# Photopolymer Plate Characterisation

(Improves the Predictability Consistency and
Repeatability of the Printing Process)

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Abstract: Commercial pressure has forced improvements in the quality and consistency of photopolymer printing plates. One restraining factor for the flexographic printing process has been the lack of consistency.

It was perceived that in order to make significant improvement to flexographic printing quality, an improved method of optimising platemaking techniques needed to be established. The aim of the experiment was not to define the optimum platemaking technique but to improve the understanding of the characteristics and properties of the photopolymer printing plate and to identify the key interacting factors affecting consistency.

Investigations into the complex interactions of many variable factors that take place during the printing plate production process were carried out. Various statistical methods were employed for the design of the experiment and for the interpretation of experimental data generated.

Three popular photopolymer printing plates from different manufactures were subjected to a series of experimental investigations. Each type of plate used in the experiment was found to have unique latitude to processing conditions. The results of the investigation have been used to fine-tune the flexographic platemaking technique to significantly manipulate the platemaking properties for the end-use application to enhance the plates printing performance and consistency.

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## Introduction

The Flexographic process is the principle printing method used by the packaging market. Commercial pressure has had the effect of increasing the technical demands/capabilities of the production process. In recent years increased competition has shifted the research emphasis from technical issues to finding solutions, methods and techniques, which will improve production efficiency, control of waste and most importantly production consistency.

Flexographic printing plates are classed as soft elastomers, which are sensitive to UV light. During the platemaking process a three dimensional flexible printing plate with relief image is formed using a photographic negative. Traditionally the calibration for each stage of the platemaking process has been carried out using separate tests based on empirical results treating each process as a separate step. A calibration technique that obviously does not take the interaction of each stage of the process into consideration needs small margins of safety built into each process. Often this technique prevents the platemaking process from being optimised. It is common practice for the trade to process several manufacturers products simultaneously. The three products selected for this evaluation were chosen on the basis that they were designed by three leading flexographic plate manufactures to be used in the same packaging market segments. For some time the flexographic industry has complained about the inconsistency of the printing process and thus this research was focused on trying to understand the variables associated with the processing of flexographic printing plates.

## Sample Data Gathering

The plates produced on the pre-tests gave an opportunity to establish the range that would be used in the experiment to produce data for the three plates under investigation. Data was subjected to two proving tests, to ensure that it was reliable.

Proving Test N$^0$1. Was used to indicate how many readings were required to be taken from each sample. A standard margin of error equation was adopted to ensure an appropriate sample size was obtained for each of the properties being investigated. An error level was set of between 1%-2% in the raw data gathered, that was included in the result field in the Minitab software.

Proving Test N$^0$2. Due to the small number of tests (12) involved in the experiment it was not always possible for the Minitab software to display a clear histogram of normal distribution. Prior to the data being input into the Minitab software a standard equation was used and referenced against a published confidence of normal distribution table. During the data gathering, each of the measurement points was selected randomly for the required number of measurements to satisfy the error criteria of Test N$^0$1. In order to be able to compare the data from the three different types of plate the raw data was first put into rank order to establish the median. Dot diagrams were then compiled using "z" values.

## Measurement Methods

UV light sensitive photopolymer flexographic printing plates require two exposures. The first is the back exposure, which builds the anchor layer. The anchor layer will hold the image and thus determines the relief depth of the plate. The second exposure is the image forming exposure through a negative. The image is formed in the plate by the crosslinking of the pre-polymer. Washing away the non-image area reveals the image. The retained solvent is driven off using heat. The final process is the post exposure and anti-tack treatment.

The first task was to define a platemaking calibration, which would generate data for all three manufacturers plates. The plates had different responses to the changing processing conditions and compromises in the setting of the high and low values for each stage of the process had to be made.

Table 1 The Factorial Designed Experiment

| C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Heat | Back | Main | Washout | Speed | Dry t° | Dry T | D/Stab | CL | GL |
| 1 | + | - | + | - | - | - | + | + | + | - |
| 2 | + | + | - | + | - | - | - | + | + | + |
| 3 | - | + | + | - | + | - | - | - | + | + |
| 4 | + | - | + | + | - | + | - | - | - | + |
| 5 | + | + | - | + | + | - | + | - | - | - |
| 6 | + | + | + | - | + | + | - | + | - | - |
| 7 | - | + | + | + | - | + | + | - | + | - |
| 8 | - | - | + | + | + | - | + | + | - | + |
| 9 | - | - | - | + | + | + | - | + | + | - |
| 10 | + | - | - | - | + | + | + | - | + | + |
| 11 | - | + | - | - | - | + | + | + | - | + |
| 12 | - | - | - | - | - | - | - | - | - | - |

The factorial experiment shown in Table 1 has ten variable factors, which are labeled under the column heading C2-C11. The design is a two level experiment represented by the +/- symbols.

## Photographic Test Negative

The 100mm x150mm test image shown in Figure 1 was created on an Apple Macintosh iMac using freehand software. The design was influenced by the need to reflect commercial custom and practice. The $60^0$Anilox roller dictated that 133 lines per inch for the test image would generate the best quality print characteristic data. Screen ruling for the tone wedges using circular dot screen technology was set at a $45^0$ angle. The negative was output onto Agfa 0.004" red laser sensitive matt Rapid Access film. The AGFA Impress Rapid Access hard dot film was processed in Agfa ACD Rapid Access chemistry. Kodak RA Fixer was used to ensure that all of the clear areas of the film did not exceed the D min 0.06. The film density was D max 4.25 and D min 0.04. A typical trade standard (rapid access) photographic negative was made with a complicated image constructed to test the plates to their limit. 5mm bearer bars were included in the design to ensure that the whole image had even printing pressure applied to the surface of the plate. Two large impression targets were used to give a visual check of the correct inking and pressure on the plate during the printing test.

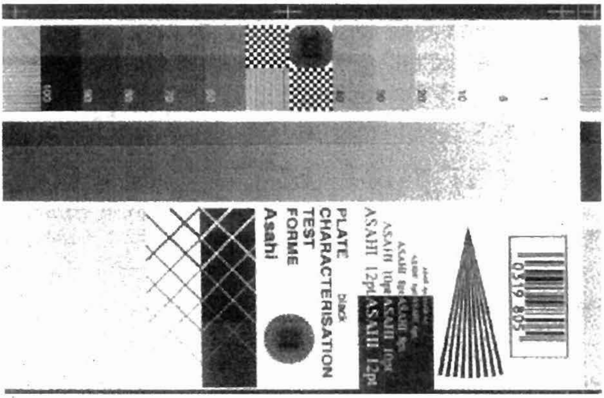


Figure 1 The experiment test image

## Solvent

The standard recipe Perconal solvent with a 3:1 mix of a chlorinated hydrocarbon perchloroethylene and n-butanol was used. Photopolymer plates have a thin protective membrane on the surface, which is dissolved by the butanol. Once the protective membrane is removed the pre-polymer is dissolved by the perchloroethylene. Specific gravity was manually checked at the start and the end of the experiment and controlled 1.42 @ 20°C.

## Apparatus, Equipment and Instruments

Image setting equipment for negative making.
The image shown in Figure 1 was output onto film at 2400 dots per inch via an Agfa SelectSet Avanttra 25S laser image setter. The image was formed by a red diode laser 650 nanometers wavelength. Resolution was set at 2400 dots per inch.

Equipment for platemaking.
The platemaking process was split into five stages namely exposure, washout, drying, stabilisation, post exposure/de-tack.
Each stage is completed in its own independent unit.
Relevant information of each of these units is given as follows:
1) AFP 912E.
A conventional standard single sided exposure unit was used for the experiment. The unit was fitted with Phillips 10r 80Watts UV A Lamps. The back exposure was controlled by a light integrator via an exposure computer. A timer controlled the main exposure. The plate exposure was quantified by measuring in milli-Joules of UV-A energy (365nm) using the following equation:

$$\text{mJ quantity} = \text{UV quantity (mW/cm}^2) \times \text{exposure time (seconds)}.$$

2) AFP 1216W.
The washout unit was fitted with a programmable logic controller (PLC) computer, which controlled all machine functions to ensure repeatability. Solvent replenishment was automatic for the duration of the experiment. The computer controlled washout speed and brush pressure settings.
3) AFP 912D.
The drying unit had controlled temperature and forced air regime.
4) AFP 912S.
The plates rested in the stabilisation unit for approximately eight hours in ambient airflow, in an attempt to achieve original plate tolerance.
5) AFP 912F.
The finishing unit was fitted with two banks of lamps set at 90°. One bank used the same lamps as fitted to the main exposure unit (UV A). The other bank of lamps was of a shorter wavelength at 250mn (UV C) and was used to de-tack the plate. Independent timers control both sets of lamps.

## Instrument for Monitoring the Platemaking Equipment

The calibrated UV meter was used to standardise the exposure calibration. The heat generated by the exothermic reaction and the heat created by the exposure lamps was monitored using a calibrated electronic thermometer. The pressures generated by the brushes within the washing unit were calibrated during every machine service using the machine manufacturers gauges. The washout solvent specific gravity was checked using a standard hydrometer.

Instruments and Equipment used for the Characterisation of Flexographic Plates

Various instruments and equipment were employed for the characterisation of flexographic plates made during the study.
***Shore Hardness "A" Gauge*** conformed to the DIN 53505 and ASTM D 2240 standards. ***Plate Gauge*** An imperial measurement gauge was calibrated with feeler gauges. ***Measurescope*** The analysis of the flexographic plates was carried out using Nikon MM-11B unit coupled with a KC 1500 electronic controller Nikon SC112 digital recorder and colour monitor.
***Vipflex 330*** Cross-reference analysis of the flexographic plates was carried out using Vipflex computer based digital imaging analysis. Using the Vipflex, in a novel way produces three benefits.
1) It improved the accuracy of the measurement and allows the image to be recorded digitally keeping costs to a minimum.
2) By using the contrast of the recorded image and pixel technology it is possible to precisely measure the samples in microns.
3) The photographic images helped communicate ideas and concepts to others.

Equipment and Materials Involved in the Printing Trial

The printing press used for the experiment was a Nil Peter Label Press. A clean Parmarco Anilox roller was used for the printing experiment with a specification of 650 lpi screen delivering 11cc/$m^2$.
Coates Lorilleux Black, water-based ink was used having a viscosity of Zhan cup №2 at 24 seconds.
A 12" repeat plate cylinder was selected.
Medium density adhesive tape used for the experiment was 0.015" 3M 1020.
Substrate used was Raflatac self-adhesive 120g/$m^2$ silk self-adhesive label stock.

Instruments used for the Characterisation of the Printed Images

The film was measured using a Macbeth Gretag D200-11 transmission Densitometer. A Gretag D 19c reflection Densitometer was used to measure the ink density of the printed images. Using the Murrey-Davies equation, dot percentage was calculated and displayed by both instruments.

Software used for the Experimental Design and Data Analysis

A MINITAB software program was employed for the design of experiments and for analysis of the data collected. The MINITAB version 12 software program is also a powerful statistical package that provides a wide range of data analysis and graphic capabilities. The exploratory data analysis functions were used in the compilation of this paper.

## Analysis Methods

The experimental data was analysed using analysis of variance techniques. Units of standard deviation (any value in a distribution can be converted into z-values by subtracting the mean of the distribution and dividing the difference by standard deviation) were used to compare the response of the three different plates. The results were analysed using an alpha of 0.10 (meaning that there was a 10% risk of the null hypothesis being rejected when it was true). The three plates responded differently during the twelve tests and it is these differences that have been used to make the characterisation of the plates by type. The tests were designed to observe the changes in the (output) response to test factor level changes (input) and to draw conclusions from the responses. The first stage in the design of the experiment was to identify all of the interacting factors that were considered to have an impact on the plate characteristics as follows:

- Exposure heat
- Back exposure
- Main exposure
- Washout pressure
- Washout speed
- Drying temperature
- Drying time
- Drying stabilisation
- CL post exposure
- GL finishing exposure.

Each of the factors monitored in the experiment was assigned high and low values. The twelve tests used for the experiment were designed to investigate if interaction between various plate production factors influence the four plate properties that were identified as important factors affecting print consistency. Experience suggests that shoulder angles, dot gain, Shore-hardness and chemical resistance are the most significant properties of the plate that are affecting flexographic print consistency. Statistical analysis was used to explain the relationship between the various resulting plate properties. Each run of the experiment consisted of a combination of factors at the high and low settings set as far apart as possible. A compromise for the high and low levels of UV radiation associated with the imaging for the experiment were necessary to accommodate the widely different photosensitivity of plate types used in the experiment. The various tests of the experiment were designed to indicate possible improvements that could be implemented into platemaking techniques and protocols in the future to improve flexo plate consistency.

Flexographic plates are three-dimensional with the UV radiation making the largest contribution to manipulation of the printing plate properties. Compromises are routinely made to accommodate the variation caused by the margin of safety built into each of the stages involved in the platemaking process giving an inconsistent result on the finished plates. The experiment was designed to investigate the possibility of devising a quick simple method of optimising the flexographic platemaking process that would take into account the interactions of the individual stages of the process.

The research is industrially sponsored and methods of easily transferring information to the industry in a practical way were of paramount importance. Computer based statistical experimental design techniques were adopted because they have proved to be reliable and can be made to carry out the design almost automatically.

## Results and Discussion

The results used to characterise the plates were the four properties highlighted as having the most significant effect on print consistency. Graphs of the various treatments are provided to illustrate the findings.

The consistency and print quality properties of flexographic printing plates have been the focus of the characterisation work carried out and reported here.
This section of the paper includes a representative selection of some of the graphs that were produced from the statistical analysis of the raw data gathered during the experiment. Such results, i.e. experimental data, were subjected to both statistical analysis and logical reasoning in order to reach conclusions that would be of benefit to the understanding of the flexographic plate manufacturing process.

### Plate Geometry (Shoulder Angle) Characterisation

Three aspects of plate geometry were monitored; total plate thickness, relief depth and the shoulder angle. The results for shoulder angle are reported. Data was evaluated on the effects of various process parameters on the plate geometry. Initially a histogram plot of the residuals was produced shown in Figure 2. The main effects of each of the ten factors on the shoulder angle were demonstrated through the normal probability plot shown in Figure 3. The significant factors affecting plate geometry are easily determined by the fact that they deviate from a straight line. It can be seen from the plot for Plate "A" that the main effects on shoulder angle appear to be being influenced by the interaction of the back and main (image forming) exposures. The graph shown in Figure 4 indicates the range of the most significant factors affecting the shoulder angle of the plates.

Whilst the chemical make-up of the three plates differ, which affects the photosensitivity, heat was also found to affect the plates shoulder angle to a greater or lesser extent. The main effects plot for Plate "C" predicted that heat build up during platemaking had the potential to adversely affect the shoulder angle by more than 10°. The plot shown in Figure 4 indicates that increased washout brush pressure and faster throughput speed will also have the effect of reducing the shoulder angle. The main effects plot for Plate "C" indicated that increased drying temperature is predicted to improve the shoulder angle.

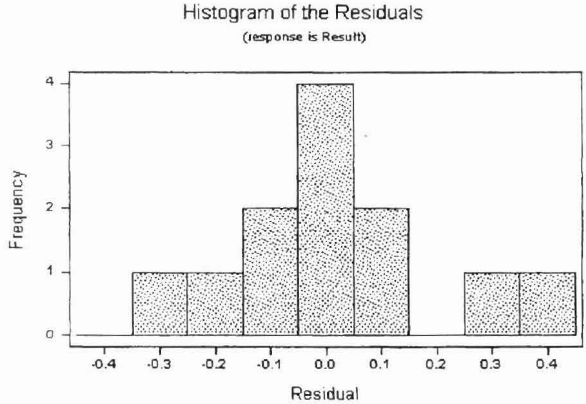

Figure 2 Typical histogram residual for Plate "B"

Whilst the effects of high and low factors on the parameters of the three plates varied, interpretation of interaction plots for individual plates revealed that similar trends could be identified for all three plates.

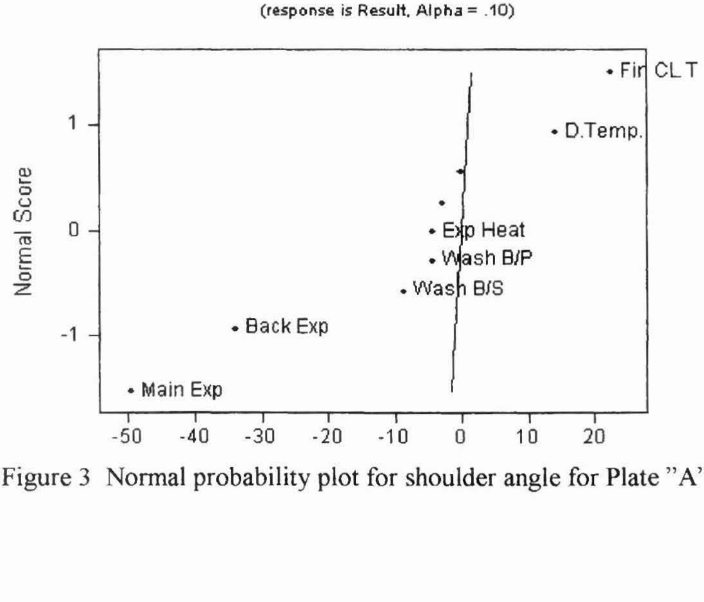

Figure 3 Normal probability plot for shoulder angle for Plate "A"

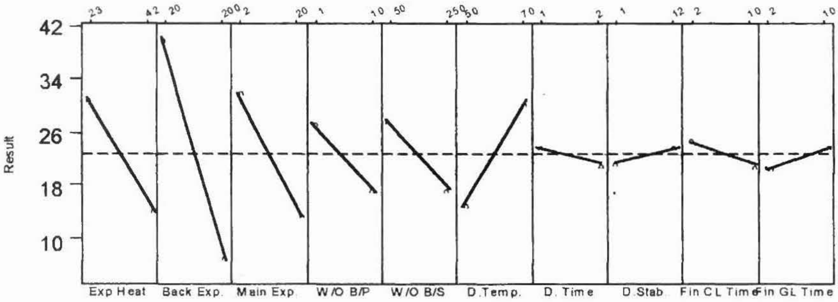


Figure 4 Main effects plots for Plate "C"

Effects on Shoulder Angle

It can be concluded from Figure 5 that Plate "B" recorded the biggest response to the variation in the back exposure factor. As shown in Figure 6 the response for Plate A" is predictably less significant due to the plate's anti halation film, which improves the exposure latitude. It can be seen from Table 1 that both plates had the same low factor main exposure.

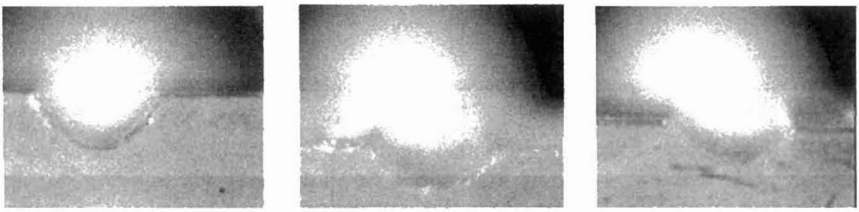

Figure 5 Shoulder angle for Plates "A" "B" "C" produced from Test 11 using a high value back exposure.

Figure 6 Shoulder angle for Plates "A" "B" "C" produced from Test 12 using a low value back exposure.

Effects on Dot Gain

The statistical analysis indicated that Plate "B" was most affected by the back exposure factor. The interaction of the back exposure and the main exposure

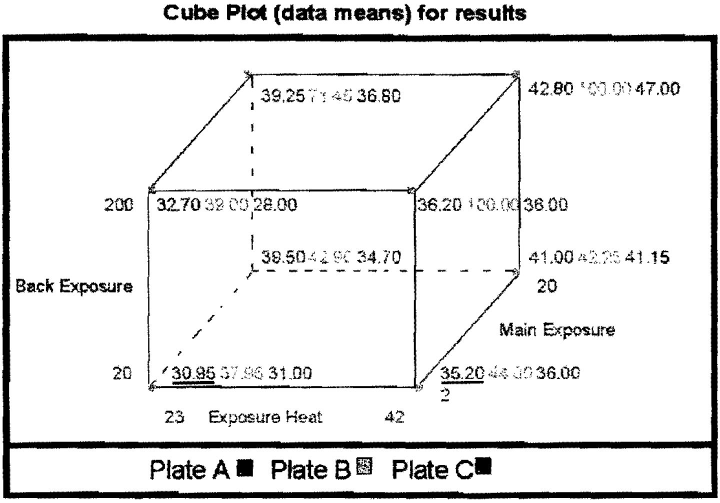


Figure 7 Showing dot gain for 30% dot for all three plates

made a significant impact on negative to plate dot gain. As a result, Plate "B" produced a solid plate with no relief depth for three of the tests. Generally, all of the dot gain values on Plate "B" were higher than Plate "A" and Plate "C".
The experiment highlighted that the heat factor made a significant contribution to plate inconsistency for all plates. Plate "B" had the least exposure latitude so the result was predictable.

The cube plot for the dot gain values for Plate "A" is shown in Figure 7. Underscored are the low settings for both the main exposure (1320mJ) and the back exposure (220mJ). The interaction of the heat difference between the 23°C and the 42°C setting made a difference of approximately 5% in the dot size. As can be seen in the cube plot, in Figure 7 the dot gain characteristic for all the plates was significantly influenced by the interaction of factors shown.

The microphotographs in Figures 8 and 9 illustrate the difference in negative to plate dot gain produced by variation in the back exposure. Figure 8 had the high value, Figure 9 had the low back exposure parameter. The main image transfer exposure through the negative was constant for both tests.

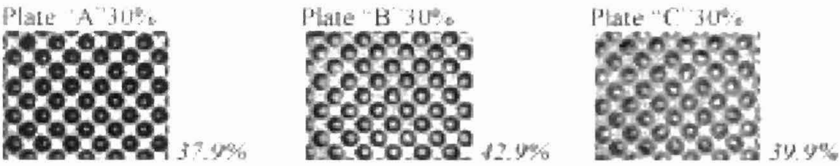


Figure 8 Dot gain for Plates "A" "B" "C" produced from Test 3

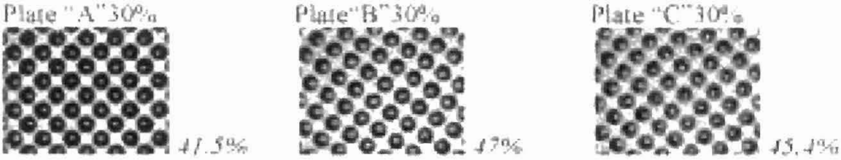


Figure 9 Dot gain for Plates "A" "B" "C" produced from test 4

## Effects on Shore Hardness

The shore hardness values of each of the plate's made were measured. Relevant results for all three plates are presented in Table 2.

Table 2 Results of Shore Hardness Measurements

| C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | Shore hardness | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | A | B | C |
| 1 | + | - | + | - | - | - | + | + | + | - | 61 | 56 | 52 |
| 2 | + | + | - | + | - | - | - | + | + | + | 59 | 51 | 57 |
| 3 | - | + | + | - | + | - | - | - | + | + | 62 | 55 | 51 |
| 4 | + | - | + | + | - | + | - | - | - | + | 60 | 56 | 51 |
| 5 | + | + | - | + | + | - | + | - | - | - | 56 | 53 | 48 |
| 6 | + | + | + | - | + | + | - | + | - | - | 62 | 66 | 50 |
| 7 | - | + | + | + | - | + | + | - | + | - | 61 | 53 | 50 |
| 8 | - | - | + | + | + | - | + | + | - | + | 59 | 54 | 52 |
| 9 | - | - | - | + | + | + | - | + | + | - | 61 | 51 | 50 |
| 10 | + | - | - | - | + | + | + | - | + | + | 59 | 54 | 50 |
| 11 | - | + | - | - | - | + | + | + | - | + | 54 | 51 | 51 |
| 12 | - | - | - | - | - | - | - | - | - | - | 49 | 48 | 45 |

In Table 3 the "z" values displayed for the results of the Shore hardness tests carried out during the experiments indicate that all three plates did not record a significant (output) change to alteration (input) in the test parameters.

As can be seen in Table 3 the results for all three plates are clustered around the mean. Using data shown in Table 2, various statistical plots were created. These are shown and interpreted as follows and compared with plots for Plates "A" "B" and "C".

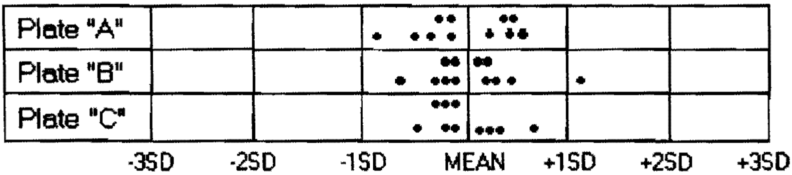

Table 3 Shore Hardness Dot Plot from Plates Obtained

On the initial run of the data no factors were highlighted as influencing the Shore hardness. As can be seen in Figure 10, the fitted reduced model revealed the main exposure and Cl post exposure lamps were making a significant contribution to the Shore hardness of Plate "A".

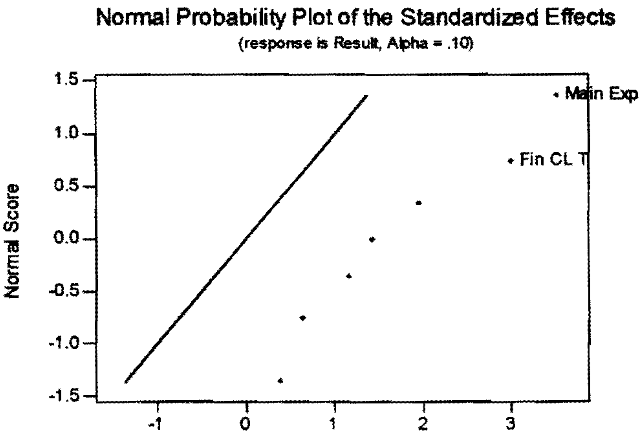

Figure 10 Normal probability plot for Shore hardness for Plate "A"

The CL (UV A) lamps used in the finishing process have the same wavelength as the main exposure lamps indicating that it is not the amount of UV radiation as important as the stage in the platemaking process that the radiation is applied.

After fitting the model, the graph for Plate "B" shown in Figure 11 indicates that the main exposure combined with the heat from the exposure unit are the factors, which are making the most significant effect on Shore hardness of Plate "B".

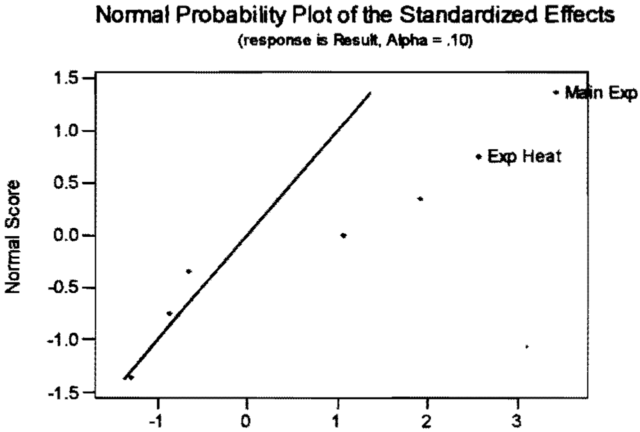


Figure 11 Normal probability plot of Shore hardness for Plate "B"

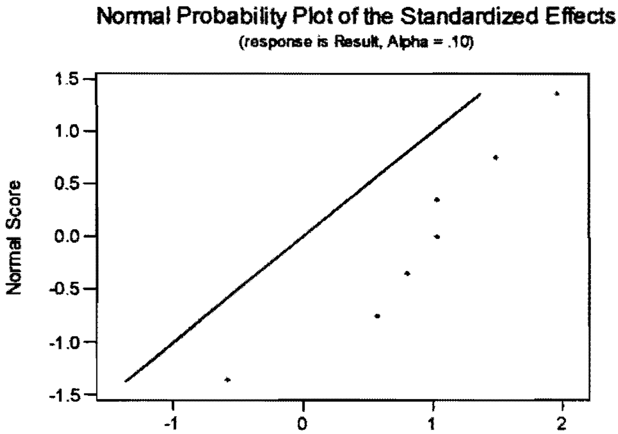


Figure 12 Normal probability plot of Shore hardness for Plate "C"

The graph for Plate "C" is produced from a reduced model and is illustrated in Figure 12. It suggests that none of the exposure unit related factors influencing the other plates are acting on the Shore hardness of Plate "C".

The main effects of each of the process parameters included in the experiment are indicated on the graph in Figure 13. It can be seen from Figure 13 that many of the factors involved in the experiment have the capacity to influence the

Shore hardness, particularly in the case of Plate "A" the main exposure and the CL exposure.

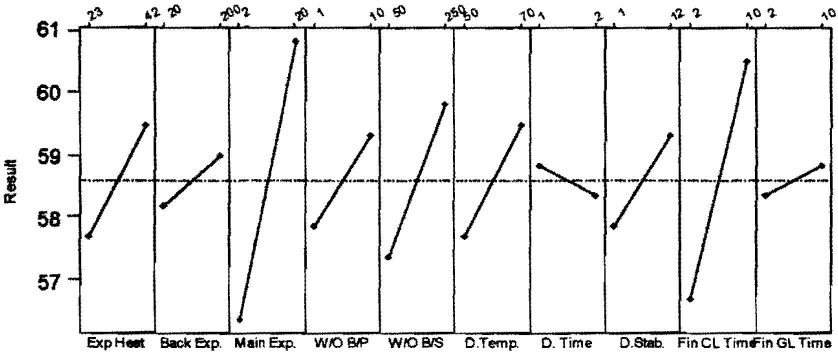


Figure 13 Main effects plot for Shore hardness for Plate "A"

One of the less obvious effects is the influence of the washout on Shore hardness. The speed affects the plate's exposure to solvent. The faster the plate is passed through the machine the less solvent is trapped within the plate's chemical lattice and thus the apparent Shore hardness is increased. The hypothesis is substantiated when cross-referenced with the effect of drying time and temperature factors. When the higher values of the processes that are designed to allow the evaporation of the solvent are applied, the plate's Shore hardness increases.

Effects on Chemical Resistance

The chemical resistance (monitored via plate thickness after swelling in specified solvent) values of each of the plates made were measured. Relevant results are presented in Table 4. The plate thickness was taken into account before the dipping test was undertaken. The swelling results were expressed as the difference.

The results in Table 5 are clustered around the mean because the data for the chemical resistance part of the experiment was taken by measuring the total thickness of the plate. The data indicates that all of the plates show similar response to the total immersion in the solvent used to provoke plate swelling.

The main effects chart, shown in Figures 12 indicates that the heat variation was a factor more significantly contributing to the chemical resistance of the Plates "A" and "C".

Table 4 Results of Chemical Resistance Measurement

| C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | Chemical Resistance A | B | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | + | - | + | - | - | - | + | + | + | - | .010 | .015 | .020 |
| 2 | + | + | - | + | - | - | - | + | + | + | .010 | .015 | .015 |
| 3 | - | + | + | - | + | - | - | - | + | + | .015 | .015 | .015 |
| 4 | + | - | + | + | - | + | - | - | - | + | .005 | .010 | .010 |
| 5 | + | + | - | + | + | - | + | - | - | - | .015 | .015 | .015 |
| 6 | + | + | + | - | + | + | - | + | - | - | .010 | .010 | .010 |
| 7 | - | + | + | + | - | + | + | - | + | - | .015 | .015 | .010 |
| 8 | - | - | + | + | + | - | + | + | - | + | .020 | .020 | .015 |
| 9 | - | - | - | + | + | + | - | + | + | - | .020 | .020 | .010 |
| 10 | + | - | - | - | + | + | + | - | + | + | .005 | .005 | .010 |
| 11 | - | + | - | - | - | + | + | + | - | + | .030 | .005 | .010 |
| 12 | - | - | - | - | - | - | - | - | - | - | .010 | .010 | .010 |

The drying and stabalisation data shown in Figure 12 is giving a false impression as the test results rely on plate total thickness and they have a direct correlation to the washout and drying of the plate.

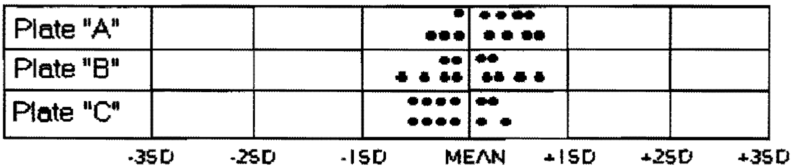


Table 5 Chemical Resistance Dot Plot from Plates Obtained

The plates did not respond in a predicted way i.e., the higher amount of UV radiation that the plate's received was predicted to improve the plate's solvent resistance and thus control swelling. Initially the predicted trend could not be identified in the data. Analysis of the interaction plot was more revealing. In particular the combination of the result of the "z" plot in Table 5 compared with the UV exposure factors in Figure 12 suggests that the processing conditions did not significantly influence the solvent resistance. The plot in Figure 12 shows that Plate "A" responded to UV exposure manipulation.

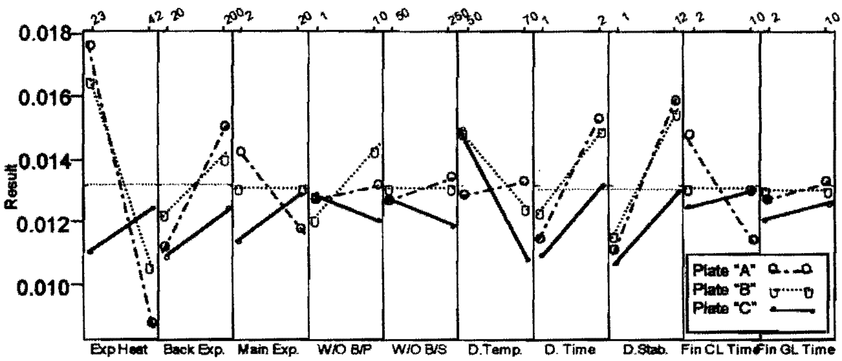


Figure 12 Main effects plots for solvent resistance for Plates "A" "B"and "C"

## Effects on Print Consistency

One of the discoveries found during the printing element of the experiment was that the best printing results were produced when printing from a low volume Anilox roller. The fine control of the ink film thickness on the surface of the plate allowed increased amount of printing pressure to be applied to the plates without causing excessive dot gain. The plates with shallow relief responded positively to the increased printing pressure, which encouraged improved ink transfer thus further enhancing print contrast with no significant increase in dot gain.

Past research has indicated that the most significant of all the plate properties is the relief depth. The data obtained through the current study revealed that all three types of plate responded to factors interacting on the back layer characteristics, in the way predicted by the analysis. The results confirmed that control of the back layer facilitated a potential reduction of the main exposure. The reduced main exposure resulted in less reflected light and undercut of the dots on the film and thus a deeper valley between dots was obtained, which increased the print contrast. The data obtained also displays a trend that increased anchor layer can influence an increase in the shoulder angle. It was found that increasing the anchor layer excited the photopolymer, which had the effect of allowing small dots to form quickly with relatively low levels of main exposure. This had the effect of improving the negative to plate image transfer, which improved the dot gain characteristics. Analysis was made of printed samples produced from Plate "C" shown in Figures 13 and 14 that were produced by Test 7 and Test 12. The print samples produced from the shallow relief plate's displayed lower dot gain and higher maximum density. The relevant shoulder angle cross sections are shown in Figure 15 and 16 indicate that lower shoulder angles, when combined with shallow relief and a fine cell Anilox roller, had a correlation to lower print dot gain and improved print contrast.

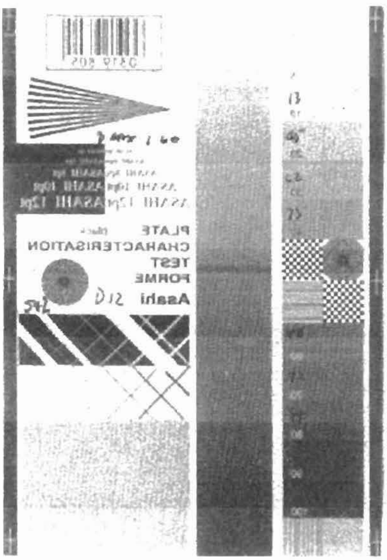

Figure 13 Test 12 print sample

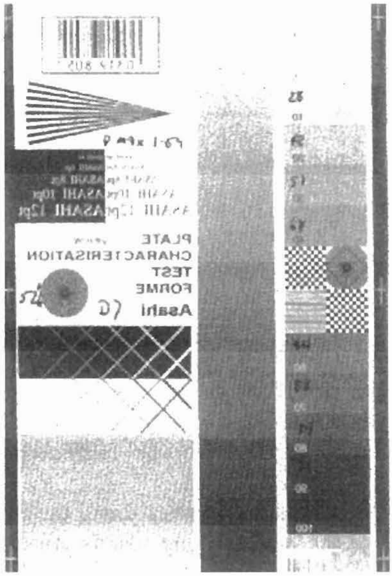

Figure 14 Test 7 print sample

The information in Table 6 confirms that the dot gain from print samples produced from Test N$^{0}$7 displayed lower dot gain. Experience with Plate "B" suggests that fast plate photospeed makes the anchor layer harder to control accurately. Plate "A" had the benefit of an anti-halation coating on the base film, which had the effect of expanding the back exposure latitude. Plate "B" and "C" recorded the best shoulder angle for the experiment recorded at 60°.

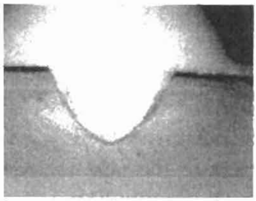

Figure 15 Cross section of Plate "C" from Test 12

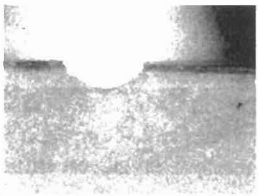

Figure 16 Cross section of Plate "C" from Test 7

The data indicates that there is a correlation between the shoulder angle decreasing, having a significant impact on reducing the print contrast. The shoulder angle is affected by photospeed. The data confirmed a link between the shoulder angle and dot gain on the plate.

Table 6 Dot Gain from Negative to Print

| Negative Dot % | 1 | 5 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plate Dot % Test Nº7 | 0 | 0 | 10 | 23 | 24 | 46 | 0 | 66 | 75 | 84 | 93 |
| Plate Dot % Test Nº12 | 0 | 0 | 8 | 20 | 33 | 41 | 0 | 63 | 73 | 82 | 91 |
| Print Sample %Test Nº7 | 0 | 0 | 28 | 42 | 57 | 68 | 52 | 84 | 88 | 94 | 99 |
| Print Sample %Test Nº12 | 0 | 0 | 13 | 45 | 62 | 73 | 54 | 88 | 92 | 95 | 99 |

## Conclusion

The most important conclusion of the results presented in this paper is that heat at the exposure stage has been shown to make a significant contribution to the plate to plate inconsistency. The experiment confirmed that the back exposure is the most important of all the platemaking factors investigated during the experiment. The results indicate that the interaction of the heat factor and back exposure are particularly significant factors affecting plate to plate consistency. The results confirm that the main exposure can be dramatically reduced when shallow relief platemaking techniques are adopted significantly improving the negative to plate image transfer. The data generated by the experiment indicates that shallow relief plates produced the best negative to plate image transfer. Printing tests that used a low volume Anilox roller and shallow relief plate combination, produced the best-printed samples, lowest dot gain and the highest print contrast. The data indicates that it was the raw material properties and not the processing factors, which had the most significant effects on the Shore hardness and the solvent resistance of the plate. Plate "A" was shown to have some increased solvent resistance when the UV radiation levels were manipulated during the experiment. Many of the tests were out of the range of the normal production processing parameters that the plates were designed to operate within. The plates were tolerant of the parameters set for the experiment thus proving that the three plates had wide processing latitude. It is thought that the wide processing latitude is in part contributing to the plate to plate consistency problem, due to inappropriate optimisation of the platemaking process. The experiment shows that the calibration of platemaking systems based on empirical test results of individual processing stages, whilst convenient, can provoke plate to plate inconsistency because the interaction of the various stages is disregarded. The results of the experiment show that it is possible to positively affect plate properties to optimise on press consistency and printing performance.

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