Optimization of Sheet Feed Offset Machine: A Case Study

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Abstract

Printing being one of the largest industries in India has seen a tremendous growth in all parts of India. With the increase in printing industries, a competition has increased and a need has been risen to fight and stay ahead in the competition. This is achieved by following standardization techniques which helps businesses to maintain the quality of printed product. Thus, this paper focuses on one such techniques that is optimization process in accordance with ISO 12647-2 which is for Graphic Arts Technology - Process control for the production of halftone colour separations, proof and production prints and part 2 for offset Lithographic process. The project has been carried out on Komori Lithrone L-426 sheet fed offset machine by following six step optimization process. The purpose of the study is to improve the quality of printed product which is achieved with dot gain compensation along with reduction in wastage as well as make ready time. With this process it was possible to eliminate the problems occurring during printing, increasing machine productivity and better print quality.

Keywords: *ISO 12647-2, printing, optimization, sheet-fed offset, dot gain, print quality.*

1. Introduction

Printing is one of the largest industries in India. In past few years Indian printing industry has grown in all parts of India. According to Indian Mirror the growth rate has been higher than 12%. Today India has become one of the major print producer and manufacture of printed paper products for the world market. *[1]*

With the increasing number of printing industries, there is an advancement in the technology, machinery, methods of printing such as from Computer to film (CTF) to Computer to plate (CTP) offset printing, inkjet printing processes, 3-D printing etc. Due to this, the competition among industries has increased. One of the strategies to compete with others in business is to have a lower cost of product than others which is applicable to printing also. Today, industries are becoming aware that not only less cost of product is important, but also the reputation for quality equally matters. Maintaining quality has become the main objective of the printing industry. The main reason behind this is customer satisfaction or pressure from customer regarding the quality. That is why, press optimization has become the necessary requirement in order to survive in the market.

Offset printing is most widely and commonly used printing method. Around 40 % jobs are carried out using offset printing. So, optimization process was implemented on sheet fed offset machine. With the press optimization we can achieve an efficient system. *[1]* This can help us in meeting the ISO standards, improve the effectiveness of the printing process, eliminating the equipment malfunctioning and defective products. *[2]*

1.1. ISO Standards

In printing, standards are provided by International Organization for Standardization i.e. ISO. (ISO 12647-1 TO 12647-7). They provide strategic tools that reduces costs by minimizing waste and errors and increasing productivity. They help companies to access new markets, facilitate free and fair global trade. For offset printing process, standards are given by ISO 12647-2. It gives us Lightness (L), Red/Green value (a) & Blue/Yellow value (b), gloss, brightness values for five types of paper. It also gives dot gain tolerance, screen frequency, image size tolerance, screen angle, tone value sum, TVI tolerances. For ink standard values are provided by ISO 2846-1 which gives L, a, b values for C, M, Y, L, R, G, B and C+M+Y for all five types of paper mentioned in ISO 12647-2. For printing plates ISO 12635 is used which consists of standard plate length, width and thickness values. *[3]*

1.2. Quality Improvement

John C. Briggs, Alice H. Klein, Ming-Kai Tse, (1999), have studied the ISO 13660 which is the standard for print quality evaluation. This standard is mainly for black & white prints. ISO 13660 includes fourteen attributes which provides tools to solve any print quality problems. It gives a simple measurement process which can be easily understood. Two most important parts of ISO 13660 are standardization print quality (PQ) measurement methods and use of calibrated spatial & density units for PQ evaluation. They applied this standard to commercially available desktop inkjet printer and checked one of the attributes – raggedness which is a geometric distortion of an edge from its ideal position. In their study they found that there are some

limitations which must be removed on order to get the good quality print. This standard can be applied all over the world but there should be availability PQ analysis system. *[4]*

1.3. Optimization

G7 (IDEAlliance) (2007) is the method used for calibrating, printing & proofing. Since optimization includes testing of materials, setting of different components, actual printing of test forms, characterization, we can use G7 method to achieve this. It provides guidelines to achieve good quality printing. It gives information about press controls such as density, dot gain, grey balance, NPDC. It tells about colour management (viewing condition, plate, ink, paper), press test (mechanical ghosting, register, print quality, digital register analysis etc), press calibration (choosing standard conditions), press characterization and proofing, production runs for smooth production. So the standardization can be achieved by G7 method. *[5]*

The optimization process includes standardization, optimizing print production, improving quality. GMG colour server and GMG ink optimizer (2008) has given a solution to enhance the quality by standardization and optimization for sheet fed offset process. GMG colour server helps in colour management by ensuring uniform colour throughout the print by separation, re-separation and colour conversion. Ink optimizer performs the ink reduction which helps in improving printing properties, shorter make-ready times, lower paper consumption and faster drying. *[6]*

1.4. ISO 12647-2 study and its implementation

Robert Chung (2009) has studied the international printing standards. He has discussed the three methods to achieve the reference values. The methods are TVI adjustment, grey balance adjustment and device link adjustment. TVI adjustment is done at CTP stage while device link adjustment is done after the device is calibrated by other two methods. By using these methods when the printing standards get fulfilled, it pushes the printing forward. *[7]*

Printcity (2010) has given a special report about process colour standardization in which key control parameters has mentioned such as grey balance, Tone Value Increase (TVI), Solid Ink Density (SID), which if properly maintained results in better quality and better colour reproduction. It has also mentioned about measurement systems, devices, and standard conditions. The report also gives the information about consumables and how they can be used according to standard. The details about different problems that can occur in printing, what should be the solution to those problem has been given in report. *[8]*

Fred Hsu and Robert Chung (2011) has done a case study on process conformance to ISO-12647-2. The study involved the TVI correction method according to ISO standard and its implementation. The evaluation has been done between Heidelberg sheet-fed Speed-master 74 off set press and the Fogra 39 characterization data set. IT8.7/4 characterization targets in two orientations were included in test form which was printed on ISO 12647-2 paper type-1 using an ink set that confirmed to ISO 2846-1. TVI adjustment curves were then applied to conform

to ISO 12647-2. It was found that by analysing TVI curve, grey balance, gamut, and materials, better colour conformance can be obtained. *[9]*

Bretherton (2012) has studied ISO 12647-2 and implemented it in KBA Ltd. He studied the development of ISO 12647-2 standard and analysed it. After study he found that ISO 12647-2 for offset process is a clear and acceptable method of certification which gives better quality and that can bring benefits to printer. After implementation he found that there is a reduction in waste, increase in press uptime. It was also observed that there is greater customer satisfaction due to increased quality. *[10]*

2. Materials and Methods

2.1. Data collection regarding production and analysis

The first step was to collect the data regarding production such as which job is going on, which ink, paper is being used, machine speed, make ready time, existing quality of printed product, problems occurring during printing. Data was collected for one month on a daily basis. Reasons were found out for wastage and downtime. Then analysis was done for basic production hours available, actual production hours recorded, total downtime hours. From the data collected pareto chart and fish bone analysis were made.

2.2. Material procurement and testing

Once analysis was done the next step was testing of consumables. Paper, ink, plates, fountain solution were tested for ink viscosity, water pickup, compatibility of fountain solution with ink, plate dimensions, L, a, b, gloss values, roller hardness etc. For testing equipment used were Digital brightness, L, a*, b*, gloss tester (model 2507 ISO type), micro meter, PH-meter, emulsification tester, viscometer, IGT tester, durometer. The calculated values were checked with standard values mentioned in the ISO 12647-2.

2.3. Press specification and diagnostics phase

This phase included the verification of press components to check whether they are set up correctly or not and whether they are operating properly or not. In this testing about ink and dampening roller condition, setting of different components was done. Also checking of lubrication, cleaning, and maintenance was done.

2.4. Preparation of test form and press test run

Test form was made in Corel DRAW X7. Using Measure Tool 5.0, test target was generated taking P2P25 as reference file. The size of test chart was 29*24 cm having total 300 patches. It also included UGRA/FOGRA Media Wedge CMYK TIFF V3.0b Proof, control strips for CMYK having patches from 5% to 100% in the interval of 5%, overprint patches, ink coverage target, star target (made in Corel DRAW X7), skin tone images, high key and low-key images. After preparing test form, the image (in TIFF format) was sent for making plates. The printing was done on KOMORI Lithrone L-426 sheet fed offset machine. For printing art paper of 170 GSM was used. 50 sheets were printed. After printing measurement was done.

2.5. Press Characterization

Measurement was done using Measure Tool 5.0 and i1iO X-rite spectrophotometer. Measured file was in .txt format. It was opened in Curve 3 software for getting dot gain curve, L, a, b, ΔE for ink and paper as well. It also gave wanted values which were used for final test run. Those vaues were sent to RIP for dot gain compensation. New plates were made and again printing was done on same art paper of 170 GSM

2.6. Press calibration to prepress

After final print, again dot gain measurement was done using same Curve 3 software. The values of dot gain before and after press optimization were compared. And then optimum values were found out.

3. Result and Discussion

Table 1. Reasons for Downtime & Wastage

Week	Reasons for downtime & wastage	No. of Occurrences
1	Customer problem	1
	Plate sensor problem	1
	Unavailability of printing plates	1
	Machine stoppage due to unskilled labours	3
	Damaged blanket	1
	Tube light problem	1
	Old plate	1
2	Machine stoppage due to unskilled labours	4
	Plate sensor problem	2
	Damaged blanket	3
	Wrong paper size	1
	Old dampening solution	1
	Scumming	1
	Electricity problem	1
3	Machine stoppage due to unskilled labours	1
	Tube light problems	1
	Unavailability of printing plates	5
	Damaged blanket	1
4	Scumming	1
	Plate problem	2

The above table shows the reasons / problems responsible for downtime and wastage of consumables occurred in each week.

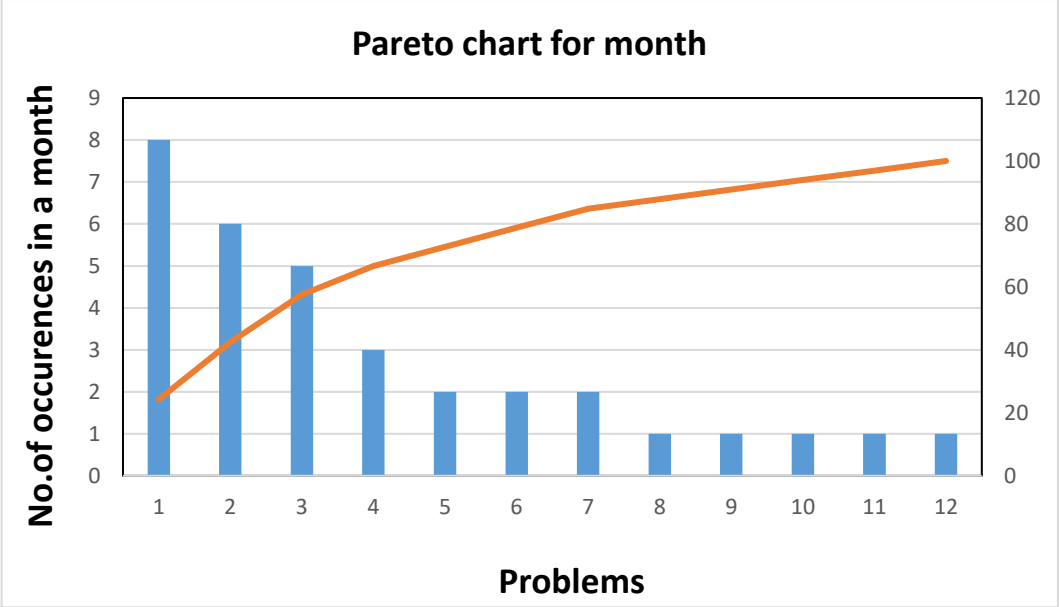

Figure 1. Pareto Chart

Total twelve problems occurred throughout the month. Pareto chart (Figure 1) was made which enabled to identify the main problems which accounted for 60% of all. These problems were machine stoppage due to unskilled labours, unavailability of printing plates and damaged blanket respectively. Fish bone analysis was made which helped in finding out the solution for these problems.

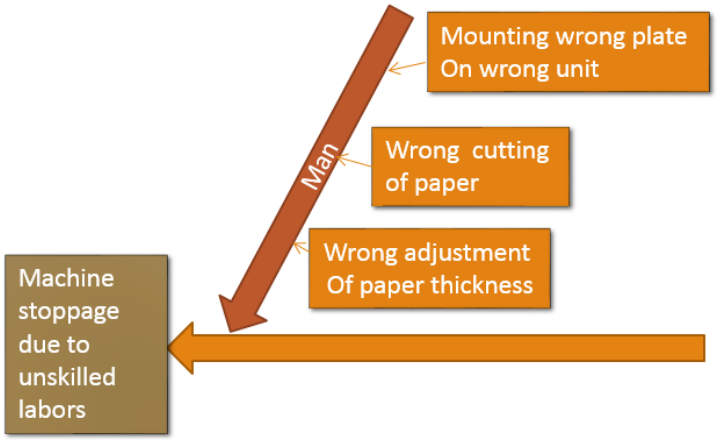

Figure 2. Fish Bone Analysis for The Problem Caused Due to Unskilled Labours

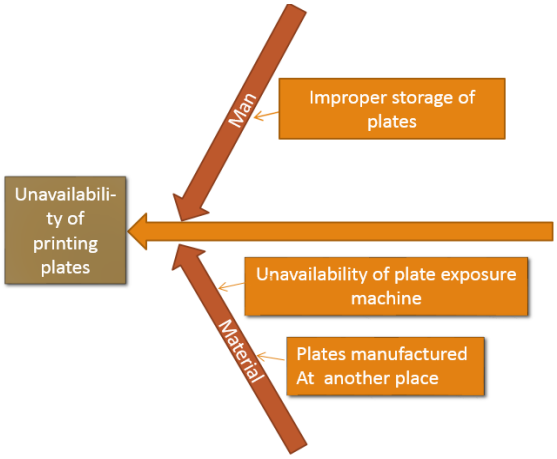

Figure 3. Fish Bone Analysis for The Problem - Unavailability of Printing Plates

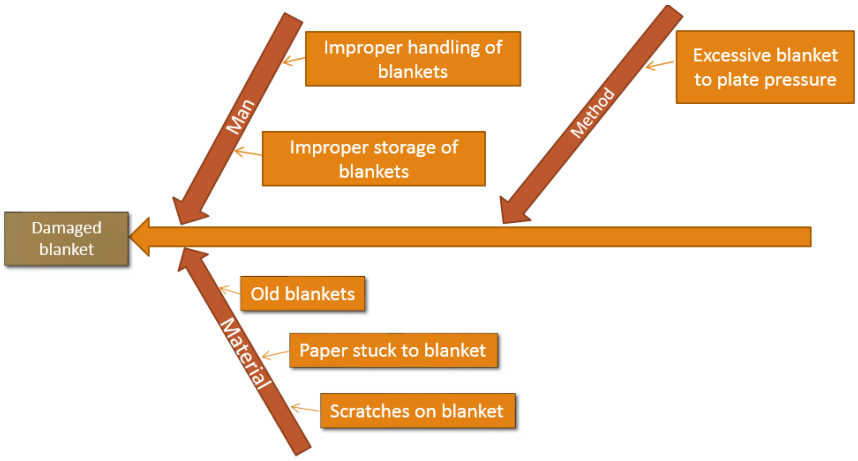

Figure 4. Fish Bone Analysis for The Problem of Damaged Blanket

Figure 2 shows three main reasons resulting in machine stoppage because of unskilled labours. Workers failed in mounting plate, paper cutting and adjusting paper thickness. On the other hand downtime happened due to unavailability of printing plates (Figure 3) and the reason for that was improper storage plates by workers, manufacturing of plates by another company. This happened as there was no plate exposure machine. Figure 4 shows the fish bone analysis for damaged blanket which was 3rd main reason behind idle machine. Blankets used for printing were damaged as a result of improper handling and storage of blankets, applying more blanket to plate pressure. Sometimes paper was stuck on the blanket whereas some blankets had scratches

Table 2. Parameters Checked During Consumable Testing Diagnostic Phase

Parameters Checked during consumable testing and dignostic phase			**Within the tolerance of standard values**
Art paper (L, a*, b*)			✓
Maplitho paper (L, a*, b*)			×
Plate thickness			✓
Dampening solution pH			✓
Ink Viscosity			✓
Ink water pick up capacity			×
Ink density (Printing on art paper)	Cyan		×
	Magenta		✓
	Yellow		✓
	Black		✓
Ink density (Printing on maplitho paper)	Cyan		×
	Magenta		×
	Yellow		×
	Black		×
Ink roller hardness	Form roller	C	×
		M	×
		Y	×
		K	✓
	Distributor roller	C	✓
		M	×
		Y	×
		K	×
Dampening roller hardness	Form roller	C	✓
		M	×
		Y	×
		K	×
	Distributor roller	C	×
		M	×
		Y	×
		K	×
Temperature			✓
Blanket hardness			✓
Blanket thickness			✓
Machine speed			✓

Table 2 shows the parameters, some of which were within whereas some were out of the tolerance limit of standard values. Parameters such as dampening and ink roller hardness, ink density, ink water pick up capacity, L, a, b value for maplitho paper needed to be corrected as values were out of tolerance limit.

Table 3. Dot Gain Comparison Before And After Press Optimization

Target dot %	C (before)	C (after)	M (before)	M (after)	Y (before)	Y (after)	K (before)	K (after)
0	0	0	0	0	0	0	0	0
2	2.59	0.12	2.13	0.12	3.03	0.13	0.76	0.15
4	5.2	0.23	4.29	0.24	6.09	0.26	4.28	0.29
6	8.07	0.45	7.28	0.52	9.00	0.54	8.48	2.1
8	11.09	2.9	10.76	4.2	11.83	3.56	11.27	5.52
10	14.14	6.67	14.25	9.02	14.67	6.73	15	10.18
15	20.98	14.54	20.36	16.76	20.76	13.77	21.02	17.11
20	27.95	22.52	26.44	24.41	26.93	20.91	28.45	25.4
25	33.15	29.02	31.47	29.35	32.23	26.22	34.01	31.07
30	38.49	35.7	36.6	34.4	37.67	31.63	40.13	36.85
35	44.07	41.86	41.59	39.99	43.16	37.32	45.22	41.99
40	49.9	48.24	46.73	45.8	48.84	43.21	50.02	48.43
45	54.3	52.76	50.55	50.05	52.75	48.33	55.15	53.56
50	59.09	57.72	54.5	54.45	56.9	53.71	59.27	58.4
55	65.04	64.46	58.24	58.43	61.41	59.44	63.69	63.76
60	71.58	71.96	62.15	62.59	66.24	65.67	67.83	67.95
65	74.25	74.57	65.59	65.96	71.27	72.21	71.71	72.41
70	76.95	77.17	69.22	69.5	76.77	79.62	75.49	76.44
75	79.31	79.17	72.94	73.01	81.55	85.56	80.12	80.75
80	81.84	81.29	76.97	76.8	86.98	92.72	84.64	85.04
85	85.79	84.78	81.33	80.64	90.82	95.32	88.65	89.19
90	90.27	88.7	86.56	85.35	95.09	98.03	92.53	92.99
95	94.06	92.79	97.94	99.04	97.22	99.05	96.17	96.5
100	100	100	100	100	100	100	100	100

Table indicates the comaprison of dot gain before and after implementation of press optimization process.

According to ISO 12647-2 dot gain for 40% mid tone should be 16, 13, 13, and 13 for K, C, M, and Y respectively. Before press optimization, the measurement of dot gain for 40% was found out to be 10.02, 9.9, 6.73, and 8.84. That means it was within the tolerance. For 80% tone, it should be 13, 11, 11, and 11. It was found out to be 4.64, 1.84, and 6.98 for K, C, and Y. whereas for magenta dot loss of 3.06 was occurred. After implementation, the measurement dot gain for 40% was found out to be 8.43, 8.24, 5.8, and 3.21. For 80% tone, it was found out to be 5.04, 1.29, and 12.72 for K, C, and Y. whereas for magenta dot loss of 3.2 was occurred. It means it was within tolerance for K & C whereas for Y it was more than desired. These can be depicted by figure 5 & 6 using print characteristic curves. After values are to be used for dot gain compensation to improve print quality.

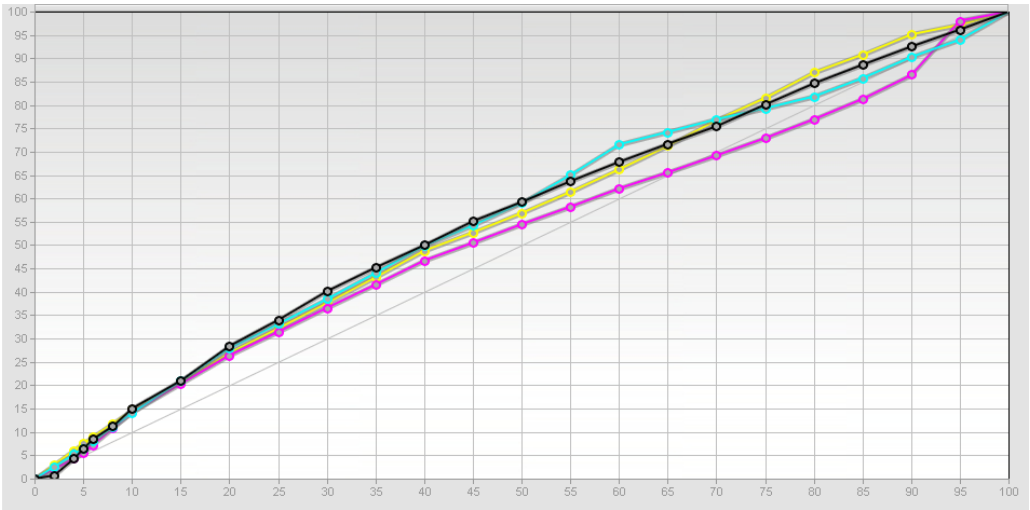

Figure 5. Print Characteristic Curve for All Four Colours Before Press Optimization

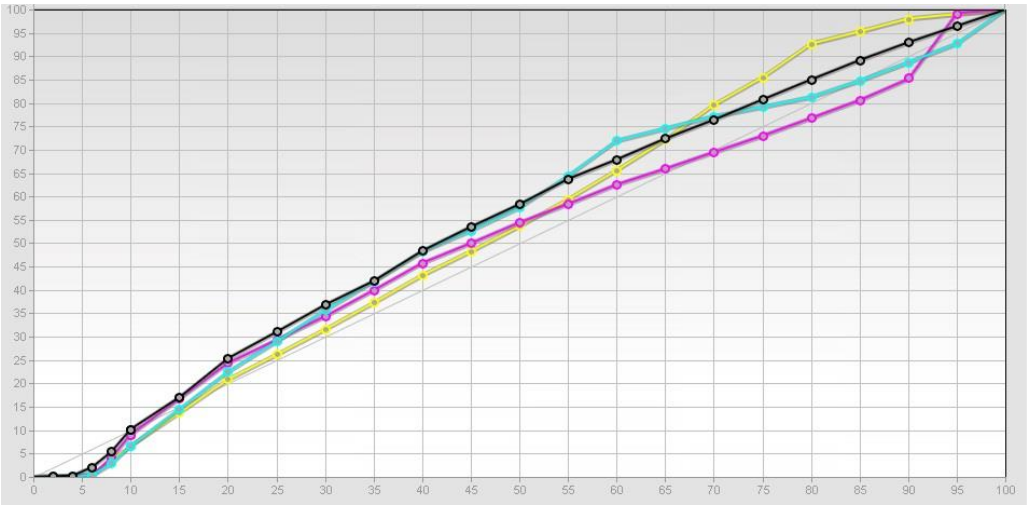

Figure 6. Print Characteristic Curve for All Four Colours After Press Optimization

Table 4. L, a, b & ΔE Comparison Before And After Press Optimization

Inks	L			a			b			ΔE	
	S.V.	Before	After	S.V.	Before	After	S.V.	Before	After	Before	After
C	**55**	58.45	56.62	**-37**	-14.93	-17.96	**-50**	-37.28	-42.38	25.81	20.69
M	**48**	46.03	46.54	**74**	74.38	72.63	**-3**	-0.94	-7.89	2.82	5.29
Y	**91**	84.58	84.71	**-5**	-3.72	-5.42	**93**	94.85	97.01	4.86	5.72
K	**16**	13.17	14.12	**0**	3.11	1.08	**0**	4.82	4.22	6.02	4.52
R	**49**	46.82	47.48	**69**	70.91	68.78	**52**	48.37	49.52	2.76	0.91
G	**50**	53.63	50.63	**-68**	-44.82	-54.58	**33**	39.16	37.65	27.76	18.77
B	**20**	22.69	24.53	**25**	21.17	18.76	**-49**	-40.06	-46.88	7.40	1.75
C+M+Y	**18**	20.20	17.78	**3**	2.94	2.17	**0**	3.40	-1.86	5.37	5.82
Paper	93	91.32	93.40	0	0.76	0.40	-3	-3.05	-4.94	3.92	3.42

Table 4 shows the comparison of L, a, b & ΔE values along with the standard values (S.V.) for ink and paper used in the experiment. ΔE is calculated from L, a & b. For better colour accuracy and its reproduction ΔE should be lower which was found out for C, K, R, G, B. But for M & Y it values of ΔE increased. For paper, it was found out that ΔE was reduced from 3.92 to 3.42 which is acceptable. These values are represented by figures 7 & 8 which were made using Curve 3 software.

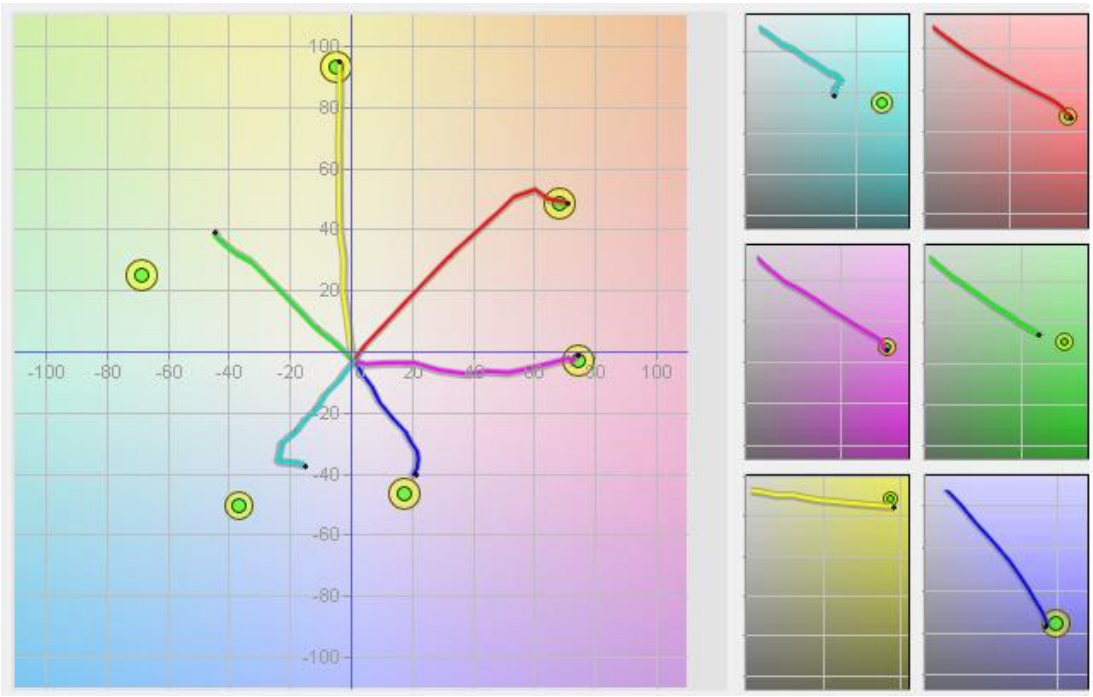

Figure 7. L, a, b & ΔE Values for C, M, Y ,R, G, B (Before Press Optimization)

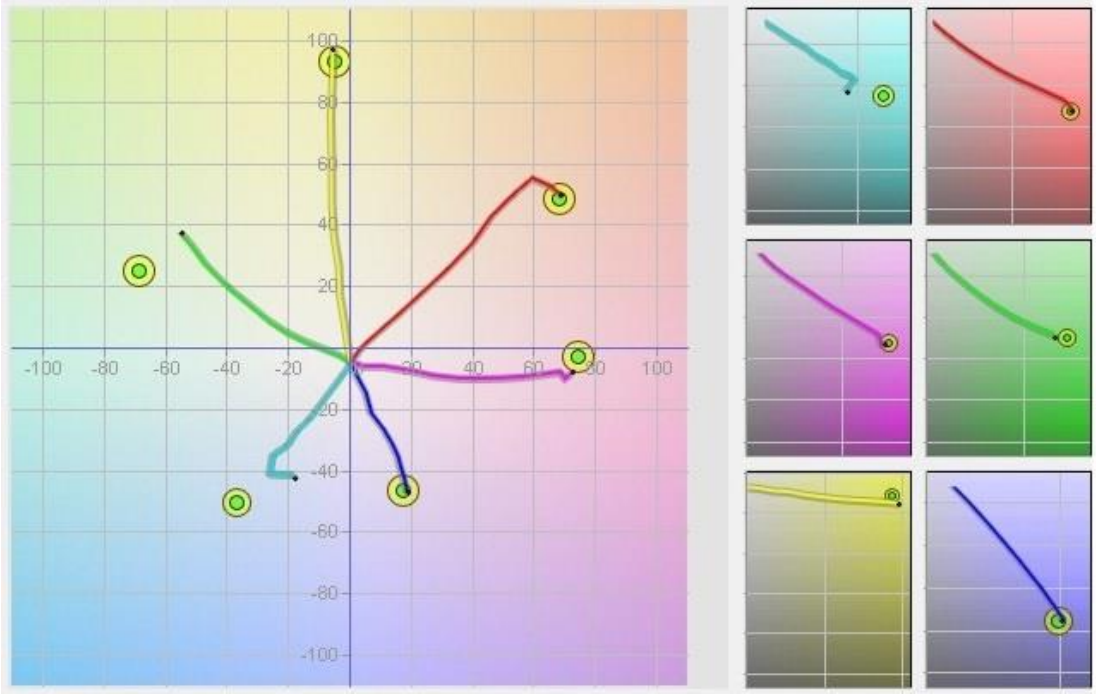

Figure 8. L, a, b & ΔE Values for C, M, Y, R, G, B (After Press Optimization)

4. Conclusion

Press optimization process enables printers to identify the problems occurring during printing. With pareto analysis the causes for those problems such as wastage or longer make ready time can be found out and solution can be given for each.

The compatibility of consumables such as paper, ink, plates, fountain solution as per ISO 12647-2 can be matched. It helps to maintain the machine as per ISO requirement and to perform the press diagnostic study.

With press characterization and calibration, quality can be improved by efficiently reproducing dots and colour. Press optimization helps printing industry in maintaining ISO standards which will make printing industry more productive and efficient.

5. Future Scope

The project was carried out on four colour sheet fed offset machine. One can implement the same press optimization process for web offset machine. Researchers can also include more quality targets in test form in order to verify and to improve the quality. The test chart can also be printed on different substrates using different ink.

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6. References

[1] S. Raha, "The growth of Indian print media in the last decade and its fallouts", Symbiosis Institute of Business Management, Bangalore, India ***(2013)****, pp. 2-5.*

[2] K. E. Rizzo (editor), "Total Production Maintenance: A guide for the printing industry", Printing Industries of America / Graphic Arts Technical Foundation Press, ***(2008)****.*

[3] ISO 12647-2, "Graphic technology — Process control for the production of half-tone colour separations, proof and production prints - Part 2: Offset lithographic processes", ISO, ***(2004)****, pp. 2-14*

[4] J. Briggs, A. Klein, M. Tse, "Applications of ISO-13660, A New International Standard for Objective Print Quality Evaluation", Imaging Society of Japan, ***(1999)****, pp. 1-5.*

[5] IDEAlliance, "Press Operator's Guide to G7", International Digital Enterprise Alliance, Inc, ***(2007).***

[6] GMG, "Standardized and optimized print production with GMG – Enhancing quality and cutting costs", GMG GmbH & Co. KG., ***(2008).***

[7] R. Chung, "International Printing Standards, a value-added proposition", Test target 9.0, RIT School of Print Media Publication, ***(2009)****, pp. 2-6*

[8] Printcity, "Process Colour Standardisation- Cross industry Special Report", GMG, Paris, ***(2010)****, pp. 4-44.*

[9] F. Hsu, R. Chung, "Process Conformance to ISO 12647-2, a case study", Test target 9.0, RIT School of Print Media Publication, ***(2011)****, pp. 8-14.*

[10] C. Bretherton, "I.S.O. 12647-2:2004/Amd.1:2007 (E) and KBA Colour Measurement Techniques", Koenig and Bauer A.G., UK, ***(2012)****, pp. 2-14.*