Delivering a Whiter White in Package Printing

A White Paper

MacDermid
GRAPHICS SOLUTIONS

"Digital MWW is a flexographic printing plate that brings unparalleled print performance to white ink delivery, providing dramatically reduced mottle and improved opacity - all in one pass."

Executive Summary

Digital MWW is a flexographic printing plate that brings unparalleled print performance to white ink delivery, providing dramatically reduced mottle and improved opacity- all in one pass. Today's "standard" system often requires the use of multiple white stations on press, or more expensive, reformulated inks just to achieve acceptable values. The use of Digital MWW in combination with the LUX® exposure process and the WhiteFX™ ink transfer solution developed by CSW, Inc., allows for dramatic improvements in print quality and reduces overall white ink consumption.

Part I: The Beginning

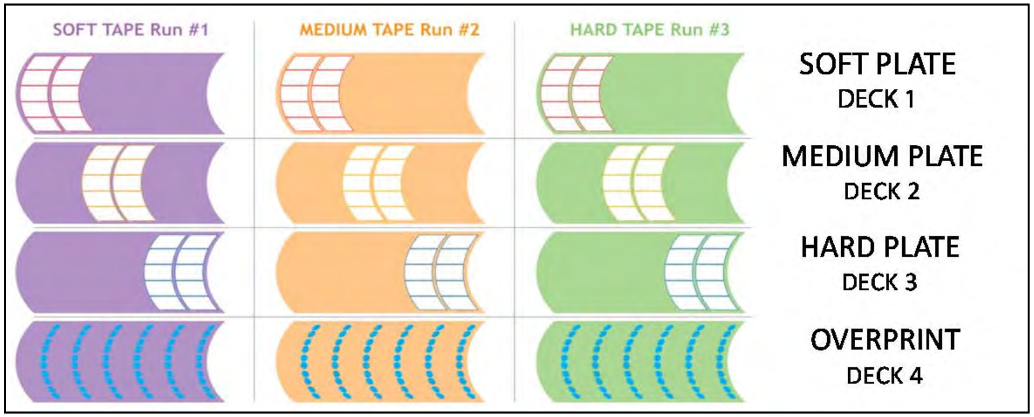
Digital MWW was an outcome of a designed experiment conducted by the combined research departments of MacDermid Graphics Solutions and CSW, Inc. The "White Print Matrix" project was prepared with a technical presentation at FFTA Info*Flex in mind. In conceiving the project, MacDermid and CSW sought to converge the capabilities of LUX® flat-top dot technology, advanced surface engineering techniques, and the on-press knowledge for printing background whites. The end result was the experimental outline shown in Table 1.

Table 1: Experimental Layout for the White Print Matrix

Factor	Levels	Levels
Plate	**3**	3 different durometers: **SOFT, MEDIUM, HARD**
Mounting Tape	**3**	**SOFT , MEDIUM , HARD**
Conv. Digital and Texture Surface	**2**	None, TS
Anilox	**3**	**250, 360, 550** lpi
Plate surface treatment	**4** + CONTROL	Multiple Frequencies

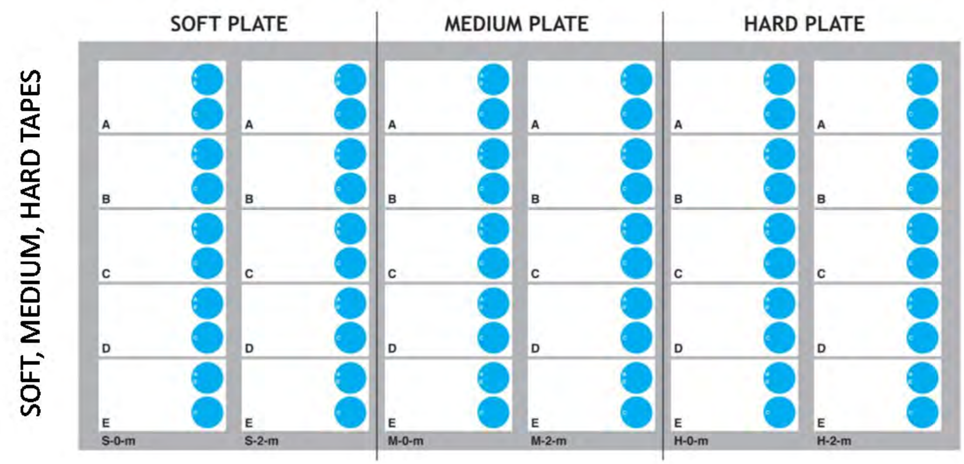
The print layout shown in Figure 1 was selected in order to optimize the efficiency and objectivity of the study. The study was conducted on a 50" wide web press, utilizing four printing decks, three anilox types, and multiple sleeves. The white ink formulation was kept constant, with a closely monitored and maintained viscosity typical for high speed production. Shrinkable polyethylene was chosen for the substrate due to its common use in wide web production. In addition, an overprint of cyan was added to the study in order to evaluate the potential impact of background white on other aspects of the print.

Figure 1: Print Layout



The final print layout is shown below in Figure 2. During this study, three different plate and tape hardnesses were evaluated, in addition to three selections of anilox rolls (250, 360 and 550). Four different screening methods were employed on two different types of digital plates, which included LUX® and standard exposure methods.

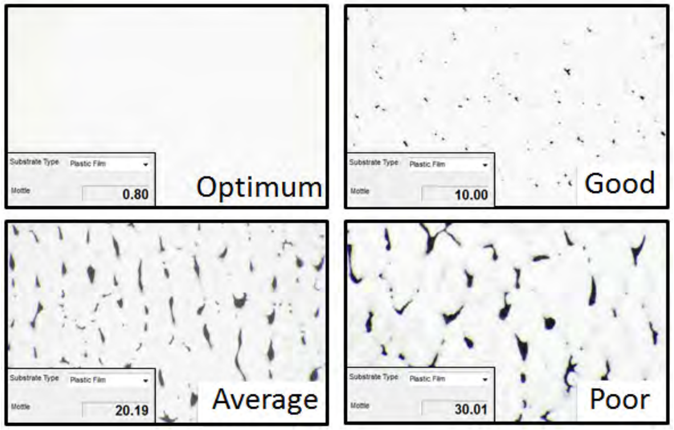
Figure 2: Test Form



The Results

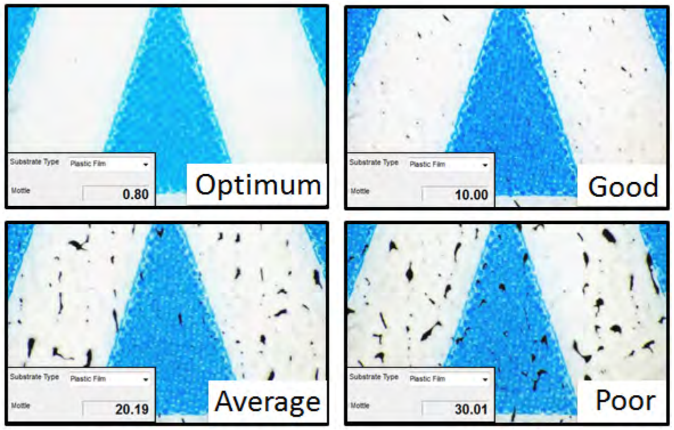
After running 270 different combinations, the results were analyzed for optimum mottle and opacity, with a "standard" method as reference. This standard method was a double print white using a medium durometer, conventionally exposed digital plate. It became evident early on that the LUX® exposed plates greatly enhanced the impact of surface screening methodologies, an observation seen in other print applications as well. The pictures shown in Figure 3 highlight the various levels of print quality seen in this study. As shown, the study was indeed effective in including numerous "poor" quality results in addition to remarkably high quality results as well.

Figure 3: Comparison of Various Mottle Levels Observed in the White Print Matrix



In addition to the noticeable impact on the white samples alone, the inclusion of the overprint cyan showed what a dramatic impact that the background white can have on other colors as well. Figure 4 shows the same four levels in the presence of the overprint color.

Figure 4: Impact of Background White Mottle on Overprint Cyan



Overall, significant improvements were noted in both opacity and mottle, but the question remained as to how to select the best of the best. The table below shows the weighted outcome of mottle using values less than 6. It should be noted that white poly has a mottle value less than 1. Out of the 270 scenarios evaluation, a total of 20 samples met the criteria of mottle less than 6. Furthermore, all of these values were obtained with the 250 and 360 anilox rolls, with 60% of the optimized results belonging to the 250 anilox.

Table 2: Final Mottle Tabulation

MOTTLE	250 ANILOX - 7.2 bcm		360 ANILOX - 5.0 bcm		550 ANILOX - 2.5 bcm		TOTALS
0 - 2.99	**OPTIMUM**	6	**OPTIMUM**	3	OPTIMUM	0	9
3 - 5.99	GREAT	6	GREAT	5	GREAT	0	11
6 - 10.99	GOOD	10	GOOD	9	GOOD	0	19
11 - 15.99	BETTER	19	BETTER	11	BETTER	1	31
16 - 19.99	NORMAL	19	NORMAL	9	NORMAL	0	28
20 - 25.99	POOR	18	POOR	16	POOR	1	35
26 - 29.99	BAD	10	BAD	19	BAD	2	31
30+	UNUSABLE	2	UNUSABLE	18	UNUSABLE	86	106
TOTALS		90		90		90	270

Similarly, the opacity values were tabulated and are shown in Table 3. In this case, samples with opacity values greater than 54 were highlighted, yielding a final total of 48 samples. Of these 48, 47 were attributable to the highest volume anilox configuration, with only one sample belonging to another anilox roll selection.

Table 3: Final Opacity Tabulation

OPACITY	250 ANILOX - 7.2 bcm		360 ANILOX - 5.0 bcm		550 ANILOX - 2.5 bcm		TOTALS
>55	OPTIMUM	4	OPTIMUM	0	OPTIMUM	0	4
54 - 55.9	GREAT	43	GREAT	1	GREAT	0	44
52 - 53.9	GOOD	39	GOOD	23	GOOD	0	62
50 - 51.9	BETTER	4	BETTER	40	BETTER	0	44
<50	NORMAL	0	NORMAL	26	NORMAL	90	116
TOTALS		90		90		90	270

Optimization

By applying further analysis to the data obtained, we were able to refine the combined optimization of all of the variables set forth in the beginning of this study. What were the optimum values of plate durometer, tape and anilox selection, screening methodology, and exposure techniques? Table 4 shows an example of the optimized values highlighted for a specific screening pattern.

“The final analysis revealed that the optimum combination for a “Whiter White” was a 250 anilox, hard tape, a proprietary plate surface engineering technique developed by CSW, and the Digital MWW photopolymer plate from MacDermid.”

Table 4: Opacity and Mottle Optimization Per Screening Type

SURFACE PATTERN	INK OPACITY						MOTTLE FACTOR						PLATE DUROMETER	ANILOX LPI
	MOUNTING TAPE DENSITY													
	SOFT	MED	HARD	SOFT	MED	HARD	SOFT	MED	HARD	SOFT	MED	HARD		
	NO TEXTURE			SURF. TEXTURE			NO TEXTURE			SURF. TEXTURE				
C	52.6	53.7	53.3	53.2	51.1	53.9	25.5	18.6	15.7	21.0	11.6	9.3	SOFT	250
	52.4	54.1	54.4	52.0	53.3	54.2	31.5	21.1	20.9	28.5	25.8	18.2	MEDIUM	
	53.5	54.7	53.5	52.8	53.8	54.2	30.0	18.3	15.3	27.3	17.0	15.5	HARD	
	49.9	51.5	51.7	50.7	52.2	53.1	28.2	19.9	11.9	22.0	11.6	7.0	SOFT	360
	49.0	50.9	51.0	49.4	50.8	51.1	36.0	26.3	28.9	37.2	29.8	25.9	MEDIUM	
	49.6	50.6	51.2	48.6	49.9	49.8	32.9	20.4	24.1	30.7	22.9	25.4	HARD	
	44.8	46.5	44.7	45.6	48.6	45.7	47.1	38.8	52.8	44.0	30.3	13.4	SOFT	550
	40.3	46.2	38.2	40.3	46.1	39.3	56.2	46.3	73.1	57.4	43.8	62.5	MEDIUM	
	39.0	41.1	40.0	41.5	41.9	42.3	53.1	54.6	49.2	53.1	44.1	49.8	HARD	

PLATE DUROMETER	ANILOX LPI	Opacity greater than 53 MOTTLE LESS THAN 16						Opacity greater than 54 MOTTLE LESS THAN 6					
		SOFT	MED	HARD	SOFT	MED	HARD	SOFT	MED	HARD	SOFT	MED	HARD
		NO TEXTURE			SURF. TEXTURE			NO TEXTURE			SURF. TEXTURE		
SOFT	250	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
MEDIUM		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
HARD		FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
SOFT	360	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
MEDIUM		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
HARD		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
SOFT	550	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
MEDIUM		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
HARD		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

The final analysis revealed that the optimum combination for a “Whiter White” was a 250 anilox, hard tape, a proprietary plate surface engineering technique developed by CSW, and the Digital MWW photopolymer plate from MacDermid. This combination yielded a mottle value of 0.8 with an opacity level of 56.3 - with one pass only!

Despite the confidence in both the observed results and the methodologies employed to achieve these results, it was still necessary for MacDermid to further evaluate the Digital MWW plate in actual live situations; i.e. have customers observe the value of Digital MWW in their environment. Two such situations are described below.

Part II: Field Implementation

Two independent field trials are reported below, each replicating the improved results seen in the designed experiment. Each customer ran the optimized Digital MWW package against either their current plate of choice, or a variety of competing options in white ink optimization.

"The Digital MWW configuration outperformed the standard plate setup in all cases."

Customer 1

Press trials were performed with Digital MWW vs. their standard print setup. Three different anilox configurations, two white ink manufacturers, and one existing spot color were tested. One production job was produced. The primary focus was ink coverage. Mottle was measured using a BetaPro 3. Secondary was opacity, measured with an X-rite exact Spectrophotometer. Other factors recorded were white ink lightness and spot color SID.

Their standard setup was a medium durometer plate with hard stickyback tape.

The test setup was the MacDermid Digital MWW plate with surface screening (provided by CSW) and a hard stickyback tape.

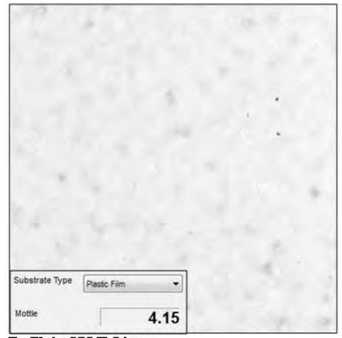
The Digital MWW configuration outperformed the standard plate setup in all cases. The optimum results recorded on the white ink was mottle of 0.35 and opacity of 65.2 and a lightness of 82. These results compare quite favorably to that of 1.5 mil white poly that typically records 0.12 mottle, opacity of 82 and a lightness of 90.

All Mottle Results

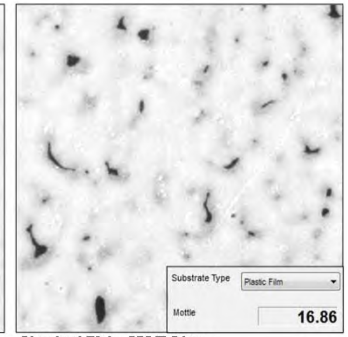
Ink	Anilox	BCM	Speed	Tape	Average Mottle Plate	
					Standard	FX plate
Ink Supplier #1	250	7.5	250 m/min	Tesa 52825	16.95	4.17
Ink Supplier #1	500	5.2	250 m/min	Tesa 52825	24.22	5.28
Ink Supplier #1	864	2.9	250 m/min	Tesa 52825	24.64	13.5
Ink Supplier #2	250	7.5	250 m/min	Tesa 52825	24.52	4.72
Ink Supplier #2	500	5.2	250 m/min	Tesa 52825	30.52	6.28
Ink Supplier #2	864	2.9	250 m/min	Tesa 52825	N/A	N/A
Production*	300	7.5	250 m/min	Tesa 52825	11.35	**0.35**

The average mottle was recorded by measuring ten spots over two repeats. The production job was a frozen food bag. The WhiteFX^{TM} production sample was compared to a previously printed sample of the same design. In terms of mottle, a reduction of every 5 points is a significant increase in ink coverage. This dramatic difference is illustrated in the photomicrographs below.

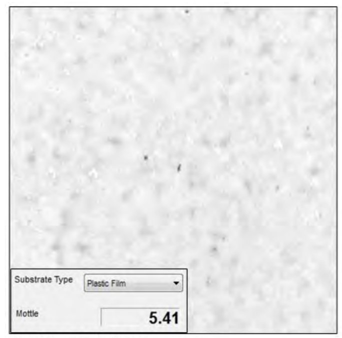
Ink Supplier #1



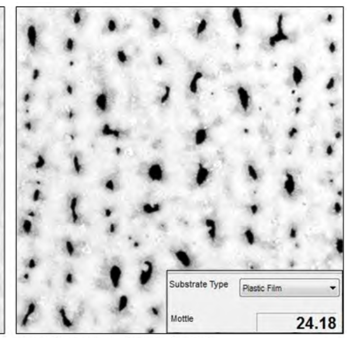
Fx Plate 250/7.2 bcm



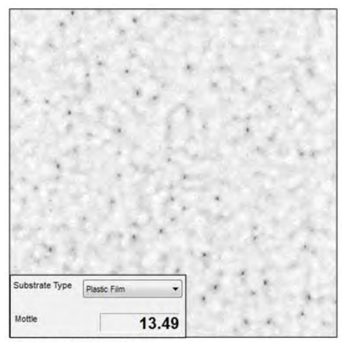
Standard Plate 250/7.2 bcm



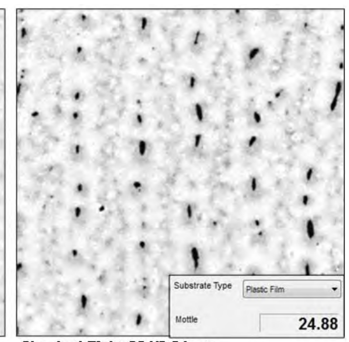
Fx Plate 500/5.2 bcm



Standard Plate 500/5.2 bcm



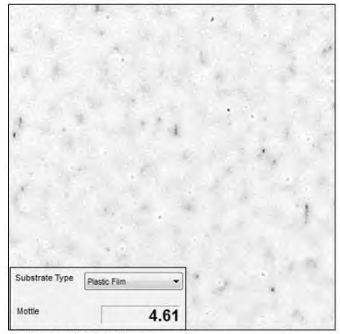
Fx Plate 864/2.9 bcm



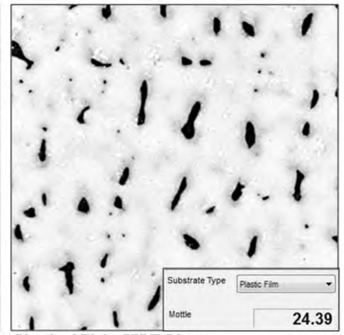
Standard Plate 864/2.9 bcm

The last two standard samples show very similar mottle number but very different appearances. This is because one sample has larger total voids but the rest of the coverage is relatively consistent. The other sample has smaller voids but has a lot more gray or inconsistent coverage. This is to be expected as the volume of ink is considerably reduced.

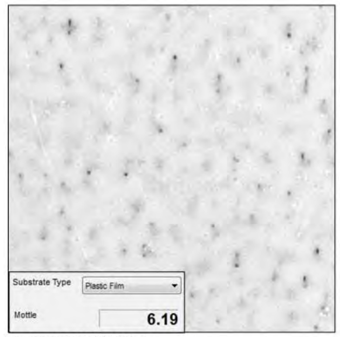
Ink Supplier #2



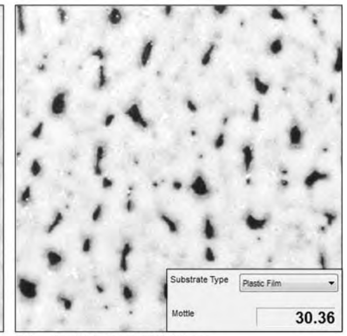
Fx Plate 250/7.2 bcm



Standard Plate 250/7.2 bcm



Fx Plate 500/5.2 bcm



Standard Plate 500/5.2 bcm

The third, higher line/lower volume anilox test was not deemed unnecessary because the previous trial with Ink Supplier #1this roller 250 produced inferior 7.5 results.

Ink	Anilox	BCM	Speed	Tape
			250 m/min	Tesa 5282
Ink Supplier #1	500	5.2	250 m/min	Tesa 5282
Ink Supplier #1	864	2.9	250 m/min	Tesa 5282
Ink Supplier #2	250	7.5	250 m/min	Tesa 5282
Ink Supplier #2	500	5.2	250 m/min	Tesa 5282
Ink Supplier #2	864	2.9	250 m/min	Tesa 5282
Production*	300	7.5	250 m/min	Tesa 5282

Opacity of Both White Inks

Ink	Anilox	BCM	Speed	Tape	Average Opacity Plate	
					Standard	FX Plate
Ink Supplier #1	250	7.5	250 m/min	Tesa 52825	54.1	56.3
Ink Supplier #1	500	5.2	250 m/min	Tesa 52825	51.7	54.6
Ink Supplier #1	864	2.9	250 m/min	Tesa 52825	51.2	51.3
Ink Supplier #2	250	7.5	250 m/min	Tesa 52825	53.8	55.0
Ink Supplier #2	500	5.2	250 m/min	Tesa 52825	51.1	53.7
Ink Supplier #2	864	2.9	250 m/min	Tesa 52825	N/A	N/A
Production*	300	7.5	250 m/min	Tesa 52825	62.92	65.2

As predicted, when the volume of ink is reduced the opacity drops accordingly. A two-point change in opacity is considered significant. There was no significant difference between the two inks. A large and significant increase is noted on the production job. This was run on a different press from the testing.

L-values of White

Ink	Anilox	BCM	Speed	Tape	Average L-values Plate	
					Standard	FX Plate
Ink Supplier #1	250	7.5	250 m/min	Tesa 52825	77	78
Ink Supplier #1	500	5.2	250 m/min	Tesa 52825	78	79
Ink Supplier #1	884	2.9	250 m/min	Tesa 52825	75	78
Ink Supplier #2	250	7.5	250 m/min	Tesa 52825	79	80
Ink Supplier #2	500	5.2	250 m/min	Tesa 52825	77	78
Ink Supplier #2	884	2.9	250 m/min	Tesa 52825	N/A	N/A
Production*	300	7.5	250 m/min	Tesa 52825	81	83

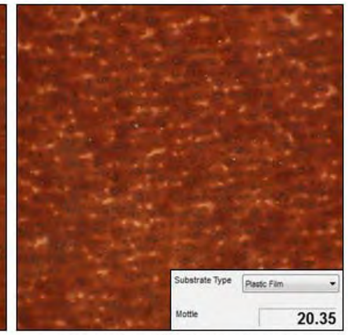
The higher the number the lighter, or cleaner, the white looks. Again, the WhiteFX production sample has the highest L-value. L-values range from zero (black) to 100 (bright white).

Spot Color Brown Mottle and Brown

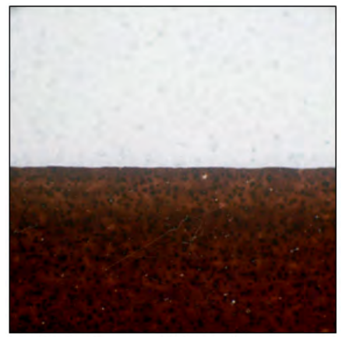
The Digital MWW plate was repositioned to a different unit that had been running a spot color for a previous job on the same press. This step was performed to test the ability of ink transfer with other pigments. The separate samples (white and brown) were laminated together to simulate this combination as it could run in production.

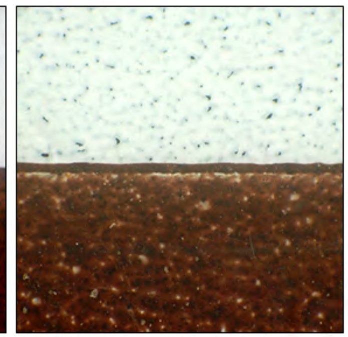
The single color brown was run with a 500/5.2 volume anilox. This sample was on clear film. As expected , the mottle level decreased from 20.39 (standard) to 10.84.

MWW Plate 500/5.2 bcm Clear film



Standard Plate 500/5.2 bcm Clear film


MWW Plate Brown on White (Laminated)

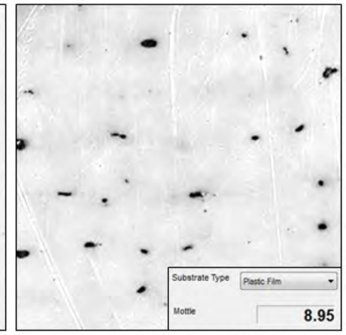

Standard Plate Brown on White (Laminated)

As you can see above, this combination has some very good potential. The SID on the standard side plate was 1.51. The MWW side plate increased to 1.62.

Production Job Comparison

Since the Digital MWW plates for this job were run on a different press with a slightly different anilox roller than typical, some additional photographic analyses was performed. The impacts of various areas of the design are shown below.

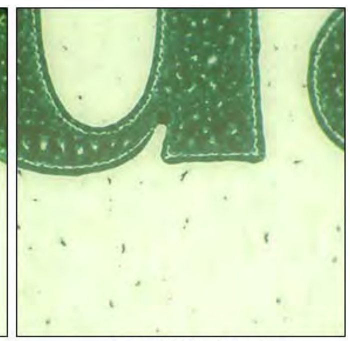
MWW Plate 300/7.5 bcm

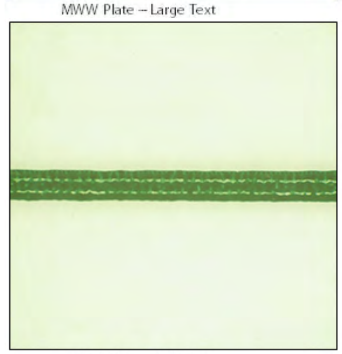


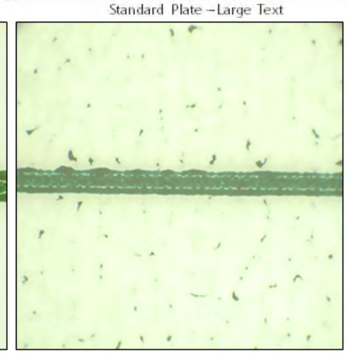
Standard Plate 300/7.5 bcm

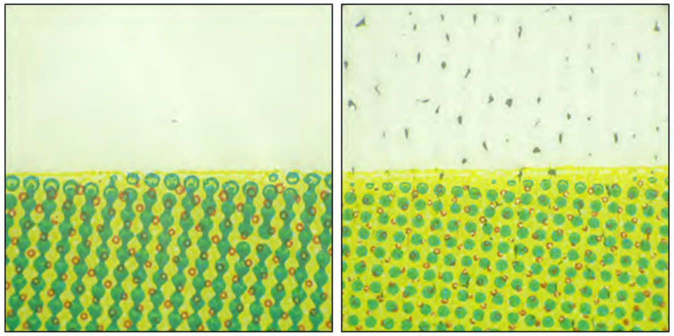
Other design Images


MWW Plate – Large Text


Standard Plate – Large Text


MWW Plate – Rule Lines


Standard Plate – Rule lines



MWW Plate – Process and Tint areas   Standard Plate – Process and Tint areas

While both plates had greatly reduced mottle numbers than what the customer was used to, the difference between the two materials was still obvious. While the standard was considered very good, the Digital MWW sample was outstanding with mottle reduction approaching that of white poly.

Customer #1 Conclusions

- The Digital MWW plates outperformed the standard configuration in all testing phases.
- Mottle reduction with all anilox rollers - the very low volume anilox would still be unsuitable for high quality coverage of the white ink as opacity and mottle suffer.
- Both the 250 or 300 lpi anilox will provide greatly increased quality when used with the Digital MWW plate.
- The main driver of opacity is ink volume, but with increased coverage the opacity is also increased. A two point increase is considered significant.
- Spot color coverage can benefit greatly with the use of the Digital MWW plate.
- Both inks performed well with little difference between them.

Customer 2

Background

In this second evaluation, we were asked by a large wide web customer to test a series of solid plates to determine their effect on press with pinhole reduction on opaque white printed on clear film.   The following plates (.067") were evaluated:

- Digital MWW, LUX exposed
- Digital Plate A, LUX exposure with Membrane 200
- Digital Plate B, LUX exposure with Membrane 200

The plates where printed at the customer site in January 2015. An additional plate was also added to the trial. This was Competitive Plate A, which was their standard plate used for printing Opaque White.

Printing Details

- Mounting Tape – E1820 3M
- Anilox – 250 Lpi with a volume of 11 cm3 m2
- Ink – SURFACE Sunprop hi Opacity White, REVERSE Duraflex White
- Press – Miriflex CM
- Press speed – 280 mpm
- Material – PEP 12 mic clear film
- Ink viscosity – 23s

Results

The following pictures detail the customer's observations for each plate type:

Digital Plate A

This plate printed with pinholing

Surface Print

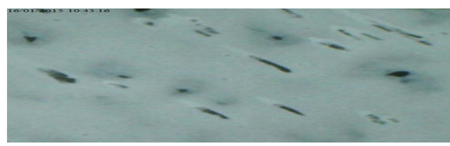
Digital Plate B

A definite improvement in pinholing was observed.

Surface Print

Competitive Plate

A very similar result to Digital Plate B



Surface Print

Digital MWW

Perfect laydown was observed.

Surface Print

Reverse Print

Customer #2 Conclusions

All plates where printed under the same conditions. Digital plates A and B showed good results with much improvement in pinhole reduction compared to what was normally seen on press. The overwhelming success was the MWW plate which printed with no pinholing at all. Print management and the press operators were very impressed with results of MWW.

Overall Conclusions

The development of the Digital MWW photopolymer was a true case study in leveraging existing innovative technologies (LUX®) and outstanding collaborative relationships. The end result was a customer-driven development that has both quality and economic ramifications for printers and brand owners alike. While existing research in the area of improving white ink laydown has led to novel combinations of plate materials and screening technologies, none of these efforts rival the level of performance achieved with the combination of Digital MWW, the LUX® process, and the ink transfer solution developed by CSW. Digital MWW represents yet another powerful innovation from the MacDermid Graphics Solutions team, enabling our customers with more tools to achieve better print quality.

For More Information About Digital MWW and the Complete Digital MWW/White FX Package, visit www.macdermid.com/graphics

or email mpsproductinfo@macdermid.com.

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