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Test Targets 10: A Collaborative effort exploring the use of scientific methods for color imaging and process control

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Test Targets

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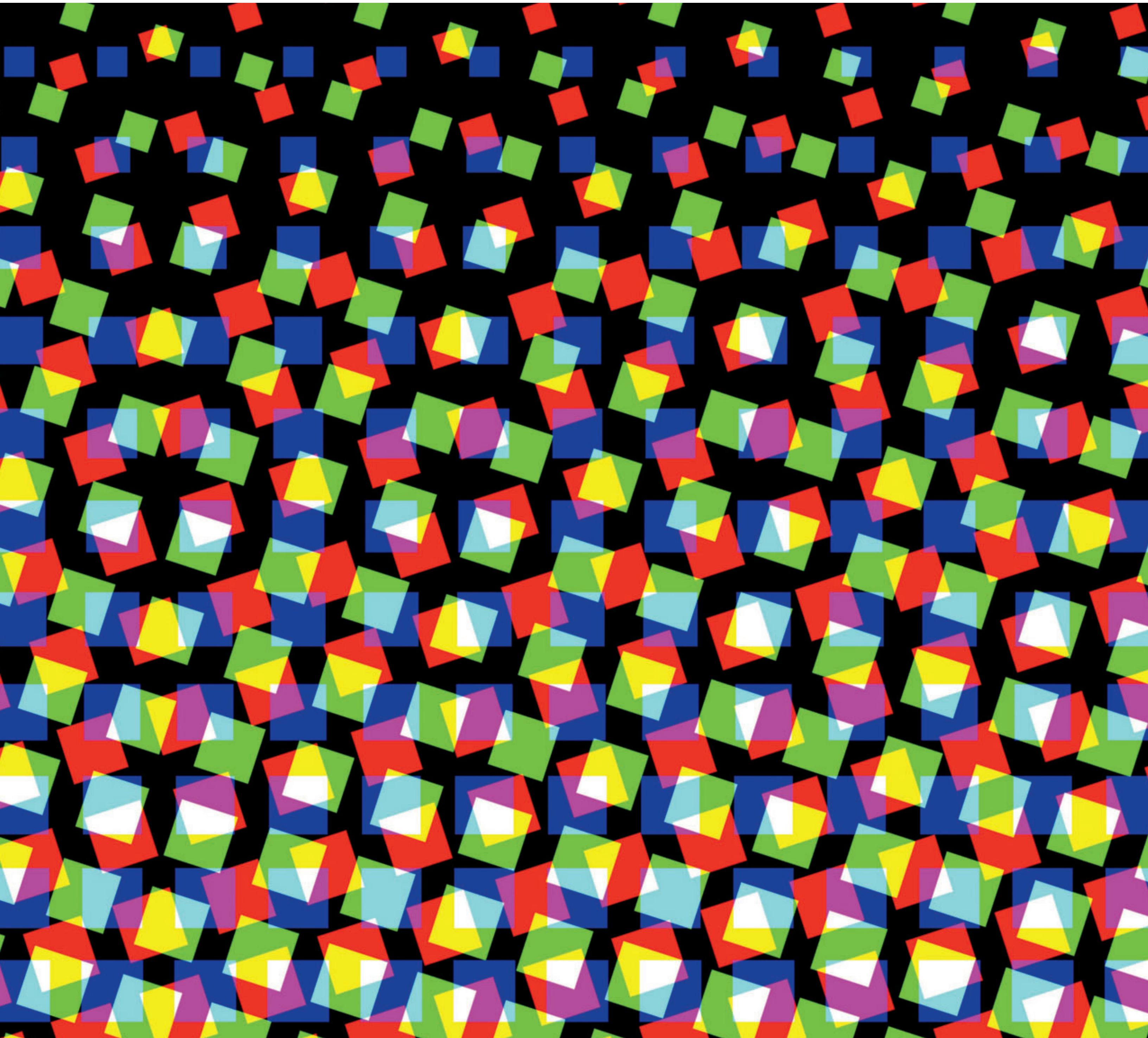

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Contents

Robert Chung

Test Targets, A Collectable

Welcome to *Test Targets 10,* published in 2011.

If you are new to *Test Targets*, this introduction offers background information about the publication as well as highlights, from content generation, pagination, graphic design, and project management in this issue.

If you are familiar with *Test Targets,* you can skip this article and go directly to any section of the publication. Enjoy!

1 Origin of Test Targets

The idea of *Test Targets* came from teaching and learning at RIT's School of Print Media. Initially, classroom learning was in the form of posters, oral presentations, and laboratory reports. The author thought, "Why not use a publication to capture print-related phenomenon that is evident and available to many?" The inaugural issue, *Test Targets 2.0,* was published in 2002 using an Indigo UltraStream 2000 electrophotographic press.

Test Targets has been a source of inspiration that drives teachers and students to be innovative. Those who have engaged in content creation and production management realize that these aspects are hard work. But there is a strong sense of gratification when the publication is held in one's hands fresh off the press. This, in turn, creates an urge wanting to repeat that experiences again.

2 Why People are Interested in Test Targets

There are a number of reasons that have made *Test Targets* a collectable item among printing students and industry professionals. An issue contains current research topics and specific findings on printing standardization, process control, and color management. An issue is typically printed by no fewer than two printing methods because of economics (cover by sheet-fed offset and body by web offset) and print quality comparisons (same test page printed by different printing processes).

An issue also contains a collection of synthetic and pictorial color reference images with explanations of how these images are used for quantitative analysis and visual comparison.

"Seeing is believing" is another reason that people collect *Test Targets*. A special section of the publication called *Gallery of Visual Interest* has made *Test Targets* a collectable.

Test Targets 4.0 demonstrated the effect of AM and FM screening on dot gain and how to compensate dot gain to achieve the same tone reproduction. The effect of 'Assign' and 'Convert' on color image reproduction was seen in *Test Targets 5.0*. *Test Targets 6.0* illustrated color pairs having the same ΔE^*ab but perceived differently. *Test Targets 6.0* also demonstrated color image match between Heidelberg sheet-fed offset and Kodak NexPress electrophotographic printing. A creative use of the folded panel that alters the visual intent of photographs was depicted in *Test Targets 7.0*. *Test Targets 8.0* demonstrated how pictorial color images were reproduced with red, green, and blue inks instead of CMYK inks. *Test Targets 9.0* illustrated color matching between Heidelberg sheet-fed offset and Kodak Prosper 5000XL high-speed inkjet printing.

3 In this Issue

There are a number of factors that contribute to the success or failure of a publication. While most pages are for contents, some pages, i.e., front matter and colophon, are for organizational purposes. While cover design makes the publication visually attractive from the outside, page layout adds inner beauty and makes information more accessible.

There are six papers that were written, peer reviewed, and published in *Test Targets 10*. Two papers focus on printing standardization and conformity assessment. Chung describes aims and tolerances specified in ISO 12647-2 and the use of color measurement and data analysis for conformity assessment. Urbain and Khoury describe data reception requirements in ISO 12647-2 and ISO 15930 and the use of a test PDF file to assess conformity of any PDF workflow.

Test Targets 10 will likely be remembered as the publication that covers OBA (optical brightening agents). Two papers focus on OBA. Tian and Chung report the effect of paper containing OBA on printed colors and how such effect can be corrected using different mathematics. Sigg and Millward report the stability of OBA as a function of exposure to light over time. In addition, *Gallery of Visual Interest* shows side-by-side the visual effect of pictorial and synthetic color images printed on paper with and without OBA.

Printing conformity is result-oriented and does not dictate the press calibration method used. The fifth paper, authored by Wang, compares the compatibility of two press calibration methods, TVI and G7, by means of gradation compensation and press run simulation.

Printing conformity requires that correct inks and paper be used. Verifying that correct inks are used is outside the capability of a printer. The sixth paper, authored by Zhang, explores an alternative ink drawdown and ink verification method that could be implemented by printers.

Test Forms is a regular feature of *Test Targets.* We are pleased to showcase pictorial color reference images, *Roman 16 Reference Images*, courtesy of Bundesverband Druck und Medien e.V. (bvdm), and many possible uses of these images for printing process control and for color management studies. For example, we can compare the appearance of an image printed from the supplied CMYK file with the image from a supplied RGB file that was converted to CMYK by a color management application.

From a project planning point of view, the Steering Committee decided from the beginning that *Test Targets 10* would be five 16-page signatures (printed by the Sunday 2000 web offset) plus inserts (printed by Heidelberg Speedmaster 74) and cover (printed by HP Indigo 7000); Smyth-sewn; and trimmed to final size of 8.5" x 11." The Colophon provides authors' biographic sketches, an imposition scheme, and three press run organizers describing production details.

4 Those Who Helped Us

On behalf of the *Test Targets* Executive Committee, I wish to recognize those individuals and organizations in the *Acknowledgments* section on page 68. Without their support, this publication could not have been completed.

Production Notes

Typefaces used in this publication are Minion Pro and Helvetica (Open Type).

Manuscript creation and editing is handled in Microsoft Office 2011.

Graphics creation and manipulation, content layout and pagination, and color management is processed using Adobe Creative Suite 5.5.

The cover is printed on the HP Indigo 7000 at RIT's Printing Applications Laboratory on Finch Fine ID Uncoated 100# Cover.

The body is printed on the Goss Sunday 2000 web-offset press at RIT's Printing Applications Laboratory on Finch Uncoated 100# text, 35" wide roll.

The Gallery of Visual Interest section is printed on the Heidelberg Speedmaster SM 74 sheet-fed press at RIT's Printing Applications Laboratory on #100 Iggesund Invercote G&T.

Software Settings

To prepare a print-ready PDF file from Adobe InDesign CS5.5 the following steps were used.

1 Place the Prinergy Refiner.ppd file in the folder: Applications > Adobe InDesign CS5.5 > Presets > PPDS.

2 From within InDesign, select File > Print. Then, for the Printer, select the Postscript® File option, and for the PPD select Prinergy Refiner. In Setup, choose Custom for paper size, and in Marks and Bleed, turn on Crop Marks and Bleed Marks. In Output select Composite CMYK. In Color Management, select Let InDesign Determine Color and for the Printer Profile, choose U.S. Web Uncoated v2. After pressing Save, InDesign will create a .ps file.

3 To create the PDF file, use Adobe Acrobat Distiller with the following Distiller Settings: Resolution 2400 dots per inch. Bicubic Downsampling to 300 dpi for images larger than 300 dpi. Compression is Off to maintain high resolution test target images. All fonts are embedded. All colors are converted to CMYK using Perceptual Rendering Intent and the U.S. Web Uncoated v2 profile. Preserve CMYK values for calibrated CMYK color spaces.

Preparing MS Excel Graphs and Tables for Print

Graphs or tables made in Excel are in RGB color space. They will look good on a monitor which is also RGB color space. But when they are converted to CMYK for print, they will have what is called Rich Blacks which means that black text or lines will also have some CMY colors. If there is even a small amount of misregistration, this does not look good. The text on this page is black only; to demonstrate, the following word 'Black+' is printed with rich black.

Another problem with Excel graphs are the line widths. Often, the default line width is a hair line, which means it is one pixel wide. This is OK on a monitor with 72 dpi, or on a digital printer with 600 dpi. It is not OK on a printing plate with 2400 dpi. Therefore graphs and tables have to be edited to make them fit for print.

The basic conversion method consists of copying a graph from Excel and transferring it into a new Adobe Illustrator file. It is essential that these graphs or table files remain vector files, and do not become bitmap image files, otherwise line and text quality suffers greatly. Never use Photoshop as it makes large bitmap files. Set the Document Color Mode to CMYK. Then the different objects can be selected and edited for color and line width. There are a few tricks to this, more details are described on page 54.

Technical Papers

Robert Chung

Assessing Print Conformance Based on ISO 12647-2

Keywords printing, standardization, ISO 12647-2, color, TVI, grey

Abstract

Creating a print conformance method requires careful examination of a number of International Organization for Standardization (ISO) documents. This paper examines ISO 12647-2 and related standards in terms of deviation of solids, TVI, and midtone spread between OK Print and ISO specifications. It also examines variation between production samples and OK Print. It addresses issues in interpreting the current standards as well as their draft revisions, including data set conformance. Only the print conformance analysis for offset printing using Type 1 and Type 2 paper according to ISO 12647-2 is described.

1 Introduction

Two forces are driving changes in the printing industry, i.e., print buyers want quality printed products at the least cost and printers want to meet customers' requirements and be profitable. Standardization addresses these changes by providing common aims and tolerances. When printers conform to well-defined and recognized standards, e.g., ISO 12647-2, print buyers receive quality printing and printers gain efficiency and profits. The same force of change, in turn, drives tool providers to develop hardware and software tools for process control and automation. This domino effect gives Rochester Institute of Technology (RIT), a neutral entity, the opportunity to provide Printing Standards Audit (PSA) and certification services to printers in North America and worldwide.

PSA is a process for certifying printing conformance to fully defined and recognized standards. Criteria for establishing the print conformance report must be objective, quantitative, and in harmony with current standards as well as future standards. The purpose of this document is to explain how the PSA print conformance assessment report is created. It focuses on normative requirements according to current *ISO 12647 Graphic technology – Process control for the production of half-tone colour separations, proof and production prints* (2004 and 2007). It also discusses informative assessment and potential changes based on *ISO/WD 12647-2 Graphic Technology – Process control for the production of half-tone colour separations, proof and production prints – Part 2: Offset lithographic processes (2010)* and *ISO/CD 15339 Graphic technology – Printing of digital data – Part 1: Basic principles* (2010). This document excludes normative requirements regarding data reception and color management requirements in prepress aspect of an ISO 12647-2 compliant workflow.

2 Key Terms and Concepts

Deviation Tolerance

According to ISO 12647-1:2004, *deviation tolerance* is the permissible difference between the measurement of the OK sheet and the ISO aim (section 3.11)

Variation Tolerance

ISO 12647-1:2004 defines the term *variation tolerance* as the permissible difference between the measurement of individual production samples and the OK sheet (section 3.53).

Pass/Fail Criterion

When judging conformance of solid, tone value increase (TVI), and midtone spread, the PSA report will display the measurements to one decimal place, but the pass/fail decision will be based on rounding of the measurement to the nearest integer.

3 Conformance: Normative

This section describes the normative conformance of ISO 12647-2, which includes (1) deviation of solid, TVI, and midtone spread and (2) variation of solid, hue difference, and TVI. The elaboration of each ensues.

3.1 Deviation of OK Print: Printed Solid

Deviation conformance of the solid, according to ISO 12647-2:2004, is achieved when the ΔE between measurement of the OK sheet and the published aim per paper type is within the specified value.

Below is an example of the deviation conformance of a cyan solid (Table 1).

Table 1
Deviation conformance of printed solids

Cyan solid	L*	a*	b*
Aim value	55.0	-35.4	-50.0
Tolerance (ΔEab)	5.0		
Measurment	52.8	-32.9	-54.2
Deviation (ΔEab)	2.9		
Conformance	Y		

The fact that colors of printed solids are affected by paper color is not well understood in the standards bodies. ISO 12647-2:2004 for instance, does not address the effect of paper color, including the effect of an optical brightening agent (OBA), on printed colors.

There is a remark about OBA in ISO/WD 12647-2 (2010) stating that, “it might be necessary to establish a new, appropriate set of solid coloration” (section 4.3.2.3, Note 6). ISO/CD 15339-1:2010, a process agnostic standard that does not tie its specifications to either paper substrate or printing process used, advocates substrate-corrected aims to reconcile the differences between the reference data set and the measurement. The Printing Standards Audit (PSA) print conformance method defaults to the published aims with the option for substrate-corrected aims.

3.2 Deviation of OK Print: TVI

Section 4.3.5 of ISO 12647-2:2004 specifies TVI. For TVI deviation conformance of the OK Print, measured TVI shall conform to published TVI values, i.e., at 50% dot. But TVI tolerances are specified for two tonal values, 40 or 50% and 75 or 80%.

In addition, ISO 12647-2:2004 states that black TVI may be equal or 3% higher to CMY TVI (Table 4, Note B). Table 2 is an example of deviation conformance of TVI at 50%. The PSA print conformance method will evaluate against both black aim points, i.e., 14% and 17%, and recognize the aim that yields closer conformance.

Table 2
Deviation conformance of TVI at 50%

TVI 50%	K	C	M	Y
Aim value	14/17	14.0	14.0	14.0
Tolerance (%)	±4.0			
Measurement	15.0	12.0	15.0	15.5
Deviation	1.0	-2.0	1.0	1.5
Conformance	Y	Y	Y	Y

3.3 Deviation of OK Print: Midtone Spread

Midtone spread (s), as defined in ISO 12647-1:2004, is the maximum of the CMY tonal differences minus the minimum of the CMY tonal difference whereby each of the three differences is between the measured tonal value and its aim (Equation 1).

Eq. 1

$$S = TVI_{max}\,(C, M, Y) - TVI_{min}\,(C, M, Y)$$

Table 3 is an example. Here, the maximum TVI among C, M, and Y is '1.5' and the minimum TVI among C, M, Y is '-2.0'. Thus the midtone spread is 1.5 – (-2) or 3.5.

Table 3
Midtone spread conformance

TVI 50%	K	C	M	Y
Aim value	--	14.0	14.0	14.0
Measurement	--	12.0	15.0	15.5
Difference	--	-2.0	1.0	1.5
Mid-tone spread (S)	--	3.5		
Tolerance (%)	--	5.0		
Conformance	--	Y		

3.4 Variation of Production Samples: Printed Solid and Hue Difference

The variation aspect of the PSA print conformance assessment is based on the measurement of 10 production samples, collected at every 500 impressions, measured once by a spectrophotometer on the IDEAlliance ISO 12647-7 Color Control Strip.

Section 4.3.2.3 of ISO 12647-2:2004 specifies that variation conformance of the solid is achieved when 68% (7 out of 10) of the ΔEs between measurements of production samples and the OK sheet is less than the specified values.
In addition, the contribution of the hue difference (ΔH*) shall not exceed 2.5.

The PSA print conformance method applies the '7 or more out of 10' rule by, first, evaluating the conformance of four solids and four hue difference sample by sample. All 8 checks must be OK for that sample to be OK. The PSA method, then, evaluates if there are 7 or more conforming samples for the variation conformance to be OK.

The construction of the variation conformance spreadsheet begins with:

1 copying and pasting spectral data of the 10 control strips into 10 tabs;
2 computing CIEXYZ, CIELAB, and Status T densities of all data;
3 collecting colorimetric solids and tint densities of CMYK;
4 computing ΔE, ΔH*, TVI; and
5 constructing decision tables and graphs.

Table 4 shows an example of variation conformance of printed solids in terms of ΔE and ΔH*.

Table 4
Variation conformance of printed solid and hue difference

#	Tol.	Solid vs. OK (ΔE)				Solid vs. OK (ΔH*)			OK?
		ΔE_K	ΔE_C	ΔE_M	ΔE_Y	ΔH*_C	ΔH*_M	ΔH*_Y	
		4	4	4	5	2.5	2.5	2.5	
1	Δ	0.60	0.51	0.59	2.00	0.26	0.48	0.29	Y
2	Δ	1.87	1.20	2.25	1.14	0.07	1.87	0.81	Y
3	Δ	2.43	1.03	2.58	1.23	0.95	2.06	0.62	Y
4	Δ	0.49	0.80	1.69	2.49	0.15	1.57	0.39	Y
5	Δ	0.97	0.48	0.64	2.50	0.48	0.63	0.33	Y
6	Δ	0.40	1.15	1.02	1.44	0.80	0.81	0.42	Y
7	Δ	0.22	1.36	0.99	1.19	0.21	0.76	0.80	Y
8	Δ	1.04	1.04	1.15	1.06	0.18	0.92	0.82	Y
9	Δ	1.97	0.45	2.15	0.97	0.27	1.89	0.58	Y
10	Δ	2.33	0.48	2.41	1.15	0.25	2.12	0.87	Y
								7 or more OK?	Yes

Figure 1
Solid variation in terms of ΔE

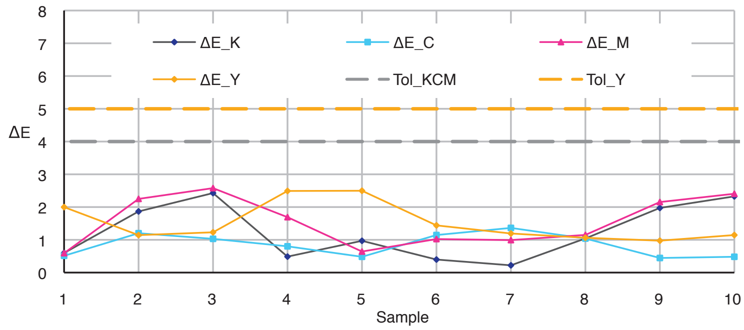
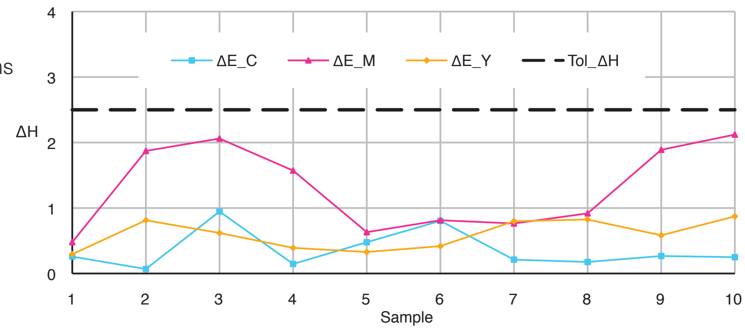


Figure 2 is the graphic depiction of the solid variation of ΔH* between sample and the OK Print. The tolerance for CMY solid is 2.5 ΔH*.

All 10 samples must conform in order to pass. In this instance, all 10 samples are in conformance.

Figure 2
Solid variation in terms of ΔH*



3.5 Variation of Production Samples: TVI and Midtone Spread

Regarding variation conformance of TVI, there is no specific statement in ISO 12647-2:2004 that parallels with the variation conformance of the solid. Instead, ISO 12647-2:2004 specifies that, "the average midtone value shall be within 4% of the specified aim value" (section 4.3.5.2). Here, aim values, not values of the OK Print, are used as the reference in the variation assessment.

Table 5 is an example of average 50% TVI comparison with the aim value. In addition, ISO 12647-2:2004 further specifies, "the statistical standard deviation of the midtone tonal values shall not exceed the variation tolerance specified" (section 4.3.5.2).

Table 5
Comparison of average TVI and midtone spread

	TVI_C50	TVI_M50	TVI_Y50	TVI_K50	Spread_50
Aim	14	14	14	17	---
Tolerance	4	4	4	4	5
1	14.0	13.0	14.7	16.9	1.7
2	14.0	13.3	15.5	17.8	2.2
3	13.8	13.9	15.7	18.0	2.0
4	13.9	13.9	14.4	18.0	0.5
5	13.4	13.1	15.3	17.4	2.3
6	13.8	13.0	15.8	19.0	2.8
7	15.0	13.4	16.7	17.1	3.3
8	14.6	13.2	17.2	17.9	4.1
9	13.7	13.2	16.2	17.6	3.1
10	14.0	12.7	16.9	18.2	4.2
Average	14.03	13.27	15.86	17.79	---
(Ave - Aim)	0.03	0.73	1.86	0.79	---
Less than Tol?	Y	Y	Y	Y	Y
Std Dev	0.44	0.40	0.91	0.60	---
Less than Tol?	Y	Y	Y	Y	---

Midtone spread variation is a requirement that must be fulfilled. There is no '7 out of 10' rule stated in this category. Thus, PSA print conformance method interprets the midtone spread conformance requirement as "all 10 production samples must not exceed the tolerance of 5."

Figure 3 is a graphic depiction of the run chart of TVI at 50% dot. The value for 50% TVI is interpolated using a 4-point interpolation routine. This procedure is described in Section 5.

Figure 3
TVI variation of production prints

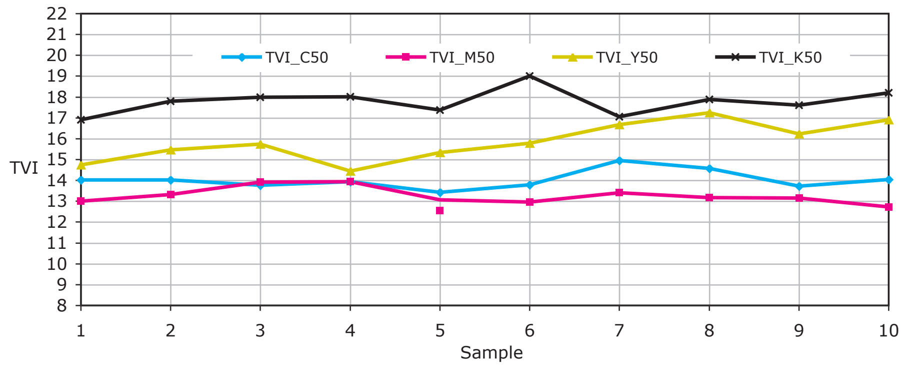
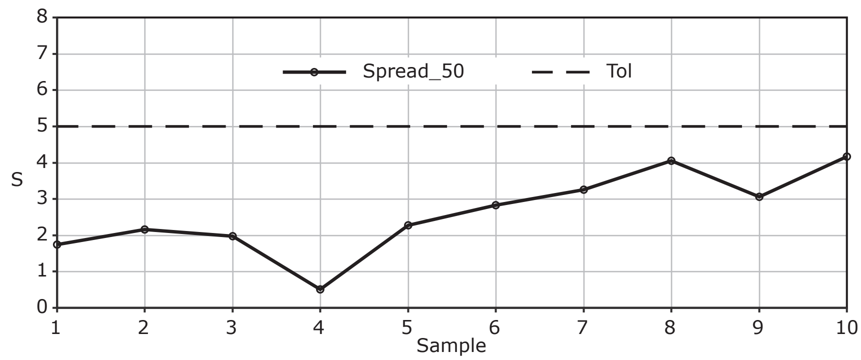


Figure 4 is a graphic display of the midtone spread variation with the tolerance superimposed. It accompanies the data table to facilitate its interpretation.

Figure 4
Midtone spread variation of production prints



3.6 Other Normative Requirements

Image positioning refers to color-to-color registration. There are six measurement conformance checks (Table 6).

The maximum allowed deviation between one printing unit to the other is 0.08 mm or 80 µm for middle format press and printing paper with 65 g/m2 or greater; and 120 µm for other conditions.

Table 6
Image positioning

Registration	C/K	M/K	Y/K	M/C	Y/C	Y/M
Tolerance	80/120 (µm)					
Measurement	65	75	70	70	75	60
Conformance	Y	Y	Y	Y	Y	Y

Figure 5 is the RIT Traffic Light target for assessing color-to-color registration. Mis-register will cause a crescent-shaped white space between the colors involved and is visible.

The magnitude of the misregister can be measured by the distance between two small dots in the center of the circle using a high-power magnifier with reticles.

Figure 5
RIT Traffic Light registration target

Enlarged, purposely out of register

Target as it is actually used

Reproduction limits refers to the ability of the process to hold the extreme highlight (3% dot) and the extreme shadow (97% dot) consistently and these patches are differentiated from the paper and solid respectively for screen rulings between 40 to 70 lines/cm.
The requirements relax to 5% dot and 95% dot for finer screen rulings, i.e., 80 lines/cm.

4 Conformance: Informative

The informative section of the PSA print conformance report contains charts and graphs that are not specified in the current standards but are likely to be included in future ISO standards.

Sources of all the graphs discussed in this section are the IT8.7/4 targets and control strips.

4.1 Measurement Validation

PSA measurement protocols include:

1. using two X-Rite i1 iSis spectrophotometers;
2. measuring the IT8.7/4 (random) targets from two OK sheets; and
3. measuring each target twice. The measurement conditions include M0 (UV included), white backing, and XRGA applied.

This yields 8 measurement data sets per submission. Explanations *a* to *d* that follow are estimates of measurement uncertainties with the magnitude of these variations shown in Figure 6.

a Eight estimates of 'within target variation' are available by evaluating color differences between 29 redundant patches in the IT8.7/4 target.

b Four estimates of 'instrument precision' are available by evaluating color differences between the two sets of measurements from a given sheet-instrument combination.

c Two estimates of 'inter-instrument' variation are available between the average of the two measurements of a single sample.

d One estimate of 'sheet-to-sheet' variation is available between the average of sample_1 and the average of sample_2.

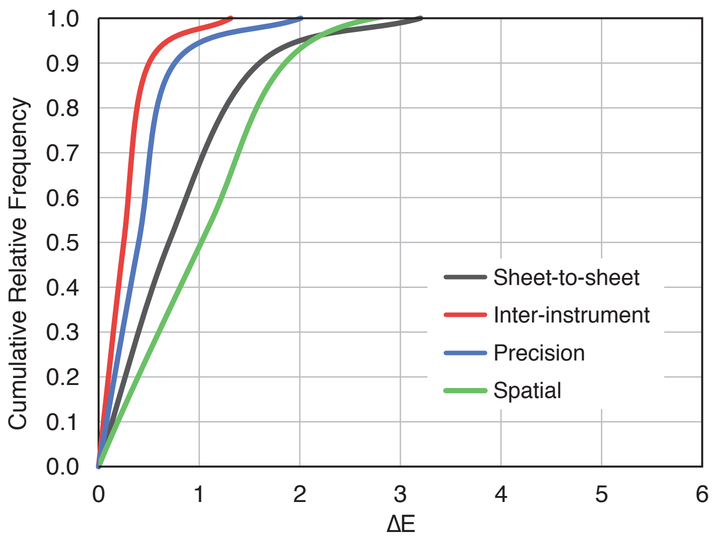


Figure 6
Four sources of measurement variation

A general observation of Figure 6 is that spatial variation and sheet-to-sheet variation is larger than the instrument precision and inter-instrument agreement.

A qualification of the inter-instrument agreement is that the two instruments used are of the same manufacturer and model (x-Rite i1 iSis). The difference may be larger between instruments of different brands and models.

4.2 Substrate Color and Gloss

Substrate color and gloss are informative parts of the ISO 12647-2 standard. When comparing ISO 12647-2:2004 and ISO/WD 12647-2 (2010) documents, aim points of paper color have been shifted toward blue.

Colors of printed solids are affected by paper color, including OBA (Chung & Tian, 2011). The PSA print conformance method offers printers the option to use substrate-corrected aim for printing conformance.

4.3 Colorimetric a*b* Plot, L*C* Plot, CRF_ΔE of Data Set

The a* b* plot (Figure 7) compares the size of the color gamut between the sample and the reference.

It gives a graphic depiction of how close the:

1. production substrate compares with the reference white;
2. sample (single and overprint) solids compare with the reference (single and overprint) solids.

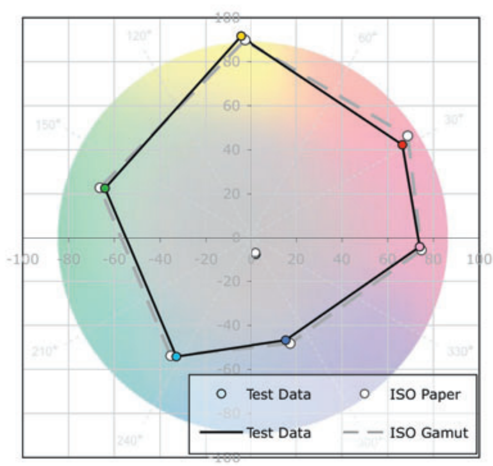


Figure 7
Color gamut in two dimensions, a* and b*

There are six L* C* planes, i.e., CMYRGB. As an example, Figure 8 shows the vertical slice of the color gamut for the cyan hue angle.

The L* C* graphs complement the a* b* plot because color has three dimensions and a graph is only capable of showing two of the three dimensions.

Figure 8
L* C* plot in two dimension, L* and C*

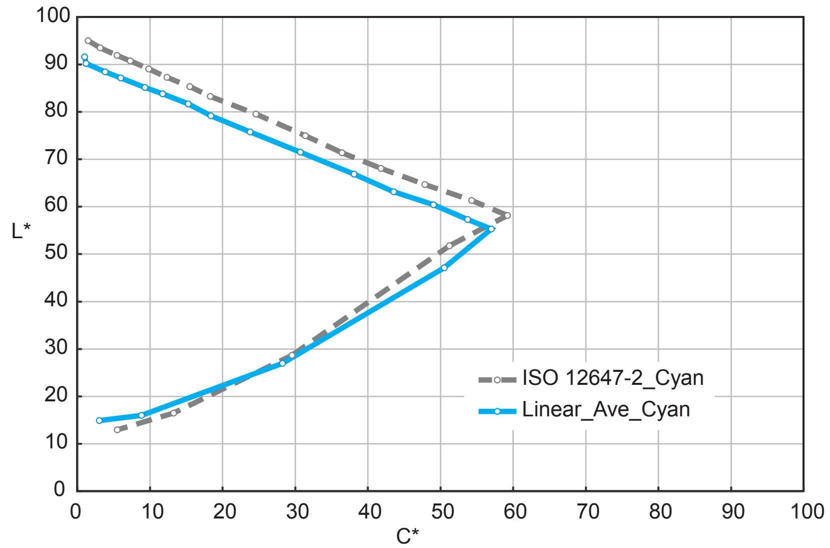
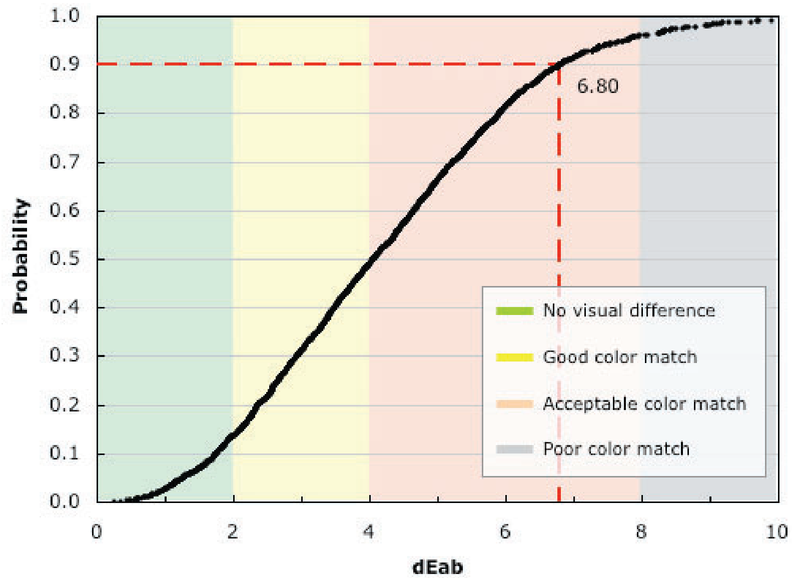


Figure 9 is the CRF ΔE that reflects all color differences, sorted from low to high, between the sample data set and the reference data set (e.g., Fogra 39).

The cumulative relative frequency (or probability) plot answers the question of similarity of two characterization data sets, and works well when implementing the ISO/CD 15339 standard.

Figure 9
Cumulative relative frequency of ΔE between two gamuts

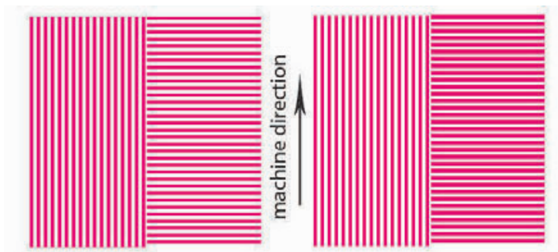


4.4 Slur/Doubling

While ISO 12647-2 stipulates color-to-color registration as normative, it does not specify dot slur/doubling which is the misregistration between the ink dots and its back trap from subsequent printing units.

In general, doubling is directional, i.e., there is a higher probability of doubling in the machine direction than in the cross machine direction. The left side of Figure 10 is a simulation of no doubling and the right side is a simulation of doubling as detected by parallel lines and can be measured in term of ΔTVI between them.

Figure 10
Doubling simulation

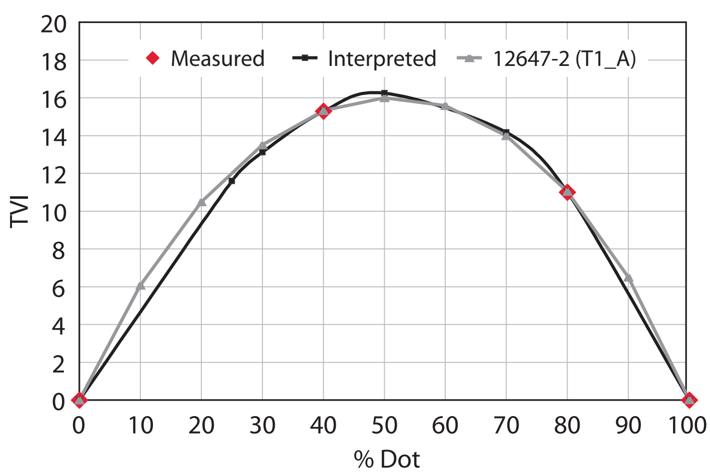


5 Targets for TVI Assessment

ISO 12647-2:2004 specifies TVI at two tonal levels, i.e., (40 or 50) and (75 or 80); ISO/WD 12647-2:2010, specifies TVI at three tonal levels, i.e., <30, 30-60, and >60. The Ugra/Fogra Media Wedge uses 40% tint and 80% tint and the IDE Alliance ISO 12647-7 Control Strip uses 30% and 70%. Neither control strip provides all the tint patches. Unless there is a control strip containing all wanted tint patches, there is a need to model the TVI curve based on four points (paper, tint_1, tint_2, and solid) and compute any TVI value of interest.

Below is a solution that uses the four-point interpolation. The grey line, in Figure 11, is the TVI Curve A per polynomial coefficients published in ISO 12674-2:2010. Dr. Edward Granger programmed a 4-point interpolation algorithm using Visual Basic in Excel 2004 and made it available as a freeware (personal communication, February 2011).
By entering the above four data points, i.e., paper, 40%, 80%, and solid (in red), the worksheet will calculate any TVI value relative to an input dot area (black line).

Figure 11
Four-point interpolation of a TVI curve



By observing the two curves in Figure 8, predicted TVI values deviate less than 1% from the polynomial values of ISO/WD 12647-2 (2010).

This means that only two tint patches in the color control strip are needed to calculate other TVI values, as evidenced in the calculation of 50% TVI and 75% TVI based 30% and 70% TVI values, with the use of the four-point interpolation routine that results in reasonable accuracy.

6 Conclusions

Interpreting standards to have the same meaning by multiple individuals and organizations have been challenging. To foster standardization in the printing industry, all stakeholders, including associations, universities, suppliers, consultants, and printers, need to work together to clarify the requirements and to develop best practices that lead to conformance.

This document describes the PSA print conformance analysis method based on both current and future ISO standards. Only the print conformance analysis for offset printing using Type 1 and Type 2 paper according to ISO 12647-2 is described. The conformance assessment methodology can be applied when developing other printing standards, such as ISO 15339, printing of digital data.

7 Acknowledgments

The author wishes to acknowledge Mr. Elie Khoury of KEE Consultants for his technical advice and encouragement; Mr. Franz Sigg and Ms. Edline Chun of RIT for their editorial reviews.

He also wants to express his appreciation to his colleagues in the PSA team at RIT for their continuing support.

8 References

Chung, R. and Tian, Q. Substrate Correction in ISO 12647-2, *2011 TAGA Proceedings*.

ISO 12647-1:2004 Graphic technology – Process control for the production of half-tone colour separations, proof and production prints – Part 1: Parameters and measurement methods. Available for purchase at ISO website: www.iso.org.

ISO/WD 12647-1 (2009) Graphic technology – Process control for the production of half-tone colour separations, proof and production prints – Part 1: Parameters and measurement methods. ISO TC 130/SC /WG 3 N 1023, 2009-10-29 available online.

ISO 12647-2:2004 Graphic technology – Process control for the production of half-tone colour separations, proof and production prints – Part 2: Offset lithographic processes. Available for purchase at ISO website: www.iso.org.

ISO 12647-2:2010 Graphic technology – Process control for the production of half-tone colour separations, proof and production prints – Part 2: Offset lithographic processes. Available for purchase at ISO website: www.iso.org.

ISO 13655:2009 Graphic technology-Spectral measurement and colorimetric computation for graphic arts images. Available for purchase at ISO website: www.iso.org.

ISO/CD 15339-1 (2010) Graphic technology – Printing of digital data – Part 1: Basic principles. In development, Stage 30.20 (2011-01-27).

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Assessing ISO Compliant PDF Workflow

Keywords ISO Standards, PDF/X, ICC profile, workflow, conformance

Abstract

Printing standards are increasingly adopted by printers wishing to work with efficient industrial practices. Standardization benefits are many, among which are: predictability of results, reproducibility of jobs, elimination of production errors, better productivity, and improved profitability. However, to achieve these benefits, the complete printing process should be controlled, from prepress to press, and reliable quality control tools should be used to ensure that print production is done according to the relevant standards.

This paper introduces a PDF workflow analysis tool that can be used to assess a prepress workflow or the ability of a color management software to check, to control quality, and to standardize PDF files. The workflow analysis tool presented assesses conformance to ISO standards and to best practice requirements for PDF color management and rendering. This study shows that this simple and intelligently designed test form can serve as a tool to assess the ability of a PDF-processing software to output print-ready files that are compliant to ISO standards.

1 Introduction

When Adobe Systems Incorporated announced the first version of its portable document format (PDF) at Comdex 1992, it is likely that no one at Adobe or in the Comdex pressroom suspected at that time that this RGB-based file format would become, in little more than a decade, a format that is used for more than 75% of file data exchange in the graphic industry worldwide, and would become an ISO standard as well. Driven by its success, the PDF file format quickly evolved to address various industries and applications needs for data exchange, including videos, 3D animations, archiving, etc.

In order to regulate and define the content of PDF files that are intended for printing, various user groups such as the Ghent PDF Workgroup and European Color Initiative were formed to introduce guidelines and recommend practices to PDF generators and users. The ISO technical committee for graphic technology (TC130) issued the first part of *ISO 15930 Graphic technology – Prepress digital data exchange – Use of PDF – Part 1: Complete exchange using CMYK data* in 1999 to define mainly a CMYK file format that embed only data properly interpretable by a print oriented workflow, PDF/X-1a standard.

Since then, several parts have been added to ISO 15930 standard to allow for additional content and color spaces to be included in the PDF/X. PDF/X-3 and PDF/X-4 gradually included non CMYK data, transparencies, layers, etc. that are relevant for modern design and desktop publishing production.

After many revisions and almost 20 years of development, Adobe's PDF file format is now far from the relatively simple, flexible, and not editable file format that Adobe presented at Comdex 1992. It has become much more complex and powerful. This complexity and power offer a rich palette of creative tools for designers, agencies, and print buyers, but they bring at the same time new risks and potential problems for printers whose production workflows may not be prepared to handle such files correctly and efficiently.
The purpose of this study is to investigate the ability of the test form by KEE Consultants to serve as a tool that can help predict and address the limitations of PDF workflows.

2 Methodology

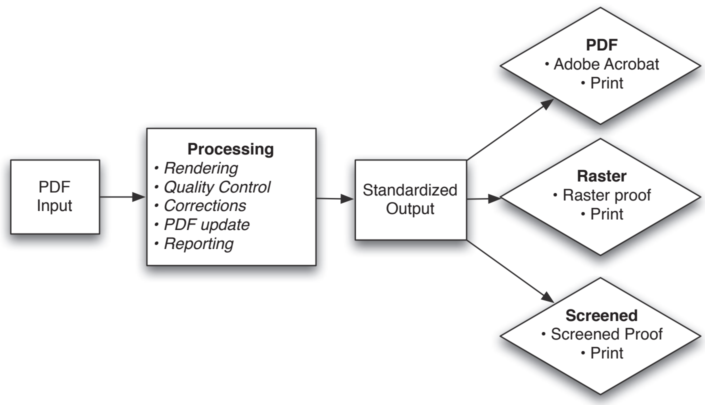
This section explains the workflow configuration that was used, conformance requirements, and the basics of an assessment tool to prepare the reader for the details, of the test form by KEE Consultants.

2.1 Workflow Description

A production workflow is a combination of hardware and software that can accept a wide variety of input file formats (native, Postscript, PDF, etc.) and produce PDF, raster, or screened files for output.

Most print-oriented workflows have one of the three following configurations shown in Figure 1.

Figure 1
Alternative print-oriented workflows



1 PDF output: the workflow output is a PDF file that can be soft-proofed and assessed using PDF « preflight » tools like Adobe Acrobat Pro, and then printed.

2 Raster output: the workflow output is a raster file that can be soft-proofed and assessed using a display software or a hard-proofing system, and then printed.

3 Screened output: the workflow output is a screened bitmap file that can be either soft-proofed and assessed using the workflow preview utility, or printed for assessment.

For the purpose of this study, a PDF input and PDF output workflow configuration was used.

2.2 Workflow Conformance

According to ISO *12647 Graphic technology – Process control for half-tone colour separations, proofs and production prints* (print conformance) and ISO 15930 (PDF/X conformance) series of standards, PDF production should be able to handle and comply with the standards shown in Table 1.

Table 1
PDF workflow conformance criteria

PDF Content	ISO Requirements
Output Intent	✓ ISO 15930-7; 6.4.2.1 ✓ ISO 12647-2; 4.2.1
Embedded ICC Profiles	✓ ISO 15930/1-7; 6.4.2.1 ✓ ISO 15930/1-7; 6.4.3 ✓ ISO 12647-2; 4.2.1
TAC (Total Area Coverage)	✓ ISO 12647-2; 4.2.7
Overprints	✓ ISO 15930/1-7; 6.4
Live transparencies	✓ ISO 15930-7; 6.20

2.3 Workflow Assessment Tool

PDF files can be manually checked and corrected using third-party or workflow embedded "preflight" tools. However these control operations result in a significant amount of operator time and cost spent checking and correcting files every time an error appears on a proof, or worst, on a print. Automating PDF quality control and correction is therefore necessary, and checking that this automation delivers the required output is of paramount importance.

GWG (Ghent PDF Work Group) and ECI (European Color Initiative) offer useful test suites for this purpose. However, KEE Consultants' v1 test form is specifically dedicated to ISO standards conformance, especially in terms of color, TAC, overprints and transparency management.

3 KEE Test Form

The test forms developed by KEE Consultants have been designed as workflow assessment and audit tools. They complement printing process ISO conformance audits. ISO print conformance guarantees standardized output conditions and stabilized printing process, while workflow conformance guarantees standardized file content and optimized data for printing. Together, they assess all the conditions necessary to match customer expectations.

The first version of the KEE Consultants test form includes elements that are used to test the conformance of a PDF workflow with the relevant ISO standards. A second version of this test form includes the ISO conformance elements of version 1, as well as additional elements that have been designed to check the conformity of a PDF workflow with important production requirements such as the handling of four-color text, equal-RGB grays, Pantone® colors, etc.

For this study, we have chosen to use the first version of KEE's test form, i.e., the one dedicated to the ISO conformance assessment (Figure 2).

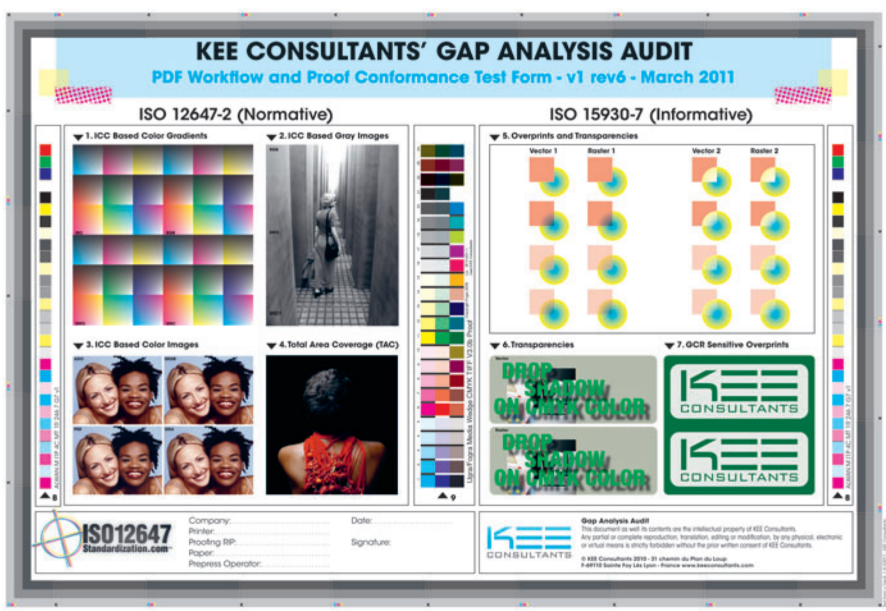


Figure 2
KEE Consultants' Test Form v1

KEE Consultants v1 test form includes various elements that can be found in widely generated and used PDF files (version 1.3 to v1.7) and in PDF/X files (PDF/X-1a to PDF/X-4). Table 2 summarizes the conformance criteria that can be assessed using KEE Consultants' v1 test form.

The six PDF assessment criteria are divided into two categories of requirements per pertinent ISO standards: Standards Normative and Standards Informative. Two control strips have been added to the test form to assess printing conditions when the form is proofed or printed.

Table 2
KEE Consultants' Test Form v1 Assessments Criteria

Test element	Standards Normative	Standards Informative
Output Intent	✓ ISO 15930/1-7; 6.4.2.1 ✓ ISO 12647-2; 4.2.1	
ICC based CMYK Gray Image	✓ ISO 15930/1-7; 6.4.2.2 ✓ ISO 15930/1-7; 6.4.3 ✓ ISO 12647-2; 4.2.1	
Embedded ICC Profile	✓ ISO 15930/1-7; 6.4.2.1 ✓ ISO 15930/1-7; 6.4.3 ✓ ISO 12647-2; 4.2.1	
TAC	✓ ISO 12647-2; 4.2.7	
Overprint Live transparency	✓ ISO 15930/1-7; 6.4.2	✓ ISO 15930-7; 6.20
Ugra/Fogra MediaWedge v3.0	✓ ISO 12647-7	
Alwan_M_i1P_4C_ MT_1R_246.7_ G7_v1 control strip	✓ ISO 12647-2	✓ ISO TS 10128 ✓ G7® specification

KEE Consultants' test form has been designed to offer a simple way of assessing processing conformance:

A visual check of the processed file or printed output allows the user to see at a glance, whether the processing has been done correctly, and if not, the areas of non-conformity that need to be addressed.

3.1 ICC-based RGB and CMYK Gray Image

This element (Figure 3) is dedicated to assess the color management capabilities of the workflow for gray images. Two aspects of ICC color management support are evaluated: honoring embedded ICC Profiles, and honoring Rendering Intents.

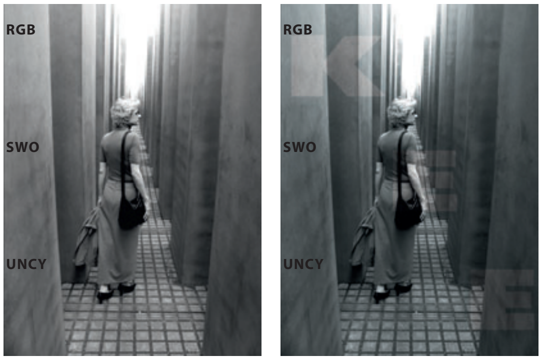


Figure 3
Left:
Processing success

Right:
Processing error

The background of this test image is composite gray and was separated using ISO Coated V2 CMYK profile, which represents ISO12647-2 printing conditions for coated paper (Paper Types 1 and 2). Three test areas, in the shape of **K, E, E** letters, overlap the background image. Each area is embedded with its own ICC profile (RGB or CMYK). These three areas have been designed to match the background once converted to the Output Intent, which is ISO Coated v2. Therefore, successful processing honoring both embedded ICC Profiles and Rendering Intent will result in a perfect visual match between the letters and the background. In this case the letters cannot be seen in the image.

One or more letters appearing after processing, means that the corresponding profile and/or rendering intent was not honored properly due to incorrect settings in the software.

3.2 ICC-based RGB and CMYK Color Gradients

This element (Figure 4) is dedicated to assess the color management capabilities of the workflow with color gradients. The goal is to test the accuracy of the color transformation as well as the workflow's ability to handle different ICC profiles and Rendering Intents.

This color gradient element is divided into four quadrants, each containing nine square vignettes. All vignettes are made of different CMY gradations defined in ISO Coated v2 color space. Inside each vignette, there is a circle overlapping the vignette. Each circle is defined in a different ICC color space, RGB or CMYK with Absolute rendering intent.

Therefore, a successful processing honoring both embedded ICC profiles and Rendering Intent will lead to a perfect match between the circles and the vignettes.

With successful processing, circles should not be seen. This means that the color transformation is accurate and smooth. If one or more circles appear after processing, this means that the corresponding Profile or Rendering intent was not honored properly, or that the color transformation was not accurate enough.

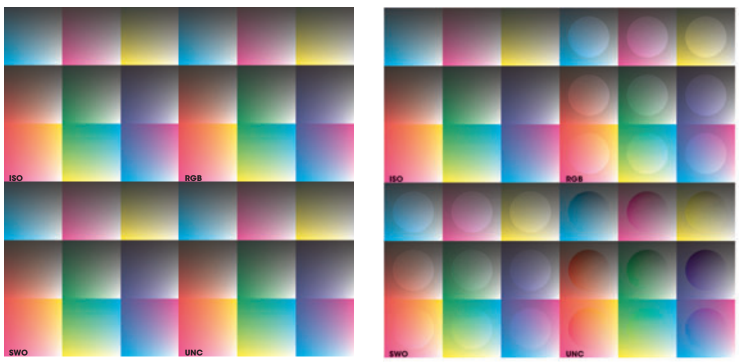


Figure 4
Processing success left

Processing error right

3.3 TAC

TAC stands for Total Area Coverage, which refers to the maximum amount of Cyan, Magenta, Yellow and Black ink that can be allowed in the dark tones a color separation. Excessive TAC may lead to printability problems and proof to press mismatch. Web offset presses are more sensitive to this problem than sheetfed offset, but both types of offset require TAC management. As a result, ISO 12647-2 limits maximum TAC to 300% for web offset and 350% for sheetfed offset.

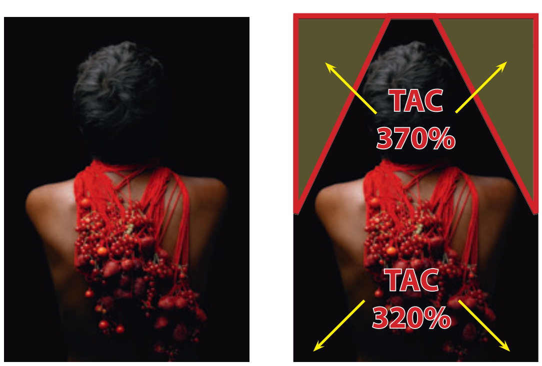


Figure 5
Processing success left

Processing error right

To assess how the workflow handles TAC management, the test form contains an image (Figure 5) that includes areas having excessive TAC. The bottom part of the image has a TAC of 320% in the blacks. The upper-left and upper-right sides of the image have a TAC of 370%. 370% TAC in offset printing will probably lead to problems such as ink set-off, pages sticking, or paper breaks.

To avoid these problems, an efficient workflow should be able to identify and limit excessive TAC. Successful processing should reduce TAC from 370% to a value that is lower than 350% for a sheetfed press (lower than 300% for web offset), with no visual difference between the image different black areas. Processing fails if the processed image has a TAC that is higher than the limits specified in ISO 12647-2.

3.4 Live Transparency

Live transparency is one of the most challenging features of Adobe PDF format. Since its inclusion in Adobe PDF 1.4 specification, document creators have the ability to create PDF files containing transparencies. Transparency can be either live or flattened. A live transparency means that the transparent object is editable and can interact with other underlying objects. A flattened transparency should have the same visual appearance as a live transparency but without its ability to be edited.

The KEE test form includes a typical case of live transparency in a production document: a drop shadow overlying both vector and bitmap elements in CMYK color space (see Figure 6). The test form includes a live transparency element as well as a flattened version that serves as a reference for the assessment. After a successful processing, live transparency (labeled Vector) should look the same as the flattened transparency (labeled Raster). The processing fails if the "vector" and "raster" visuals show any difference.

Figure 6
Processing success left

Processing error right

3.5 Overprints and Transparency

This element (Figure 7) is a sophisticated combination of two conditions: Overprint and Live transparency. It is composed of a « Vector » and a « Raster » part, each containing two sections with eight objects each. The two columns under « Vector » contain vector objects composed of overlapping shadings (vectorial gradient) and squares; the two columns under « Raster » contain their flattened version and serve as references.

The purpose of this test is to check the ability of the workflow to address different blending modes with various transparency and overprint combinations.

If this element is correctly processed, the rendered objects of the two « Vector » columns should be identical to their counterpart found on the two « Raster » columns.

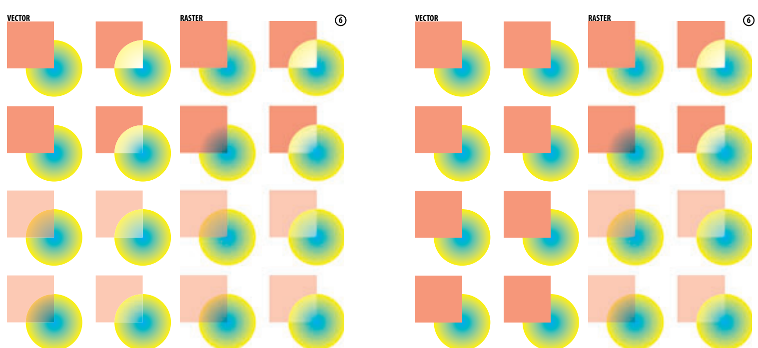


Figure 7
Processing success left

Processing error right

4 Conclusion

Producing jobs that meet customer expectations without production problems is key to profitable printing. Printers who conform to standards are able to achieve this goal through efficient industrial printing practices.

Achieving an ISO complaint workflow requires conformance with the following standards: PDF/X specifications described in ISO 15930 Parts 1-7, ICC Color Management specifications described in ISO 15076-1, and print conformance criteria described in ISO 12647 Parts 2-6. In order to cap- ture
the full benefits of printing in conformance to standards, an ISO compliant workflow should be able to transform nonconforming input PDF files to « optimized » and problem-free files for printing. When an ISO compliant PDF workflow is combined with standardized printing conditions, the result is an end-to-end process that results in accurate color and correctly rendered content.

The first step in achieving an ISO compliant workflow is to assess the degree of conformance achieved using the workflow already in place. A test form is an indispensable tool for conducting such an assessment, and the KEE Consultants' test form includes the elements needed to test a PDF workflow for ISO compliance. This test form is currently used by KEE Consultants in their Gap Analysis Audit (www.iso12647standardization.com), and is available to interested users at this website.

Even though the simple and visual assessment method provided by this test form is a powerful tool for assessing conformance, the test form remains a quality-control tool. It identifies problems and limitations but does not fix them. Fixing nonconformance issues is the second step in the journey toward an ISO compliant workflow. Interested printers will find that a wide variety of resources are available to assist them in taking this step to realize the benefits of adopting efficient industrial printing practices.

4.1 Acknowledgments

We would first like to thank Professor Robert Chung for his encouragement. We would also like to extend our gratitude to Professor Edline Chun for her editorial guidance. Without all of their hard work this publication would not be possible.

5 Resources

ISO Standards

ISO 12647-2: 2004/Amd 1:2007 Graphic technology–Process control for the production of half-tone colour separations, proof and production prints–Part 2: Offset lithographic processes. Available for purchase at ISO website: www.iso.org.

ISO 15930-7: 2010 Graphic technology–Prepress digital data exchange using PDF–Part 7: Complete exchange of printing data (PDF/X-4) and partial exchange of printing data with external profile reference (PDF/X-4p) using PDF 1.6. Available for purchase at ISO website: www.iso.org.

ISO 15076-1: 2010 Image technology colour management–Architecture, profile format and data structure–Part 1: Based on ICC.1:2010. Available for purchase at ISO website: www.iso.org.

Organizations

Adobe PDF Technology Center
www.adobe.com/devnet/pdf

European Color Initiative
www.eci.org

Ghent PDF Workgroup
www.gwg.org

International Color Consortium
www.color.org

KEE Consultants
www.keeconsultants.com

See also
www.iso12647standardization.com

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Effect of Paper Containing OBA on Printed Colors

Keywords paper, optical brightening agents, color difference

Abstract

Papers used for color reproductions contain optical brightening agents (OBA). The amount of OBA in paper is increasing which causes a problem in measurement-based printing conformance. To correct OBA effects, this paper investigates the conversion methods of color measurement using paper without OBA to those with OBA. IT8.7/4 test target was printed using two kinds of papers with OBA and without OBA under the same printing conditions; the target was measured with a spectrophotometer.

Spectral data was converted to tristimulus values and corrected with the backing conversion method documented in ISO 13655, the ICC relative colorimetric conversion method, and the polynomial conversion method.

The results show that
1 paper nonconformance can be corrected by all of the conversion methods; and
2 better conversion by using the polynomial method is an indication that the OBA effect is curvilinear as opposed to linear between the tristimulus values and their differences due to OBA.

1 Introduction

Widely used today, optically brightened papers look whiter and brightener due to added optical brightening agents during paper making. Optical brightening agents (OBA) are chemical additives that correct for the natural yellow color of pulp. It works on absorption of ultraviolet energy and emission of short-wavelength energy.

The use of OBA results in some problems in printing conformance to *ISO 12647-2:2007 Graphic technology – Process control for the manufacture of half-tone color separations, proof and production prints – Part 2*. ISO 12647-2 recommends five typical kinds of papers with b* values from −3 to 6 and tolerances of ±2. Therefore, if paper contains OBA, its presence would make color measurement of the paper out of ISO print standard.

2 Literature Review

A survey of relevant literature may be categorized by effect of OBA and background explanations of the measurement backing conversion in ISO 13655, ICC relative colorimetric correction, and polynomial regression.

2.1 Effect of OBA

Paper makers use OBA to make substrates brightener and whiter. According to Lee, Shen, and Chen (2001), "fluorescent materials have higher lightness and saturation compared with traditional non-fluorescent materials" (p. 1). Papers with OBA require ultraviolet radiation of wavelengths of illuminate below 400 nm for their excitation and then emit light in the blue region. It brings the peak reflectance wavelength at about 457nm. As a result, a shift of the CIELAB b* coordinate towards the blue by about 1 to 10 units will be found (ISO 13655:2009, Appendix G).

International Color Consortium (ICC) White Paper 14 (2005) summarizes CIE Publication 163 (2004), which "indicates and quantifies that the fluorescence of the substrate can be found in both solid ink areas and halftone ink area with different papers (p. 1).

That means the colors reproduced by papers with and without OBA are different and the methods to predict or correct the OBA effects are important for color reproduction.

2.2 ISO 13655 Backing Conversion

Based on the backing conversion in ISO 13655:2009, the CIE X, Y, and Z between measurements made over two backing materials (black and white) could be converted by a linear formula. This linear conversion formula is shown as follow:

Eq. 1

$$X_w = X_b(1+C) - X_{min}C$$

$$C = \frac{X_{sw} - X_{sb}}{X_{sb} - X_{min}}$$

Where:

X_w is the converted tristimulus value X of the specimen simulating white backing

X_b is the measured tristimulus value X of the specimen over black backing

C is a constant

X_{sw} is the measured tristimulus value X of the specimen substrate over white backing

X_{sb} is the measured tristimulus value X of the specimen substrate over black backing

X_{min} is the minimum tristimulus value X of specimen over black backing

Conversion of Y and Z is accomplished in analogous manner

Because the differences of CIE X, Y, and Z between measurements made over two backing materials (black and white) are plotted versus X, Y, and Z for measurements made over black backing, the best fit result is approximately a straight line (McDowell, Chung, & Kong, 2005), shown in Figure 1.

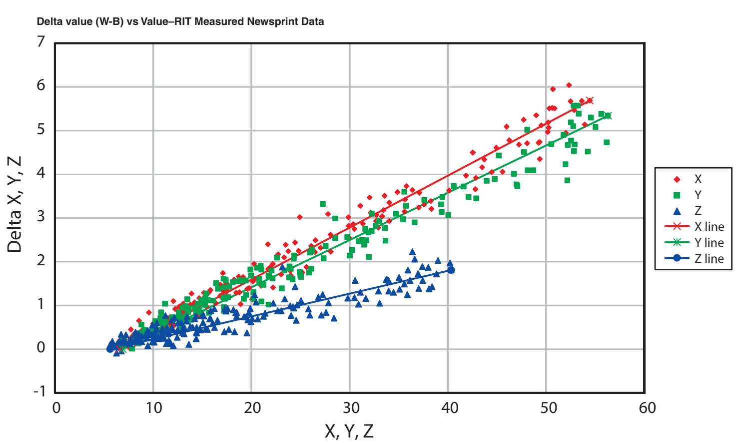


Figure 1
The relationship of CIE X, Y, and Z of measurements and the differences over two backing materials

Color differences between measurements made over two backing materials are as larger as 2.8 ΔE_{76}.

The color difference between converted values and measured values over the same backing material are reduced to less than 1.5ΔE_{76}, shown in Figure 2.

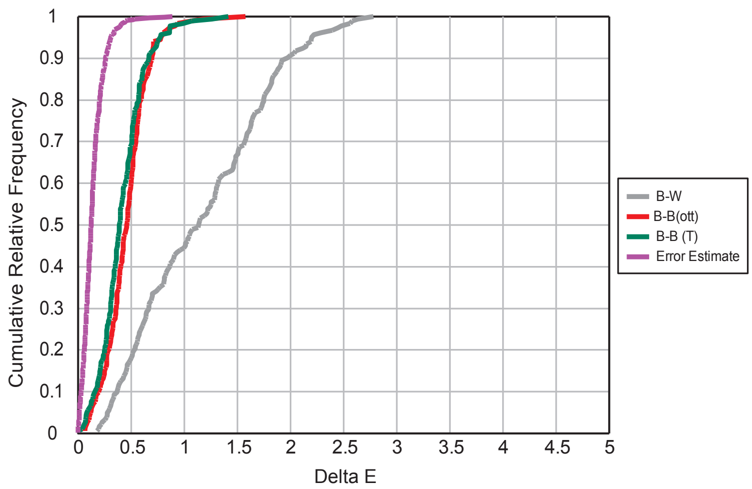


Figure 2
Color difference between the measurements made over two backing material and between the converted values and measured values over the same material

The Committee for Graphic Arts Technologies Standards (CGATS) conducted a substrate study (McDowell, 2009). This project showed there are significant color differences of printed colors between two substrate colors.

The study used 13 kinds of papers to compare the differences of CIE X, Y, and Z between measurements made with different substrates. However, there is a non-linear and scattered relationship between the measurement of CIE X (X) and the difference between measurements made with different substrates (ΔX), as shown in Figure 3.

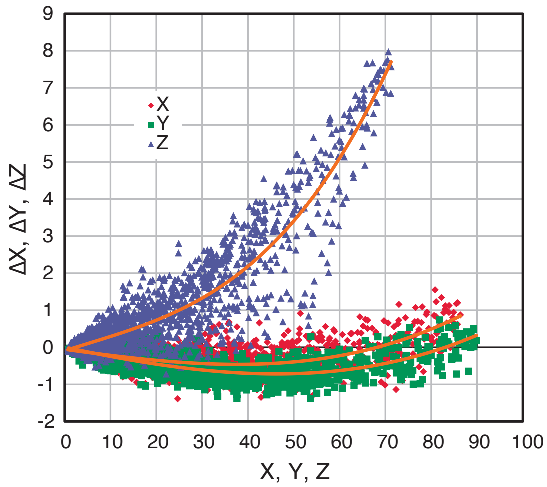


Figure 3
The non-linearity relationship between ΔX and X

2.3 ICC Relative Colorimetry

Birkett and Spontelli (2009) applied ICC media relative colorimetry for paper white correction. The method uses the ratio of the two white points is linear relationship. The equations of this method are shown in Eq. (2).

Eq. 2

$$X_2 = X_1\left(\frac{X_{w2}}{X_{w1}}\right)$$

$$Y_2 = Y_1\left(\frac{Y_{w2}}{Y_{w1}}\right)$$

$$Z_2 = Z_1\left(\frac{Z_{w2}}{Z_{w1}}\right)$$

X_2, Y_2, Z_2 are converted tristimulus values of printed color on substrate 2

X_1, Y_1, Z_1 are the tristimulus values of printed color on substrate 1

X_{w2}, Y_{w2}, Z_{w2} are the tristimulus values of substrate 2

X_{w1}, Y_{w1}, Z_{w1} are the tristimulus values of substrate 1

2.4 Polynomial Regression

Polynomial function is an approach to fitting a nonlinear equation of x. For interpolative purposes, Stat Point Technologies, Inc. (2006) points out that "polynomials have the attractive property of being able to approximate many kinds of functions" (para. 1).

Therefore, based on the nonlinear relationship between printed colors with and without OBA, this research tested the polynomial method with regression analyses. The formulas are as follow:

Eq. 3

$$X_2 = X_1 + \Delta X$$
$$Y_2 = Y_1 + \Delta Y$$
$$Z_2 = Z_2 + \Delta Z$$

$$\Delta X = C_{X1}X_1^3 + C_{X2}X_1^2 + C_{x3}X_1 + C_{X4}$$
$$\Delta Y = C_{Y1}Y_1^3 + C_{Y2}Y_1^2 + C_{Y3}Y_1 + C_{Y4}$$
$$\Delta Z = C_{Z1}Z_1^3 + C_{Z2}Z_1^2 + C_{Z3}Z_1 + C_{Z4}$$

X_1, Y_1, Z_1 are measured tristimulus values of printed color on paper without OBA

X_2, Y_2, Z_2 are corrected tristimulus values of printed color to simulate the values in paper with OBA

C_{xi}, C_{Yi}, C_{zi} are constants from the relationship between ΔX and X, ΔY and Y, and ΔZ and Z, and are derived from Excel's trend line analysis

X_1, Y_1, Z_1 are measured tristimulus values of printed color on paper without OBA

X_2, Y_2, Z_2 are corrected tristimulus values of printed color to simulate the values in paper with OBA

C_{xi}, C_{Yi}, C_{zi} are constants from the relationship between ΔX and X, ΔY and Y, and ΔZ and Z, and are derived from Excel's trend line analysis

3 Research Questions

There is awareness how measurement backing impacts the outcome of color measurement. There are studies that address how computational procedures may be applied to reconcile color measurement differences due to backing. There is no comprehensive study that compares how various methods correcting color differences due to OBA in paper.

Thus, this paper is aimed at the following objectives:

1. What is the effect of OBA on printed color between a paper with OBA and the same paper without OBA?
2. Which of the conversion methods is most suited for predicting the OBA measurement from non-OBA measurement?

4 Methodology

We conducted a printing experiment using paper with and without OBA. We then modeled the color differences of the IT8.7/4 target using different computational procedures.

Detailed explanation of the method and major findings follow.

4.1 Print the Color Characterization Target

This research used two kinds of papers, with and without OBA (the grammage as 220 g/m², Invercote G contains OBA and its white point is 96L*, 0.76a*, -3.82b*. Invercote T does not contain OBA and its white point is 95.9L*, -0.53a*, 2.56b*) to print out the same color targets (IT8.7/4 1,617 color patches) with the same printing conditions (Heidelberg SM74 Sheet-fed Offset press).

Spectral values of color samples were measured with X-Rite ProfileMaker 5 Measure Tool. The instrument is X-Rite DTP 70 spectrophotometer and measurement condition is M0 (UV-included) and white backing. The measurements consisted of two groups, one for the colors using paper with OBA, the other for the colors using paper without OBA.

4.2 Data Analyses

Initial color difference (ΔE) of the printed IT8.7/4 data set was calculated between the $Paper_{OBA}$ and $Paper_{noOBA}$ as a CRF_ΔE curve. Conversion methods from $Paper_{noOBA}$ value (X_1) to $Paper_{corrected}$ value (X_2) were applied. Color difference (ΔE) of the printed IT8.7/4 data set was recalculated between $Paper_{corrected}$ and $Paper_{OBA}$ as a CRF curve.

Furthermore, spatial (with-in sheet) variability was analyzed using the 29 repeated color patches in the IT8.7/4 target. The CRF_ΔE curve was generated to serve as a measure of system noise when comparing the accuracy of conversion by different models.

5 Results

We first report the color difference between the two papers used in the experiment. We then describe how colors of printed solids and printed colors are affected by paper color.

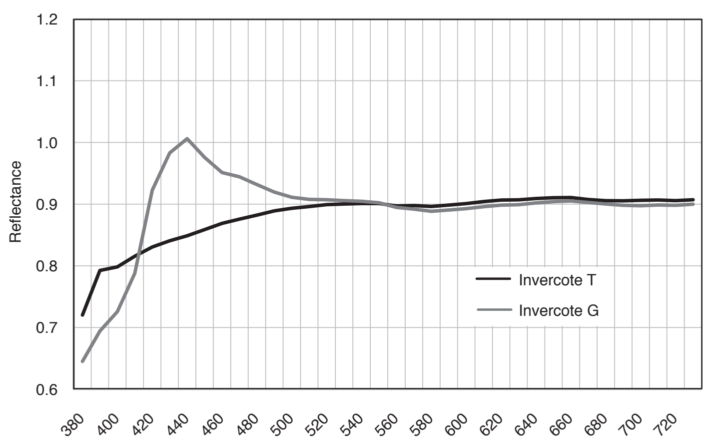
Finally, we compare how different models perform in reducing paper-induced measurement bias.

5.1 Effect of OBA on Substrate

Figure 4 compares the paper named Invercote G containing OBA with the paper named Invercote T without OBA. The peak reflectance wavelength occurs at 450 nm. This indicates that the OBA effect makes a difference between different papers.

Figure 4 shows that Invercote G emitted more short wavelength energy and affected mostly for Δz. The color difference of two substrates is 6.5 ΔE76, mostly from Δz.

Figure 4
Effect of OBA
on paper white



5.2 Effect of OBA on Printed Solids

CMY solids, presented as CIE XYZ and CIELAB values, and color differences of solid colors in two substrates are shown in Table 1. By means of visual inspection of the data in Table 1, magenta solid has the largest ΔE (3.51), and followed by yellow solid (2.76), and cyan solid (1.74).

Due to the OBA difference between the two papers, Δb* is the largest component among ΔL*, Δa*, and Δb*.

Table 1
Color of printed solids on different papers

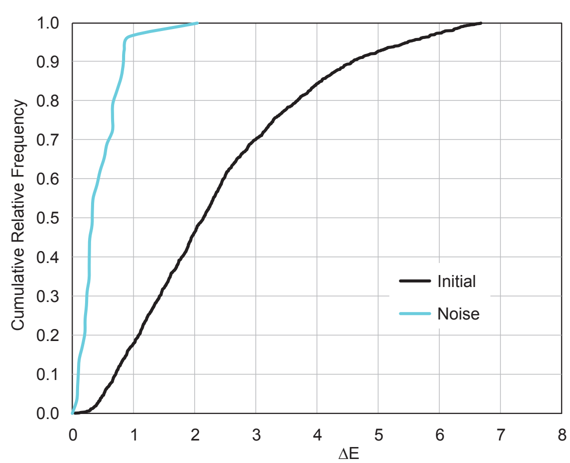
Color	X	Y	Z	L*	a*	b*	ΔX	ΔY	ΔZ	ΔE
M	32.5	16.4	13.0	47.4	74.6	1.4	0.55	0.32	1.57	3.51
M_OBA	33.1	16.7	14.6	47.8	74.8	-2.1				
C	14.8	22.5	51.6	54.5	-36.2	-49.4	0.19	0.00	1.18	1.74
C_OBA	15.0	22.5	52.7	54.5	-35.0	-50.7				
Y	68.5	71.7	6.0	87.8	-1.4	95.7	-0.43	-0.24	0.56	2.76
Y_OBA	68.1	71.5	6.5	87.7	-1.9	93.0				
K	1.8	1.9	1.5	14.8	0.2	0.2	0.00	-0.01	0.00	0.18
K_OBA	1.8	1.9	1.5	14.8	0.4	0.1				

5.3 Effect of OBA on Printed Colors

Printed colors are represented by 1,617 CIELAB values from the IT8.7/4 target. The effect of OBA on printed colors is summarized by the CRF curve of ΔE in Figure 5. There are two CRF curves in Figure 5.

The blue CRF curve, situated at left, represents the noise of measurement and within-sheet variation. The magnitude of the noise indicates that more than 90% of the time, random variation of the measurement is less than one ΔE.

Figure 5
The effect of OBA on printed colors



Relative to the noise, color differences of printed colors between printed colors using paper with and without OBA, as shown by the black CRF curve, is far more significant. The maximum ΔE is 6.59 ΔE76.

There are 16% of printed colors, in which ΔE is larger than 4 ΔE76, and in which total ink quantities are less than 85%. It means the effects of OBA impact light ink covered areas the most.

5.4 Comparison of Different Conversion Methods

Three conversion methods, i.e., backing conversion, ICC relative colorimetry, and polynomial conversion methods, were used to covert the tristimulus values of measurements from printed colors using paper without OBA to with OBA.

The performance of the three correction methods is shown in Figure 6.

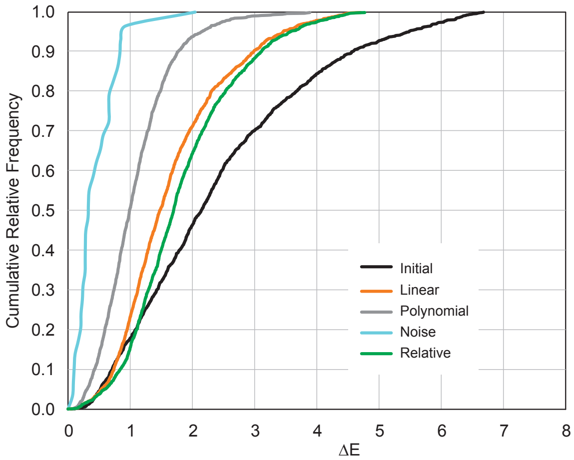


Figure 6
CRF_ΔE of three correction methods

The initial CRF curve, situated at far right of Figure 6, is the color difference between measurement values of paper with and without OBA. There is a color difference of up to 4.5 ΔE 90% of the time. Using the ICC relative colorimetry correction method, the color difference is reduced from 4.5 ΔE to 3 ΔE. Using the tristimulus linear correction method, the color difference is further reduced from the ICC relative colorimetry correction method by a small margin.

The use of the polynomial correction method further reduces the color difference from 3 ΔE to less than 2 ΔE. By comparison, the polynomial conversion is the most efficient than other conversions from CRF_ΔE.

6 Discussion and conclusion

To conclude, the color difference due to OBA in paper (6 ΔE76) is greater than the color difference due to measurement backing (2 ΔE76). Larger color differences due to OBA in paper are observed in color patches with less ink coverage. As the ink coverage increases, less correction is needed. This is why the linear correction in the tristimulus color space works out okay initially.

From mathematical modeling point of view, the linear tristimulus correction and the ICC relative colorimetry are almost identical, i.e., both models have a slope of the straight line. The linear tristimulus method has an intercept which can be approximated at (10L*, 0a*, 0b*) in the CIELAB space, but the ICC relative colorimetry does not.

The fact that there is a curvature between the ΔX and X, as evidenced in Figure 3, gives the polynomial method an improved performance out of three methods examined. The down side of the polynomial method is that the full data set of the production paper and the full data set of the reference printing are required to determine the coefficients in the polynomial method.

From this research, we have learned that printed colors are affected by paper containing OBA. While there is an overall reduction of color difference by using any one of the three correction methods tested, there is no clear understanding if printed solids or substrate-corrected TVI will show improvement. This is a research direction to be further examined.

7 Acknowledgment

The authors wish to express their sincere appreciation to Mr. Bob Henry of Iggesund Paperboard for providing the papers with OBA and without OBA to perform the printing experiment.

They also want to thank Mr. Daniel Hawkrigg of Iggesund Paperboard for his interest and support of the project.

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SEEING IS BELIEVING

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1. A VISUAL EXPERIMENT

Printed color is the result of the ink-paper-press interaction. The perception of the printed color is influenced by the color of the inks used. It is also influenced by the color of the paper and the light source the print is viewed.

If you turn the page and examine the two facing pages, you will see the two facing pages look alike. The reason they look alike is because the same pictorial color images are printed on both facing pages.

If you are observant, you soon realize that colors of the paper are different. The amount of color difference between the two papers depends on the light source they are viewed under. In general, the left-side page looks yellower and the other side whiter and brighter.

If you are curious, you will see less color difference between the two pages under tungsten light and more color difference under fluorescent light or daylight. In other words, the more UV content the light source contains, the whiter and brighter the right-side page looks.

Now you understand why we recognize paper as the fifth color. But, you want to know what makes a paper brighter than the other, don't you?

2. THE SECRET AGENTS

Papermakers know how to turn trees into pulp, and from pulp into paper. Depending on recipes used, different grades of paper, e.g., coated, supercalendared, uncoated, newsprint, are made.

Optical properties of a paper include color, brightness, whiteness, gloss, and opacity. For the same paper grade, these optical properties can be influenced by the addition of either dye or an optical brightening agent (OBA) in the papermaking process.

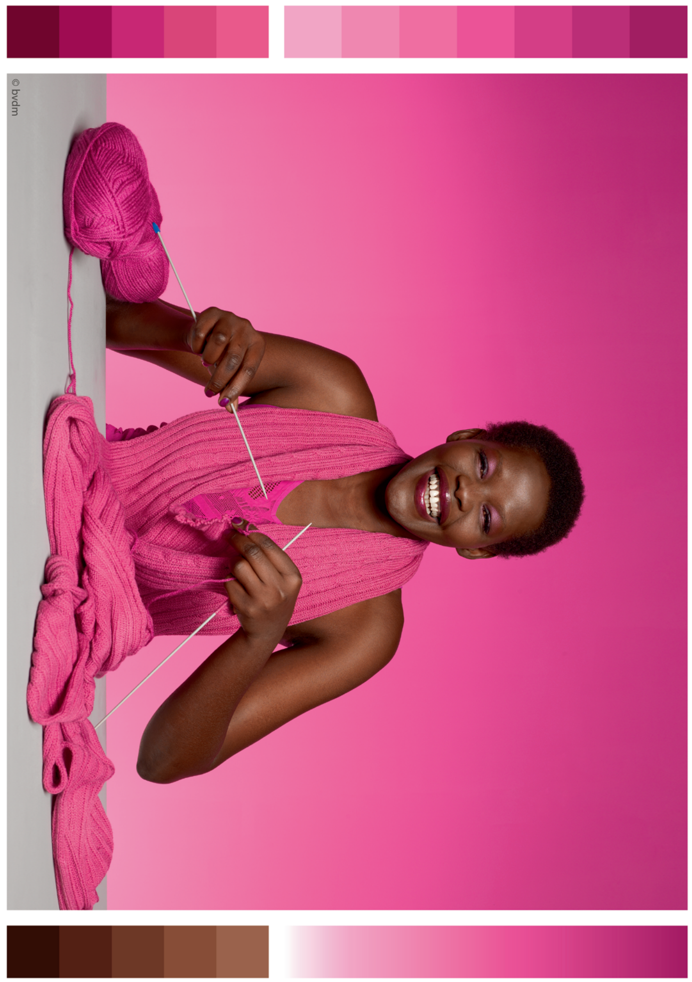
Dye dissolves in water and stays on fibers during the papermaking process. Dye absorbs medium wavelength energy in 500-600 nm, thus, moving paper color towards lower L^* and b^* values. When the rate of reduction in b^* is greater than the loss in L^*, dye will increase the perceived whiteness.

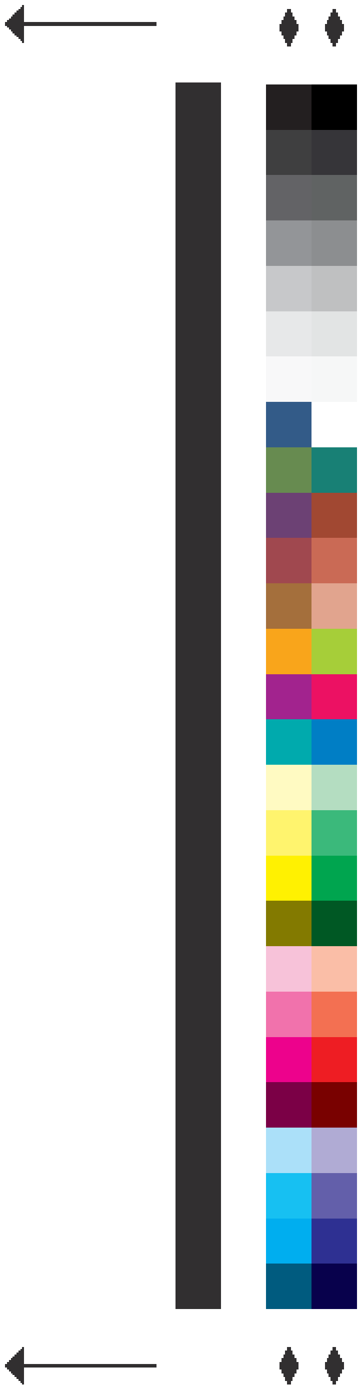
An OBA is a mixture of monomers and dimers. It absorbs UV energy from the light source and emits the energy back as short wavelength visible light, thus, moving paper color towards increased L^* and reduced b^*.

Roman16 bvdm Reference Images

Press Heidelberg Speedmaster 74
Paper Invercote T (no OBA)

Content Roman 16 CMYK
IDEAlliance ISO12647-7 Control Strip 2009



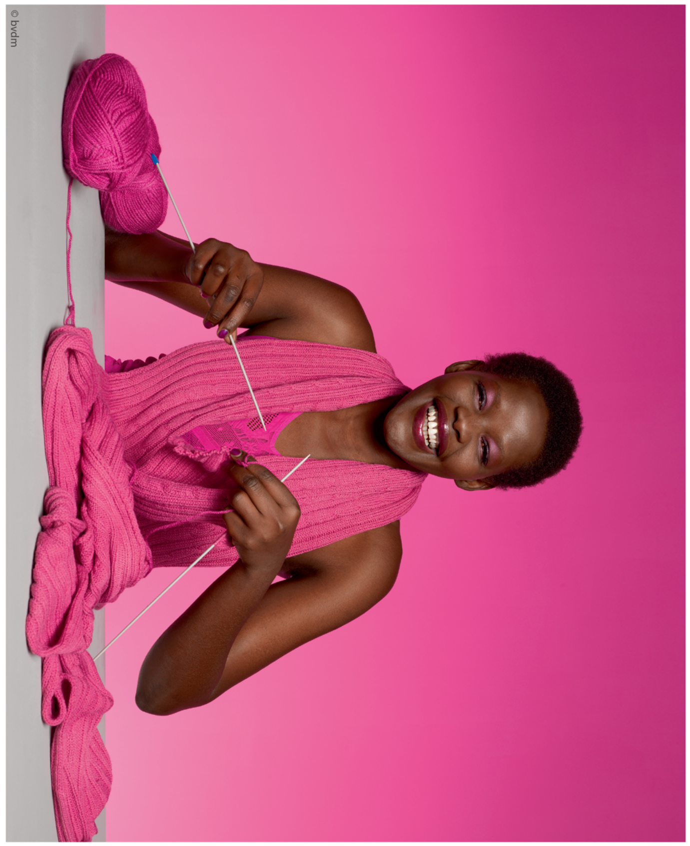


Idealliance_ISO12647-7_ControlStrip09_iSis
Test chart page 1 of 1, Size: 19.2 x 17.1 cm, complete patch amount: 54
2A1
A1

Roman16 bvdm Reference Images

Press Heidelberg Speedmaster 74
Paper Invercote G (OBA)

Content Roman 16 CMYK
IDEAlliance ISO12647-7_Control Strip 2009



2A1

A1

Idealliance_ISO12647-7_ControlStrip09_iSis
Test chart page 1 of 1, Size: 19.2 x 17.1 cm, complete patch amount: 54

3. IS OBA A BLESSING OR A CURSE?

OBA can add brightness to paper at relatively low cost, and it keeps designers, publishers, and brand owners wanting more. Without OBA, these papers look yellowish and dull. Thus, there is no question that OBA is a blessing to papermakers.

Depending on the OBA grade, it is neither lightfast nor thermally stable. Thus, OBA is like a curse that can cause customer complaints and get papermaker as well as printers in trouble.

4. TAMING OF OBA

ISO 12647-2:2004, Graphic technology—Process control for the production of half-tone colour separations, proof and production prints – Part 2: Offset lithography is a well-known international printing standard It specifies process parameters, aim values, and tolerances so that printers and print buyers can specify and communicate requirements with clarity and ease.

Paper color is one of the process parameters in ISO 12647-2. The paper color, e.g., Type 1 gloss coated, is specified as (95L*, 0a*, -2b*) with a tolerance of 3 ΔL*, 2 Δa*, and 2 Δb*. Due to the popularity of OBA, paper color has become much bluer and there are more papers on the market that are out of tolerance than are in tolerance. In other words, OBA has invalidated the methodology used in the current ISO 12647-2 printing standard. Fortunately, published colorimetric aims can be altered with the use of published formulas to account for the difference due to production paper. If this interests you, please see the technical papers published in this publication for more information.

5. PHOTOGRAPHIC ILLUSTRATION

The two printed pages were photographed side-by-side using a Nikon D70 digital camera under two different lighting conditions. The two pages look yellowish and alike when illuminated under tungsten lighting. This is because tungsten has little UV, but ample long wavelength energy.

The photograph below was illuminated in D50 lighting plus UV. The page on the left, containing no OBA, looks duller and the page on the right, containing OBA, looks brighter and bluer.

ACKNOWLEDGMENT

A special recognition goes to Iggesund Paper for providing Invercote G (the paper with OBA) and Invercote T (the paper without OBA) to make this issue's Gallery of Interest possible.

Franz Sigg
Scott Millward

Stability of Optical Brightening Agents in Paper when Exposed to Light

Keywords optical brightening agents, OBA, fluorescence, paper, stability

Abstract

Two proofing papers and 16 offset papers were tested for their stability to light exposure. It was found that the greater the apparent OBA content, of a given sample sheet, the larger the change in color and/or brightness, however, some changes occur even for papers that have no OBA content. Different metrics were used and compared to one another when the effect of OBAS was evaluated.

1 Introduction

Optical brightening agents (OBA) are chemical additives put into papers to increase apparent brightness. OBAS absorb energy in the ultra violet (UV) below 400 nm and emit visible light in the blue portion of the spectrum. This adds to the energy reflected by the substrate and increases the apparent reflectance. This increases the CIE Z values and thus impacts mainly the b*component of the computed CIELAB values. The magnitude of this effect is proportional to the amount of UV energy present in the incident light of the measuring instrument and/or viewing booth.

It is becoming more and more difficult to find papers without OBAS. But the amount of the OBA effect varies greatly and is neither standardized nor documented by the paper manufacturers. Therefore the OBA effect becomes one more variable that makes life difficult for the people who attempt to standardize printing. In addition, these OBA chemicals break down over time. This means that, as time passes, OBA present in the paper looses its ability to convert UV energy into visible light, which changes the color of the paper. This degradation of OBAS is sped up when exposed to light and was studied for this report.

2 Methodology of Preliminary Test

To investigate the stability of OBAS, first, a simple test was conducted where a brightened proofing paper (Epson Photo Quality Inkjet paper) and a UV suppressed proofing paper (ORIS Pearl Semimatte) were exposed to normal room light. A second sample set of these papers was protected from light in a dark drawer. The UV suppressed paper in question is actually a brightened paper but has been coated to make it printable with ink jet inks. This coating absorbs UV energy and therefore prevents stimulating the OBAS in the paper.

The samples were exposed to a 'normal' lighting condition with unknown UV content, comparable to an office situation. All samples were measured at regular time intervals over a period of one year. An X-Rite Eye-One iSis scanning spectrophotometer in both UV-included and UV-cut modes was used to track the changes. The test form consisted of 34 measured locations on a sheet of unprinted paper that were then averaged to obtain an overall spectral curve of paper white.

The samples that were kept in the dark, were exposed to a little bit of room light and the measuring light each time they were measured.

3 Results and Discussion of Preliminary Test

Over 351 days the brightened paper changed color as witnessed by the 7.2 ΔE change when measured with the UV component included (High OBA-Exp_UVInc). The majority of this color difference is a change of the b* value (Δb* of 6.9) making the paper more yellow. When measured under the UV-cut condition (High OBA-Exp_UVCut) the color difference was only about 2.6 ΔE. Again, most of this is due to the change in b* but less dramatically because the OBAs are not stimulated. The UV suppressed proofing paper and the samples kept in the dark stayed stable with only about a +0.5 b* color change.

Figure 1 shows the effects of OBAs on the brightened paper, there is a difference between the UV-included and UV-cut measurements of the brightened paper. As the time has passed the peak of the spectral curve, around 440 nm has dropped from 100% to 85% when exposed to light while the protected sample dropped from 100% to 97%.

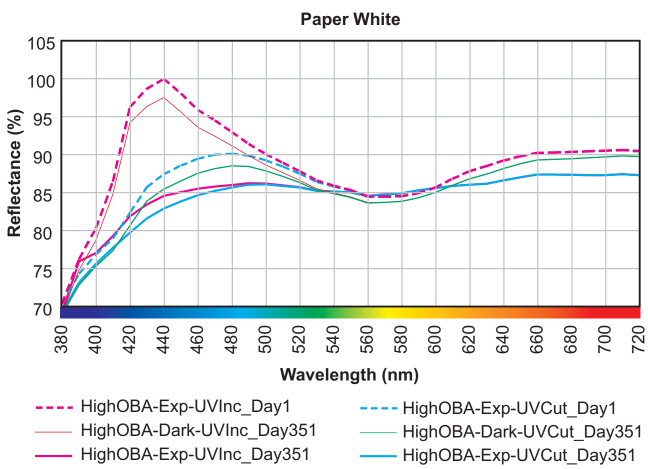


Figure 1
Spectral curves of brightened proofing paper before and after 1 year exposure

Figure 2 shows the data for the UV suppressed paper. As expected, there is very little change due to exposure.

This stability is what color management experts would like to see also for optically brightened papers, so they do not have to chase a changing paper over time.

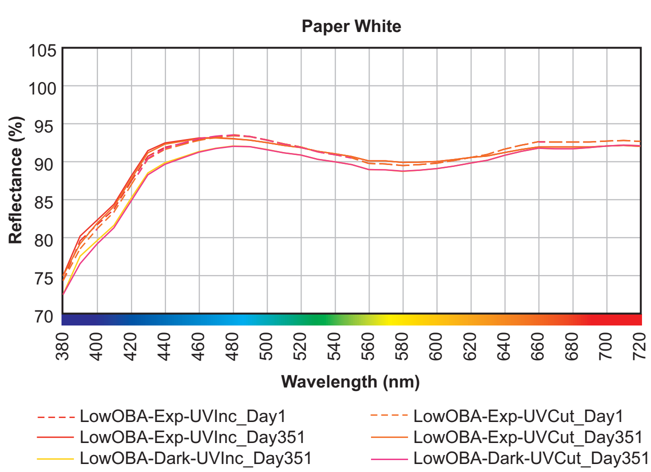


Figure 2
Spectral curves of low brightened paper before and after 1 year exposure

This graph shows the change in color of all samples over time using the UV-included measurement only. The protected samples and low OBA paper have stayed pretty much constant, the exposed highly brightened paper has been changing steadily. After 351 days there is a 7.23 ΔE in the highly brightened paper. This amount of change is a magnitude that most customers find very unacceptable for color difference and was noticeable (ΔE 2.0) after only a month and a half.

Figure 3 shows the change of b* value over 351 days. The papers kept in the dark and the low brightened paper have remained quite constant. The exposed brightened paper has a b* value that steadily increased from −6.60 to +0.31 making the paper more yellow. This is because the OBAs in the paper have started to degrade and lose their ability to convert UV wavelengths into short visible wavelengths. The stability of this chemical is poor when a paper changes this much in less than a year. This observation is based on only one proofing paper that is designed for short term proofing, other papers may use different OBA chemicals that are more stable. Figure 4 shows the change of ΔE* over time.

Figure 3
Change of b* over time

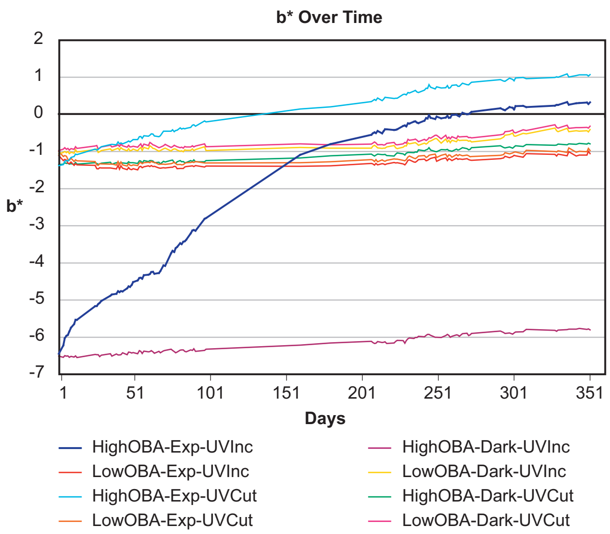
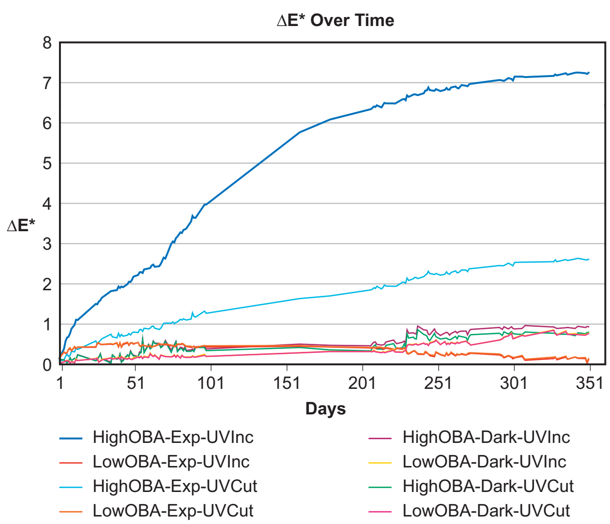


Figure 4
Change of ΔE* because of light exposure and time



This preliminary test indicates that there can be substantial color changes due to a change in OBA effectiveness.

The results pertain to inkjet proofing papers that have a coating to make them compatible with the inks. The question is, how stable are OBAS in normal offset printing papers.

4 Methodology of Second Test

For the second test, samples from 16 papers were collected in the press rooms at the Printing Applications Lab at RIT. From each sample, a one inch square piece of paper was cut out and glued at the edges on a paper template that had printed tick marks, so that it could automatically be read by an X-Rite Eye-One iSis scanning spectrophotometer. Two such templates were made, one was always kept in the dark (designated as "L"), the other was exposed to light, (designated as "D").

"L" and "D" do not stand for light or dark, they are just a poor choice of labels. The not exposed "L" samples were also measured at the same time intervals, to document possible changes over time. Even though they were kept in the dark, the "L" samples were exposed to the repeated measuring light. For each sample, 9 readings were taken at different locations and then averaged. Table 1 lists these papers.

Table 1
List of sampled offset papers

Red values indicate large OBA effects

Green values indicate small OBA effects (before exposure)

	Company	Specs	Sheetfed or Web	Coated Uncoated Matt	Date of Manufacturing	g/m ^{2}	Basis Weight lb	Thickness mm	Reflectance UVyes-UVcut at 440nm	Reflectance ratio of 380nm / 440nm
1	Sappi	Flo Matte 7 Pt	S	M	5/15/2009	162	110	0.18	0.071	0.533
2	Sappi	Flo Gloss	S	C	8/16/2010	118	80	0.10	0.074	0.416
3	Sappi	New Somerset gloss	S	C	4/25/2006	148	100	0.13	0.073	0.439
4	Sappi	McCoy Gloss	S	C	10/04/2010	118	80	0.10	0.183	0.046
5	New Page	Producto lith Dull Cover	S	C	12/01/2010		80	0.18	0.087	0.398
6	Finch	Fine Cover soft white	S	M		270	100	0.31	0.040	0.710
7	U Velvet	Cover	S	M		148	100	0.28	0.110	0.317
8	?		S	C				0.08	0.043	0.613
9	?		S	M				0.10	0.189	0.064
10	Mohawk	Superfine Softwhite smooth	S	M		118	80 text	0.13	0.005	1.047
11	?		S	M				0.31	0.146	0.167
12	?		S	C				0.08	0.109	0.251
13	Newton Falls	Commercial Dull	W	C	ca. Dec. 2010		105	0.18	0.093	0.430
14	Int. Paper	Williamsburg Smooth	W	M	ca. Dec. 2010		50	0.10	0.154	0.176
15	New Page	Orion Gloss Text	W	C	ca. Nov. 2010		60	0.08	0.075	0.409
16	Vergo	Advocate Offset Gloss	W	C	ca. Nov. 2010		40	0.07	0.003	0.526

Even though some papers had no designation and are marked with a question mark, they are still samples that show possible variation. At first, the "D" set was kept in the dark for 5 days and measured once every day. Then the "D" samples were exposed to the fluorescent room light in the measurement lab, and measured every day. After that, "D" samples were exposed to daylight behind a glass window.

At this stage there were sometimes more than one day between measurements, but regular measurements were taken. Sometimes the sky was overcast, sometimes the sun was shining. Extensive Microsoft Excel spreadsheets were programmed using Visual Basic to automatically input and process the measured data.

5 Results and Discussion of Second Test

One of the challenges for presenting the results was to find the best ways to measure the changes. The focus was on changes of b* values, since they are often used in the industry as a measure of the amount of OBA in a given paper. But other criteria were considered as the following discussion shows. All the papers were unknown in the sense that there was no data available from the manufacturers on how much OBA or which type was added to the paper.

Therefore, the following questions were formulated and attempted to answer:

1. *How much of an effect did the applied exposures have on the b* values?*
2. *How much of an effect did the applied exposures have on the a* values?*
3. *How could the OBA content of a sample be measured?*
4. *Do papers with a lot of OBAS change more than papers with little or no OBAS?*

1 How much of an effect did the applied exposures have on the b values?*

Figures 5 and 6 shows how the b* values of the exposed "D" samples changed:

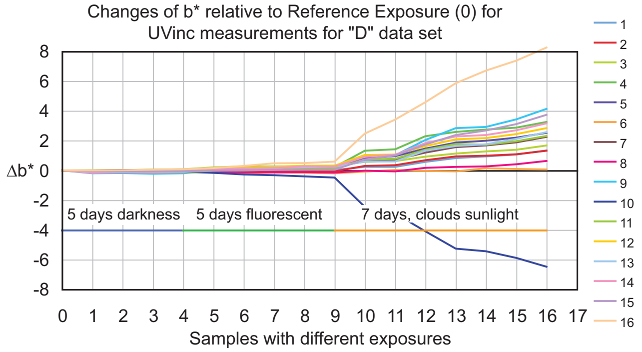


Figure 5
Changes in b*
for UV-included

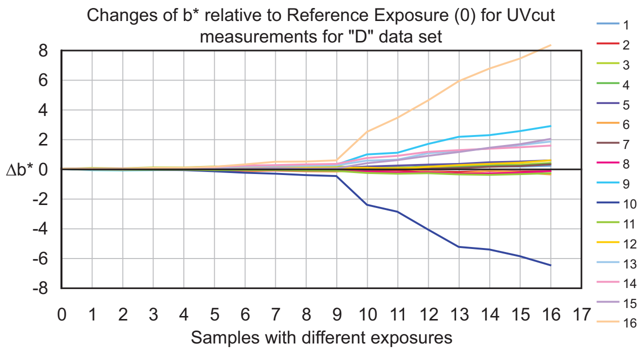


Figure 6
Changes in b*
for UV-cut

Figure 6a shows how the b* values of the not exposed "L" samples changed. Note that the Δb* axis is different:

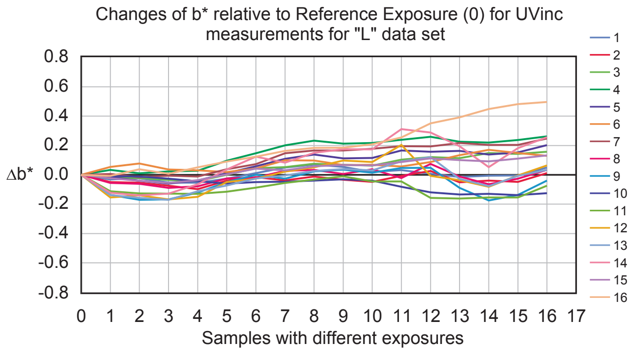


Figure 6a
Changes in b*
for UV-included,
not exposed
sample set "L"

Observations:

a Daylight has a much stronger effect than fluorescent light.

b Paper 16 has an unusually strong reaction in the +b* (yellow) direction.

c Paper 10 has a very unexpected reaction in the –b* direction. It almost seems that it gets bleached by the light and gets bluer, not yellower. This is also confirmed by visual inspection.

d When measuring without UV light, most papers show little change. But some papers change measurably (2+ b*) or even strongly. So, by measuring without UV light, the effects of OBAs is disabled, and yet, there are still changes. We need to remember that there are also effects other than OBA.

Even when the samples are kept in the dark and are not exposed to light (except for measurement), they still change. The b* change for the "L" data set (Fig. 6a) shows small changes, less than 0.5 b*, and they are systematic, not just measurement noise. The samples were not only (not) exposed to light, they are also exposed to the oxygen of the atmosphere. So, time is also a variable.

2 *How much of an effect did the applied exposures have on the a* values?*

Figures 7 and 8 show the effect on a* values:

Figure 7
Changes in a* for UV-included

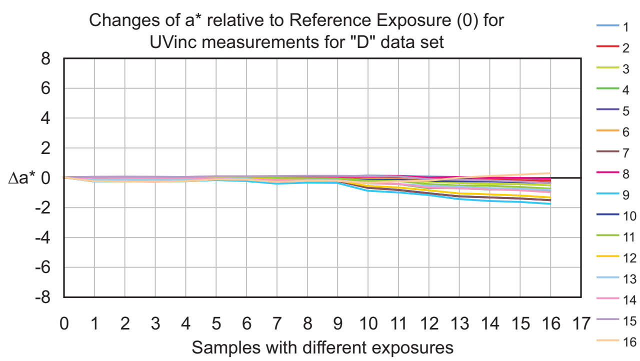
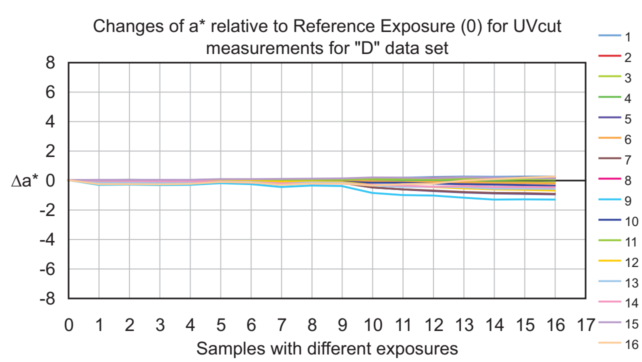


Figure 8
Changes in a* for UV-cut



Observations:

e a* values do change less than b* values, and the direction is minus red or plus green for all papers.

f For UV-cut measurements a* changes almost as much as for UV-included measurements. This means that the majority of the a* changes are independent of the UV effect of OBAs

3 *How could the OBA content of a sample be measured?*

A good way to evaluate the amount of OBA is to look at the spectral curves. See Figure 9:

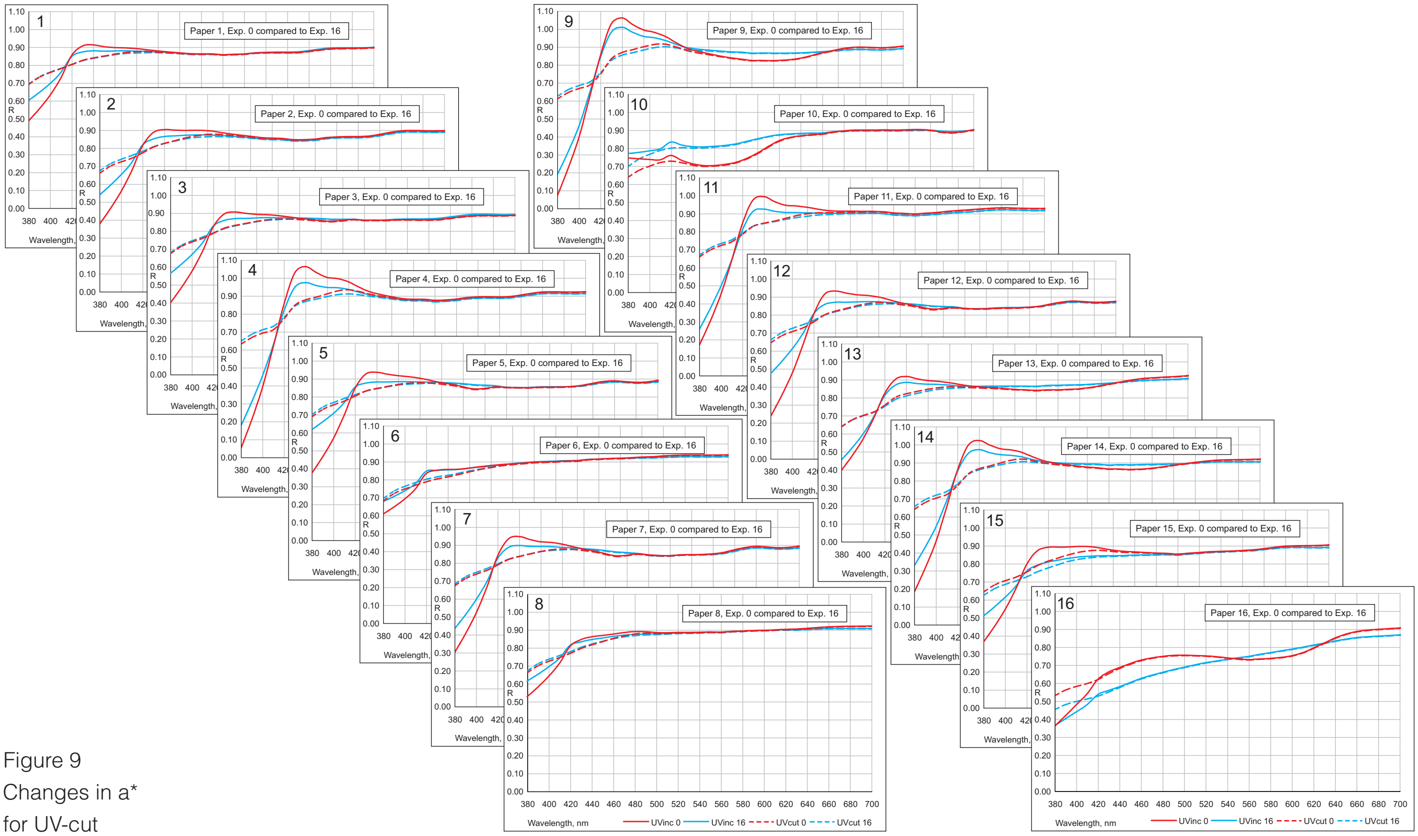


Figure 9
Changes in a*
for UV-cut

Observations:

g There are three methods that could be used to estimate the amount of OBAs:

1 The presence or absence of a peak of the spectral curves is an indication of the amount of re-emitted blue energy by the OBAs. But in practice this is difficult to quantify.

2 The difference of reflection at the peak (440 nm) between the UV-included (solid red curve) and UV-cut (dashed red curve) measurements. (The red curves show the original curves, the blue curves show the curves after exposure to light). Previous researchers have measured the area between the UV-included and UV-cut curves in the blue region to obtain a more complete measure of the OBA effect (Löffler, E.M. 2008). For the present investigation, the simpler method of only taking the distance at 440 nm was used.

3 The low reflection at 380 nm can be an indication that UV light is absorbed by the OBAs, therefore the reflectance ratio between 380 nm/440 nm can also be a measure of the OBA effect. This can be thought of as a measure of the slope of the spectral curve in that region.

The last two columns in Table 1 (p. 30) show these calculated parameters. Figure 10 shows the relation between the results obtained from method 2 and 3. If papers 10 and 16 are excluded, then there is a fairly good correlation between the two.

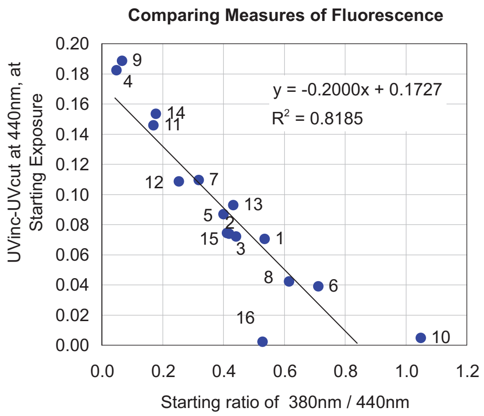


Figure 10
Comparing measures of fluorescence

Observations:

h Using these measures of fluorescence it can be concluded that:

Papers 6 and 8 have very little OBA effect if any (no peaks and very little difference between UV-included and UV-cut), and are the most stable (solid and dashed curves of Figure 9 are almost the same).

Paper 16 has no peak and no difference between UV-included and UV-cut, but a big difference after exposure. Apparently, it does not have OBAs. It probably changes a lot because of a discoloration of wood fibers or other substances due to exposure to light.

Papers 1, 2 and 3 may have a small amount of OBA (small difference between UV-included and UV-cut).

Papers 4 and 9 have a large OBA effect, a strong peak and a big difference between UV-included and UV-cut.

Papers 11, 14 and 12 also have a large OBA effect, but less than papers 4 and 9.

Papers 5, 7, 13 and 15 have an intermediate OBA effect.

Paper 10 is in a class all by itself, it is the only paper that reflects more blue light after exposure (blue curve is higher than red curve in Figure 9). It does not seem to have OBAs since there is practically no difference between UV-included and UV-cut measurements.

4 *Do papers with a lot of OBAs change more than papers with little or no OBAs?*

Figures 11 and 12 answer this question.

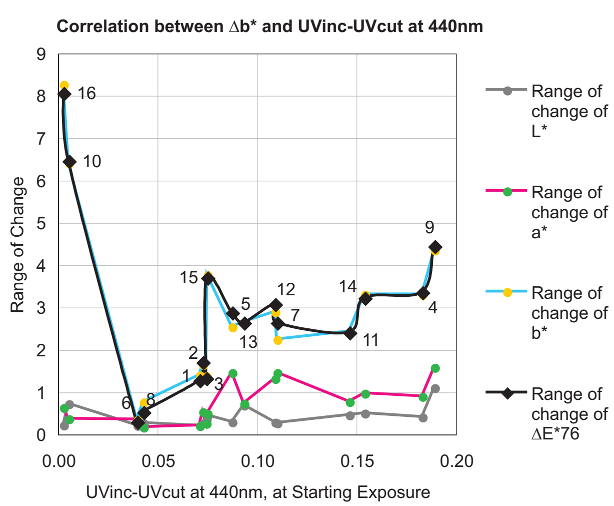
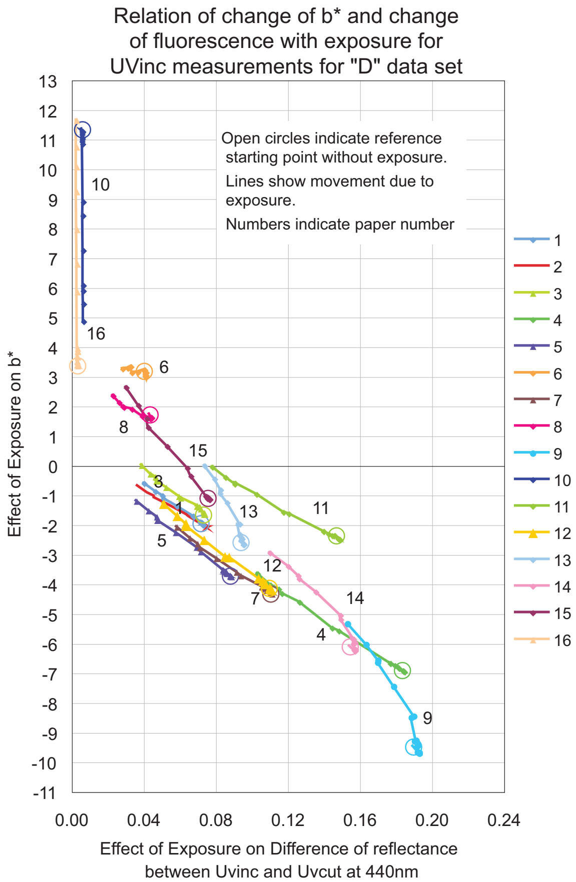


Figure 11
Relation between change in b* as a function of OBA content

Figure 12
Comparing change due to exposure of OBA effect and b*



Observations:

i If papers 10 and 16 are excluded, then it can be said that the more OBA, the more change in b* due to exposure.

6 Conclusions

This was an investigation into the stability of the effect of OBAs in various papers, when exposed to light over time. It was found that::

1 Papers vary greatly.

2 OBAs are not stable, several weeks of fluorescent office light or a few days of daylight (sometimes sunlight) can change the color of some papers by 8 ΔE*76 or more.

3 Not all changes are due to OBAs, but papers with less OBA also show a better stability when exposed to light.

4 Although there is not a perfect correlation, the degree to which b* is negative can be an approximate measure of the OBA content of paper. However, b* can be low even in the absence of OBAs.

5 Since there are so many differences between papers, paper manufacturers should start to document the amount and uniformity of OBA in a given paper, and the type of OBA and its life expectancy. Also, there is a need for quality inspection procedures that can be used by printers to assess the OBAs in papers.

7 Reference

Löffler, E.M. 2008 “Method for Dealing with Colour Measurements on Offset Papers Containing Fluorescent Whitening Agents,” Master's Thesis, London College of Communication, London, England.

Yi Wang

Comparing TVI and G7 Calibration Methods by Simulation

Keywords tone value increase (TVI), gray balance, calibration, simulation, G7, standard

1 Abstract

There are usually two steps in press calibration. The first step is to align the corner points of the target color gamut. The second step is to adjust press tonality either by TVI(tone value increase) or gray balance method. The IDEAlliance G7 calibration method is a gray balance method that is in popular use in the printing industry in the United States.

Given the fact that a printing condition is characterized by (1) color gamut, (2) TVI curves, and (3) gray balance, the question is that "will the adjustment either using TVI or gray balance method be effective for all three requirements to conform to specifications?"

This research uses a simulation method to compare the TVI and IDEAlliance G7 calibration methods to see whether the two methods conform to aim values specified in *ISO 12647-2:2004, Graphic technology–Process control for the production of half-tone colour separations, proof and production prints–Part 2: Offset processes* with respect to performance under a no-drift printing condition. The results indicate that by using either the TVI or G7 calibration method, all three requirements can be in compliance with the tolerance.

2 Introduction

"Printing to numbers" refers to printing to a specified press condition by numbers. It is the latest concept adopted in the printing industry, which is gradually replacing the "visual evaluation" approach to judge the printing production quality.

The International Standard Organization (ISO) publishes sets of printing standards to standardize and guarantee the production quality that benefits printers as well as buyers. *ISO 12647-2, Graphic technology–Process control for the production of half-tone colour separations, proof and production prints* is one of the important printing standards which specifies colorimetric values of the process ink solids, TVI curves, and mid-tone spread. In other words, the document standardizes the color gamut, tonality, and gray balance of the press. There are usually two steps to calibrate the press according to a specified press condition. First, the CMYK ink film thickness is adjusted according to the colorimetric values of the printed solids. Then, TVI or gray balance method can be used to adjust the tonality of the press.

The TVI method calibrates the press by matching the specified tone values with the use of four one-dimensional curves. The IDEAlliance G7 calibration method is one of two gray balance methods that adjusts gray reproduction based on the substrate color. The other method, not investigated here, is known as the Heidelberg method that was proposed at the meeting of ISO/TC 130/WG 3 in St. Gallen on April, 2010 (pp. 6–7). The RIT method, as mentioned in *Achieving Color Agreement: Evaluation the Options* (2007), is similar to the Heidelberg method in concept.

Since a printing condition is characterized by the color gamut, TVI curves, gray balance, the question is that "based on the same color gamut, will the adjustment of using either the TVI or G7 method be effective in achieving *full* conformance? "

Consider that printing drift in real press runs can be offset possible differences between the TVI and G7 methods, the simulation method by means of ICC profile application is used to compare the two methods base on a real press condition.

3 Literature Review

Elie Khoury (2010, January/February) stated that working to standards was a new and inevitable revolution for the second decade of the new century and it would be a requirement for all printers seeking clients.

ISO 12647-2 is an important printing standard which defines the aim values for color gamut and TVI curves. Currently, the latest version *ISO 12674-2:2004* is being reviewed and the draft *ISO/WD 12647-2:2010* shows the trend of including gray reproduction in printing conformance.

The gray balance method introduced by IDEAlliance is widely used.

According to Joe Fazzi's article *IDEAlliance G7 Master and G7 Expert Programs* (2010, 4th Quarter), there were 512 Qualified G7 Master Printer and Proof providers by September of 2010 (p. 36). Once *ISO/WD 12647-2:2010* includes the aim values and tolerance for gray reproduction, will they also be adapted to TVI method? As known, the TVI method is popular in use in Europe. According to Khoury (2010, January/February), there were more than 400 printers currently certified according to PSO/ISO 12647 (p. 19), which uses the TVI adjustment.

4 Methodology

The following details the equipment and materials used in this research project, preparation of the press, and generation of transfer curves using the TVI and G7 methods.

4.1 Equipment and Materials

The initial press run was carried out on a Goss Sunday 2000 web offset press using a KCMY ink sequence. Opus gloss 80-lb. text (ISO Type 1 paper) was used in the press run. Kodak Prinergy 4 (2400 dpi) was used to generate linear plates with 150 lpi AM screening ruling.

The test form (shown in Figure 1) used in the calibration run contained two randomized IT8.7/4 characterization targets, two P2P targets, linear control bars, ISO Standard Color Image Data (SCID), and Altona Test Suite 1.2a images.

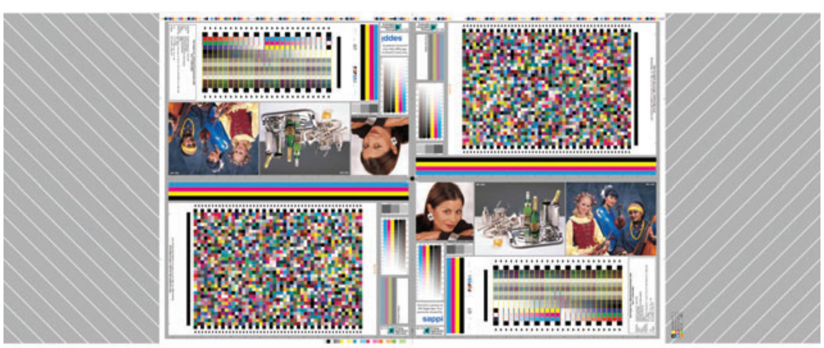


Figure 1
Test form used in the calibration run

CHROMix ColorThink 3.0 Pro, ProfileMaker 5 (Version 5.0.10), ProfileMaker 5 Measure Tool (Version 5.0.10), and IDEAlink Curve2 software were used to collect and analyze the data.

Adobe Photoshop CS4 was used to apply correction values for the press.

4.2 Aims and Tolerances

The colorimetric aims of the process ink solids, per ISO 12647-2:2004/Amd 1:2007, are shown in Table 1.

Table 1
CIELAB coordinates and deviate tolerance for process inks on ISO Type 1 paper under white backing measurement condition

Source: ISO 12647-2:2004/Amd 1:2007

Colorants	L*	a*	b*	Tolerance ΔE_{ab}
Black	16	0	0	5
Cyan	55	-37	-50	5
Magenta	48	74	-3	5
Yellow	89	- 5	93	5

Figure 2 shows the aim TVI curves for commercial printing that is specified in *ISO 12647-2*. The curve A on the figure is the aim TVI curve for cyan, magenta, and yellow tonality; and the curve B is the aim TVI curve for black tonality.

The deviation tolerance for 40% or 50% patch is 4% and that for 75% or 80% patch is 3%.

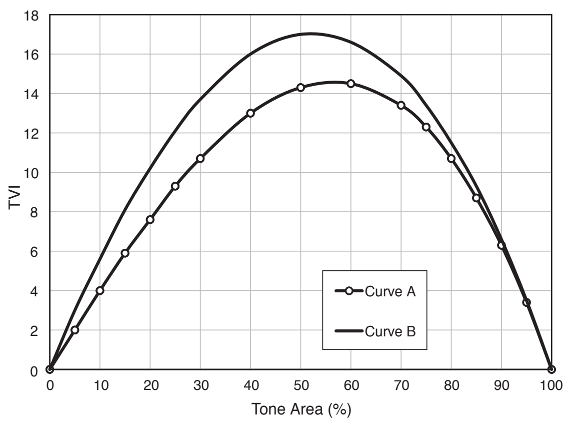


Figure 2
TVI curves specified in ISO 12647-2:2004

Source:
ISO 12647-2:2004

The quarter-tone (25C 19M 19Y), mid-tone (50C 40M 40Y), and three-quarter-tone (75C 66M 66Y) were assigned with ISO Coated (v2) ICC profile using the absolute colorimetric rendering to specify colorimetric aims of the CMY triplets.

Table 2 shows the gray reproduction aims based on the three triplets. The gray tolerance is evaluated using ΔF* in ISO/WD 12647-2:2010. Currently, there is no tolerance for ΔL* in the ISO document.

Table 2
The generated aim values for quarter-tone, mid-tone, and three-quarter-tone gray and their proposed tolerance according to ISO/WD 12647-2:2010 (p.18)

	C	M	Y	K	L*	a*	b*	Tolerance (ΔF*)
Quarter-tone	25.1	18.8	18.8	0	77.0	0.4	-2.1	3.6
Mid-tone	49.8	40.0	40.0	0	58.1	0.4	-1.2	4.1
Three-quarter-tone	74.9	65.9	65.9	0	38.7	0.3	-0.3	4.3

The chroma difference parameter, ΔF*, is used. It is computed using Equation 1.

Note: ΔF* is officially recognized as ΔC_h.

Eq.1

$$\Delta F^* = \sqrt{(a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2}$$

4.3 Run 1

In the first step press calibration (Run 1), the colorimetric values of CMYK solids were adjusted within the tolerance of the aim values specified in *ISO 12647-2:2004/Amd1:2007* (as shown in Table 1).

Then, the test form shown in Figure 1 was printed under this condition.

4.4 Transfer Curves Generation and Run 2 Simulation

The following explain the steps taken to generate transfer curves using the TVI method and the IDEAlliance G7 Calibration method.

4.5 TVI Calibration Method and Run 2 Simulation

The steps from 1 to 5 aim to generate transfer curves using the TVI adjustment and Step 6 is to assess its gray reproduction conformance.

Step 1
Plot a dot percentage vs. tone values between the reference and the sample for the four process inks and then derive the adjustment curves.

Step 2
Apply the transfer curve to the IT8.7/4 target in Adobe Photoshop CS4 using curve adjustment.

Step 3
Open the adjusted IT8.7/4 target in the CHROMiX ColorThink 3.0 Pro application.

Step 4
Apply the Run 1 ICC profile to the adjusted IT8.7/4 target and sample it to generate a list of CIELAB values. This step is the operational definition of printing simulation.

Step 5
Verify the TVI curves conformance according to 40% and 80% tint area.

Step 6
Assess gray reproduction in terms of
1 a* and b* of the triplets as a function %dot, and
2 ΔF* to see if there is improvement in gray reproduction conformance using the TVI method.

4.6 G7 Calibration Method and Run 2 Simulation

The step from 1 to 4 shows how to generate transfer curves using the G7 calibration and Step 5 assesses the TVI conformance.

Step 1
Get the G7 correction values from IDEAlink Curve2 application by dragging the measured P2P25X target measurement file into the application.

Step 2
Apply the correction values to an initial IT8.7/4 data set in Adobe Photoshop CS4 using curve adjustment.

Step 3: Assign the Run 1 ICC profiles to the IT8.7/4 data set in the CHROMiX ColorThink 3.0 Pro application.

Step 4
Verify the gray reproduction in terms of (1) a* and b* of the triplets as a function %dot and (2) ΔF*.

Step 5
Assess TVI curves at 40% and 80% tint area and see if there is improvement in TVI conformance using the G7 method.

5 Results

Based on the preceding methodology, this section describes the initial press condition before showing performance results for TVI and gray balance calibration methods.

5.1 Initial Press Condition

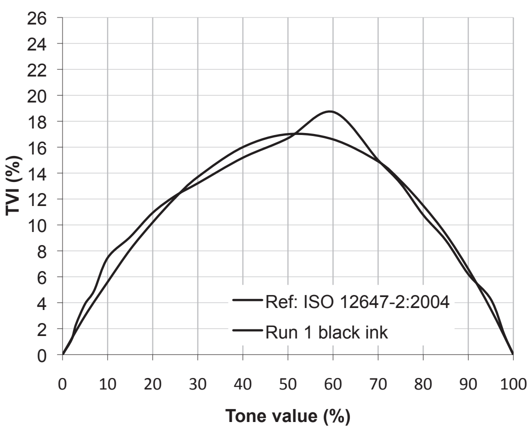
The initial press data is collected from a real press run, whose colorimetric values of the process ink solids are calibrated within the tolerance of the aim values specified in ISO 12647-2:2004/Amd 1:2007.

The colorimetric values of the process ink solids are listed in Table 3.

Figures 3a to 3d show the TVI curves for CMYK. Table 4 lists the TVI values for the control patches.

Table 3
Color gamut of the initial press condition

	ISO 12647-2:2004/Amd 1:2007			Run 1			
	L*	a*	b*	L*	a*	b*	ΔE_{ab}
Black	16.0	0.0	0.0	15.6	0.7	0.5	0.9
Cyan	55.0	-37.0	-50.0	56.3	-35.3	-49.3	2.3
Magenta	48.0	74.0	-3.0	47.8	74.6	-6.6	3.7
Yellow	89.0	-5.0	93.0	89.7	-6.8	90.6	3.1
Paper	95.0	0.0	-2.0	94.7	0.6	-4.2	2.3



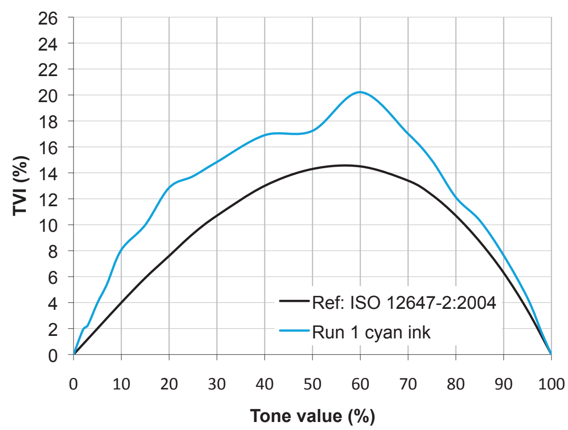


Figure 3a and 3b
The TVI curves of the intitial press condition compared with aim values specified in ISO 12647-2:2004

Figure 3c and 3d continued

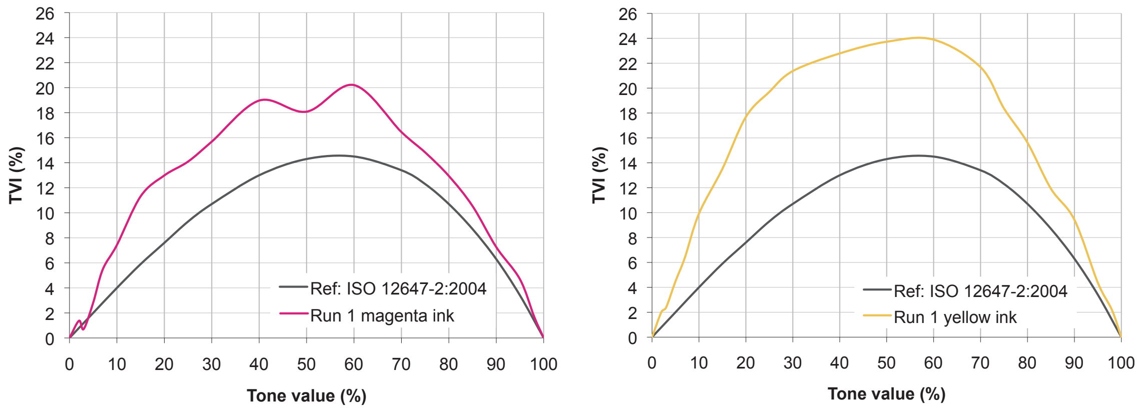


Table 4
Comparison between Run 1 TVI values at 40% and 80% tint area and their specified tolerance in ISO 12647- 2:2004

Tone value of control patch	Run 1_C	Run 1_M	Run 1_Y	Run 1_K	Tolerance
40	4	6	10	1	4
80	1	2	5	1	3

Red numbers indicate non-conformance.

Figure 4 shows the gray balance of the press and Table 5 shows the gray conformance results that mid-tone and three-quarter-tone gray are both out of conformance.

Figure 4
Gray balance of the initial press condition

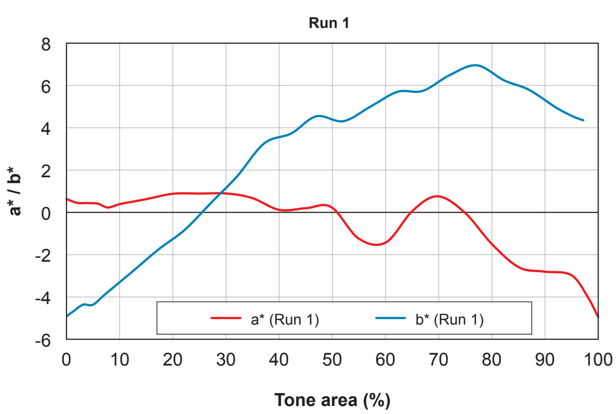


Table 5
Quarter-tone, mid-tone, and three-quarter-tone grays of Run 1

	aim_L*	aim_a*	aim_b*	Run1_L*	Run1_a*	Run1_b*	ΔL*	ΔF*	Tolerance (ΔF*)
25C 19M 19Y	77.0	0.4	-2.1	73.6	0.9	-0.1	3.4	2.1	3.6
50C 40M 40Y	58.1	0.4	-1.2	54.8	0.3	5.3	3.3	6.4	4.1
75C 66M 66Y	38.7	0.3	-0.03	35.2	0.0	7.2	3.6	7.5	4.3

Red numbers indicate non-conformance.

5.2 Assessment of TVI Calibration Method

The TVI curves from the TVI calibration results are shown in Figure 5.

As seen in these graphs, the TVI curves of the simulated Run 2 condition follow well to the aim curves. Table 6 shows the results of the TVI curves conformance.

Figure 5
TVI performances of the TVI calibration method results

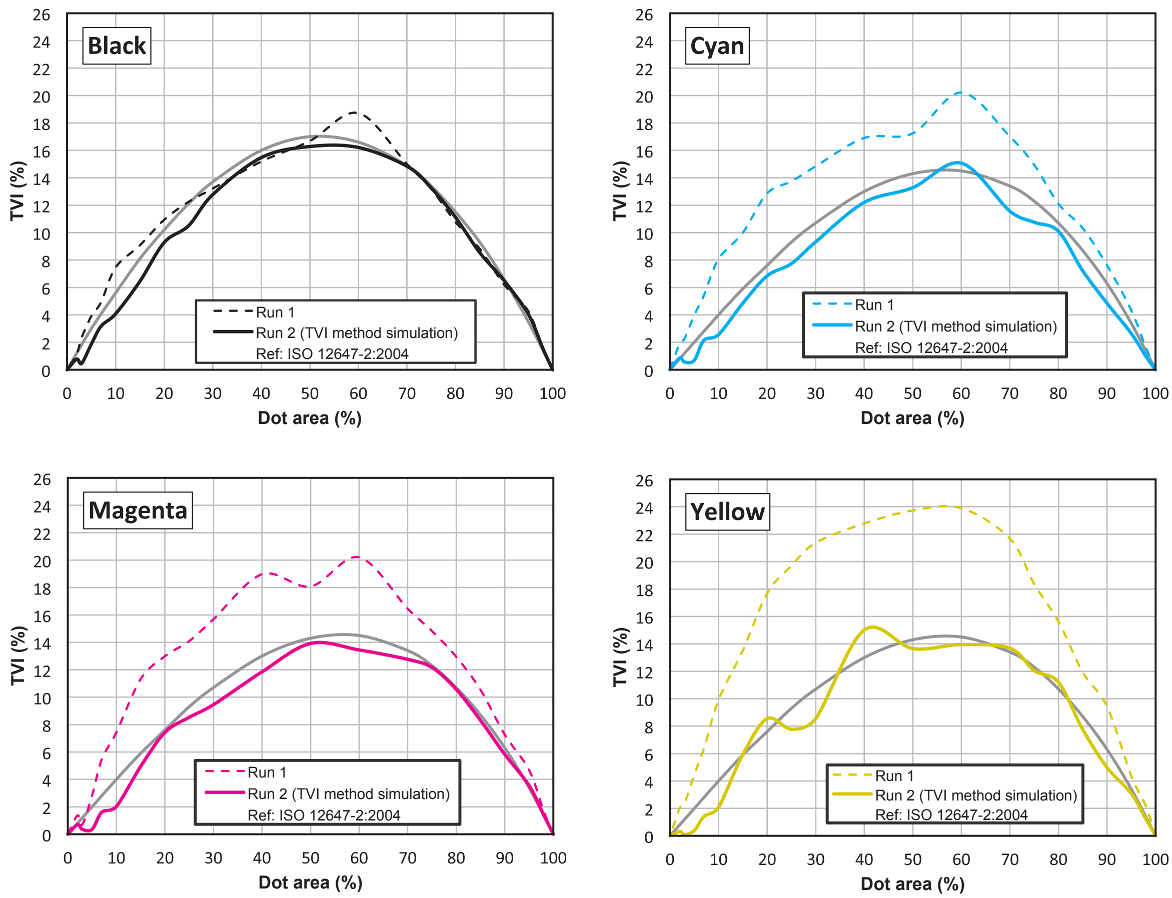


Table 6
Comparison between Run 2 TVI values at 40% and 80% tint area and their specified tolerance in ISO 12647-2:2004

Tone value of control patch	Run 2_C	Run 2_M	Run 2_Y	Run 2_K	Tolerance
40	1	1	2	1	4
80	1	0	0	0	3

Figure 6 shows the gray ramp curves of the simulated Run 2 condition using the TVI method. Table 7 shows the simulated and aim colorimetric values of the quarter-tone, mid-tone, and three-quarter-tone grays. As shown in the table, the gray balance is within the tolerance.

Figure 6
Gray balance performance of the TVI calibration method results

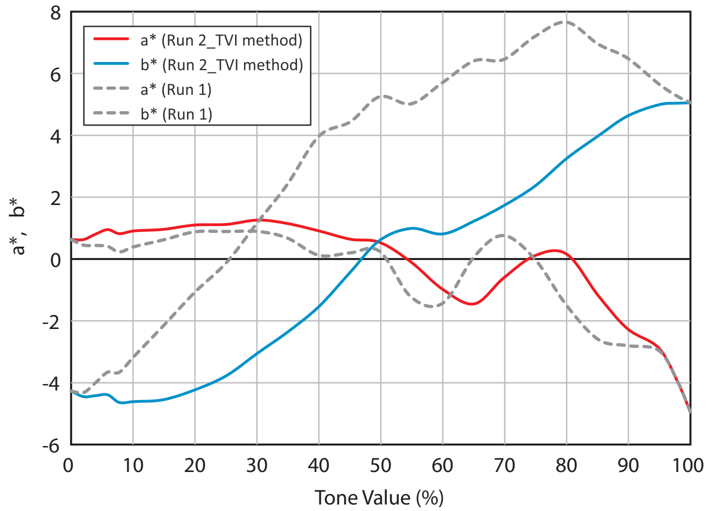


Table 7
Quarter-tone, mid-tone, and three-quarter-tone grays of the simulated Run 2 condition using the TVI method

TVI Method	aim_L*	aim_a*	aim_b*	Run2_L*	Run2_a*	Run2_b*	ΔL*	ΔF*	Tolerance (ΔF*)
25C 19M 19Y	77.0	0.4	-2.1	77.2	1.1	-3.8	0.2	1.8	3.6
50C 40M 40Y	58.1	0.4	-1.2	59.3	0.5	0.6	1.2	1.8	4.1
75C 66M 66Y	38.7	0.3	-0.3	38.0	0.1	2.4	-0.7	2.7	4.3

Figure 7 shows the gray ramp curves of the simulated Run 2 condition using the TVI method. Table 8 shows the simulated and aim colorimetric values of the quarter-tone, mid-tone, and three-quarter-tone grays. As shown in the table, the gray balance is within the tolerance.

Figure 7
The graph shows the gray balance from the G7 calibration results

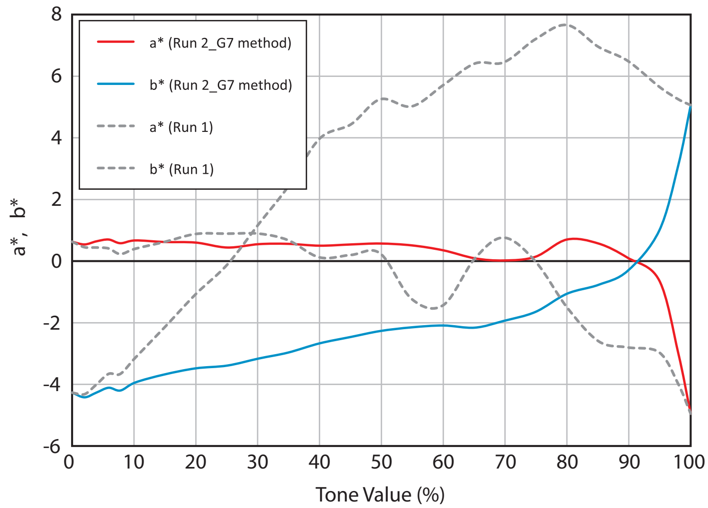


Table 8
The quarter-tone, mid-tone, and three-quarter-tone grays of the simulated Run 2 condition using the G7 calibration method

TVI Method	aim_L*	aim_a*	aim_b*	Run2_L*	Run2_a*	Run2_b*	ΔL*	ΔF*	Tolerance (ΔF*)
25C 19M 19Y	77.0	0.4	-2.1	75.2	0.4	-3.4	1.7	1.3	3.6
50C 40M 40Y	58.1	0.4	-1.2	57.5	0.6	-2.3	0.6	1.1	4.1
75C 66M 66Y	38.7	0.3	-0.3	39.8	0.1	-1.7	1.0	1.3	4.3

5.3 Assessment of Gray Balance Calibration Method

The simulated Run 2 condition using G7 method is shown in Figure 8. Table 8 lists the comparison between simulated and aim values of gray balance.

As seen from the table, the gray balance of the simulated Run 2 is in conformance. Table 9 shows the comparison results with the ISO standard.

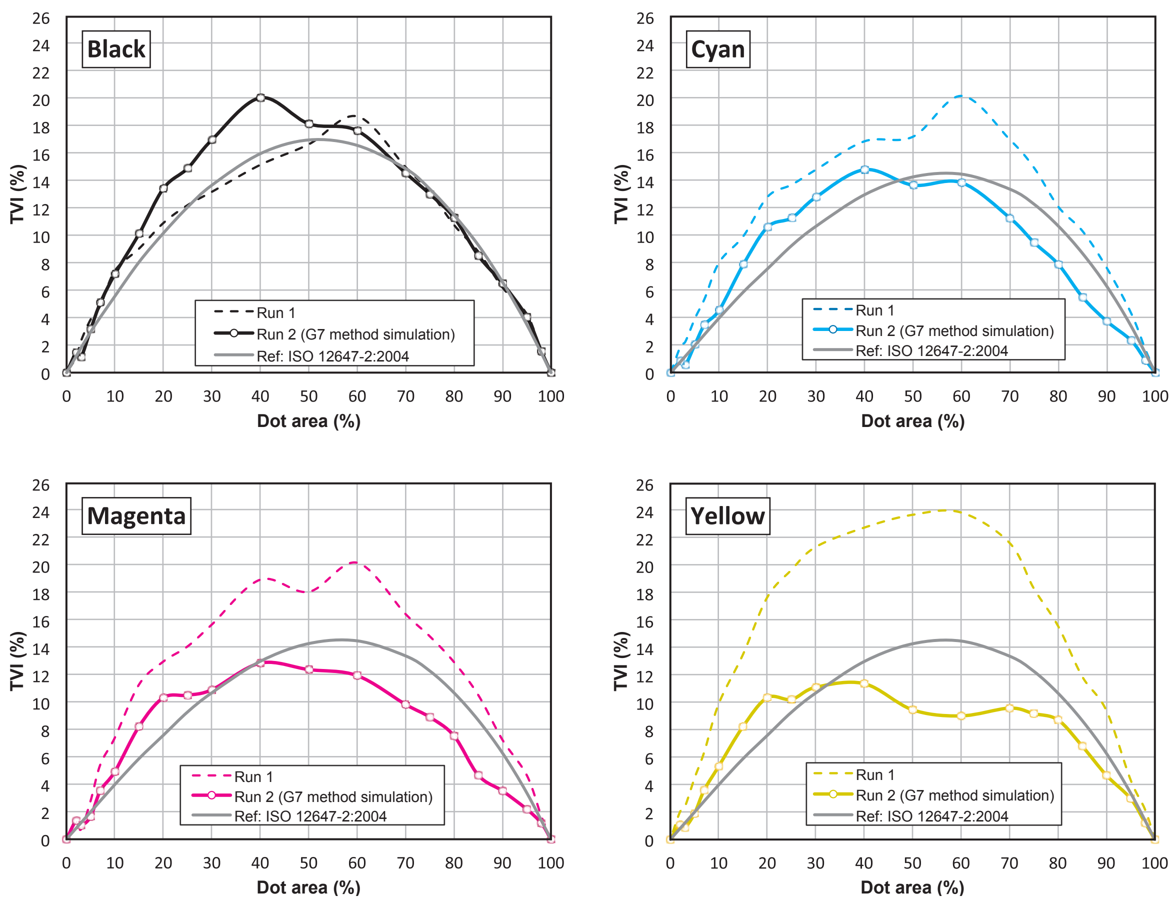


Figure 8
TVI performances of the G7 calibration method result

Table 9
Comparison between the simulated Run 2 TVI values at 40% and 80% tint area and their specified tolerance in ISO 12647-2:2004

Tone value of control patch	Run 2_C	Run 2_M	Run 2_Y	Run 2_K	Tolerance
40	2	0	2	4	4
80	3	3	2	0	3

6 Discussions

According to the G7 method, Equation 2 can be used to compute the aim a* and b* values for the CMY triplets.

The aim values of a* and b* go towards zero as gray darkens.

Eq.2

$$a^* = a^*_{paper} \bullet \frac{100 - C\%}{100}$$

$$b^* = b^*_{paper} \bullet \frac{100 - C\%}{100}$$

Figure 9 shows the gray balance of simulated Run 2 condition against the reference a* and b* values computed by Equation 2.

As seen, the gray ramp follows the reference well, however, it does not reach zero at the three-color-overprint as the reference does.

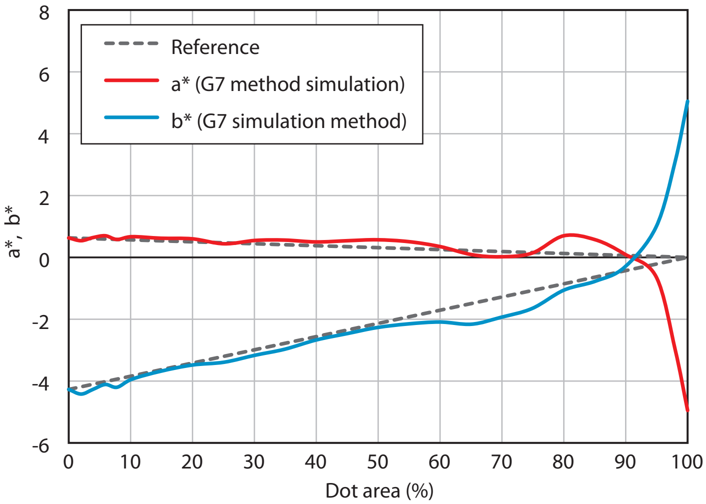


Figure 9
The simulated Run 2 condition using G7 method compared with aim a* and b* values of the G7 method

As seen from Figure 6 and 7, there are no adjustments on the a* and b* values at the three-color-overprints in the Run 2 condition. In the other words, ink solids are only defined by Run 1 condition.

Moreover, as seen from the TVI curves of the G7 simulation result, yellow is over corrected, which implies that if tonality of Run 1 condition is far away from the aim the third requirement may be out of conformance.

Maximum mid-tone spread in *ISO 12647-2:2004* indicates gray balance performance. It uses 5% as its tolerance.

Table 10 shows the maximum mid-tone spread of the Run 1 and the two Run 2 conditions. As seen from the table, the maximum mid-tone spread is out of conformance in Run 1 condition but within conformance in the two Run 2 conditions, which is the same result as using the ΔF* criteria.

Table 10
Maximum mid-tone spread of Run 1 and the two simulated Run 2 conditions

	Run 1			Run 2_TVI method			Run 2_G7 method		
	C	M	Y	C	M	Y	C	M	Y
TVI 50%	17.2	18.1	23.7	13.3	13.9	13.7	13.7	12.4	9.5
Aim values	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
Difference	2.9	3.8	9.4	-1.0	-0.4	-0.6	-0.6	-1.9	-4.8
Max mid-tone spread	6.5			0.6			4.2		
Tolerance	5.0								

Red numbers indicate non-conformance.

What should be noted in ISO/WD 12647-2:2010 is that it only specifies ΔF* as tolerance for gray and it does not specify values for ΔL*. However, the L* value is also an important parameter in gray reproduction conformance. It specifies the accuracy of tone reproduction. In the two simulation results, the maximum ΔL* at the quarter-tone is 1.7, at mid-tone 1.2, and at three-quarter-tone 1.0.

7 Conclusions

Color gamut, TVI curves, and gray balance are three requirements in press calibration. The results of this studies indicate that based on the same color gamut, TVI curves and gray balance can be both in conformance using either the TVI or gray balance method.

The simulation method used in this study minimizes possible variations from printing drifts and measurement bias, which helps to look at the true difference of the two methods.

8 Acknowledgements

The researcher would like to thank Professor Robert Chung and Fred Hsu for their help with designing the methodology for this research.

9 Editor's Note

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That publication was published by the Technical Association of the Graphic Arts (TAGA) Student Chapter, Rochester Institute of Technology, Rochester, New York. The *Test Target 10* article by Yi Wang and her earlier version have the same title.

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Enqi Zhang

Verifying Process Ink Conformance by Means of a Graduated Gauge

Keywords density, calibration, IFT, color

Abstract

To verify ink conformance according to ISO 2846, several ink film samples with various known ink film thicknesses (IFTs) should be produced by use of a printability tester. The ink will pass if at least one ink film sample with a thickness within the range of 0.7 to 1.1 microns (0.7–1.3 for black ink) has less than 4 ΔE color difference from the aim points specified by the standard. One of the current ink transfer mechanisms recommended by ISO 2834 is an IGT printability tester. However, it is time consuming to produce enough number of ink samples. Samples can be produced on a Little Joe proofer, using the fineness of graduated grind gage to obtain multiple ink film thicknesses within a single sample. However, all the IFTs within the sample are not absolute values. This research investigates whether a calibration curve of optical density vs. IFT could be used to convert the relative values to absolute values.

1 Introduction

ISO 2846-1:2006 Graphic technology – Color and transparency of ink sets for four-colour printing – Part 1:sheet-fed and heat-set web offset lithographic printing states that, "The similarity of two inks on a reference substrate generally ensures similarity on another substrate, and it is this that has enabled industry specification or standards such as ISO 12647-2 [1], which specify the color of these inks on other substrates, to be developed (Introduction).

Therefore, it is important to define color of an ink on a reference substrate so the same ink can deliver the same color on other non-reference substrates. On the other hand, lower priced inks have less pigmentation, which means more ink film thickness (IFTs) is needed to achieve a certain color. This will lead to issues, such as delayed drying time and more dot gain. Thus, it is important to use good inks, i.e., an ink formulated with sufficient pigment such that the color of the ink is well defined on a reference substrate.

2 Literature Review

A survey of the literature indicted that two standards are applicable to this work.

ISO 2846-1:2006 defines what a *good* offset process ink will be like in terms of a set of colorimetric specifications.

ISO 2834-1:2006 Graphic Technology – Laboratory preparation test prints – Part 1: Paste inks defines a method (ISO 2834 method) of sample production "using a printability tester, a known quantity of ink is printed uniformly on a known area of the reference paper or any other chosen substrate" (Section 3.1).

3 Methodology

This research developed an alternative method for process offset inks verification. An ISO-certified magenta ink manufactured by Superior Printing Ink Co., Inc. was used, and the samples were produced by the ISO 2834 method using a printability tester manufactured by IGT Testing Systems. A calibration curve of the relationship between density and ink film thickness was generated, and then a Little Joe model H, manufactured by Little Joe Industries, was used to produce a sample with multiple ink film thicknesses. Density and CIELAB were measured and density was converted to ink film thickness through the calibration curve.

In this research, APCO II/II paper was used as reference substrate with the colorimetric values of $L^* = 95.5\ 2.0$, $a^* = -0.4\ 1.0$ and $b^* = 4.7\ 1.5$ (ISO 2846, Reference substrate).

An IGT AIC2-5T2000 round-to-round printability tester manufactured by IGT Testing Systems was used as ink transfer mechanism for calibration generation. A Little Joe Proofer manufactured by Little Joe Industries was used to produce multi-IFTs samples.

A precision DeltaRange AG204A scale manufactured by Mettler Toledo with the accuracy better than 0.1 mg was used to weight the weights of the disc before and after ink transfer.

In addition to a Little Joe Proofer, a graduated grind gage was used as a wedge printing plate to produce multi-IFT samples. A wedge printing plate manufactured by Precision Gage and Tool Company "is used for quick and easy proof press testing of stocks and inks. It is especially effective in the routing production of standard prints having controlled ink film thickness"(Precision Gage and Tool Company, 2010, p. 4). This gage is a thick solid steel plate with a wedge-shaped indented surface and a scale along the side of it. There are two bearing surfaces at each side of the indentation. They serve to support the scraper that is used to draw down the ink. There is an engraved scale on the bearings that will also be printed together with the wedge to the paper. This gage is used to meter out an ink film layer with varying thickness along the length of the plate.

3.1 Calibration Curve Generation

Generation of the calibration curve required

1. determination of the mass density of the ink;
2. production of the ink samples;
3. calibration of IFTs; and
4. generation of the calibration curve.

3.2 Determining Mass Density of Ink

a. Fill the pipette compactly with the ink to be tested.
b. Place a 3 x 3 glass plate on the scale and zero the scale with the glass plate on it.
c. Squeeze 2 cc volume of the magenta ink with a pipette to the glass plate, after the scale is stable, record the weight of the 2 cc ink, denoted as w.
d. Note that the mass density of the ink is equal to w/2; the unit is mg/cc.

3.3 Producing Ink samples

a. Mount a test strip on the IGT printability tester.
b. Squeeze 0.04 cc ink with the pipette to the distribution rubber roller of IGT High Speed Inking Unit 4, and start the inking unit to distribute the ink for 10 seconds.
c. During the 10-second distribution time, place the printing disc on the inking unit and then bring it in contact with the distribution roller for 5 seconds.
d. Place the disc on the scale and record the weight of the disc with the ink, denoted as w1.
e. Take the disc off the scale and place it on the top shaft of the printability tester, and turn the sector to the printing position.
f. Print by holding the buttons on both sides of the IGT printability tester.
g. Place the disc with the remaining ink on the precision scale and record the weight of it, denoted as w2. h. Clean the disc and rollers of the inking unit for the next test. i. Repeat Steps a through h to produce more ink samples. Change the ink volume at Step b to 0.05 cc, 0.06 cc, 0.07 cc, 0.08 cc, 0.09 cc, 0.11 cc.
j. Make another 4 sets of 7 samples by repeating Steps a to i.

3.4 Calculating IFT (Ink Film Thickness)

a Calculate the transferred weight of the ink by w1–w2 for each of the five sets. Then average the 5 sets at each input volume.
b Since mass density was determined in Section 3.1.1, note that the transferred ink volume is equal to the averaged transferred ink weight divided by mass density: Δw/mass density.
c Calculate the print area by multiplying the length by the width of print.
d Calculate IFT at each ink input volume:

Eq. 1

$$IFT = (\text{Averaged } (w1–w2) / (\text{mass density} \times 69)) \times 10000$$

3.5 Generating the Calibration Curve

Measure density on each of the 7 samples in Set 1 three times. Average three densities at each IFT in Set 1. Then do the same to the remaining four sets. At each IFT, density will vary due to the experimental error uncertainty of the IGT system, so the uncertainty of the density at each IFT level will be calculated in terms of standard deviations.

According to the uncertainty of the system, the calibration curve of the ink will not be a single curve. Average the densities at each IFT level and draw the averaged calibration curve. Then add and subtract the uncertainty from the averaged calibration curve to form upper and lower limit of the calibration curves. Lastly, measure the CIELAB values at the same locations where the densities were measured, and calculate color difference from ISO 2846 magenta offset ink colorimetric specifications: L*= 50, a*= 76 and b*= -3.

3.6 Verifying the Ink

The ISO 2834 method and the calibration curve were used to verify the ink.

3.7 Using ISO 2834 Method

Use the averaged IFTs and their corresponding ΔEs to draw the U-shaped ink qualification curve.

3.8 Using the Calibration Curve to Calibrate Prints Made on Little Joe Proofer

a Produce a multi-IFT sample by a Little Joe proofer.
b After a 24-hour drying period, measure spectral data at 100 spots along the sample with an X-Rite Eye-One Pro spectrophotometer.
c Calculate CIELAB values and densities at each spot based on the spectral data.
d Select six spots on the multi-IFT sample where the calculated densities were the same as the measured averaged densities on the calibrated samples, and record the calculated densities and CIELAB.
e Find out the corresponding IFT through the calibration curve by the densities.
g Plot the curves of ΔE vs. IFT, ΔE vs. Upper IFT and ΔE vs. Lower IFT.

4 Results

The following tables and figures show the results of the experiment.

4.1 Mass Density of the Ink

Mass density of the magenta ink used in the experiment is 1.0495 mg/cc as listed in Table 1.

The length of the ink film was 21 centimeters and the width was 3.3 centimeters, so the print area was 69 square centimeters.

Table 1
Mass density of the magenta by Superior Printing Inks

Ink Volume	Weight(W)	Mass density
2 cc	2.099	1.0495

4.2 Ink Film Thickness at each Input Volume

Table 2 lists the calculated IFT at each input volume by use of Equation 1.

Then the density on each sample at each IFT (input volume) was measured and the standard deviation of each is calculated; all the data is shown in Table 2.

Table 2
Transferred ink weight and density at each IFT (or input volume) for each set with averaged density and standard deviation

Input Vol.(cc)	0.04 cc	0.05 cc	0.06 cc	0.07 cc	0.08 cc	0.09 cc	0.11 cc
Transferred Weight (g)	0.0032	0.004	0.005	0.0054	0.006	0.007	0.008
IFT(μ)	0.462	0.577	0.722	0.780	0.866	1.011	1.155
1st set Averged D	1.030	1.240	1.387	1.498	1.607	1.636	1.769
2nd	1.040	1.220	1.383	1.514	1.617	1.659	1.795
3rd	1.010	1.220	1.368	1.499	1.610	1.660	1.814
4th	1.050	1.240	1.386	1.519	1.609	1.678	1.809
5th	1.060	1.230	1.395	1.538	1.610	1.664	1.791
Averaged D at each IFT	1.038	1.230	1.384	1.514	1.611	1.659	1.796
Standard Deviation	0.019	0.010	0.010	0.017	0.004	0.015	0.018

4.3 Calibration Curve Generation

Two standard deviations at each IFT was added to and subtracted from the averaged density at each input volume as the uncertainty range.

Table 3 shows upper and lower limits of densities, CIELAB, and ΔE at each IFT level.

Table 3
Density at each IFT for each set with averaged density and standard deviations

IFT	CIELAB			ΔE
	L*	a*	b*	
0.442	54.68	69.95	-7.3	8.78
0.552	52.5	73.34	-5.75	4.57
0.690	50.26	75.92	-3.59	0.65
0.746	48.51	77.65	-1.1	2.92
0.829	48.07	78.23	0.98	4.96
0.967	46.81	79.7	4.98	9.36

The calibration curve of the magenta ink therefore was generated by use of the data listed in Table 3, and Figure 1 shows the curve

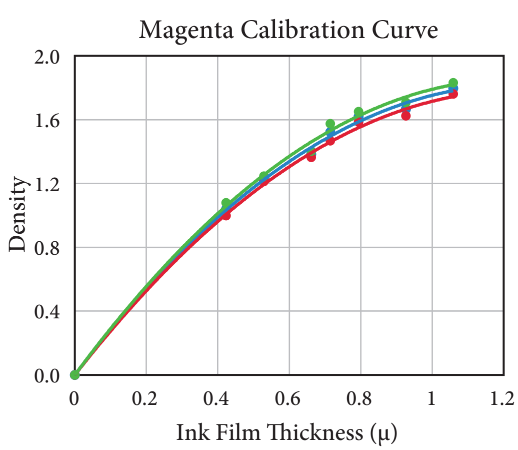

Figure 1
Calibration curve of superior magenta ink

Blue curve in middle comes from averaged density vs IFT

Top one from averaged density +2σ vs IFT

Bottom one from density –2σ vs IFT

4.4 Verification of the Ink by ISO 2834 Method

By using the averaged IFTs and ΔEs in Table 3, the U-shape ink qualification curve was generated as shown in Figure 2 (p. 52).

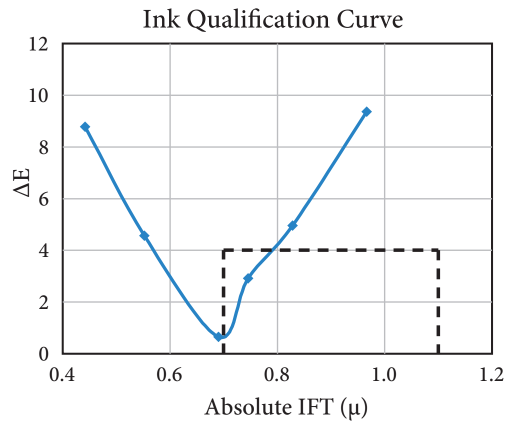

Figure 2
U-shaped
ink qualification
curves derived from
Table 3

ISO 2834 does not take the uncertainty of the printing system into account, so the blue U-shaped curve is actually the final ink qualification curve for the ISO 2834 method. According to this result, the magenta ink used for this research project passes the ISO 2846 colorimetric specification.

4.5 Verification of the Ink by Use of the Calibration Curve

After measuring densities and CIELAB values on the multi-IFT sample, all the densities were converted to IFT through the calibration curve, and ΔEs between each measurement and the ISO 2846 specified aim point was calculated.

The results are listed in Table 4. The U-shape curve generated based on data in Table 4 is shown in Figure 3.

Table 4
Data derived from
prints made on
Little Joe Proofer

IFT	Upper IFT	Lower IFT	CIELAB			ΔE
			L*	a*	b*	
0.44	0.45	0.46	54.43	68.58	-5.44	8.98
0.54	0.56	0.58	51.73	72.37	-2.88	4.02
0.64	0.66	0.68	49.63	75.12	-0.13	3.02
0.74	0.76	0.78	47.86	76.75	1.61	5.14
0.82	0.85	0.88	47.38	77.31	4.05	7.63
0.9	0.93	0.96	45.87	78.6	7.69	11.75

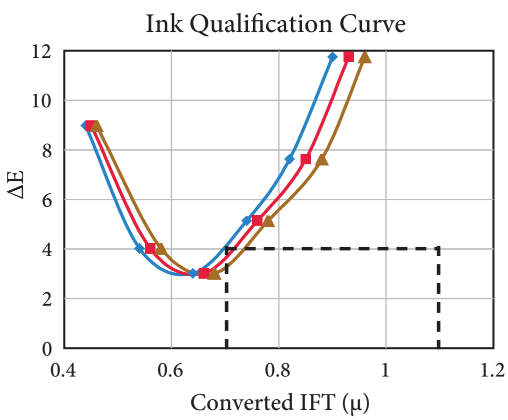

Figure 3
U-shaped
ink qualification
curves derived from
prints made on
Little Joe Proofer.

5 Findings

Analysis of results obtained by using a graduated grind gauge highlights two areas: uncertainty within the system due to experimental errors and the relationship between density values and colorimetric values.

5.1 Uncertainty of the System

Theoretically, a density is supposed to correspond to only one IFT, hence the calibration curve is supposed to be a single curve. However, due to the experimental errors associated with the ink transfer mechanisms, process variables such as cleaning rollers or time delays between operations, locations of measurements and possible and human errors, the ink calibration curve will not be a single line but needs to be similar to the ones shown in Figure 1.

According to the empirical rule of statistics, "approximately 95% of the data values will be within two standard deviations of the mean" (Anderson, Sweeney & Williams, 2008, p. 101). That is why 2σ was added to and subtracted from the averaged calibration curve. The range between upper and lower curve includes 95% possibility of IFT at a given ink input volume level. According to Table 3, the uncertainty varies over all input levels, and the averaged uncertainty of the IGT system is 4*0.013=0.052 μ . In other words, this is the averaged distance between the two limits of the calibration curve.

5.2 Ink Verification by the Calibration Curve

According to Tables 3 and 4, at the same density, the CIELAB values are different between a sample that is produced by IGT printability tester and a spot on a multi-IFT sample that is produced by a Little Joe proofer.

This shows that due to the difference in ink transfer mechanism, the same ink and same paper may produce different colorimetric values at the same density level.

6 Future Study

Theoretically, the same ink and paper should yield the same color at the same density level, but for this experiment, this was not the case. One of the reasons for this result might be the impurity contained in the Little Joe proofer.

For cleaning, only one solvent was used in the IGT system, but alcohol was also used for the second cleaning in the Little Joe system after the system is cleaned using the solvent. In the future, the alcohol should not be used to clean the Little Joe proofer.

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Preparing MS Excel Graphs and Tables for Print

Franz Sigg

Many graphs have been used over the years in the TestTargets publications. We had to learn how to optimize the reproduction of Microsoft Excel graphs or tables. A graph that is just copied and pasted into MS *Word* or Adobe *InDesign*, will have rich blacks (Black with C, M and Y) and it may be converted to a bitmap rather than remaining a vector object. While this is OK for display on a monitor, it is not OK for printing, particularly on an offset press. A description of how to optimize a graph for print was published in *Test Targets* 5, but since then, application programs have changed and a few more tricks have been learned. The following is an updated procedure, tested with an *Apple* computer, Microsoft *Excel* 2004, Adobe *Acrobat Pro v10*, *Illustrator CS5.1*, and *InDesign CS5.5*.

1. Graphs should not be copied and pasted out of *Excel*, instead click on the graph and then Print it as a *PDF*. In the print dialog box, select *Page Setup ...* and go to *Chart* and set to *Custom*; go to *Margins* and set all to zero; go to *Page Setup ...* and choose a size that is larger than the graph. After hitting OK, the preview should show the graph fitting well within the displayed page, otherwise *Excel* may reformat the graph in unexpected ways. (Do not print to *Postscript*, otherwise the text will be outlined, and is not editable.)

2. Open the created *PDF* in *Acrobat Pro*, and in the top menu bar, go to *Tools > Print Production > Convert Colors*, and select *Promote Gray to CMYK Black*. This converts the rich blacks to K only, and converts the file to CMYK. Then click OK and save the file.

3. Open the *PDF* out of *Illustrator*, or, simply drag the icon of the *PDF* from *Finder* to the icon of *Illustrator* in the *Dock*. This way the file is automatically set to CMYK color mode. (If a *PDF* is Placed from within an open *Illustrator* file, then it is essential that the *Illustrator* file be opened in CMYK mode.) (Do not use *Photoshop* otherwise vectors are convert to a not editable bitmap.)

4. After selecting All, it will be shown that the text is not outlined and therefore editable, and it is a vector file. This is good. However, there may be several unnecessary boxes that are in the way when selecting single items. Unselect everything, then open the *Color* window, and, using the open arrow *Direct Selection Tool*, try to find one box where both the fill and stroke icons have a red diagonal line through them in the *Color* window (which means there is no fill and no stroke). Keep it selected and go to *Select > Same > Fill & Stroke*. Now these boxes can be safely deleted. There may also be boxes filled with white color. These boxes could be needed, for instance, to block out the grid lines underneath a legend. But sometimes such boxes are not needed and can also be deleted.

5. The fact that there are no rich blacks can be verified by going to *Windows > Separations Preview*, and then, in the window that opens, *Overprint Preview* is selected, which enables turning off the black separation. All black lines and text should disappear. Additionally, single black items can be verified by checking the CMYK values in the *Color* window. (*Separations Preview* only works for CMYK color mode.)

6. This should take care of most color issues. However, some specific colored items may also need editing, because very small tone value percentages might be used for some colors. These values do not add much to the color, but will make the object more sensitive to misregistration. Also, complementary colors can be replaced with black (GCR). For instance a red item might have these tone values: C 4.3, M 93.2, Y 98.4, K 13.7. This should be changed to C 0, M 100, Y 100, K 18.

7. Before verifying line thicknesses and font sizes, it is advisable to use the *Scale* tool in *Illustrator* to change the overall size of the graph to match the final size in the printed document. This way the graph can be imported to *InDesign* at full size, and the same font size can be selected in *Illustrator* as is used in the document.

8. For *Test Targets 10*, the following line thicknesses have been used: grid lines 0.5 pt. (should be solid lines, not dashed, and have 30% black color); frame around graph or plot area 0.75 pt., using 100% black; curves 1.0 pt. or slightly more. Similar line thicknesses can be used for tables.

9. If there are colored cells in a table, then the black dividing lines of the cells should not knock out the colors underneath, otherwise potential misregistration becomes a problem. In such a case, click on the black line, then go to *Window > Attributes* and select *Overprint Stroke*. The grid lines should be underneath the curves of a graph: select all grid lines, then go to *Object > Arrange > Send to Back*. You then may also select all the graphs (same line width) and set them to *Overprint Stroke*.

10. Now we have a clean vector file, optimized for print, without rich blacks.

Note: This page was not part of the printed version of Test Targets 10.

Test Forms

What is Roman16?

Keywords test form, TVI, color, assessment, reference images

1 Description

Roman16 represents a set of images for visual assessment, processing and output in premedia and printing.

The Roman16 is also a publication of the *Bundesverband Druck und Medien e.V.* (bvdm). The reference images are specially created test motifs for visual assessment, processing, and output in premedia and printing. They allow comprehensive statements to be made about color reproduction and details of the image reproduction in the production process.

2 What Can We Do with It?

- Assessment of different profiles for generating CMYK data from RGB data sets
- Using existing profiles, e.g., ISO Coated v2 (ECI)
- Using self-generated profiles
- Comparison of separation results on the monitor
- Comparison of separation results by means of printed proofs (gamut mapping) and in the print run (black generation, tone value sum)
- Comparison with reference file/CMYK or reference proof
- Comparing rendering intents (approaches to color separation)
- Relative colorimetric with black point compensation
- Perceptual
- Comparison of color space reproduction on the monitor
- Comparison of the color space reproduction by means of printed proofs
- Checking different versions of CMM (Color Matching Modules)

Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**


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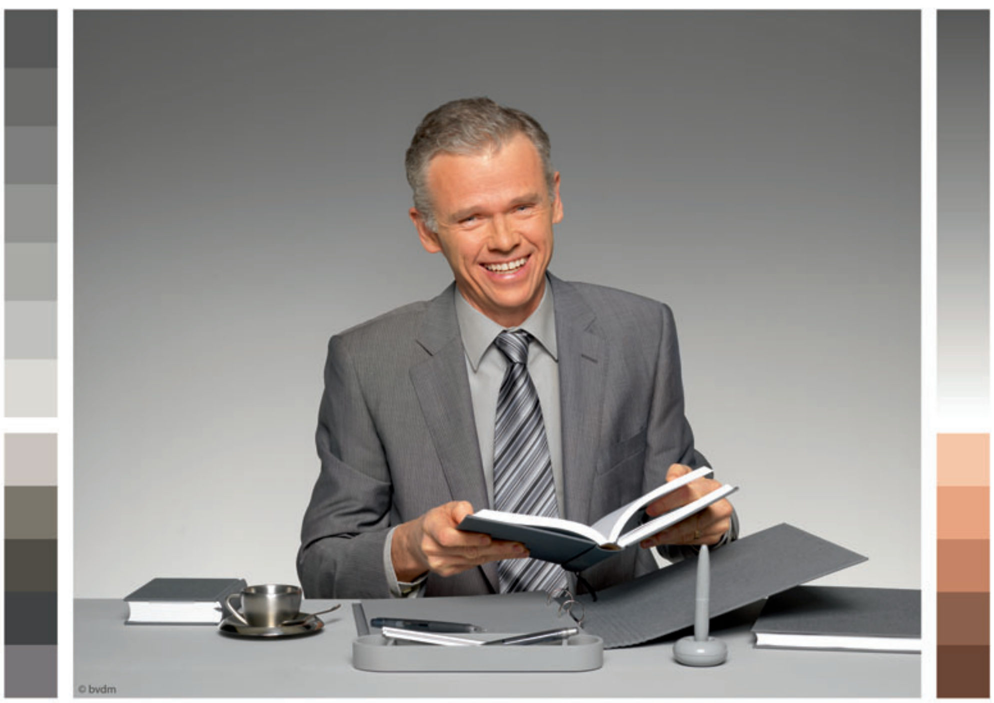
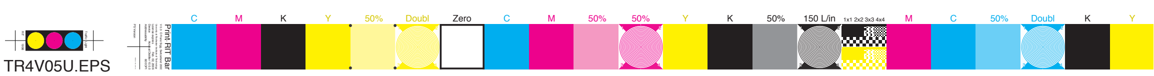
P4BAR03U.EPS

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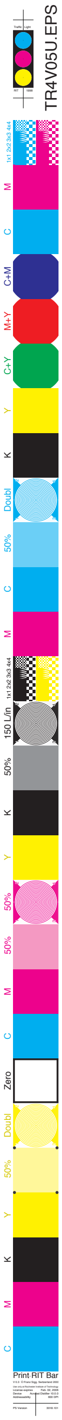
P4BAR03U.EPS

Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**



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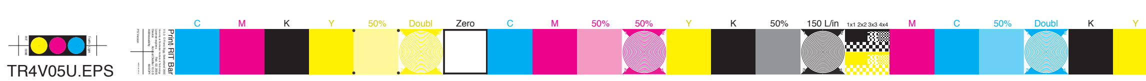

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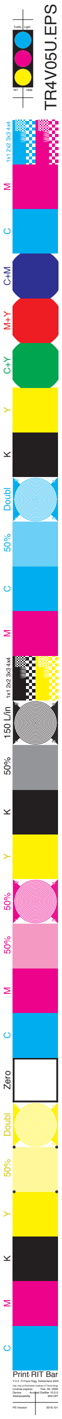
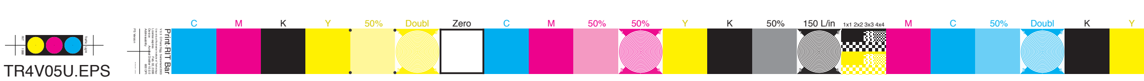
Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**



TR4V05U.EPS

P4BAR03U.EPS



TR4V05U.EPS

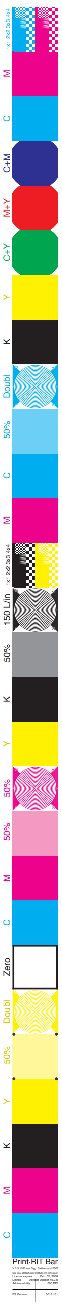
P4BAR03U.EPS

Roman16 bvdm Reference Images

Press **Goss Sunday 2000**
Paper **Finch Uncoated**
Text 100#, 35" wide roll

Premedia **InDesign CS5**
Notes **Legacy CMYK**
Prepress **Prinergy 3, 150 lpi AM**

TR4V05U.EPS



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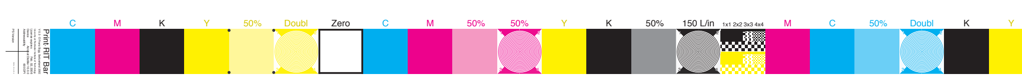

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Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**

TR4V05U.EPS

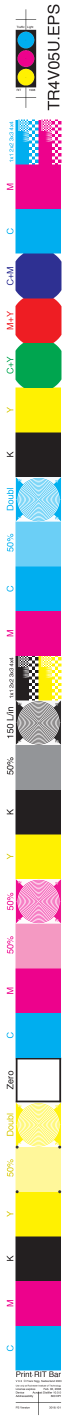
P4BAR03U.EPS

TR4V05U.EPS

P4BAR03U.EPS

Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**



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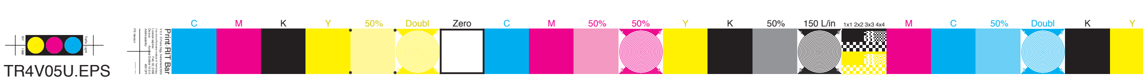


TR4V05U.EPS

P4BAR03U.EPS

Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**

TR4V05U.EPS

P4BAR03U.EPS

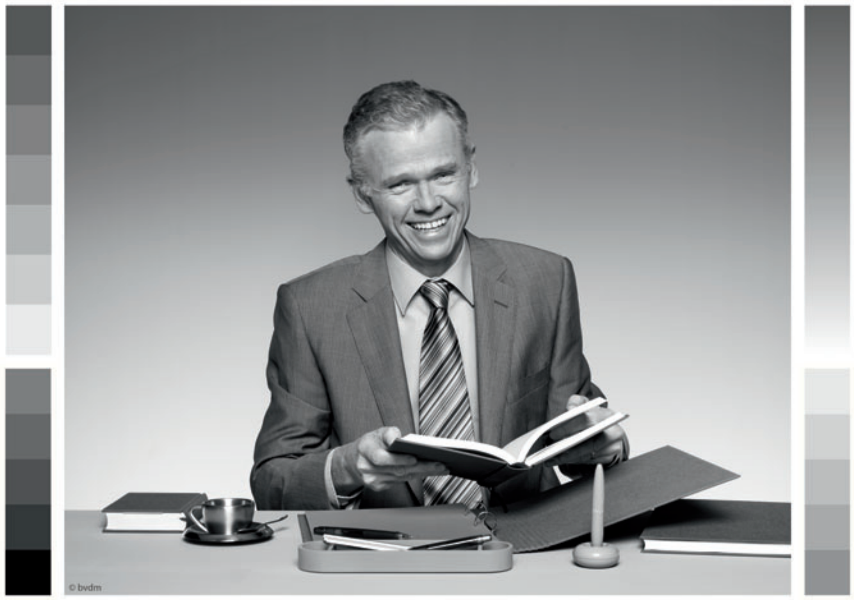
TR4V05U.EPS

P4BAR03U.EPS

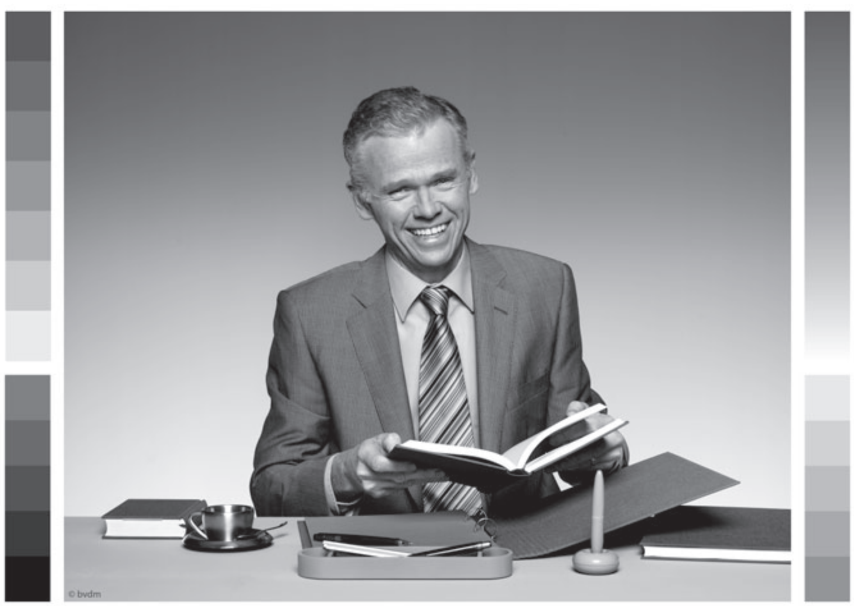
Roman16 bvdm Reference Images

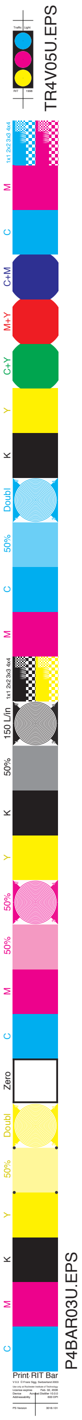
Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**

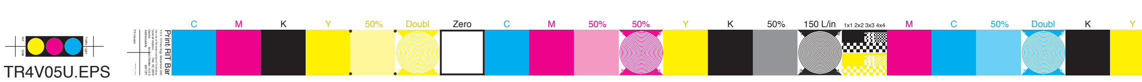
Legacy CMYK



K-Only



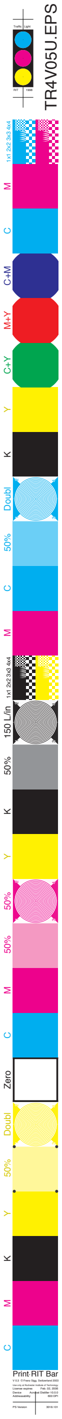




P4BAR03U.EPS

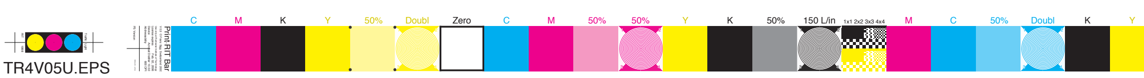
Roman16 bvdm Reference Images

Press	**Goss Sunday 2000**	Premedia	**InDesign CS5**
Paper	**Finch Uncoated**	Notes	**Legacy CMYK**
	Text 100#, 35" wide roll	Prepress	**Prinergy 3, 150 lpi AM**



TR4V05U.EPS

P4BAR03U.EPS



TR4V05U.EPS

P4BAR03U.EPS

Roman16 bvdm Reference Images

Press **Goss Sunday 2000**
Paper **Finch Uncoated**
Text 100#, 35" wide roll

Premedia **InDesign CS5**
Notes **Legacy CMYK**
Prepress **Prinergy 3, 150 lpi AM**


TR4V05U.EPS
P4BAR03U.EPS

CMYK

Highkey

Midtone

Lowkey

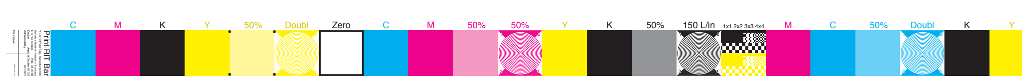
Black only

Highkey

Midtone

Lowkey


TR4V05U.EPS


P4BAR03U.EPS

Colophon

Acknowledgments

From the Test Targets Executive Committee

Test Targets 10 begins from teaching and learning in the classroom. The process requires creativity and the involvement of students and faculty to turn research questions into lab experiments. It also requires writing, peer reviewing, editing, and organizational support to transform lab reports into a scholarly publication.We did premedia work and submitted PDFs for CTP and presswork at RIT's Printing Applications Laboratory. All finishing was outsourced in Rochester, New York.

We recognize the talented student authors of *Test Targets 10* for writing the manuscripts, and to faculty and staff at RIT who serve as mentors. We thank our peer reviewers and the *Test Targets* Steering Committee for planning, coordination and implementation. We thank Robert Eller as project coordinator, and Pierre Urbain for layout. We are grateful for the financial support from RIT's Printing Industry Center and industry experts serving as technical reviewers.

Executive Committee	Robert Chung, RIT Frank Cost, RIT	Bill Garno, RIT Patricia Sorce, RIT
Steering Committee	Edline Chun, RIT Robert Chung, RIT Robert Eller, RIT Bill Garno, RIT	Fred Hsu, RIT Bruce Ian Meader, RIT Michael Riordan, RIT Franz Sigg, RIT
Content Editor	Edline Chun, RIT	
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IT and Print Production Support	RIT College of Imaging Arts and Sciences RIT Printing Applications Laboratory	
Project Coordinators	Robert Eller, RIT	Pierre Urbain, RIT
Authors	Robert Chung, RIT Elie Khoury, KEE Consultants Scott Millward, RIT Franz Sigg, RIT	Ivy Tian, RIT Pierre Urbain, RIT Yi Wang, RIT Enqi Zhang, RIT

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Rochester Institute of Technology

Bob's research has resulted in more than 70 papers in the areas of printing process control and color management. Bob is a member of ISO/TC 130 and convener of ISO/TC 130 Working Group 13, Printing Certification Requirements. During his more than 30 years as a professor, Bob has received numerous awards recognizing his excellence as an educator, including the 2007 Educator of the Year award from the Electronic Document Systems Foundation (EDSF).

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President, Alwan Color Expertise
Chair of KEE Consultants

During the past two decades, Elie has been a leading visionary and tireless advocate of the use of international standards to introduce state-of-the-art industrial practices into printing. Elie is the French National Representative to ISO/TC 130, the International Standards Organization's Technical Committee for the Graphic Arts, and is actively involved in shaping the future of standards.

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Franz Sigg is a teacher, researcher, and thesis adviser in the School of Print Media, Rochester Institute of Technology. Franz has spent much of his professional career developing, testing, and producing both analog and digital test targets of the graphic arts industry. His current research interests include designing and programming PostScript targets for digital imaging systems.

Quanhui Tian
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Professor
Shanghai Publishing and Printing College

Quanhui (Ivy) Tian is a professor at the Shanghai Publishing and Printing College, and a visiting professor at the Rochester Institute of Technology. Ivy's interests include printing and color management. While at RIT, Ivy's research focused on the effect of using Optical Brightening Agents (OBAs) in papers on colors printed on them.

Author Biographies

Scott Millward
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Scott's concentration is in color management and color theory, with a primary research interest in papers containing optical brighteners.

Pierre Urbain
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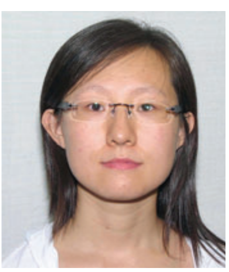
Pierre's concentration is in print workflows and international standards, with a primary research interest in the development of international standards for digital printing.



Yi Wang
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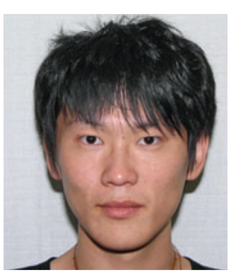
Yi's concentration is in color management and printing standards. Yi's research included an extensive investigation of process control based on near neutral process aims.



Enqi Zhang
Graduate Student
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Rochester Institute of Technology

Enqi's concentration is in printing process control, with a primary research interest in control of ink conformance in printing

TT10 Imposition 10/28/11

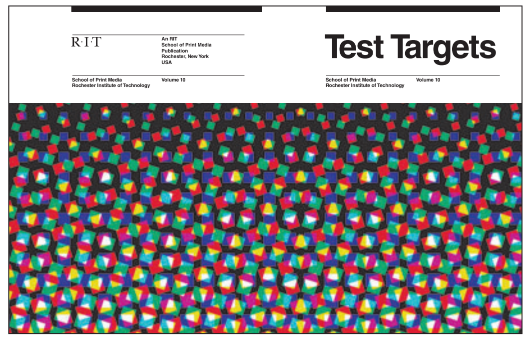
5-16pg Signatures off Sunday 2000, 2- 2pg SM74 (not numbered) = **84pg book plus cover**

Press	Signature	Physical Pg #	Pagination	Right Left	F/B of Press sheet	Category	Content
Sunday 2000		1		R	F	Prologue	Half Title Page
Sunday 2000		2		L	B	Prologue	Library of Congress ISBN Page
Sunday 2000		3	i	R	B	Prologue	Table of Contents
Sunday 2000		4	ii	L	F	Prologue	Prologue
Sunday 2000		5	iii	R	F	Prologue	2
Sunday 2000		6	iv	L	B	Prologue	Production Notes
Sunday 2000		7	1	R	B	Articles	Technical Papers Section Page
Sunday 2000	Sig. 1	8	2	L	F	Articles	Chung_ISO Conformity (10)
Sunday 2000		9	3	R	F	Articles	2
Sunday 2000		10	4	L	B	Articles	3
Sunday 2000		11	5	R	B	Articles	4
Sunday 2000		12	6	L	F	Articles	5
Sunday 2000		13	7	R	F	Articles	6
Sunday 2000		14	8	L	B	Articles	7
Sunday 2000		15	9	R	B	Articles	8
Sunday 2000		16	10	L	F	Articles	9
Sunday 2000		17	11	R	F	Articles	10
Sunday 2000		18	12	L	B	Articles	Urbain_Khoury_PDF (7)
Sunday 2000		19	13	R	B	Articles	2
Sunday 2000		20	14	L	F	Articles	3
Sunday 2000		21	15	R	F	Articles	4
Sunday 2000		22	16	L	B	Articles	5
Sunday 2000		23	17	R	B	Articles	6
Sunday 2000		24	18	L	F	Articles	7
Sunday 2000	Sig. 2	25	19	R	F	Articles	Tian_Chung_OBA (8)
Sunday 2000		26	20	L	B	Articles	2
Sunday 2000		27	21	R	B	Articles	3
Sunday 2000		28	22	L	F	Articles	4
Sunday 2000		29	23	R	F	Articles	5
Sunday 2000		30	24	L	B	Articles	6
Sunday 2000		31	25	R	B	Articles	7
Sunday 2000		32	26	L	F	Articles	8
Sunday 2000		33	27	R	F	Articles	Sigg_Millward_OBA Decay (9)
Sunday 2000		34	28	L	B	Articles	2
Sunday 2000		35	29	R	B	Articles	3
Sunday 2000		36	30	L	F	Articles	4
Sunday 2000		37	31	R	F	Articles	5
Sunday 2000		38	32	L	B	Articles	6
Sunday 2000		39	33	R	B	Articles	7
Sunday 2000		40	34	L	F	Articles	8
Sunday 2000	Sig. 3	41	35	R	F	Articles	9
Sunday 2000		42	36	L	B	Articles	Wang_TVI vs. G7 (12)
Sunday 2000		43	37	R	B	Articles	2
Sunday 2000		44	38	L	F	Articles	3
Sunday 2000		45	39	R	F	Articles	4
Sunday 2000		46	40	L	B	Articles	5
Sunday 2000		47	41	R	B	Articles	6
Sunday 2000		48	42	L	F	Articles	7
Sunday 2000		49	43	R	F	Articles	8
Sunday 2000		50	44	L	B	Articles	9
Sunday 2000		51	45	R	B	Articles	10
Sunday 2000		52	46	L	F	Articles	11
Sunday 2000		53	47	R	F	Articles	12
Sunday 2000		54	48	L	B	Articles	Zhang_IFT (6)
Sunday 2000		55	49	R	B	Articles	2
Sunday 2000		56	50	L	F	Articles	3
Sunday 2000	Sig. 4	57	51	R	F	Articles	4
Sunday 2000		58	52	L	B	Articles	5
Sunday 2000		59	53	R	B	Articles	6
Sunday 2000		60	54	L	F	blank	(blank)
Sunday 2000		61	55	R	F	TF	Test Form Section Head
Sunday 2000		62	56	L	B	TF	Roman16 Test Images (11)
Sunday 2000		63	57	R	B	TF	2
Sunday 2000		64	58	L	F	TF	3
Sunday 2000		65	59	R	F	TF	4
Sunday 2000		66	60	L	B	TF	5
Sunday 2000		67	61	R	B	TF	6
Sunday 2000		68	62	L	F	TF	7
Sunday 2000		69	63	R	F	TF	8
Sunday 2000		70	64	L	B	TF	9
Sunday 2000		71	65	R	B	TF	10
Sunday 2000	Sig. 5	72	66	L	F	TF	11
Sunday 2000		73	67	R	F	Colophon	Colophon Section Page
Sunday 2000		74	68	L	B	Colophon	Acknowledgments
Sunday 2000		75	69	R	B	Colophon	Author Bios (2)
Sunday 2000		76	70	L	F	Colophon	2
Sunday 2000		77	71	R	F	Colophon	Imposition Scheme
Sunday 2000		78	72	L	B	Colophon	PressRunOrg - Cover
Sunday 2000		79	73	R	B	Colophon	PressRunOrg - Body
Sunday 2000		80	74	L	F	Colophon	PressRunOrg - Inserts
SM74		81	no #	R		GVI	GVI (4)
SM74	Insert (between Sig. 2 & 3)	82	no #	L		GVI	2
SM74		83	no #	R		GVI	3
SM74		84	no #	L		GVI	4

Press Run Organizer - Cover

Press run date:	11/21/2011	Objectives:	(1) Content preparation for Test Targets 10
Project description:	**Test Targets 10**		
Project coordinators:	Bob Chung & Bob Eller		
	475-2722 (Office)	Notes:	File location: CMS_3 server

Job Specifications	Production Data
COMMUNICATION File Submission Protocol: HTTP Verify Submission: Yes Hard Copy Proof: Yes	Notes:
DFE RIP manufacturer: HP Indigo Brand: Indigo7000 Screening: HDI 180	
PRESS Manufacturer: Hewlett Packard Brand: HP7000 Number of colors: 4 Colorant sequence: KCMY	Notes: Simplex Print
PAPER Brand: **Finch Fine iD** Basis weight: Uncoated 100# Cover Grain direction: Grain short	Notes: Sheet Size: 19" x 13" (48.26cm x 33.02cm) Quantity: Ship 2000 sheets minimum to bindery (Coat with UV Gloss)
PRINTING Reference: HP Indigo Internal Std	Notes: Calibrate by LUT followed by color adjust.
SAMPLING 1) Short-term: None 2) Long-term: None	



Press Run Organizer - Body

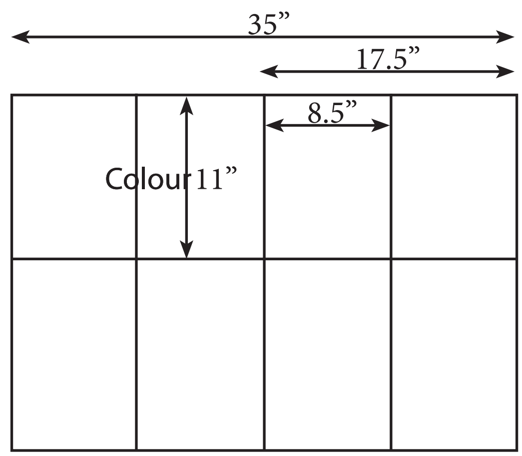
Press date: 11/21/2011
Project description: **Test Targets 10 Body**
Project leader(s): Robert Chung & Bob Eller

Printing description: (1) Prepare publication text using InDesign CS5; (2) prepare CtP with 150 lpi AM screening by Creo Prinergy; (3) print to specifications using Heidelberg Goss 2000 as indicated; (4) ship 2,000 signatures for bindery.

	Job Specifications
PREPRESS	Print on both sides
Signature contents:	Five 16-page signatures
Image resolution:	300 ppi
Color control bar:	RIT Color Control Bar plus local color bar
PROOF	
Manufacturer:	HPZ3200
Brand:	
Proofing guide:	
RIP/PLATE	Creo Prinergy 3; 150 lpi AM
Manufacturer:	CREO VLF 2400 dpi
Brand:	KPG(12mil); thermal Gold
Plate exposure guide:	Rex28.eps, Kexp34.eps
PRESS	
Manufacturer:	Goss
Brand:	Sunday 2000
Size (max):	57" wide
FOUNTAIN SOL'N	
Manufacturer:	Fuji
Brand:	Emerald Premium KDHP
pH/Conductivity:	pH 4.5 buffered; Conduct. 2800
BLANKET	
Manufacturer:	Day International 3000
Brand:	Gapless
Packing:	n/a
INK	Process color
Manufacturer:	Flint
Note:	ISO2846-1 Certified
Temp./Tack:	
PAPER	Finch
Brand:	**Finch**
Basis weigh / Size:	Uncoated 100# text, 35" wide roll
Quantity:	**2000 of each signture**
PRINTING	Reference:
Ink-down sequence:	KCMY
SID (wet):	**K: 1.15 M: 1.0**
(±0.10)	**C: 1.0 Y: 0.85**
Dot gain:	**K: 21 M: 18**
(-3%/+6%)	**C: 18 Y: 17**
Note:	
Print Speed	38,000 IPH
ICC PROFILE	
Process Control	GMI Closed loop Quick Color
SAMPLING & REPORTING	None

position and Signature Alignment of the Hybrid Digital/Offset Workfl

Five 16-page signatures (80 pages)
Plus four page cover (4)
Plus 2 two page inserts (4)
Total 88 page book



Press Run Organizer - Inserts

Press date: 11/21/2011
Project description: **Test Targets 10 Inserts**

Project leader(s): Bob Chung & Franz Sigg
Telephone No: 475-2722 (Office)
Prepared by: Barb Giordano

Printing description: (1) Prepare publication cover using InDesign CS5 and distill as PDF/X1a file (2) prepare CtP using Creo Prinergy; (3) print to specifications using Heidelberg SM 74; (4) ship 2,000 for bindery.

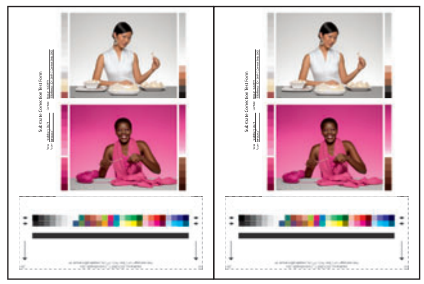
Product description: Cover printed by 4/c process; five 16-page signatures of text printed by Goss 2000; Inserts printed by Heidelberg SM 74; Smyth sewn binding and cover trimmed to final size 8.5"x11"; quantity: 1,500
lamination; 8.5 x 11 finished size

Job Specifications

PREPRESS	
	(pick up TT9 InDesign file & modify)
Contents:	4-up: 2 page inserts, one with OBA; one without
Color control bar:	n/a
PROOF	
Manufacturer:	HPZ3200
Brand:	
Proofing guide:	
RIP/PLATE	Creo Prinergy 3; 150 lpi AM
Manufacturer:	CREO VLF 2400 dpi
Brand:	KPG(12mil); thermal Gold
Plate exposure guide:	Rex28.eps, Kexp34.eps
PRESS	
Manufacturer:	Heidelberg sheetfed offset press
Brand:	Heidelberg 6-color SM 74
Size (max):	20'x29' (max)
FOUNTAIN SOL'N	
Manufacturer:	Anchor
Brand:	#20047 Emerald Premium
pH/Conductivity:	pH 4.0 buffered; Conduct. 3050
BLANKET	
Manufacturer:	Day International 3000
Brand:	Patriot
Packing:	0.006" over bearer (all units)
INK	
Manufacturer:	Superior Ink
Brand:	
Temp./Tack:	
PAPER	
Brand:	**Iggesund Invercote G & T**
Basis weigh / Size:	10.6 pt. (G); 10.8 pt. (T)20x26, grain long
Quantity:	**2,000 (incl. 1,000 for makeready)**
PRINTING	Reference:
Ink-down sequence:	
*Solid ink density:	**K: n/a** **M: n/a**
(±0.10)	**C: 1n/a** **Y: 1n/a**
**Dot gain:	**K: n/a** **M: n/a**
(-3%/+6%)	**C: n/a** **Y: n/a**
SAMPLING & REPORTING	Riverside to return all unused inserts

Production Notes / Quality Assurance

Notes on digital workflow:
Paginated as reader's spead in InDesign CS5;
PDF/X-1a using Prinergy PPD and JobOptions as single page;
Impose in Preps according to the imposition layout
Make sure 1/8" bleed is included in pagination; spine 7/32"



Notes on server: smb://cias-files.rit.edu/courses; then push to PAL server

Notes on RIP and screening:
RIP: Creo Normalizer JTP; PS Version: 3011.104

Notes on standardized platemaking:
Plate dot is equal to digital dot on the color control bar.
Use CCDot meter or 1 x 1 checkerboard to verify plate dots

Production schedules:
Cover press run by HP7000:
Body by Goss 2000:
Inserts by Heidelberg SM74 - Completed
Bindery by Riverside:
Finished book delivery:
Paper donor 200
RIT/PAL 200
RIT/Sloan 200
RIT/SPM 900

Paper donation: Iggesund