

- **Any** printing process
- **Any** number of inks
- **Any** gray balance
- **Any** tonality

Digital

CMYK Offset

Flexo RGB

CMYKOGV

Gravure

Properties

- **Any** printing process
- **Any** number of inks
- **Any** gray balance
- **Any** tonality

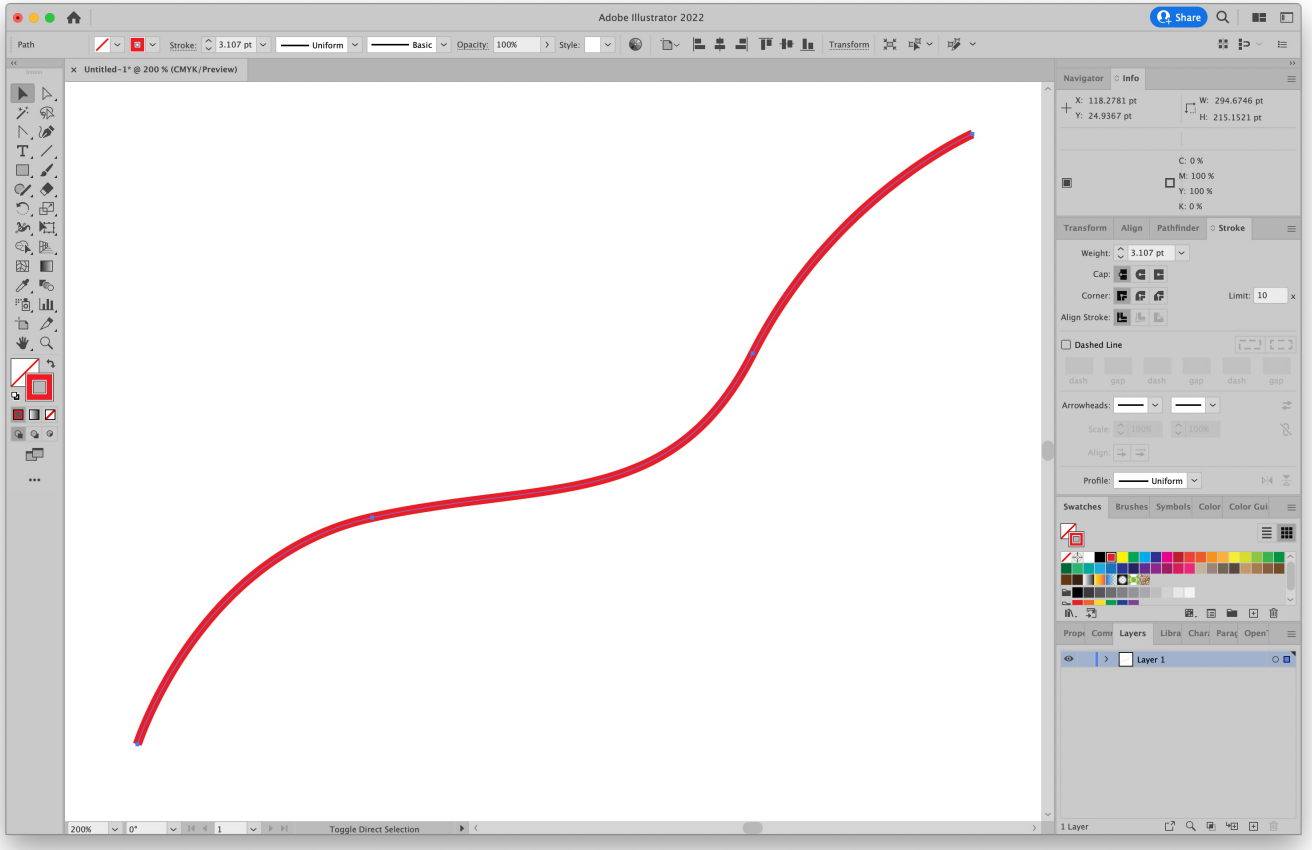
GRACoL2013_CRPC6.icc

PSOcoated_v3.icc

My_CMYKOGV_Profile.icc

Properties

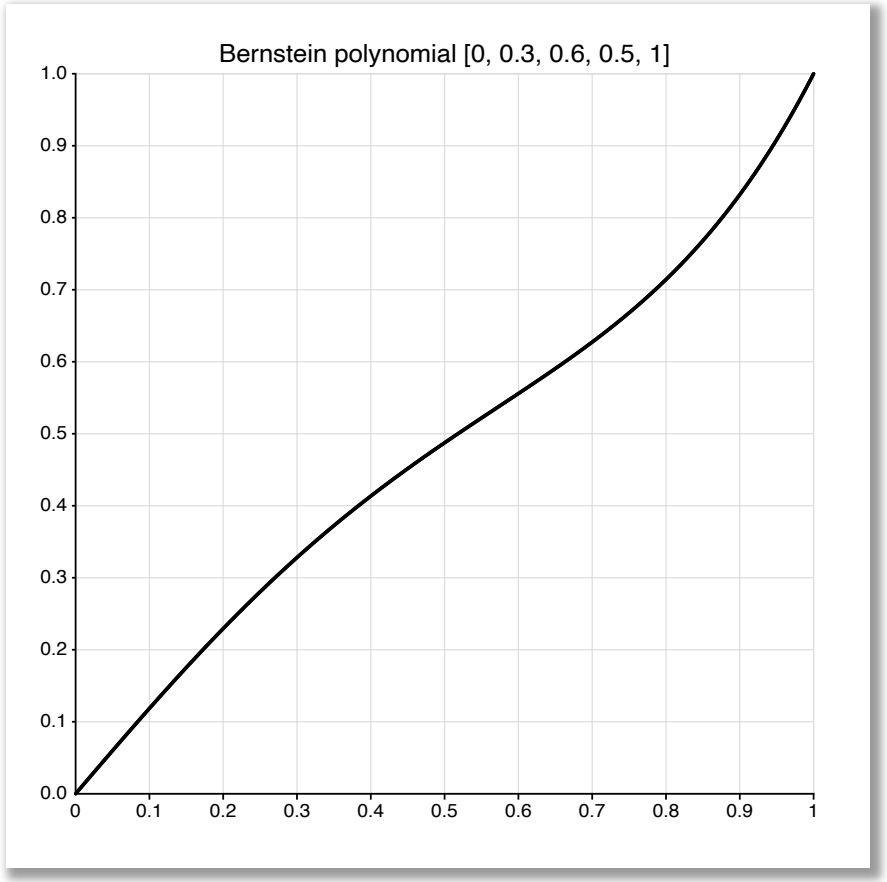
- Creates **vector** curves
- Curves are always **smooth**
- Adjustable curve **complexity**



OPTIMAL METHOD

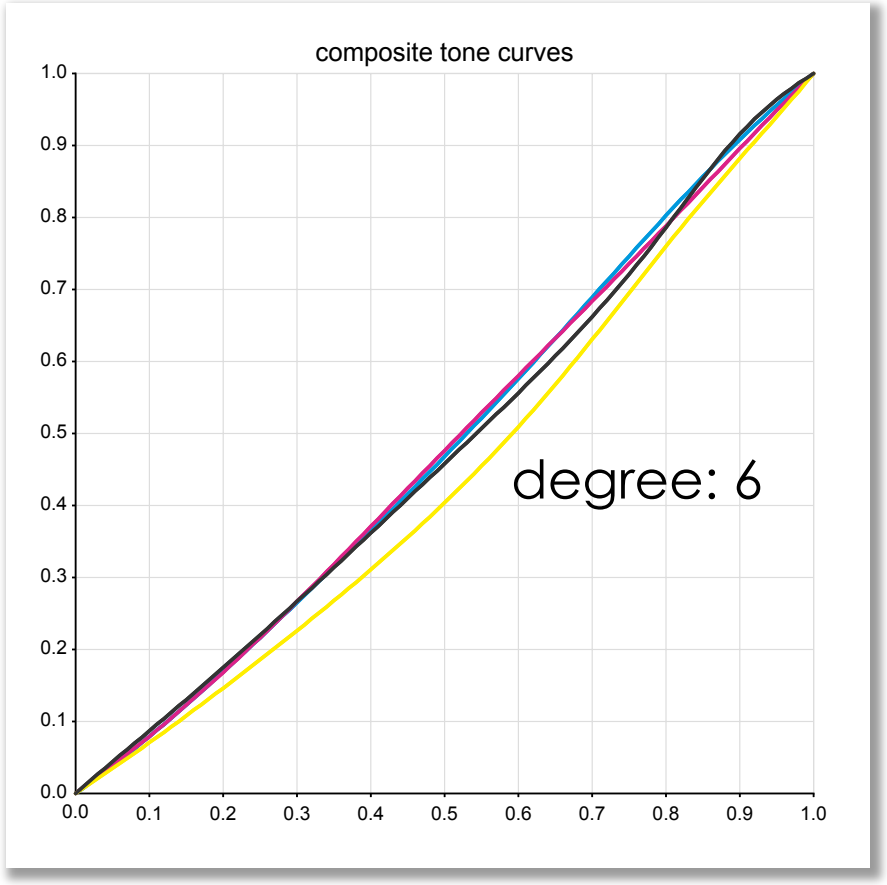
Properties

- Creates **vector** curves
- Curves are always **smooth**
- Adjustable curve **complexity**



Properties

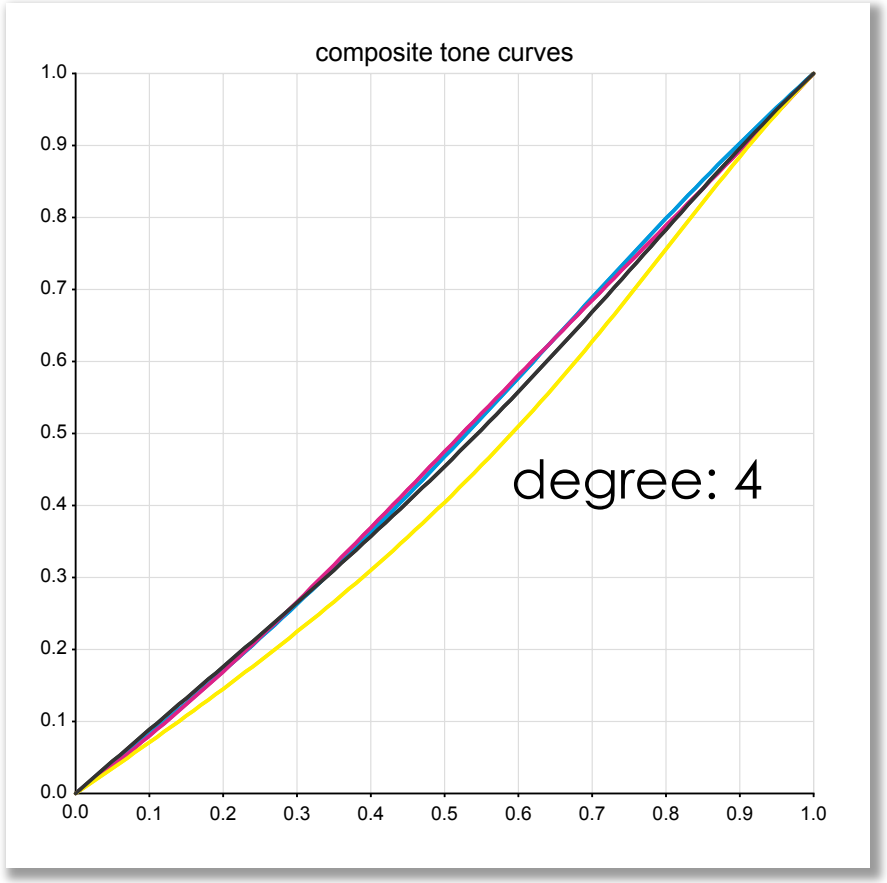
- Creates **vector** curves
- Curves are always **smooth**
- Adjustable curve **complexity**



OPTIMAL METHOD

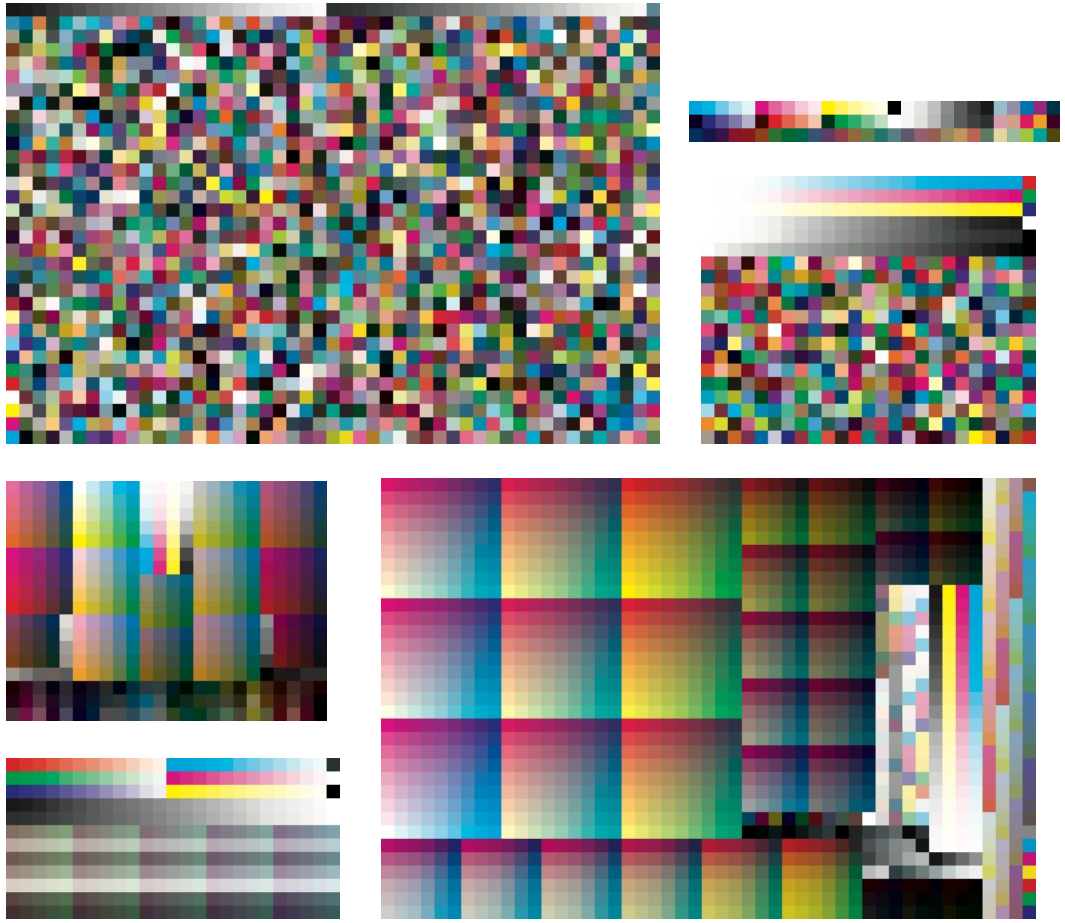
Properties

- Creates **vector** curves
- Curves are always **smooth**
- Adjustable curve **complexity**



Properties

- **Any** sample set
- Samples may contain **any mixture of inks**
- Accounts for the effects of **UCR/GCR**
- Accounts for ink **trapping variations**

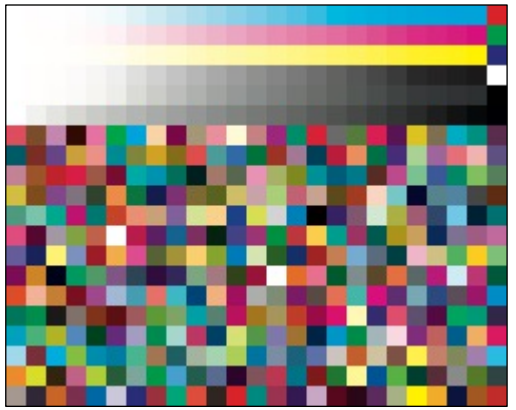


Properties

- **Any** sample set
- Samples may contain **any mixture of inks**
- Accounts for the effects of **UCR/GCR**
- Accounts for ink **trapping variations**

TVI/SCTV

Near-Neutral



Optimal

OPTIMAL METHOD

Properties

- **Any** sample set
- Samples may contain **any mixture of inks**
- Accounts for the effects of **UCR/GCR**
- Accounts for ink **trapping variations**

CMY gray scale				L*a*b* values			CMYK gray scale			
C	M	Y	K	L*	a*	b*	C	M	Y	K
0	0	0	0	95.0	1.0	-4.0	0.0	0.0	0.0	0.0
2	1.5	1.5	0	93.3	1.2	-3.8	2.0	1.5	1.5	0.0
4	3	3	0	91.7	1.3	-3.7	4.0	2.9	3.0	0.0
6	4.5	4.5	0	90.1	1.2	-3.6	6.0	4.4	4.5	0.0
8	6	6	0	88.5	1.1	-3.5	8.0	5.9	6.0	0.0
10	7.5	7.5	0	86.9	1.1	-3.5	10.0	7.4	7.5	0.0
15	11.2	11.2	0	83.0	0.9	-3.2	15.0	11.2	11.2	0.0
20	15	15	0	79.1	0.8	-3.1	20.0	15.0	15.0	0.0
25	18.9	18.9	0	75.4	0.8	-2.9	24.8	18.7	18.7	0.3
30	22.8	22.8	0	71.8	0.7	-2.7	29.0	22.0	22.1	1.3
35	26.9	26.9	0	68.2	0.6	-2.6	32.7	25.1	25.2	2.9
40	31.1	31.1	0	64.6	0.6	-2.3	36.2	28.0	28.1	5.3
45	35.5	35.5	0	61.0	0.5	-2.2	39.4	30.8	30.9	8.0
50	40	40	0	57.5	0.4	-2.1	42.5	33.5	33.7	11.2
55	44.7	44.7	0	53.9	0.3	-1.9	45.6	36.3	36.5	14.7
60	49.7	49.7	0	50.3	0.2	-1.8	48.6	39.2	39.5	18.5
65	54.9	54.9	0	46.6	0.2	-1.5	51.7	42.4	42.8	22.7
70	60.4	60.4	0	43.0	0.3	-1.1	54.8	45.6	46.2	27.1
75	66.1	66.1	0	39.3	0.3	-0.7	57.7	48.8	49.6	32.3
80	72.2	72.2	0	35.7	0.3	-0.3	60.4	51.7	52.8	38.5
85	78.6	78.6	0	32.2	0.3	0.0	62.7	54.6	55.7	45.3
90	85.3	85.3	0	28.8	0.4	0.2	64.8	57.3	58.4	52.4
95	92.5	92.5	0	25.6	0.0	0.0	67.5	59.4	60.5	59.5
98	96.9	96.9	0	23.9	0.0	-0.0	68.9	60.8	61.6	63.5
100	100	100	0	23.0	0.0	-0.0	69.5	61.5	62.3	65.7
				20.0	0.0	0.0	71.6	63.9	64.1	73.0
				17.0	0.0	0.0	73.3	65.9	65.0	80.6
				14.0	0.0	0.0	75.3	68.2	65.4	88.4
				11.0	0.0	0.0	78.2	70.8	64.5	96.1

Properties

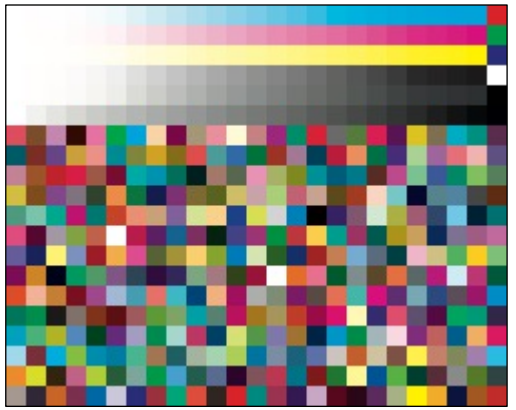
- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements

100 samples

TVI/SCTV

50 samples

Near-Neutral



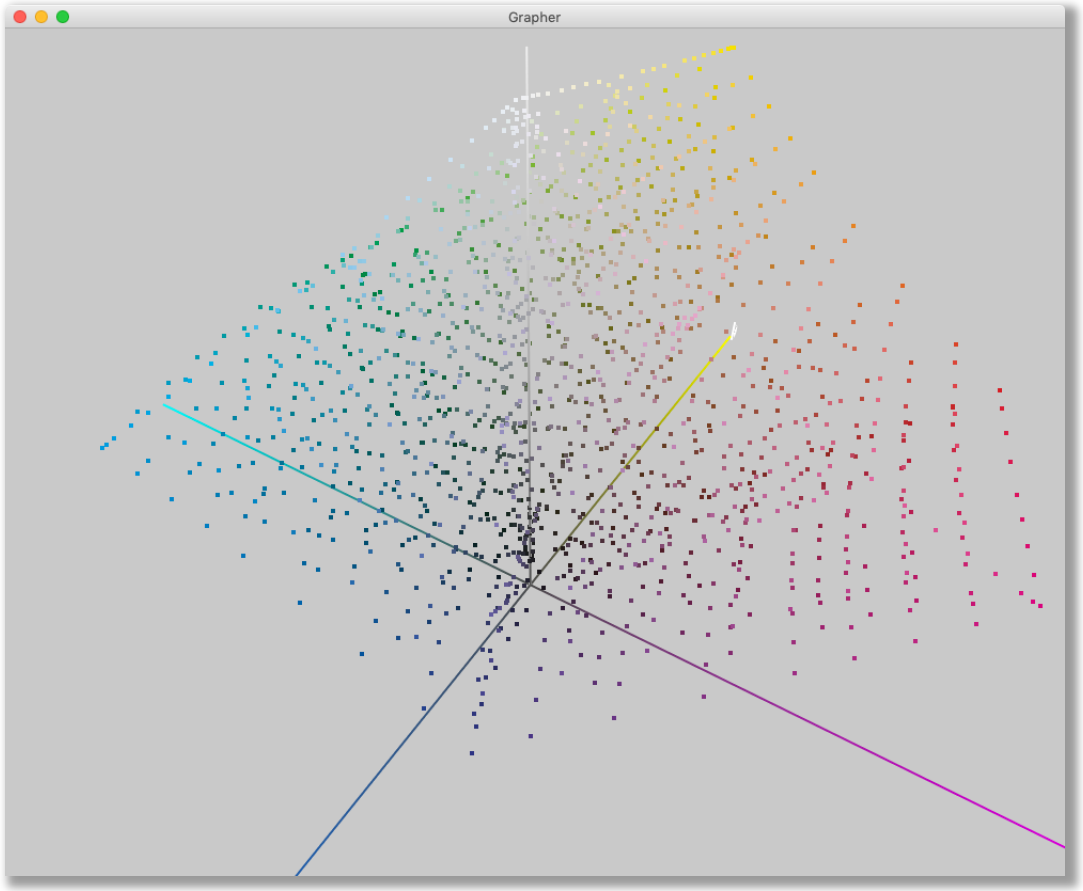
300 -1000 samples

Optimal

OPTIMAL METHOD

Properties

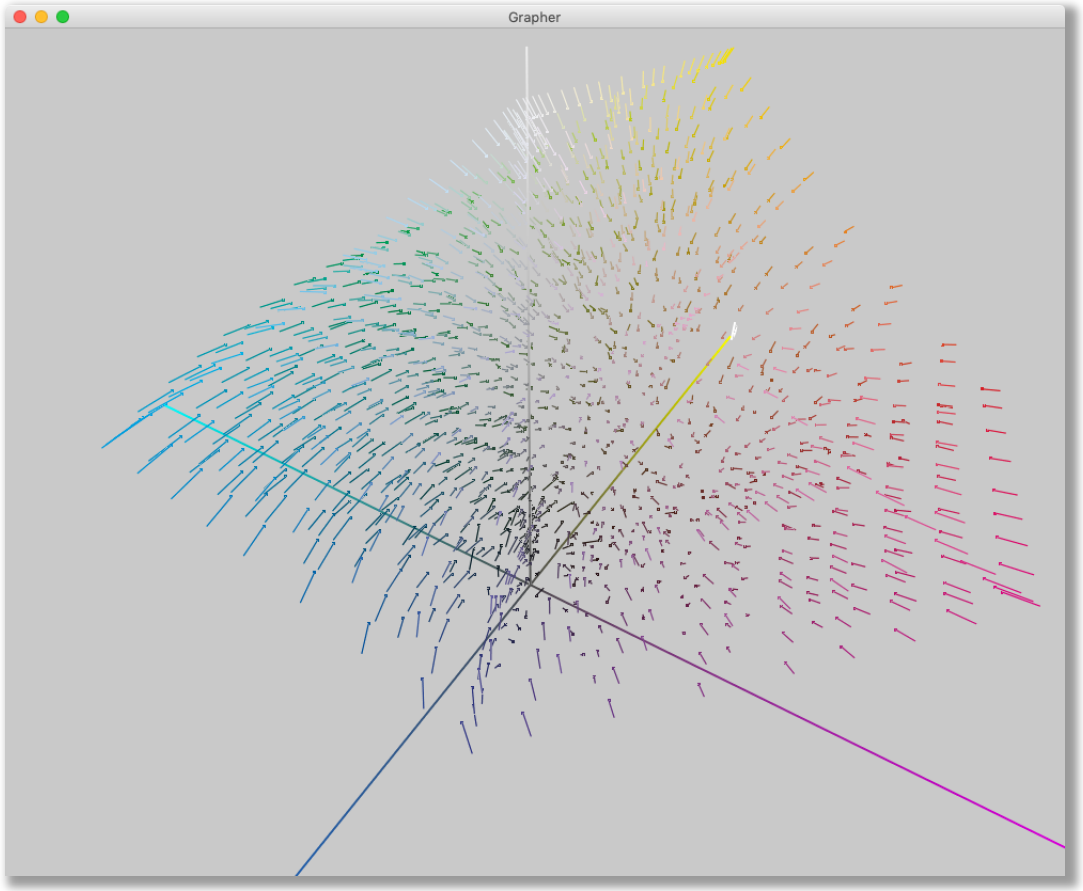
- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements



OPTIMAL METHOD

Properties

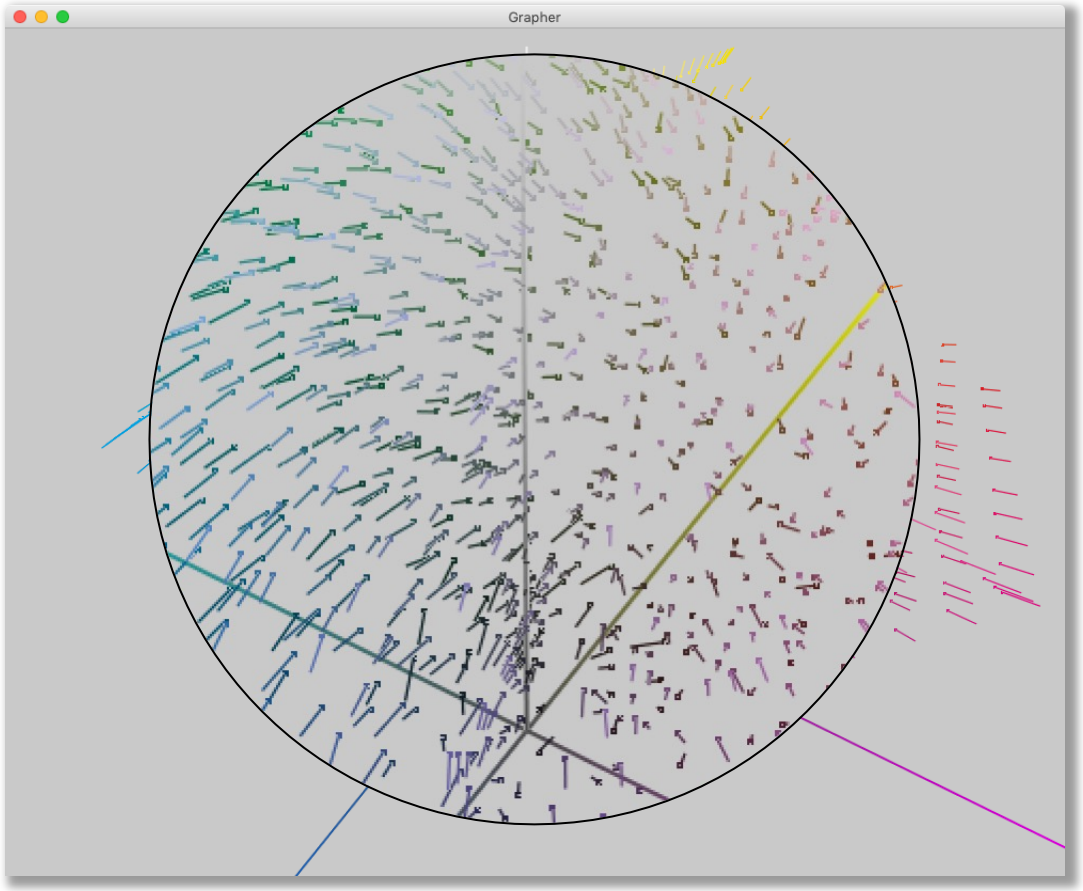
- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements



OPTIMAL METHOD

Properties

- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements



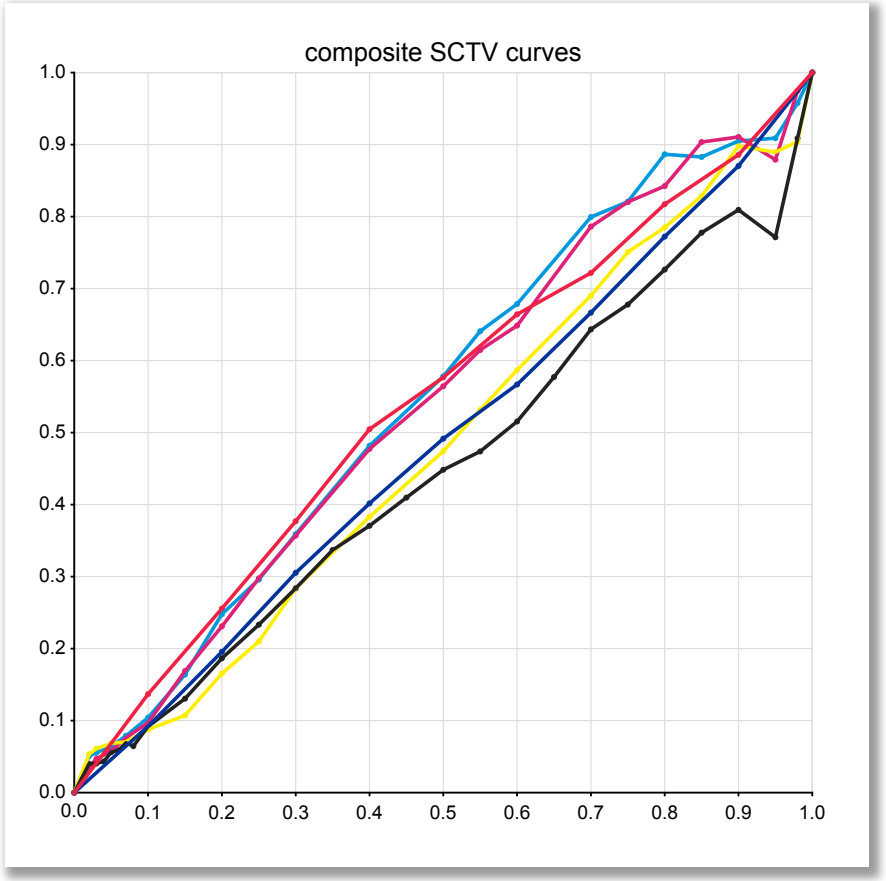
OPTIMAL METHOD

Properties

- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements

Properties

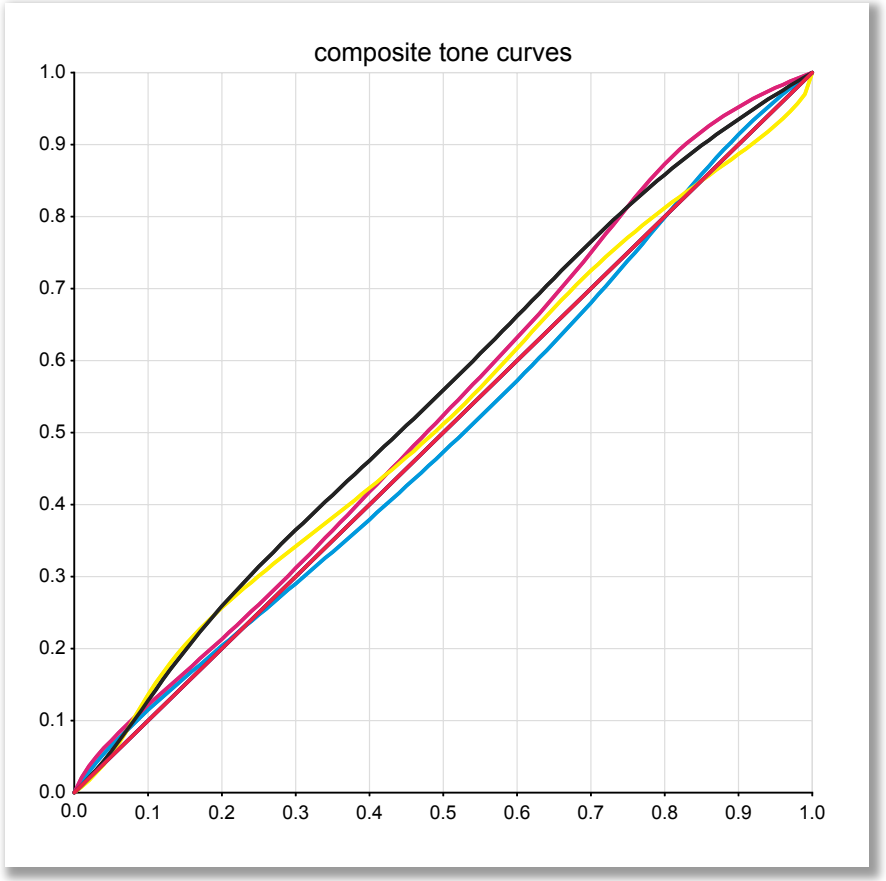
- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements



OPTIMAL METHOD

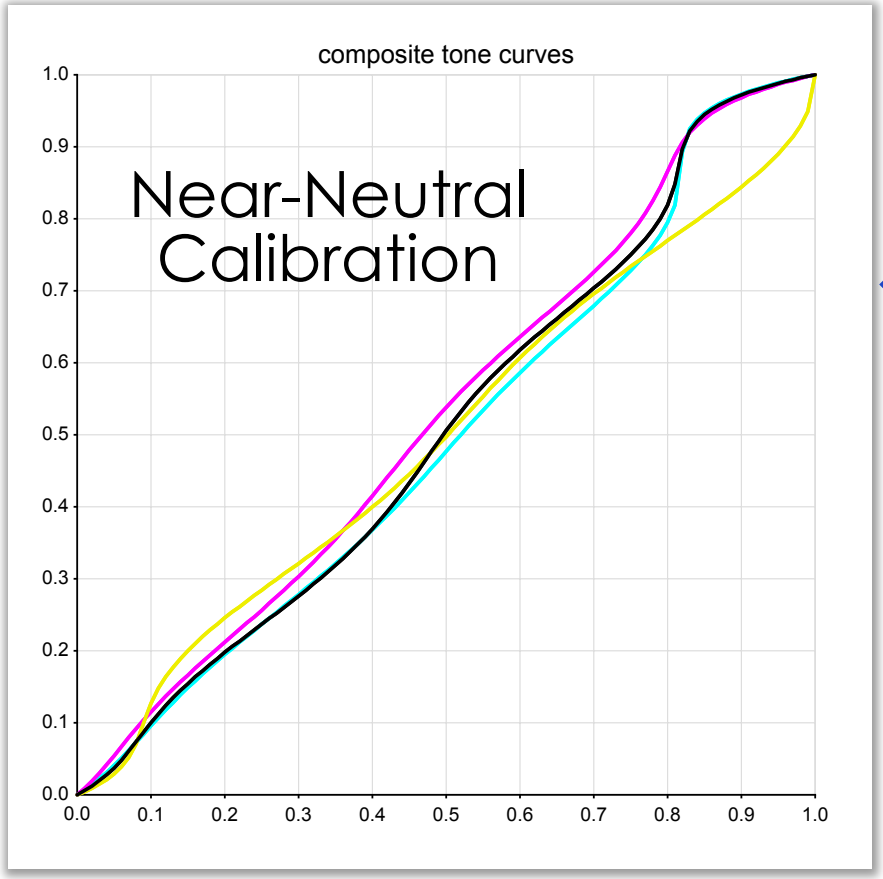
Properties

- **Robust** (no surprises or failures)
- **Smooths** process and measurement variations
- **Small impact** from bad or missing sample measurements

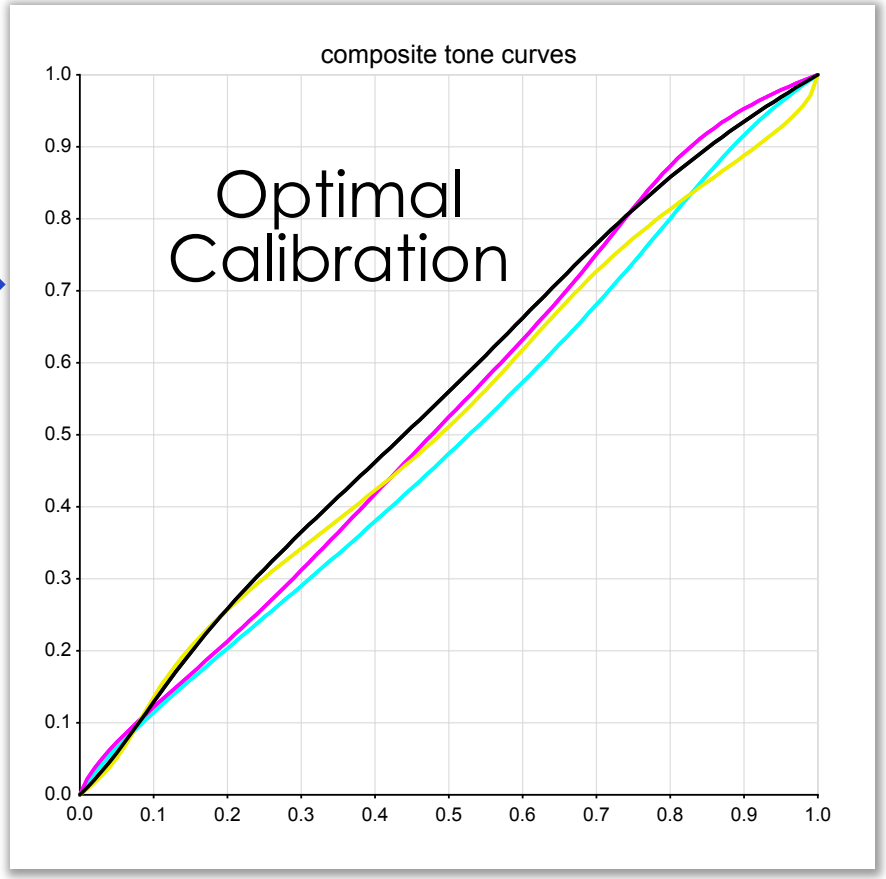


OPTIMAL METHOD

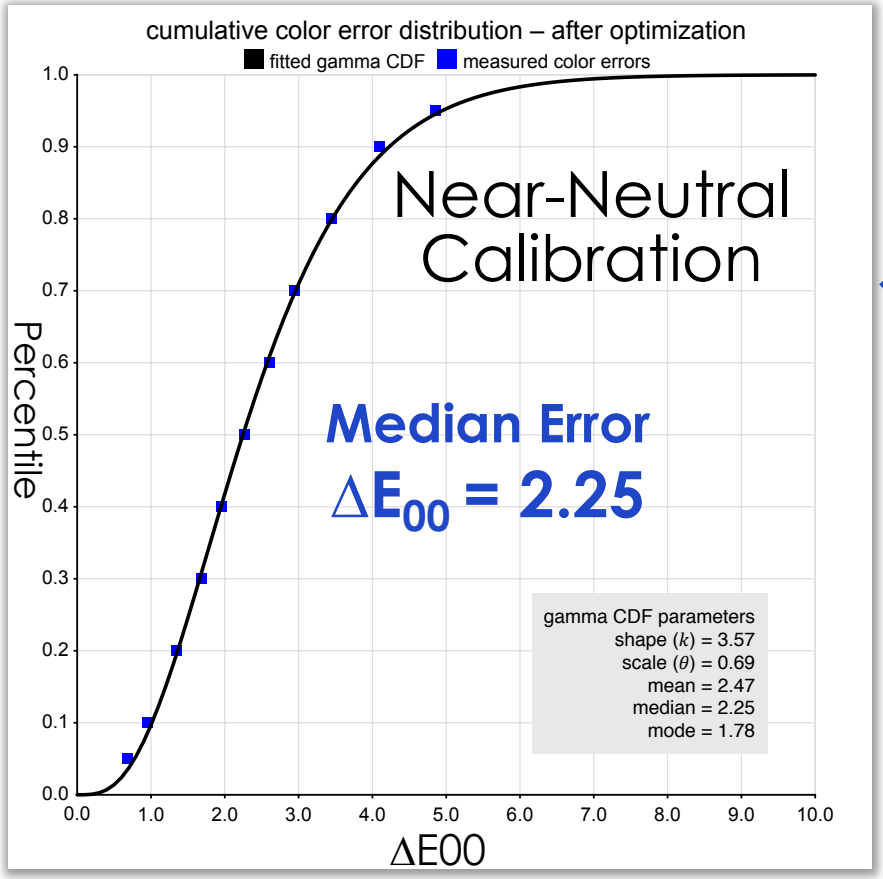
Tone Curve Comparison



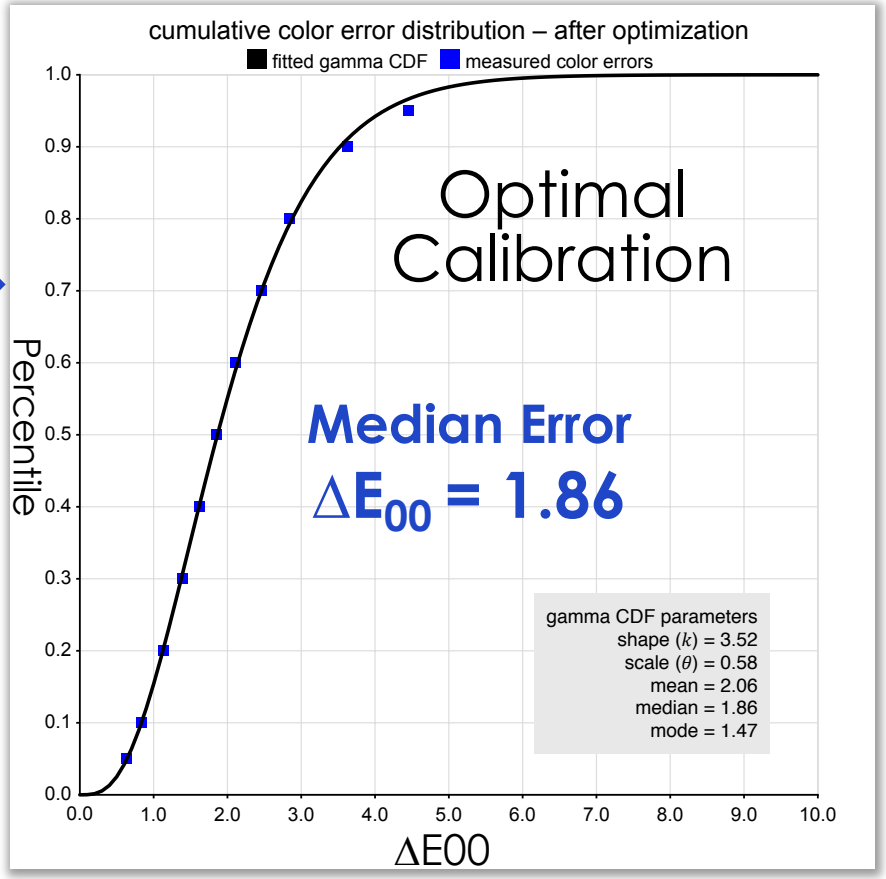
SAME
Flexo Press Data



Color Error Comparison



SAME
Flexo Press Data

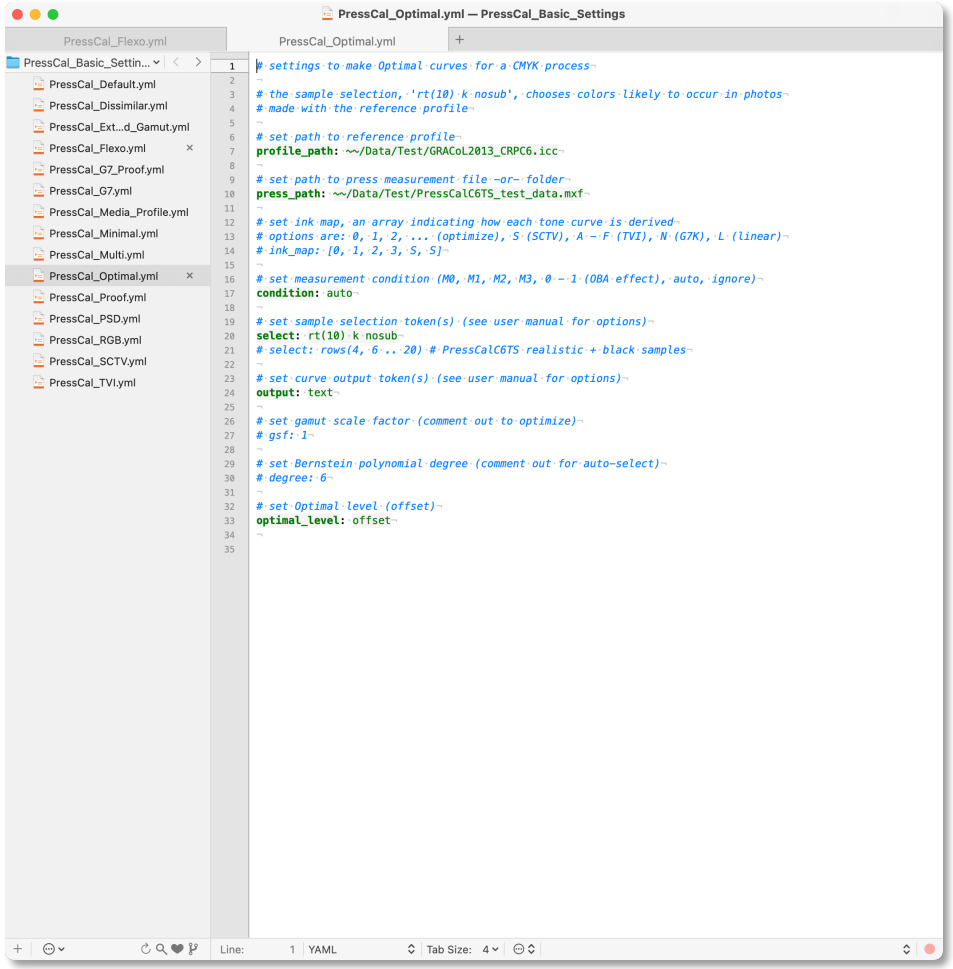


Prepress Simplified

- The **color match** to reference proofs is **surprisingly good**
- The reference **color gamut** is mapped to the press
- No **unwanted colors** are introduced
- No **color management artifacts** are introduced
- **Simplifies** prepress work
- **Reduces** the likelihood of prepress **errors**

PressCal

- Free software implementing the Optimal Method
- Open source, GPL license, actively developed and maintained
- Powerful optimization engine to perform the complex calculations



OPTIMAL METHOD

PressCal

- Free software implementing the Optimal Method
- Open source, GPL license, actively developed and maintained
- Powerful optimization engine to perform the complex calculations

PressCal

- Free software implementing the Optimal Method
- Open source, GPL license, actively developed and maintained
- Powerful optimization engine to perform the complex calculations

Levenberg-Marquardt algorithm levmar C/C++ library linked to macOS Accelerate framework

PressCal Demo

- We've described the Optimal method and its properties. Now we'll show you our software implementation, which has many features for flexo users.

Supports *FIRST*

Using measurements from the fingerprinting press run, PressCal will generate:

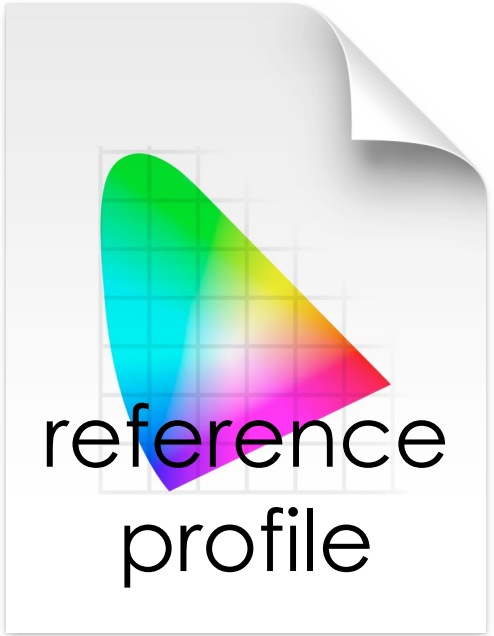
- **Tone curves** to calibrate against a reference profile
- **Process control data** (L*a*b*, SCTV, density, M-D, TVI)
- **Curve-adjusted data set** to build a characterization profile

This could save time and money

(For more info, see **appendix H** of ***FIRST*** 7.0)

Calibration Scenarios

- Calibrate **re-runs** to original reference profile
- Calibrate **multiple presses** to common reference profile
- Calibrate **different facilities** to common reference profile
- Calibrate **different substrates** to common reference profile



Contact Info

The Optimal Method **web site** contains software downloads and extensive background information.

Feel free to contact us via **e-mail**

Chuck.Spontelli@colortuneup.com

csponte@bgsu.edu

wbirkett@doplganger.com

OPTIMAL METHOD

https://optimalmethod.org