Digital Glossing, Its Applications and Performance Evaluation

C. Jeffrey Wang, NexPress, Rochester, New York, USA

Introduction

In Graphic Arts industry, the surface treatment of glossing provides two major functions to the printed sheets. The first is to accentuate the piece giving it more emphasis and the second is to serve as a protecting layer against damage to the information underneath. The common practice of glossing involves both in-line and off-line processes of aqueous, varnish, Ultra Violet (UV) and lamination. Aqueous and varnish could be applied in-line using one of the inking units of an offset press. UV could be applied through a build-in device that's part of the offset press or an off-line UV applicator. Aqueous and UV could be done real-time but varnish has to be applied after the printed ink is dry completely, usually overnight. Lamination is an off-line process adhering a layer of glossy thin film material on top of the entire printed sheet to deliver high gloss if so desired and this is gloss lamination. When a layer of matte film is applied to the printed sheet it will give a matte appearance instead of glossy and it's known as matte lamination. Both solid and liquid films are available for lamination processes. The gloss lamination could achieve a gloss level of 80 (G20) or higher.

Several attempts were made by the digital printing industry to increase the overall gloss level of electro-photographic prints. They include both in-line and off-line processes. The results were mixed. Gloss lamination and UV coating remain as the two major methods to provide high gloss for electro-photographic prints.[1] A novel method to deliver high gloss on these prints is being reported in this article.[2] This approach utilizes a belt in fusing a layer of Clear DryInk overcoat on top of a printed sheet to achieve a high level of gloss. It also makes use of barcodes and barcode-scanner to communicate the machine parameters between the digital press and the glossing unit hence an optimized system level near-line solution. Several substrates were tested using this method in comparison to aqueous, varnish, UV and lamination. The achieved gloss level and protection performance were reported in this study.

The Process

The digital glossing unit is not a marking engine. It doesn't produce any images by itself. Printed sheets feeding the digital glossing unit have to be generated by a NexPress digital production color press of five imaging units. Four imaging units of the process colors, cyan, magenta, yellow and black enable full color prints to be made1210. The fifth imaging unit, in this case, is intelligently applying a layer of Clear DryInk material on the entire imaging area of the print based on its image content and substrate.[3] Digital press also prints barcodes on the banner sheet of each job. Each digital glossing unit is equipped with a barcode scanner. At the beginning of each glossing job, operators scan the barcodes on the banner sheet using the barcode scanner. The data transmitted through the barcode scanner is print job and substrate specific. This information sets the glossing unit to an optimal operating condition for that particular job. The printed sheet with Clear DryInk overcoat is now ready to be processed by the digital glossing unit. It begins at the paper feeder of the unit. It's fed from the paper feeder drawer, enters a vertical paper transport and a horizontal paper transport. The sheet then makes contact with the fuser belt where a nip is formed between the heater roller and the pressure roller. While the sheet is in the fuser belt nip, heat and pressure were applied to the DryInk on the sheet so that the image surface retains the smoothness and surface characteristics of the fuser belt. Heat, pressure, and the fuser belt produce the high gloss on the printed sheet. Finally, the sheet is cooled by a plate in the cooling unit, separated from the fuser belt, and transported onto the paper platform of the glossing unit with a glossy finish.

Experiment

This study investigated the applications and performance of the digital glossing method in comparison to the aqueous, varnish, UV and lamination. A set of four print applications was designed for this purpose. They are post card, poster, marketing brochure and book cover.

A coated gloss paper of 216 gsm was used for the post cards. It's a perfecting job with images on the front and text on the backside. The paper for the poster job was a coated gloss of 270 gsm. This is a single-sided job of mostly images. Marketing brochure was printed on a coated gloss paper of 118 gsm. It's also a perfecting job of images and text on both sides. The book cover utilized both uncoated and coated gloss papers of 216 gsm. It's a single-sided job.

A NexPress digital production color press was utilized to make the digital prints for this study. This press is capable of printing both four-color and five-color jobs. Digital glossing was only applied to the five-color print sheets with Clear DryInk overcoat. The four-color print sheets were surface treated with the near-line and off-line processes as listed in the following table. An analog lithographic offset press using computer-to-plate technology was employed to generate the offset prints. For the offset prints, the surface treatments of aqueous and UV were applied real-time and in-line. The varnish and lamination processes were applied off-line. All the surface treatments on four-color digital prints were applied off-line. Digital glossing on five-color prints was a near-line process as described earlier.

After printing and surface treatments, the post cards were mailed through the USPS to California, Florida and Illinois from Rochester, NY. The mailing method used was pre-sort standard bulk rate. These pieces were then collected at the destinations, packed and shipped back to Rochester for evaluation of their ability to withstand the mailing process.

Gloss readings, abrasion and scratch resistance, scuff and smudge resistance and spill and stain resistance of these prints were measured and evaluated. In addition, the workflows and cycle times of these processes were compared and recorded.

Print Jobs and Applications

Applications	Printing	Finishing
Post card	Four-color digital press	None, Aqueous, Varnish
	Five-color digital press	Digital glossing
	Four-color Lithography	Aqueous, Varnish
Poster	Four-color digital press	None, UV
	Five-color digital press	Digital glossing
	Lithography	UV
Marketing brochure	Four-color digital press	None, Aqueous, Varnish
	Five-color digital press	Digital glossing
	Lithography	Aqueous, varnish, UV
Book cover	Four-color digital press	None, lamination
	Five-color digital press	Digital glossing
	Lithography	Lamination

Experimental Results

Gloss Readings

Gloss readings were obtained using a BYK-Gardner micro-TRI-gloss glosser. Both measuring geometries of G20 and G60 were used because of the wide range of gloss levels.[4] Multiple measurements were taken on each print sample. Only the average data is presented in the following tables.

Post Card

Printing	Finishing	G20° / G60°
Four-color digital press	None	4.1 / 31.3
	Aqueous	8.7 / 43.4
	Varnish	9.0 / 43.4
Five-color digital press	Digital glossing	90.3 / 94.7
Four-color Lithography	Aqueous	14.7 / 55.9
	Varnish	19.9 / 64.1

Poster

Printing	Finishing	G20° / G60°
Four-color digital press	None	3.1 / 30.4
	UV	53.5 / 92.5
Five-color digital press	Digital glossing	70.3 / 90.5
Four-color Lithography	UV	58.3 / 92.1

Marketing Brochure

Printing	Finishing	G20° / G60°
Four-color digital press	None	3.3 / 29.3
	Aqueous	7.7 / 39.3
	Varnish	8.9 / 37.8
	UV	56.5 / 91.9
Five-color digital press	Digital glossing	78.3 / 92.8
Four-color Lithography	Aqueous	14.8 / 53.9
	Varnish	20.3 / 63.0
	UV	70.5 / 93.5

Book Cover

Printing	Finishing	G20° / G60°
Four-color digital press	None	4.3 / 30.2
	Gloss lamination	82.5 / 94.0
Five-color digital press	Digital glossing	81.2 / 93.3
Four-color Lithography	Gloss lamination	49.8 / 89.6

Gloss readings of post cards were measured without sending them through the USPS system. The USPS mailing process doesn't have a negative impact on the print gloss unless where the printed surface was damaged. Digital post cards with the digital glossing method produced the highest gloss[5] reading of 90.3 G20°. Offset prints of aqueous and varnish finishes produced low gloss. The gloss levels achieved by the digital post cards of aqueous and varnish were also low.

Digital glossing achieved a high gloss finish that's better than the UV process. This is showing clearly by the G20° data. The gloss level produced by the UV process on digital prints was lower than that on the offset prints.

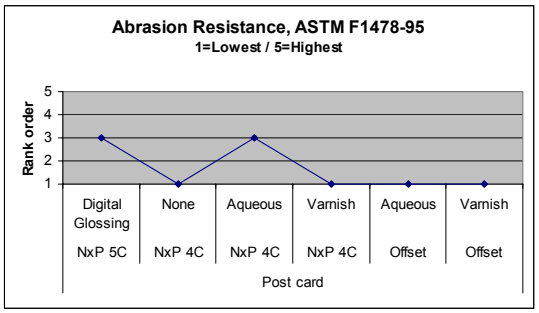
Digital glossing produced the highest gloss level on this print application. The offset prints of UV process also produced high gloss but the gloss level of digital prints with UV was low. G20° measurement represents the high gloss readings better than G60°. Offset prints of aqueous and varnish provided higher gloss than that of the four-color digital prints.

Digital glossing achieved high gloss on the book covers. It provided a gloss level that's comparable to gloss lamination.

Abrasion and Scratch Resistance

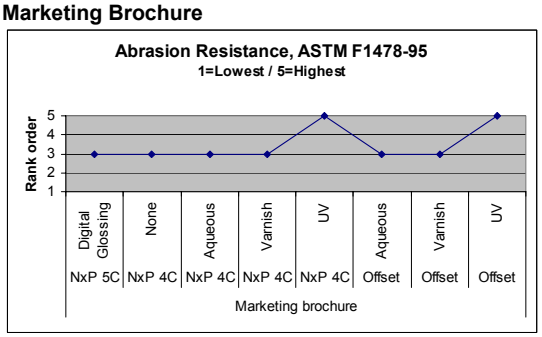
The test method used, ASTM F1478-95, is a standard procedure for determining the amount of imaged material abraded from the surface of a print by a rubbing or grinding force. This is known as the Taber method. Both reflection density measurement and subjective image quality evaluation were implemented to assess the results of this study. A set of numbers from 1 to 5 was used to evaluate the performance. A ranking value of 3 or higher represents satisfactory performance.

Post Card



Test results indicated that electro-photographic prints of digital glossing and aqueous treatment have better abrasion resistance than the other processes. They showed slight to no content loss or gloss loss. The other processes suffered significant content loss. Their results were not satisfactory.

Marketing Brochure

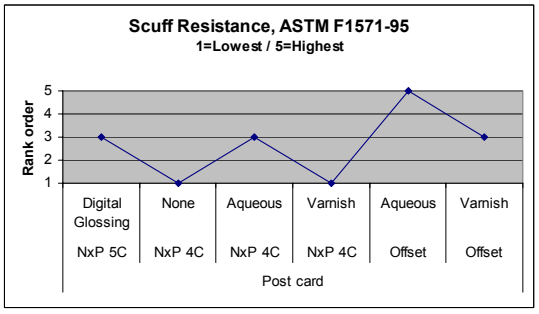


For the combination of image content, substrate and surface treatment, this print application performed well during abrasion test. Digital glossing on marketing brochures maintained its abrasion resistance as with the post cards. UV process provided the most protection against abrasion for both digital and offset prints.

Scuff and Smudge Resistance

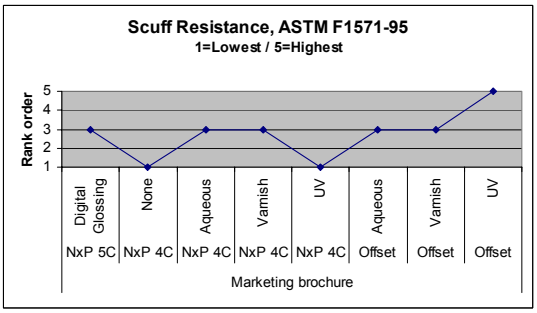
ASTM F1571-95 is the standard procedure for determining the amount of image transferred from one surface and re-deposited at another surface on a print. This is known as the Sutherland method. Both reflection density measurement and subjective image quality evaluation were implemented in the assessment of this study. Ranking numbers used were 1 to 5. Ranking number of 3 or lower indicates unsatisfactory results.

Post Card



In this application, offset prints of aqueous finishing provided the most smudge resistance among all the processes evaluated. It is the only process produced the satisfactory results. Offset prints of varnish performed unsatisfactorily. All surface treatments on digital prints produced unsatisfactory results.

Marketing Brochure

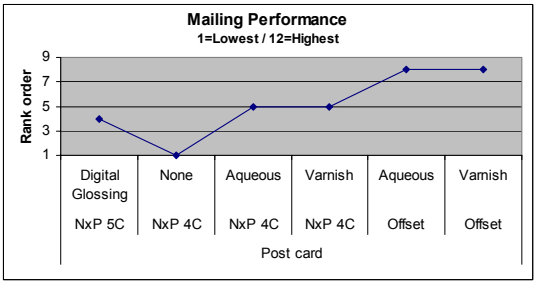


Offset prints of UV treatment demonstrated the best performance. However, UV treatment on digital prints produced the worst performance. Digital glossing performed better than digital prints of UV treatment.

Mailing Results

This mailing excise was designed to evaluate how well the prints of different surface treatments withstand the abrasion and smudge produced by the rollers and belts of the automated sorting process of the US Postal Service. Post cards of different surface treatments were mailed to addresses in three States, California, Illinois and Florida from Rochester, New York. They were sent by the USPS pre-sort standard bulk rate. The addressees collected the post cards mailed to them, packed them in boxes and shipped them back for evaluation of the overall image quality. The following table lists the results of the mailing test. Ranking values from 1 to 12 were used to indicate the performance, higher number better performance.

Post Card



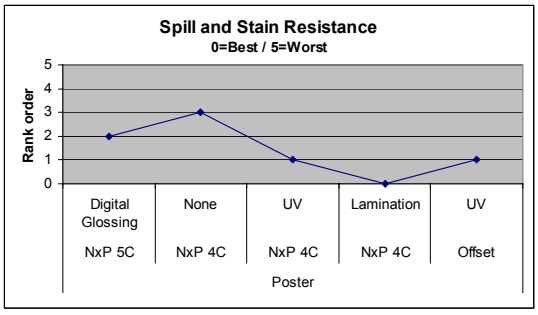
Abrasion and smudge were observed on these prints. The performance of the offset prints with aqueous and varnish was better than the rest. Digital prints without any surface treatment demonstrated unsatisfactory performance. Digital glossing improved the performance of digital prints in the mailing process.

Spill and Stain Resistance

This test is to evaluate the stain resistance of print surfaces of different treatments. Mustard, coffee, fruit juice and water were

used as staining agent. One drop of each liquid was placed on the print surface, after 30 minutes, these liquid drops were removed and observation of any residual on the print was recorded. This was done using a subjective scale of 0 to 5, 0 being the best and 5 the worst. The following is a list of the observation.

Poster



The lamination process provided the best protection against spill and stain. UV process performed satisfactory on both digital and lithographic prints. The stain resistance of digital glossing was adequate. Digital prints without any surface treatment didn't provide good stain resistance.

Workflow and Cycle Time

The digital glossing unit is not a marking engine. It doesn't contain any imaging material and the amount of cleaning and maintenance is minimum. The materials used for aqueous, varnish and UV have different characteristics than that of the electro-photographic process. Different cleaning and maintenance procedures and the impact on the environment have to be considered by digital print-shop owners who are to co-locate these print surface treatments together with the digital press. Therefore, it's common for digital print shops to outsource these surface treatment jobs. For lamination, the return-of-investment of the laminators makes it undesirable for most print shops to equip. By outsourcing the task, the cycle time of the job is increased. With more people touching the job the probability of mistakes being made is also increased. Some of these processes also require printing plate as the applicator. This complicates the process and further delays the turn-around time.

Conclusion

For the experiments conducted in this study, the following conclusions could be made. The digital glossing process produced the highest level of gloss on the four printing applications in comparison to aqueous, varnish, UV and lamination. Abrasion resistance of digital glossing was satisfactory. The smudge resistance of digital glossing was better than the UV treatment on digital prints. The mailing test also indicated that digital glossing provided improved protection to digital prints than those without it. Digital glossing eliminated outsource of glossing jobs making the workflow management easier and more efficient.

References

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Author Biography

C Jeffrey Wang received a M.S. degree from Imaging Science of Rochester Institute of Technology in 1987. He worked at RIT Research Corporation between 1987 and 1996. Had joined Eastman Kodak Company in 1996 and transitioned to NexPress in 1998. His current work involves System Engineering and Product Development. He has published in IS&T and TAGA proceedings and journals.