Generic Matching Tool

William B. Birkett
Charles Spontelli

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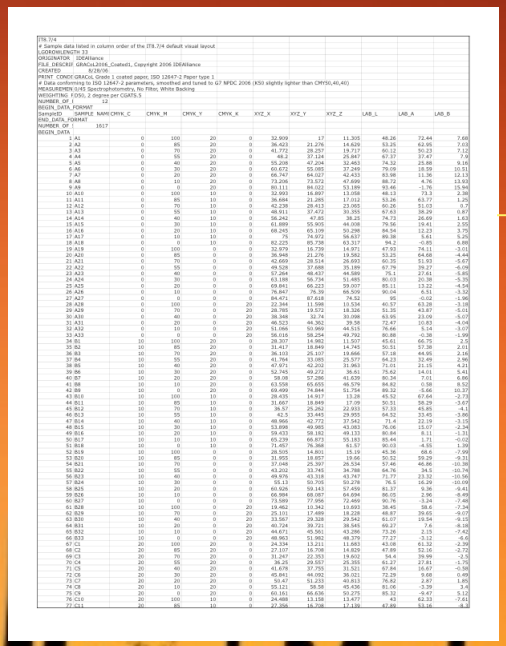
Resolution 304
ISO/TC130 authorizes its Secretariat to distribute a NWI ballot for a Technical Specification with the title of "*Graphic technology - Method for calibration of a printing system with digital data*" and to include as part of that ballot the acceptance of the associated draft for distribution as DIS (effectively a CD ballot) based on a document to be provided by WG3. This document will include three methods, which are generally identified as 1) using tone value increase, 2) using near neutral scales, and 3) using ICC (device link) profiles.

Dave McDowell:

- Create a software tool to make tone curves from characterization data, based on near-neutral tone scales.
- The tool should be freely available so that anyone can test the methods we are investigating.

Generic Matching Tool Concept

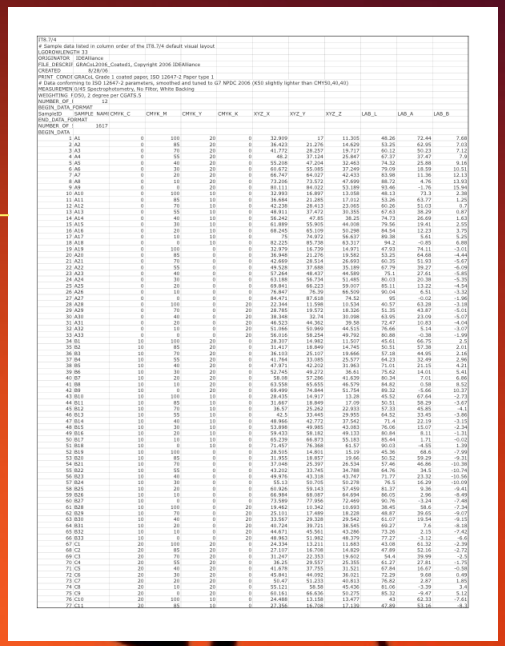
Reference Data Set



Generic Matching Tool

Tone Curves

Matched Data Set



Matching with Near-Neutral Tone Scales (TRAND Method)

- The TRAND method was developed in 1972 by Brent Archer and Zenon Elyjiw at RIT.
- At the time, tone curves were used to calibrate drum scanners.
- The TRAND method was revived in 2005 by Idealliance and called “G7 methodology”.
- Now, with CtP, tone curves are applied in platemaking.

Technical Advances Make TRAND Method Practical

- In 1972, curves were plotted by hand on graph paper - slow and inaccurate.
- In 2006, computers do the work.
- In 1972, neutral balance was determined visually.
- In 2006, we have automated spectrophotometers to measure color.

GMT Function - TRAND

- Calculate corresponding gray scales for the reference and matched data sets.
- Paper colors may differ, so we use xyz scaling to build gray scales.
- Gray is defined as in ICC relative colorimetry (relative to paper white).

GMT Function - TRAND

GMT_Sample_Output_v2.txt **Page 1 of 1**
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CGATS/ISO Generic Matching Tool

reference: SWOP2006_Coated5.txt

--transformed--			gray
L*	a*	b*	L*
90.1	-0.0	4.1	100.0
85.5	-0.0	4.0	95.0
80.9	-0.0	3.8	90.0
76.3	-0.0	3.6	85.0
71.8	-0.0	3.4	80.0
67.2	-0.0	3.2	75.0
62.6	-0.0	3.1	70.0
58.1	-0.0	2.9	65.0
53.5	-0.0	2.7	60.0
48.9	-0.0	2.5	55.0
44.3	-0.0	2.4	50.0
39.8	-0.0	2.2	45.0
35.2	-0.0	2.0	40.0
30.6	-0.0	1.8	35.0
26.1	-0.0	1.6	30.0
21.5	-0.0	1.5	25.0

matched: TR001_Lab.txt

--transformed--		
L*	a*	b*
88.7	-0.3	3.6
84.2	-0.3	3.5
79.6	-0.3	3.3
75.1	-0.3	3.2
70.6	-0.3	3.0
66.1	-0.3	2.9
61.6	-0.3	2.7
57.1	-0.2	2.5
52.6	-0.2	2.4
48.1	-0.2	2.2
43.6	-0.2	2.1
39.0	-0.2	1.9
34.5	-0.2	1.8
30.0	-0.2	1.6
25.5	-0.1	1.4
21.0	-0.1	1.3

GMT Function - TRAND

- Load both data sets.
- Build CMY 3-D arrays from each.
- For each gray scale value, locate its bounding pyramid in the corresponding 3-D array.
- Compute the Jacobian matrix.
- Interpolate the CMY values.

GMT Function - TRAND

GMT_Sample_Output_v2.txt **Page 1 of 1**
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CGATS/ISO Generic Matching Tool

reference: SWOP2006_Coated5.txt matched: TR001_Lab.txt

--reference--			--transformed--			gray	--transformed--			--matched--		
C	M	Y	L*	a*	b*	L*	L*	a*	b*	C	M	Y
0.0	0.0	0.0	90.1	-0.0	4.1	100.0	88.7	-0.3	3.6	0.0	0.0	0.0
5.6	3.9	4.7	85.5	-0.0	4.0	95.0	84.2	-0.3	3.5	5.0	3.7	3.9
11.7	8.6	9.5	80.9	-0.0	3.8	90.0	79.6	-0.3	3.3	9.5	7.9	8.3
18.0	13.3	14.6	76.3	-0.0	3.6	85.0	75.1	-0.3	3.2	16.1	12.3	13.3
24.3	18.7	20.1	71.8	-0.0	3.4	80.0	70.6	-0.3	3.0	23.8	18.0	18.6
30.8	23.9	25.4	67.2	-0.0	3.2	75.0	66.1	-0.3	2.9	30.6	23.2	23.9
37.5	29.5	31.2	62.6	-0.0	3.1	70.0	61.6	-0.3	2.7	36.6	28.9	28.8
44.4	35.5	37.1	58.1	-0.0	2.9	65.0	57.1	-0.2	2.5	42.5	35.0	35.6
51.2	42.4	43.6	53.5	-0.0	2.7	60.0	52.6	-0.2	2.4	49.7	41.8	42.4
58.9	49.0	50.0	48.9	-0.0	2.5	55.0	48.1	-0.2	2.2	57.5	48.9	49.2
66.0	56.9	58.0	44.3	-0.0	2.4	50.0	43.6	-0.2	2.1	65.0	57.8	57.1
73.6	64.9	65.7	39.8	-0.0	2.2	45.0	39.0	-0.2	1.9	72.9	66.7	67.1
81.2	73.9	75.2	35.2	-0.0	2.0	40.0	34.5	-0.2	1.8	81.7	75.9	76.6
89.3	83.8	86.7	30.6	-0.0	1.8	35.0	30.0	-0.2	1.6	90.3	85.2	86.6
97.5	96.3	100.1	26.1	-0.0	1.6	30.0	25.5	-0.1	1.4	99.0	96.6	99.2
104.9	109.3	114.2	21.5	-0.0	1.5	25.0	21.0	-0.1	1.3	107.6	108.1	111.9

GMT Function - TRAND

- Black printer is computed separately.
- L* values are interpolated to %-dot values.

GMT Function - TRAND

44.4	35.5	37.1	58.1	-0.0	2.9	65.0	57.1	-0.2	2.5	42.5	35.0	35.6
51.2	42.4	43.6	53.5	-0.0	2.7	60.0	52.6	-0.2	2.4	49.7	41.8	42.4
58.9	49.0	50.0	48.9	-0.0	2.5	55.0	48.1	-0.2	2.2	57.5	48.9	49.2
66.0	56.9	58.0	44.3	-0.0	2.4	50.0	43.6	-0.2	2.1	65.0	57.8	57.1
73.6	64.9	65.7	39.8	-0.0	2.2	45.0	39.0	-0.2	1.9	72.9	66.7	67.1
81.2	73.9	75.2	35.2	-0.0	2.0	40.0	34.5	-0.2	1.8	81.7	75.9	76.6
89.3	83.8	86.7	30.6	-0.0	1.8	35.0	30.0	-0.2	1.6	90.3	85.2	86.6
97.5	96.3	100.1	26.1	-0.0	1.6	30.0	25.5	-0.1	1.4	99.0	96.6	99.2
104.9	109.3	114.2	21.5	-0.0	1.5	25.0	21.0	-0.1	1.3	107.6	108.1	111.9

--reference--	--transformed--			gray	--transformed--			--matched--
K	L*	a*	b*	L*	L*	a*	b*	K
0.0	90.1	-0.0	4.1	100.0	88.7	-0.3	3.6	0.0
6.8	85.5	-0.0	4.0	95.0	84.2	-0.3	3.5	4.2
13.9	80.9	-0.0	3.8	90.0	79.6	-0.3	3.3	12.2
20.8	76.3	-0.0	3.6	85.0	75.1	-0.3	3.2	19.3
27.7	71.8	-0.0	3.4	80.0	70.6	-0.3	3.0	25.9
34.6	67.2	-0.0	3.2	75.0	66.1	-0.3	2.9	32.4
41.5	62.6	-0.0	3.1	70.0	61.6	-0.3	2.7	39.6
48.2	58.1	-0.0	2.9	65.0	57.1	-0.2	2.5	46.5
54.9	53.5	-0.0	2.7	60.0	52.6	-0.2	2.4	53.6
61.5	48.9	-0.0	2.5	55.0	48.1	-0.2	2.2	61.0
67.8	44.3	-0.0	2.4	50.0	43.6	-0.2	2.1	68.4
73.9	39.8	-0.0	2.2	45.0	39.0	-0.2	1.9	75.0
79.8	35.2	-0.0	2.0	40.0	34.5	-0.2	1.8	80.6
85.6	30.6	-0.0	1.8	35.0	30.0	-0.2	1.6	86.1
91.3	26.1	-0.0	1.6	30.0	25.5	-0.1	1.4	91.6
97.0	21.5	-0.0	1.5	25.0	21.0	-0.1	1.3	97.1
102.7	16.9	-0.0	1.3	20.0	16.5	-0.1	1.1	102.6

No ICC Profiles

- Note that all calculations are done directly from the data sets. No ICC profiles are needed.

Testing

- Numeric results from preliminary testing looked correct.
- Additional testing with ink jet proofs to confirm the results.
- Ink jet proofs are highly repeatable, which is important for matching tests.

Testing

- Made reference proof using GRACoL 2006 Paper Type 1 data set.
- Made matched proof using IPA 48Aps data set (a “G7 calibrated” press sheet).
- There were visually obvious differences between these proofs (good).

Testing

- Made a set of tone curves matching 48Aps to GRACoL 2006.
- Applied these tone curves to the test file, and made a third proof using the same 48Aps ink jet setup.

Test Results

- Gray balance of the matched proof was much closer to the reference.
- Overall match was generally improved.
- Problems in the rendering of flesh tones and darker colors.

Shadow Incongruence

- Problem areas are caused by “shadow incongruence” of the IPA press sheet.
- Incongruence means “different shape.”
- Measurements of the CMY overprint ramp don’t correspond to those of the individual C, M and Y ramps (in the shadows).

Shadow Incongruence

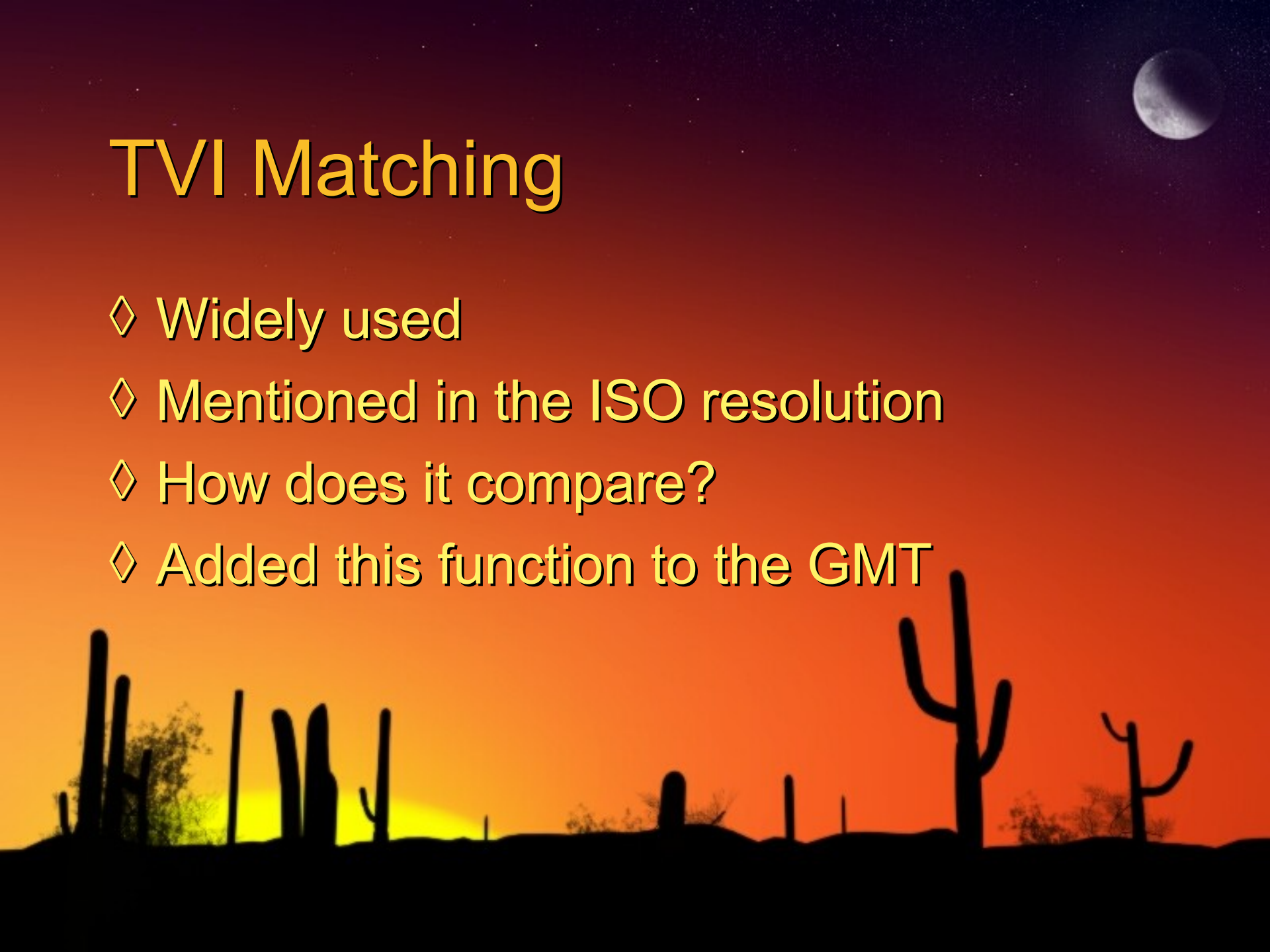
- Typically caused by imperfect trapping
- Frequently observed in real presswork
- The main problem in matching with near-neutral scales
- Take a good look at the test proofs to understand the phenomenon.

Process Incongruence

- Similar to shadow incongruence, but not confined to the shadows
- Example - Kodak Approval vs. a real press sheet
- Caused by optical effects

TVI Matching

- Widely used
- Mentioned in the ISO resolution
- How does it compare?
- Added this function to the GMT



GMT Function - TVI

- Based on tone ramps of individual process colors
- Spectral data is required to compute density values.
- With colorimetric data, we use XYZ values.

GMT Function - TVI

- Start with %-dot tone scale.
- Interpolate the calculated reflectance values to %-dot for each data set.
- With TVI matching, 0% maps to 0% and 100% maps to 100%.

GMT Function - TVI

GMT_Sample_TVI.txt **Page 1 of 1**
Printed: Friday, October 27, 2006 6:26:21 AM

CGATS/ISO Generic Matching Tool

reference: GRACoL2006_Beta04.txt matched: 48Aps.txt

--reference--					--matched--			
C	M	Y	K	Nominal	C	M	Y	K
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.1	3.1	3.0	2.6	5.0	4.2	2.8	3.1	2.8
6.3	6.2	6.0	5.3	10.0	6.6	6.6	4.7	5.8
9.6	9.5	9.0	8.1	15.0	9.7	8.8	8.0	7.4
13.0	12.8	12.1	11.0	20.0	12.6	11.6	11.1	9.6
16.7	16.3	15.4	14.0	25.0	15.8	14.8	15.2	12.2
20.5	19.9	18.9	17.2	30.0	19.6	18.0	17.9	14.9
24.3	23.5	22.6	20.5	35.0	23.4	21.5	21.2	17.7
28.3	27.2	26.5	24.1	40.0	26.9	25.7	25.3	21.0
32.4	31.2	30.5	27.8	45.0	30.3	28.3	28.8	25.4
36.8	35.3	34.8	31.8	50.0	34.5	32.6	33.1	28.3
41.5	39.7	39.1	36.1	55.0	38.9	38.1	37.5	31.5
46.3	44.4	43.6	40.5	60.0	43.4	42.8	41.8	34.9
51.5	49.4	48.4	45.2	65.0	48.0	47.2	46.2	39.2
56.8	54.5	53.5	50.3	70.0	53.2	52.0	50.5	44.6
62.5	60.0	59.1	55.9	75.0	58.2	56.8	55.2	50.3
68.4	65.8	65.1	62.0	80.0	63.8	61.4	60.8	55.2
74.6	72.1	71.5	68.5	85.0	70.4	68.4	67.0	61.6
81.4	79.0	78.4	76.3	90.0	79.9	76.7	74.1	70.1
89.7	87.7	87.0	85.7	95.0	91.3	86.3	81.8	79.0
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

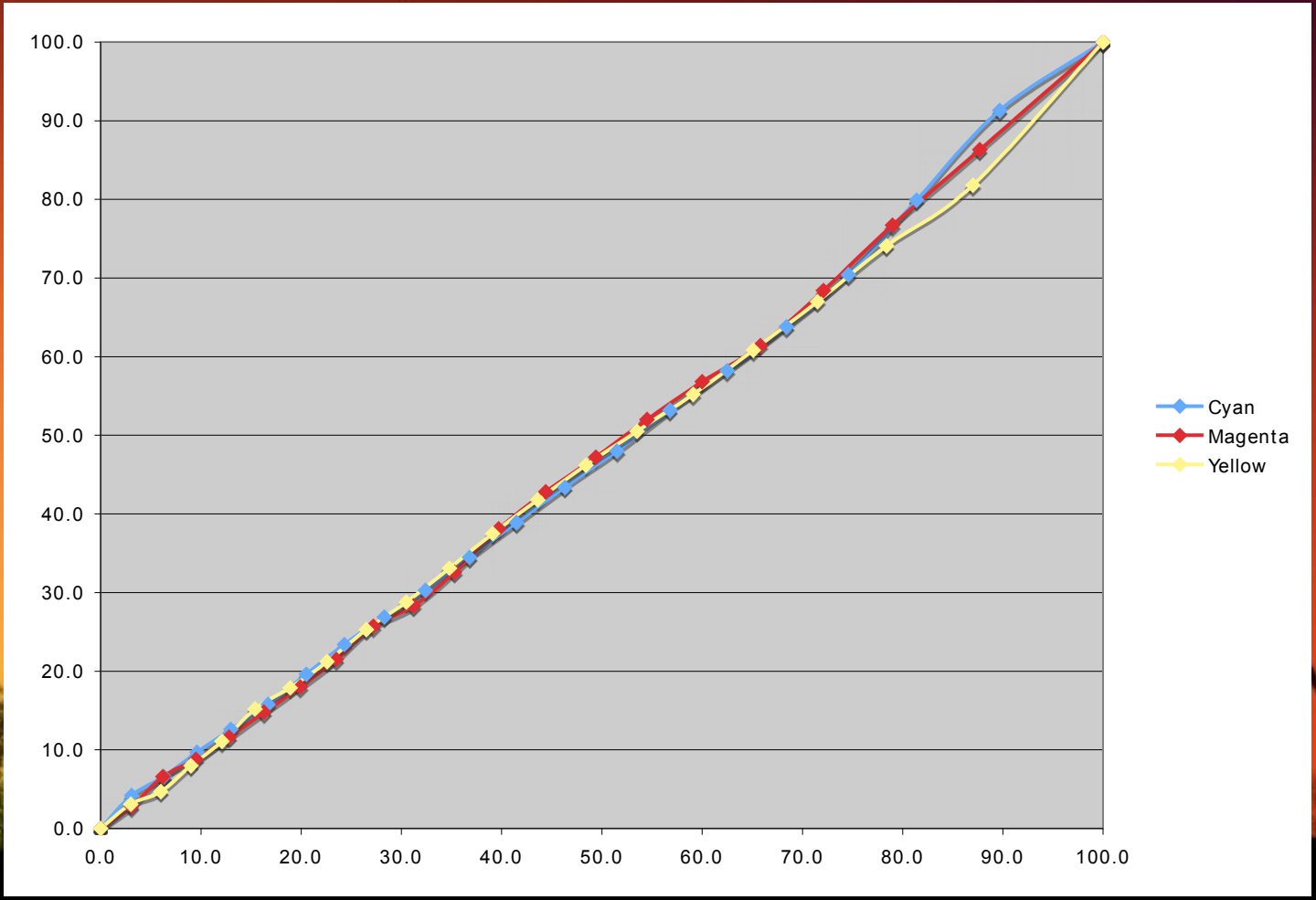
Test Results - TVI

- Applied the TVI-based tone curves to the test file.
- Made a fourth proof using the 48Aps ink jet setup.

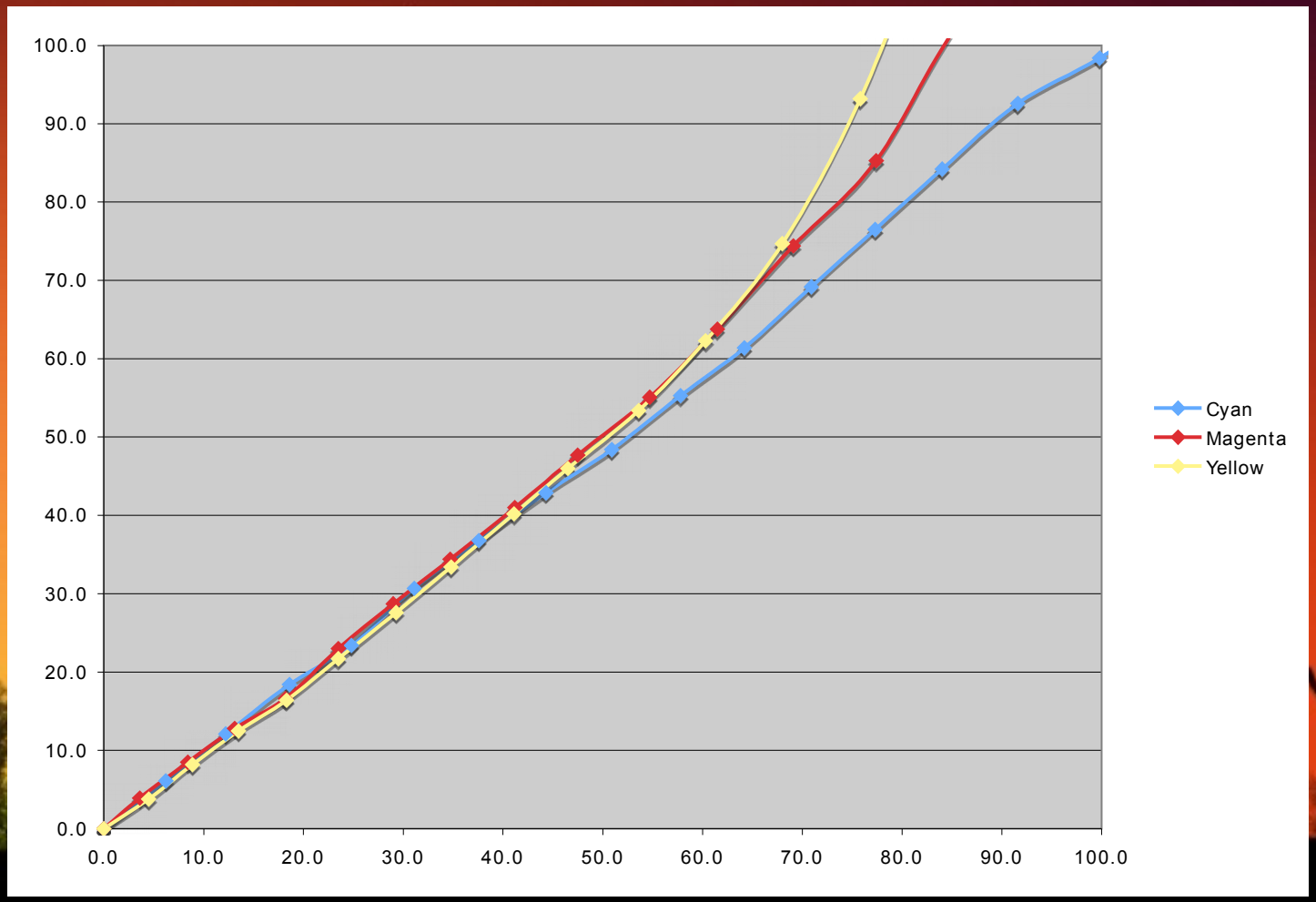
Test Results - TVI

- Gray balance is slightly inferior to the TRAND match.
- Flesh tones and darker colors are good.
- Overall, a respectable result.

Test Results (TVI)



Test Results (TRAND)



Gray Balance in the Pressroom

- Gray balance is easy to “trim” on press.
- Therefore, achieving correct gray balance by means of tone curves may not be all that important.
- When inking is fixed, achieving gray balance through calibration has greater importance.

Conclusions

- Calibration using the TRAND method has advantages when the process is congruent, and inking is fixed.
- European concerns about using the TRAND/G7 method for pressroom calibration are justified.

Conclusions

- Tone curves, being one-dimensional, are limited in what they can accomplish.
- Tone curves built from near-neutral ramps will favor neutral reproduction.
- Tone curves built from individual ramps seem to favor color reproduction.

Conclusions

- Can we create “optimal” tone curves?
- UCR makes gray balance of shadows largely independent of C, M and Y.
- Why not use tone curves that are “blended” from TRAND-style in the highlights to TVI-style in the shadows?

Conclusions

- TVI matching is not the only way to build tone curves from individual color ramps.
- There are better measures than density for building color-favoring curves.
- TVI matching implies a very crude style of tone compression.

Conclusions

- Neither of the calibration methods mentioned in ISO resolution 304 will produce optimal results.
- We have the opportunity to develop a better solution in cooperation with our European and Asian colleagues.