Print-to-Proof & OBA Visual Assessments

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print-to-proof (P2P) match, standards

Abstract

The market for commercial printing in North America and Europe continues to change and evolve in current economic conditions, as media consumers have moved 'online'. By necessity, most printers have been driven to utilize a manufacturing approach for efficiencies. They have benefited from the adoption of a variety of workflow best practices, as well as national and international standards, which define final quality expectations and help printers be profitable in the changing landscape of the printing and communications marketplace (Smyth 2015).

There are standards that apply throughout the stages of a print workflow. A key part of the overall process is working with clients and print buyers to manage expectations of the final visual appearance of the product. Utilizing standards and 'printing to the numbers' can achieve this by accurately predicting the final appearance of a printed product. Contract color proofs can be created which will closely match the final printed piece, a 'Print-to-Proof' match (P2P).

Supporting this model requires that the standards be communicated effectively, that measurement devices which capture characteristics and behaviors be used, and quality control measures are used to ensure conformity to the standard or specification (Chung, Wu 2014).

A challenge in the effectiveness of the P2P match process has been the increasing use of optical brighteners in the paper supply chain.

This project had two parts; the first was to evaluate the overall applicability of GRACoL2013 as M1. The second was to capture subjective impressions of visual P2P matches for higher OBA stocks, when using M1 Measurements.

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Background

Optical Brightening Agents (OBAs) are chemical additives used in a variety of manufacturing sectors (cosmetics, fabrics, laundry detergents, paper, and others) to make products appear 'whiter'.

They work by first absorbing light in the ultraviolet (UV) and violet regions of the electromagnetic (approx. 340-370 nm), and re-emitting this light energy in the 'bluer' region of the spectrum (420–470 nm).

This has the effect of making 'yellowish' products appear whiter. The yellowish colored products reflect less blue light; the optical brighteners supply this light, and therefor the product appears whiter to our eye.

In recent years the paper industry has increasingly used OBAs as a means of increasing the whiteness/brightness of printing papers instead of the traditional washing and bleaching processes. They offer an alternative method to provide a 'whiter' sheet at a lower cost compared to traditional paper manufacturing (lower cost substrates, less processing) (Chung 2013).

These issues become more apparent in the field with the publication and adoption of new standards; ISO 3664:2009 and ISO 13655:2009.

ISO 3664:2009 & ISO 13655:2009

With varying substrates and lighting conditions, the printing industry in North American, for the most part, has 'standardized' on using D50 color-viewing and D50 color-measurement in an effort to establish common viewing conditions for contract color P2P visual matches.

However conventional color management workflows did not take into account the UV portion of the spectrum. Different lamps and measuring devices had varying levels of support for UV, and often effectively ignored.

ISO 3664:2009 – Viewing Conditions

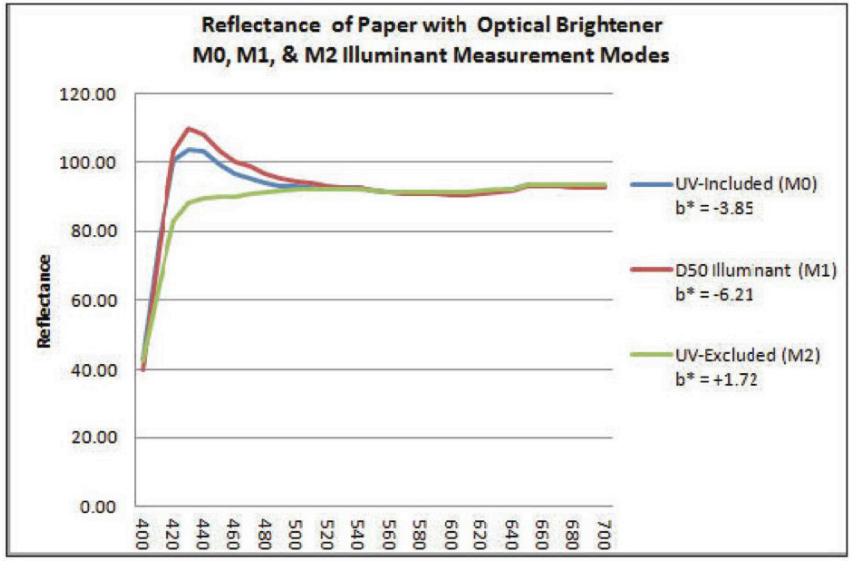
Published in 2009, and in effect internationally in 2012, ISO 3664:2009 Graphic technology and photography (viewing conditions) was designed to support viewing conditions which included the UV portion of the industry standard D50 viewing condition. Previously, ISO compliant lamps were not required to have a specified about of UV light. As a result substrates with higher levels of OBAs would not appear consistent in the 'viewing booth', as the OBAs were not emitting the same level of light as outside of the booth (ISO 2009a).

ISO 13655:2009 - Spectral measurement and colorimetric computation for graphic arts images

Also in 2009, ISO 13655:2009 Graphic Technology – Spectral measurement and colorimetric computation for graphic arts images was introduced to include additional measurement approaches, in part to help accurately measure and predict the impact of UV light. New measurement classifications included the ability to use legacy 'unfiltered' measurement (M0), which effectively ignored UV light, and new "D50 full spectrum measurements" (M1) that take UV into account (ISO 2009b). Other measurement conditions include M2, which is designed for 'filtered' measurements, meaning that the impact from the UV light is significantly reduced from the measurement ('UV-cut'). There is also M3 mode, which is also UV-cut, but includes a polarizing filter.

Combining the new M1 measurement with ISO 3664 compliant lighting, the instrument measuring light, and the viewing light are better aligned. However, the higher OBA content in some press sheets meant that the proof to press comparisons did not match, either visually or numerically. OBA infused press sheets can look blue (or the proofs look too yellow), due to the addition of UV light, and the resulting blue re-emitted by the OBAs.

The G7 based GRACoL 2013, ISIO 15339 and the CGATS.21 datasets are all based on M1 measurements (Idealliance 2015).



Cheydleur, R., O'Connor, K. (2014)

Figure 1. *Comparison of M0, M1, and M2 Measurement Modes*

GRACoL2006 & GRACoL2013 CRPC6

Specific types of printing are generally described by their color characterization data, which is the relationship between the CMYK input data and the actual color measured on the printed substrate. When this data is collected and used as a reference, it is referred to as a characterized reference printing condition (CRPC) (ISOc 2015).

CRPC6 is the newer print characterization data set that was developed by the Committee for Graphic Arts Technology Standards (CGATS) to help the industry work with the more current, bluer, stocks.

The main difference between the GRACoL 2006 and the new GRACoL 2013 dataset is the white point. The target white point for GRACoL 2006 (95 L*, 0 a*, -2 b*) was based on the legacy ISO 12647-2 standard, which in turn was based on typical commercial printing stocks available in 1994. The GRACoL 2013 white point (95, 1, -4) is slightly bluer, in line with today's typical commercial stocks (Idealliance 2015).

Substrate Corrected Colorimetric Aims (SCCA)

Substrate Corrected Colorimetric Aims (SCCA) is a mathematical approach developed for adjusting the color for final contract proofs on low to moderate OBA stocks, to better visually compare with higher OBA stocks. A printer selects their desired dataset target (for example TR006), enters their particular substrate's L*, a*, and b* values, and the required L*, a*, and b* aims for a suitable visual match are calculated.

In general SCCA benefits the midtone areas, in terms of conformance to a standard, more than it does in the solids, because "there is more unprinted paper visible in the midtone area (Chung, Wu 2014).

When printing using higher OBA papers in a controlled calibrated environment, the correct application of SCCA is meant to remove the paper color difference, and ultimately make for a closer P2P match (Chung, Wu 2014).

Introduction

This project was part of a larger initiative undertaken though the Idealliance Print Properties & Colormetric Council, and their OBA Working Group under the Paper Task Force. Numerous organizations have donated time and resources to the questions surrounding P2P matches and OBAs, including Epson America, efi, FujiFilm, gti, Komori, Konica Minolta, Rochester Institute of Technology, Ryerson University, Sappi, and x-rite.

This research paper has two objectives. The first seeks to verify the applicability of GRACoL2013 (which is built using CRPC6) as an M1 reference data set for current commercial printing, on range of OBA stocks available in the North American market.

The second objective of this research is to investigate the relative acceptability of proof-to-press matches for combinations of low, moderate, and higher OBA media (proofs and press sheet sample), when using M1 measurements. This also includes involves capturing the options of a variety of observers as to the acceptability of a particular proof-to-press match, in ISO 3664:2009 compliant, controlled, viewing conditions.

Objective 1 Methodology - applicability of GRACoL2013 as M1 reference dataset.

The first objective of this research was to confirm the applicability of GRACoL2013 as M1 reference dataset.

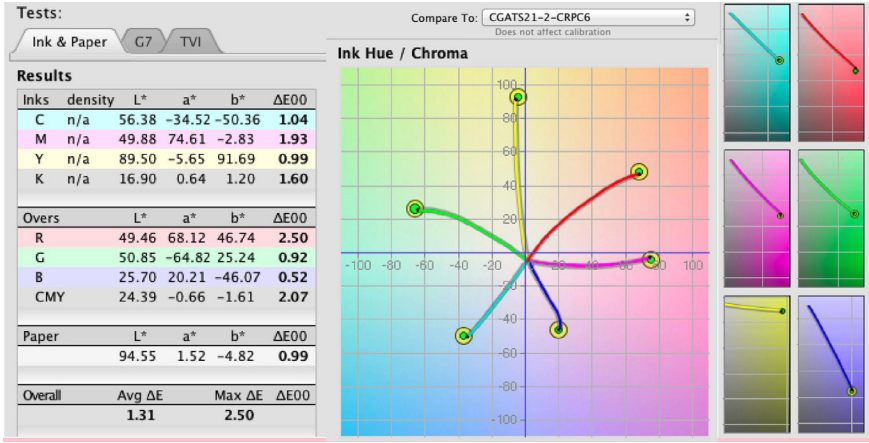
This confirmation was tested by first measuring the 'Print-to-Proof' (P2P) targets from a wide collection of approved 'G7 Master certified sheets' (define). The 27 commercial coated press sheets making up the sample set were collected over the course of several months, from different facilities across North America, with the generous assistance of Rochester Institute of Technology through their G7 Master Printer Qualification Lab services, offered in partnership with the Idealliance G7 program (Idealliance n.d.).

The method applied was to measure the 'P2P' targets from each side of the sheet three times, this number was averaged, and then the overall average between the left and right sides of the sheet was determined.

The results for each sheet were collectively averaged, to calculate a final overall common dataset. All measurements were taken using the same X-Rite i1Pro 2, capturing M1 data, and an X-Rite i1iO Automated Scanning Table. The calculations were completed using 'ColorLab' software.

Objective 1 Results and Discussion

The b* values from these sheets ranged from b* +1.66 through - 9.95. A b* value is considered a suitable metric for evaluating OBA content, as papers with OBAs require ultraviolet radiation (below 400nm) for their excitation and then they emit light in the blue region. This brings the peak reflectance wavelength at about 457nm and therefore a shift of the CIELAB b* (Quanhui1, Chung 2011).
The derived common dataset from the collected G7 Master Printer qualified sheets was compared and analyzed with the CRPC6 dataset, by Mike Rodriguez, Color Consultant, using Curve3 software.



Mike Rodriguez (2015) screen captures from 'Curve3' software

Figure 2. *a comparison of G7 Master Sheets derived data and CRPC6*

The analysis shows a 'Delta-E 2000' of less than 2, which is within tolerances, and generally accepted to be a very small difference, slightly visible to a trained eye (efi n.d.).

The colorimetry of the solids on moderate OBA substrates, defined as those with a b* ~ - 4 are close to the solids represented in CRPC6.

The overprints show the highest difference in the 'red', which is understandable as the magenta ink is showing the highest variance. As expected, the lines aren't straight - as more ink is applied, impurities in the pigments build up, resulting in a slight 'hook' towards the end.

The analysis shows that the derived dataset is overall a good comparison with CRPC6.

Objective 2 Methodology - Visual Assessment P2P matches

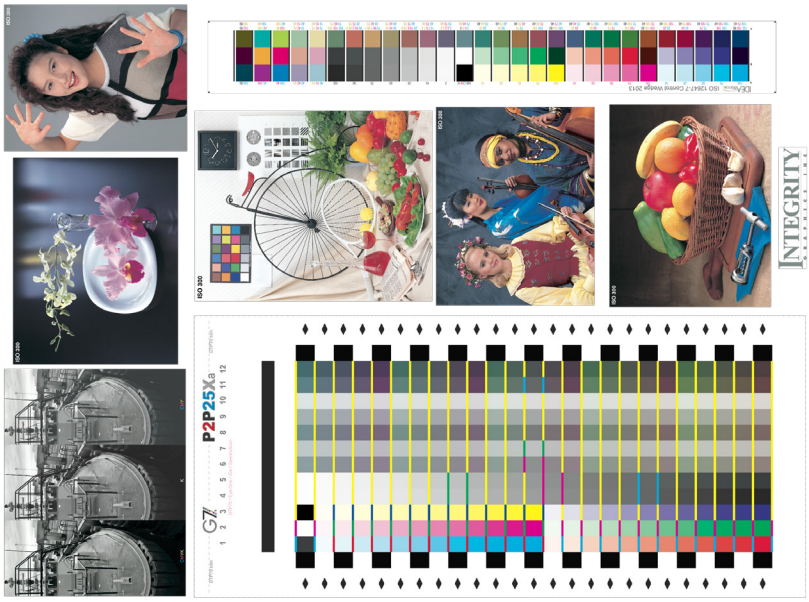
The second objective of this research report was to investigate the relative acceptability of P2P matches, using pairs of substrates with various levels of OBA content.

This was accomplished with three different groups of viewers, using paper based survey response cards.

The survey uses common industry visual targets found on G7 Master Printer qualifying sheets, on a variety of press sheet and proof substrates.

'P2P' pairs were compared under ISO 3664:2009 viewing conditions, using a new GTI Graphiclite viewing system donated by GTI to Ryerson University for this project with the Idealliance.

The press sheets used were obtained from G7 Master Printer certifications, as well as pressruns organized by the Idealliance Print Properties and Colormetric Council (PPC) Paper Task force projects; FujiFilm arranged a series of pressruns with support Komori presses, utilizing different stocks donated by Sappi paper.



GATF / PIA (n.d.)

Figure 3. *Sample G7 Test Form used for visual comparisons*

The surveys were designed using a Likert-Type Scale Response, participants were asked to select one of four options for each pair of P2P comparisons:

1a unacceptable
2b slightly unacceptable
3c slightly acceptable 4d acceptable

Participants were also given the option to include subjective information along with their overall rating with regards to the match ('too warm', 'too blue'), and to include their own descriptions/feedback.

The press sheets and proofs were labeled with generic titles (for example 'proof 001', press C'). Each participant was shown one pair at a time, by the survey facilitator (either Assistant Professor Christopher Smyth, or a Research Assistant). When not in use they were stored in a light proof environment to minimize fading.

Any brand names mentioned are used as references; they are not intended as criticism, or endorsement, of specific products. Printing and proofing is a manufacturing process with numerous variables that can impact visual perceptions. The samples here are used as references due to their different levels of optical brighteners.

For the purposes of this research project, 'low' OBA stocks are considered to have a b* above -2. 'Moderate' OBA stocks are between -2 and -6, and 'higher' OBA stocks have a b* 'bluer' than -6.

Three different surveys were utilized, with different pools of participants, as well as some different samples.

Survey Participants were asked to first complete a basic online color acuity exercise – 'The X-Rite Color Challenge' found at www.xrite.com/hue-test, and record their result. This test was completed in color-controlled environment (reduced ambient lighting, neutral gray walls, no exterior light), using calibrated Eizo 240 monitors. This online test is based on the Farnsworth Munsell 100 Hue Test, a hue discrimination/arrangement test. This online version is informational only; it is not meant to replace the physical test.

x-rite (n.d.) http://www.xrite.com/hue-test

Figure 4. *screen capture of 'The X-Rite Color Challenge'*

The primary purpose using this was to help participants 'warm up' their eyes, before making their subjective analysis. It was not used to screen survey participants, a goal of the survey was to capture first hand impressions of acceptability of 'matches' from as wide a range of viewers as possible – how people 'see' P2P comparisons. Please note that is some cases survey totals do not equal 100%, due to rounding errors, and some participants did not complete every question in the survey.

Objective 2 Results and Discussion - visual assessment P2P matches

Survey 1

The first survey had 25 participants, a pool of senior undergraduate students as well as instructors in the School of Graphic Communications Management at Ryerson University in Toronto Canada.

There were three press sheets used in this survey; one supplied by a printer from a successful G7 Master qualification run; coded anonymously as 'KBUG', an unidentified gloss text weight sheet. The other two were from an Idealliance PPC test run in November 2015 ('pressrun 01'), organized by FujiFilm, and supported by Komori and Sappi; 100lb gloss text 'McCoy' and 100lb gloss text 'Flo'.

A total of 3 different inkjet proofs were used in this survey, one output on Epson 240 Standard Proofing Paper (240SP), using the GRACoL 2006 reference condition. The second proof was output on EFI Proof Paper 245 OBA Semimatt, again using GRACoL2006. This was used instead of GRACoL2013, as examples of proofs still commonly found in the field.

Both were output using a calibrated Epson 9880 inkjet proofer, driven by Kodak Prinergy Workflow v7 and Kodak Proofing software.

The third proof was made in the FujiFilm labs, on a high OBA prototype paper from Mid States, using SCCA-spreadsheet data, beginning with CRPC6 and adjusted to the McCoy white point.

Survey 1 list of L*a*b* values for Proofs and Prints			Proof			Print			Survey Percentage 1a unacceptable – 4d acceptable			
	Proof	Print	L*	a*	b*	L*	a*	b*	1a	2b	3c	4d
Proof 001	Low OBA: Epson 240SP GRACoL2006 proof	"A" -KBUG-	94.01	0.79	-3.09	91.93	1.74	-7.25	24	40	32	4
		"B" McCoy press run 1	94.01	0.79	-3.09	94.66	3.18	-9.77	28	20	36	16
		"C" Flo press run 1	94.01	0.79	-3.09	93.77	1.3	-4,97	8	24	52	16
Proof 002	Moderate OBA: efi 245 OBA GRACoL2006 proof	"A" -KBUG-	95.52	1.05	-5.5	91.93	1.74	-7.25	4	24	44	28
		"B" McCoy press run 1	95.52	1.05	-5.5	94.66	3.18	-9.77	0	8	44	48
		"C" Flo press run 1	95.52	1.05	-5.5	93.77	1.3	-4.97	4	24	28	44
Proof 003	High OBA: Mid States prototype SCCA with McCoy white point proof	"A" -KBUG-	95.68	1.66	-8.91	91.93	1.74	-7.25	24	44	32	0
		"B" McCoy press run 1	95.68	1.66	-8.91	94.66	3.18	-9.77	28	24	44	4
		"C" Flo press run 1	95.68	1.66	-8.91	93.77	1.3	-4.97	28	24	28	20

Figure 5. *Survey 1 list of the proofs and press sheets L*a*b* values and survey results. For proofs these show the measured absolute white point of the processed proof, not the 'raw' stock white point.*

The following bar charts highlight the results of each proof type, and the three press sheets evaluated for Survey 1:

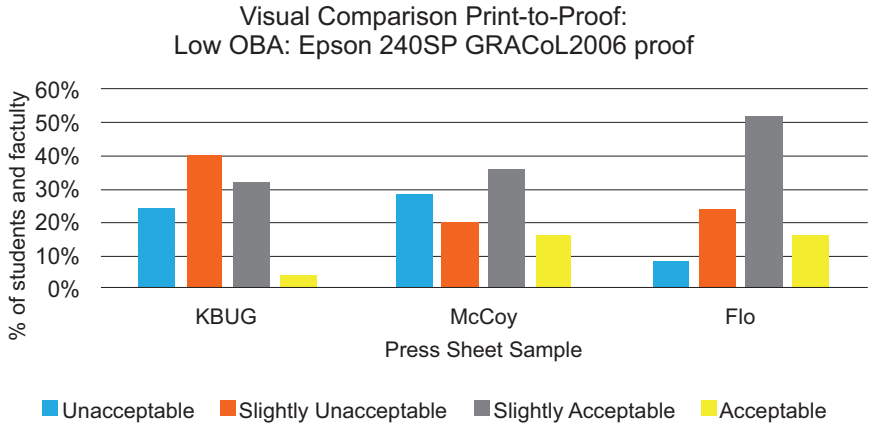


Figure 6. *Survey 1 Low OBA: Epson 240SP GRACoL2006 proof*

Considering 'unacceptable / slightly unacceptable' and ' slightly acceptable/ acceptable' as two aggregated options, these results indicated that the 'Nov. 2015' Komori Flo sheet was the better visual match to the Epson 240 GRACoL2006 proof. This aligns with what could be predicted based on colormetric numbers – the 'Flo' sheet is closest to the Epson240 GRACoL2006 proof white point.

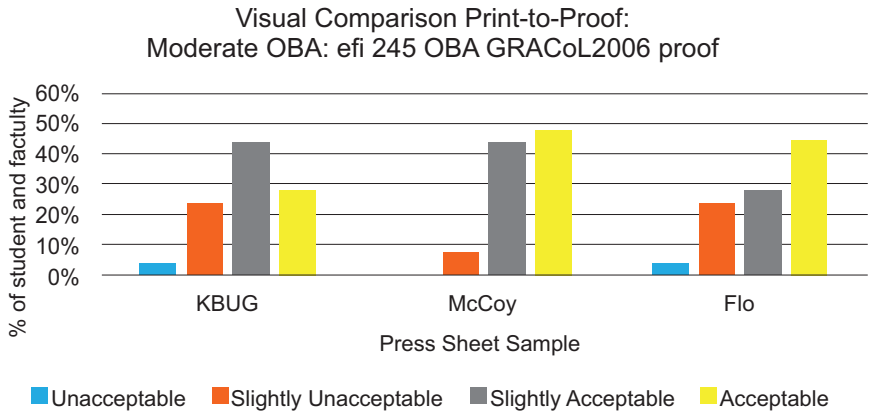


Figure 7. Survey 1 Moderate OBA: efi 245 OBA GRACoL2006 proof

Again, considering 'unacceptable / slightly unacceptable' and ' slightly acceptable/ acceptable' as two aggregated options, these results indicated that the 'Nov. 2015' Komori McCoy sheet was the best visual match to the efi 245 OBA GRACoL2006 proof. This is different from what the colormetric numbers would have predicted, however all three press sheets were evaluated as being closer than the first 'non' or low OBA proof.

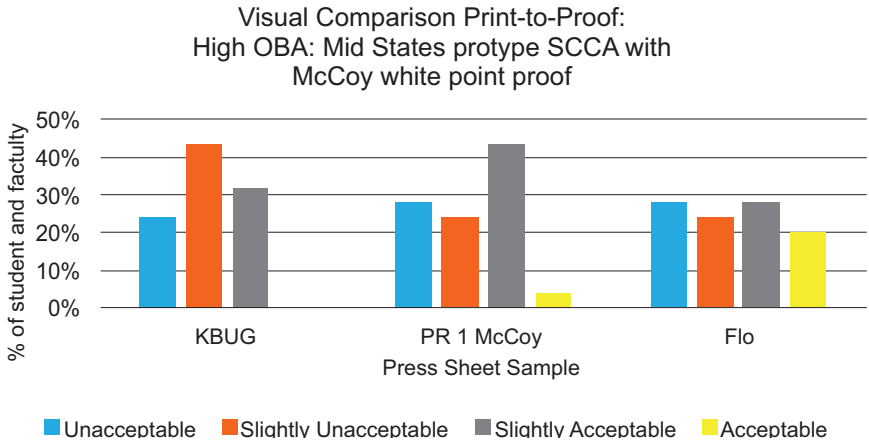


Figure 8. *Survey 1 High OBA: Mid States prototype SCCA with McCoy white point proof*

Considering 'unacceptable / slightly unacceptable' and ' slightly acceptable/ acceptable' as two aggregated options these results indicated a tie between the Komori McCoy and Komori Flo sheets, however the Flo had more responses as 'acceptable' than the McCoy.

This is different from what the colormetric numbers b* numbers might have predicted, perhaps because of the higher a* value with the McCoy.

In addition, note that there were a higher number of 'unacceptable' responses than with the moderate OBA proof.

In summary, the results of phase 1 of the survey indicate the most overall acceptable P2P were with a 'higher' OBA content press sheet, compared to a 'moderate' OBA proofing stock, adjusted using SCCA to the sheets white point.

Survey 2

The second group for the survey was completed using 7 participants, color industry professionals who were available from Idealliance G7 training course, hosted at Ryerson University in May 2016.

The two press sheets used were the same two, 100lb text gloss 'McCoy' and 'Flo' from the first Idealliance PPC test run in November 2015, organized by FujiFilm, and supported by Komori and Sappi from 'Survey 1'.

The 'KBUG' G7 Master qualification press sheet was removed from the comparisons, as subsequent readings showed the L*, a* and 'b*' numbers of this sheet to be different than original readings (this could be due to fading due to ambient light exposure, or errors in the original readings).

The four proofs used in the second survey were:

Low OBA:	Epson 240SP GRACoL2006 proof
Moderate OBA:	efi 245 OBA CRPC6 proof
Moderate OBA:	efi 245 OBA with pressrun 01 McCoy profile
Moderate OBA:	efi 245 OBA with pressrun 01 Flo profile

These were again output from the Kodak system at Ryerson University, driving a calibrated Epson 9880. The 'McCoy' and 'Flo' profiles were built from data from 'pressrun 01'.

Figure 9, Survey 2 list of the proofs and press sheets L*a*b* values and survey results. For proofs these show the measured absolute white point of the processed proof, not the 'raw' stock white point.

Survey 2 list of L*a*b* values for Proofs and Prints			Proof			Print			Survey Percentage 1a unacceptable – 4d acceptable			
	Proof	Print	L*	a*	b*	L*	a*	b*	1a	2b	3c	4d
Proof 001	Low OBA: Epson 240SP GRACoL2006 proof	"B" McCoy press run 1	94.01	0.79	-3.09	94.66	3.78	-9.77	100			
		"C" Flo press run 1	94.01	0.79	-3.09	93.77	1.3	-4.97	57			28
Proof 002	Moderate OBA: efi 245 OBA CRPC6 proof	"B" McCoy press run 1	95.52	1.05	-5.5	94.66	3.18	-9.77	14	14	28	43
		"C" Flo press run 1	95.52	1.05	-5.5	93.77	1.3	-4.97		28	43	28
Proof 003	Moderate OBA: efi 245 OBA with pressrun 01 McCoy profile	"B" McCoy press run 1	94.93	3.41	-9.52	94.66	3.18	-9.77	14	43	14	28
		"C" Flo press run 1	94.93	3.41	-9.52	93.77	1.3	-4.97	14	28	28	28
Proof 004	Moderate OBA: efi 245 OBA with pressrun 01 Flo profile	"B" McCoy press run 1	94.1	1.29	-3.67	94.66	3.18	-9.77			28	71
		"C" Flo press run 1	94.1	1.29	-3.67	93.77	1.3	-4.97			57	43

Figure 9. *Survey 2 list of the proofs and press sheets L*a*b* values and survey results. For proofs these show the measured absolute white point of the processed proof, not the 'raw' stock white point.*

Based on preliminary feedback to 'Survey 1' from the Idealliance PPC group, 'Survey 2' was also updated to allow respondents to include written comments and feedback describing how they perceived the P2P comparisons.

This cohort of respondents did not complete the online color acuity test; they had each been actively evaluating multiple press sheets and proofs prior to completing the survey.

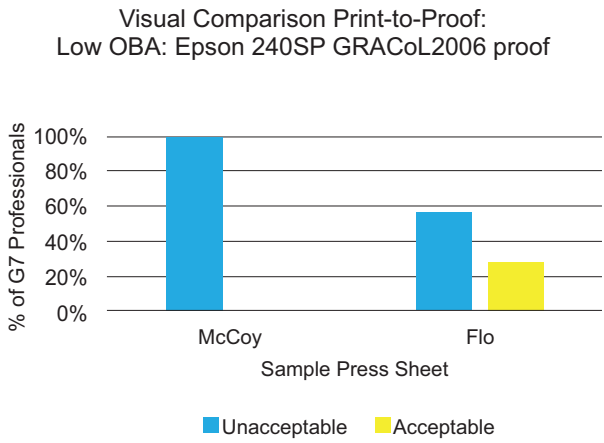


Figure 10. *Survey 2 Low OBA: Epson 240SP GRACoL2006 proof*

All respondents saw the Nov. 2015 Komori McCoy run not acceptable. The majority of respondents described the print sample as 'too blue'.

In first survey (Figure 6) 50% found the Nov. 2015 FLO sheet to Epson non-OBA proof comparison slightly acceptable, with 16% finding it acceptable. In this one an unusual split, most found it unacceptable, but two found it acceptable, one abstained. Written responses indicated that the printed sample was 'a little warm' or that the proof was 'too blue'.

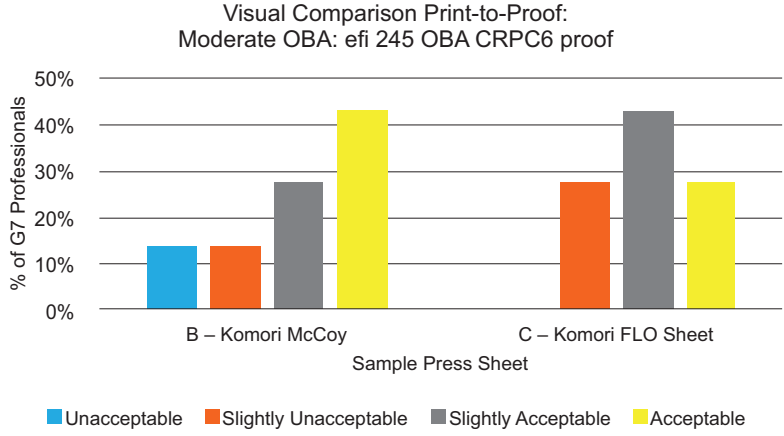


Figure 11. *Survey 2 Moderate OBA: efi 245 OBA CRPC6 proof*

Considering 'unacceptable / slightly unacceptable' and ' slightly acceptable/ acceptable' as two aggregated options, this was a tie with 71% in both cases, although the Nov. 15 Komori McCoy sample had more overall 'acceptable' ratings. This follows what the first version of the survey saw with the same pairs.

Written responses describe the McCoy as ‘too warm’, which would match the colormetric numbers with the McCoy having a ‘higher’ a* value.

Interestingly the McCoy was the only one in this comparison that was rated ‘unacceptable’ as well. It could be that one respondent did not apply the survey scale correctly.

The Flo sheet was also rated as being ‘too warm’, with the proof having ‘better gray balance’ by multiple
respondents.

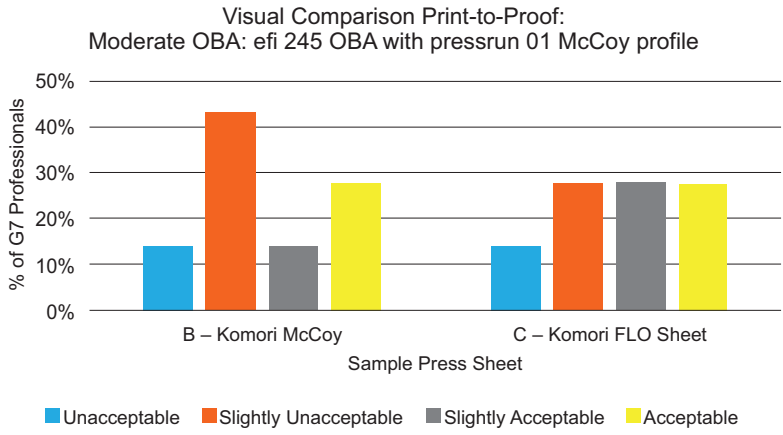


Figure 12. *Survey 2 Moderate OBA: efi 245 OBA with pressrun 01 McCoy profile*

Overall, each press sample had lower ‘slightly acceptable or acceptable’ rankings as compared to the moderate efi OBA Proof made to the Flo pressrun profile.

The McCoy had a combined acceptable rating of 42% with multiple respondents adding that the proof was ‘slightly warm’, with one saying it was ‘too blue’, and another adding that the ‘paperwhite on proof way off, affects highlight areas’.

The Flo had a slightly higher overall acceptable rating of 56%, with written comments describing the match as the press sheet was too warm, or conflictingly that the proof paperwhite was either ‘too blue’ or too warm’.

These results are lower than the same press sheets compared to the same proofing substrate, with a standard CRPC6 profile, in Figure 11. Generally, we would have expected a proof made to a press profile overall to be a better match.

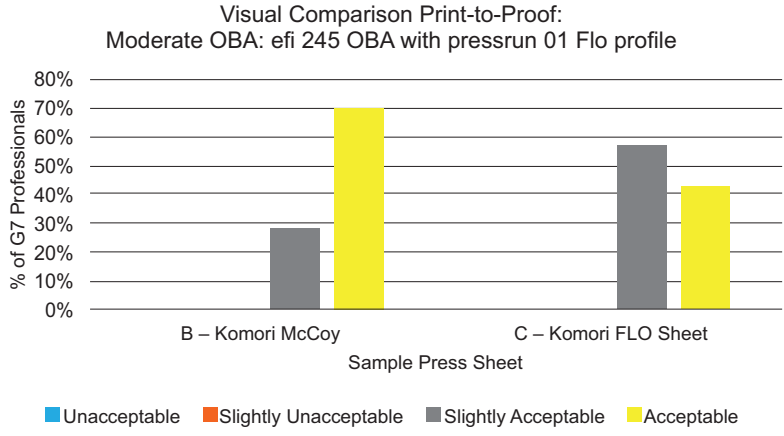


Figure 13. *Survey 2 Moderate OBA: efi 245 OBA with pressrun 01 Flo profile*

The efi OBA stock made with the Flo press profile had combined slightly acceptable / acceptable ratings of 100% for both press sheet samples. Interestingly the McCoy was slightly higher for the 'acceptable' rating, with a much different 'b*' see Figure 9.

Summary, as in survey phase 1, a higher OBA press sheet, McCoy to a proof with a moderate OBA content was the highest rated overall match, although in this case the proof was made with a moderate OBA content profile, not to the standard CRPC6 dataset.

Survey 3

The third group for the survey was composed of 17 first and second year undergraduate students in the School of Graphic Communications Management at Ryerson University.

Just over 50% of the participants scored between '20 – 29' on the 'color challenge', with 40% below 20, and the remaining 10% did not record their scores.

The Idealliance PPC group had arranged additional press runs, again with the support of Fuji, Komori and Sappi, using a 100lb text gloss McCoy. A sample McCoy from 'press run 2' was used, as well as the 100lb text gloss Flo from 'press run 1'.

The four proofs used in the third survey were:

Low OBA:	Epson 240SP GRACoL2006 proof
Moderate OBA:	efi 245 OBA CRPC6 proof
High OBA:	Epson prototype with pressrun 01 McCoy profile
Moderate OBA:	efi 245 OBA with pressrun 01 Flo profile

Survey 3 list of L*a*b* values for Proofs and Prints			Proof			Print			Survey Percentage 1a unacceptable – 4d acceptable			
	Proof	Print	L*	a*	b*	L*	a*	b*	1a	2b	3c	4d
Proof 001	Low OBA: Epson 240SP GRACoL2006 proof	"B" McCoy press run 2	94.01	0.79	-3.09	94.66	3.18	-9.77	6	19	44	25
		"C" Flo press run 1	94.01	0.79	-3.09	93.77	1.3	-4.97	19	38	25	13
Proof 002	Moderate OBA: efi 245 OBA CRPC6 proof	"B" McCoy press run 2	95.52	1.05	--5.5	94.66	3.18	-9.77	0	25	44	31
		"C" Flo press run 1	95.52	1.05	--5.5	93.77	1.3	-4.97	19	12	25	44
Proof 003	High OBA: Epson prototype with pressrun 01 McCoy profile	"B" McCoy press run 2	94.93	3.41	-9.52	94.66	3.18	-9.77	19	25	56	0
		"C" Flo press run 1	94.93	3.41	-9.52	93.77	1.3	-4.97	38	32	6	19
Proof 004	Moderate OBA: efi 245 OBA with pressrun 01 Flo profile	"B" McCoy press run 2	94.1	1.29	-3.67	94.66	3.18	-9.77	6	19	50	25
		"C" Flo press run 1	94.1	1.29	-3.67	93.77	1.3	-4.97	6	31	38	19

Figure 14. *Survey 3 list of the proofs and press sheets L*a*b* values and survey results. For proofs these show the measured absolute white point of the processed proof, not the 'raw' stock white point.*

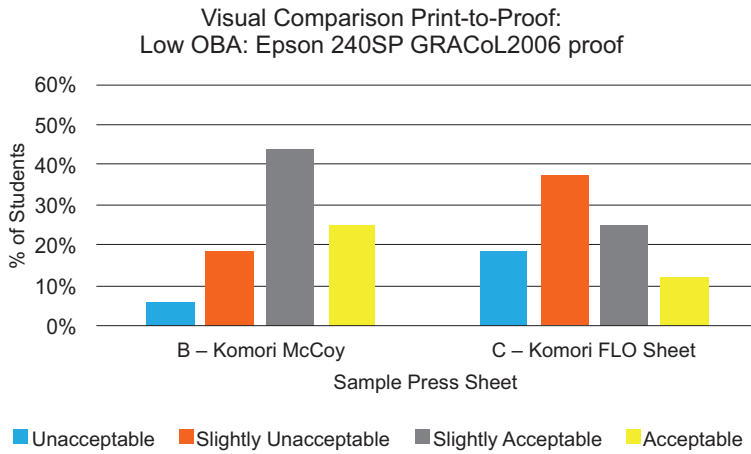


Figure 15. *Survey 3 Low OBA: Epson 240SP GRACoL2006 proof*

The McCoy sheet was seen as a more acceptable match, compared to the Flo sheet for this pair. Written comments include that the proof was 'brighter' with 'higher contrast' and more 'intense shadows' compared with the McCoy print.

For the Flo print, the 'shadows are more intense' on the proof, and 'images aren't as crisp' as the proof as well as 'colors look slightly faded' on the press sheet.

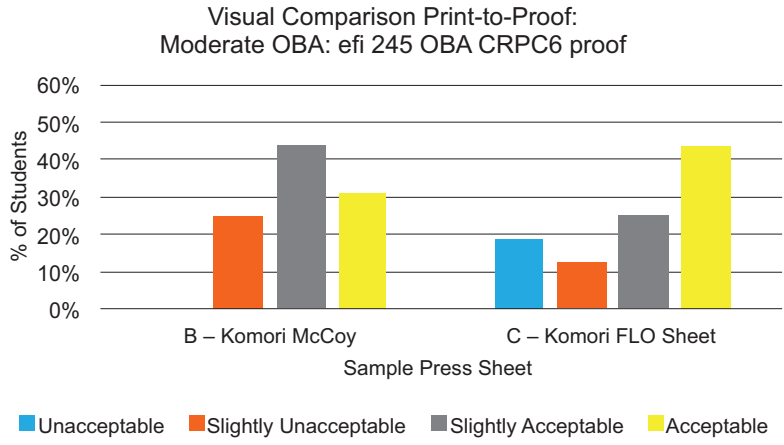


Figure 16. *Survey 3 Moderate OBA: efi 245 OBA CRPC6 proof*

Overall the McCoy press sheet was seen by 75% of respondents as acceptable, while the Flo was 69%, note that with the small sample size this equates to a difference of one person. However more viewers rated the Flo as an 'unacceptable' match overall. Comments on the Flo to proof match indicated that viewers saw the press sheet as more yellow, and that the proofing paper was 'brighter' or 'whiter', which matches what the colormetric numbers would predict.

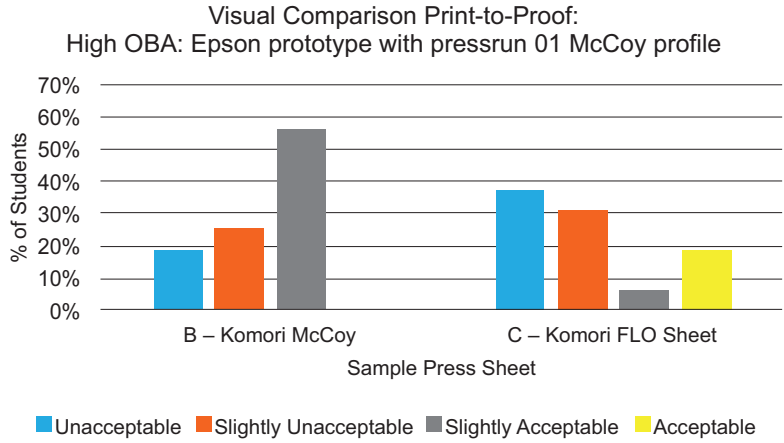


Figure 17. *Survey 3 High OBA: Epson prototype with pressrun 01 McCoy profile*

The McCoy sheet was seen as 'slightly acceptable' by 56% of respondents. The Flo had 75% rating it unacceptable/slightly unacceptable, however 19% found that it was an overall 'acceptable match'.

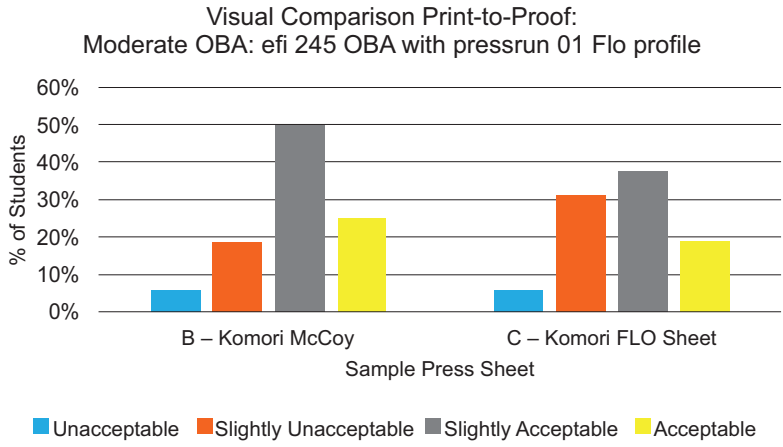


Figure 18. *Survey 3 Moderate OBA: efi 245 OBA with pressrun 01 Flo profile*

The McCoy sheet was seen as 'acceptable / slightly acceptable' by 75% of respondents, while the Flo had 56% rating it acceptable / slightly acceptable. Respondents added that the McCoy 'greys are more blue' as well as that the 'neutrals are better in proof'.

The highest combined 'slightly acceptable / acceptable' matches overall were for the 'moderate efti OBA proof CRPC6' proof.

In this case the least acceptable match was with a higher OBA content proof, made using a high OBA stock press profile, compared to a moderate OBA print sample.

Conclusions

Reviewing the three different surveys, the pairs that had the highest combined ratings of 'slightly acceptable and acceptable' were:

Survey 1: higher OBA McCoy print to moderate OBA proof GRACoL2006

Survey 2: This was a tie between the moderate OBA Flo sheet and the high OBA McCoy sheet to the Moderate OBA proof output with Flo profile. However, the McCoy sheet had a higher total of 'acceptable' ratings, 71 %, as compared to the Flo sheet at 43%. The next highest was again a tie, with both prints to moderate OBA proof GRACoL2006 at 71%.

Survey 3: higher OBA McCoy print to moderate OBA proof GRACoL2006

For P2P comparisons with prints with OBAs, viewers tend to most accept a higher OBA press sheet compared to a moderate OBA proof, output with a standard profile. In survey 2, while the highest rated proof was output to a custom sheet profile, the

second highest rating of ‘slightly acceptable and acceptable’ was with higher OBA prints to the ‘moderate OBA proof GRACoL2006’.

P2P matches with close numeric (colormetric) values do not necessarily yield the highest numbers of ‘slightly acceptable and acceptable’ rankings.

The P2P pairs that had the highest combined ratings of ‘slightly unacceptable and unacceptable’ were:

Survey 1: higher OBA KBUG print to high OBA proof with SCCA adj whitepoint . The second overall least acceptable match was higher OBA KBUG print to low OBA proof.

Survey 2: higher OBA McCoy print to low OBA proof – unanimous at 100% unacceptable. The second overall least acceptable match was a tie at 57% with moderate OBA Flo print to low OBA proof ‘unacceptable’, however 28 % also rated this same match ‘acceptable’. 57% also found the McCoy print to moderate OBA proof with McCoy profile to be unacceptable/slightly unacceptable.

Survey 3: moderate OBA Flo print to high OBA proof with McCoy profile, with 70% unacceptable/slightly unacceptable. The second least acceptable match was moderate OBA Flo print to low OBA proof, with 57% unacceptable/slightly unacceptable.

Substrates with higher OBA values appear to be more challenging to match, even when both the print and proof substrate have higher b* values.

These are not conclusive results – subjectivity of viewers is evident from the differences within and between the survey cohorts, with the G7 experts perhaps understandably consistent to each other due to training and experience, but even with the G7 experts, a moderate OBA print to a moderate OBA proof with custom profile was distributed fairly evenly across the four rating options.

In all groups, however, moderate increased amounts of OBA in proofing materials do seem to lead to more acceptable visual matches with prints containing higher levels of OBAs. This supports the proposal that the North American industry should be developing a standard characterization set, specifically for higher OBA workflows, to help achieve better P2P comparisons.

As well is helps demonstrate the need for suppliers to provide additional options for proofing substrates with increased levels of OBAs; availability in the market appears to have increased since mid-2016.

Future Considerations

Imperfect press calibrations; the variability associated with offset printing, color separations, substrates, and consumables could be contributing factors to mismatch, and could be impacting the identification of OBA matching issues.

FujiFilm is working with Komori, Sappi, and the Idealliance to go back on press in 2017 for additional 'G7 runs', with additional profiles and visual comparisons.

There is the potential for additional survey work, with proofs calibrated to the new press data, as well as potential new characterization sets, on a variety of newer stocks to get broader perspectives on the acceptability of P2P comparisons. This could include additional testing of SCCA derived proofs.

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