Printing Over Flutes.
A Current Problem From The Past

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Keywords: flexography, corrugated board, printing plate,
stereos, distortion, stretch, deflation coefficient

Abstract

In the use of flexographic presses to print over corrugated cardboard, printing plates with thicknesses between 2 and 8 mm are used. Due to its flexible nature, the ink from the plate surface is transferred to the substrate surface in a postprint process.

This same fact, which enables the possibility of printing over a substrate with height differences on its surface (differences due to the tip flute and flute valley areas of the corrugated paper inside the cardboard sheet), makes distortions between the different colors in a print.

Modern flexographic presses with direct drive technology have tools to correct these inaccuracies, but in the corrugated industry's current machinery fleet, there are many flexographic presses with older technologies, which do not have these tools.

The results of this research reveal the method to minimize these imperfections, working directly in the printing plate manufacturing process by applying different deflation coefficients to the colors of the same set of stereos, depending on the nature and size of each color design.

The obtained results imply considerable time savings in the adjustment of the machine in a job set up time. Also, the reduction of ink consumption and cardboard sheets used during the set up process in a new order. Another consequence in pre-press area is the possibility of reducing the trapping between colors in cases where the trapping is increased above necessary due to registration deviations due to the specifications of the machine itself, in order to mask the unequal development between colors.

Cartonajes Santorromán, S.A.

Introduction and Goals

One of the common problems faced by flexo corrugated board printers is that the material is compressible and varies in thickness.

It is a common problem to find differences in the size of the printed images in the printing direction, produced by the "Stretch" of the printing plates or also known as stereos.

As Forcadell A. (2008) said, when we apply excess pressure between the plate and the cardboard, the images tend to stretch. This problem is usually solved by applying the correct cliché-cardboard pressure.

In addition to stretching due to pressure, each press has a different footprint that will depend on the construction factors of the machine, the geometry of its components and the thickness of the stereos. Stretching is a phenomenon that occurs when mounting a printing plate over a tool cylinder. The surface of the plate stretches more than the base, causing the print to be longer in the direction of the press rotation (printing direction).

As has been explained, this stretching is specific to each press and until now the correction of this aberration has been calculated through a formula, thanks to which a "deflation coefficient" could be calculated and applied to the manufacture of the plates to compensate for the elongation. Formula 1, in Sources review.

This difference in stretching between the surface and the base of the printing plate is due to the printing form being curved on the tool cylinder, Figure 1: Plate surface elongation when it is curved, the roller rotates applying a certain pressure between the relief of the plate and the corrugated cardboard sheet. In addition, the stereo requires a suitable hardness range so that it adapts to the cardboard surface and correctly transfers the ink from its surface to the corrugated cardboard sheet.

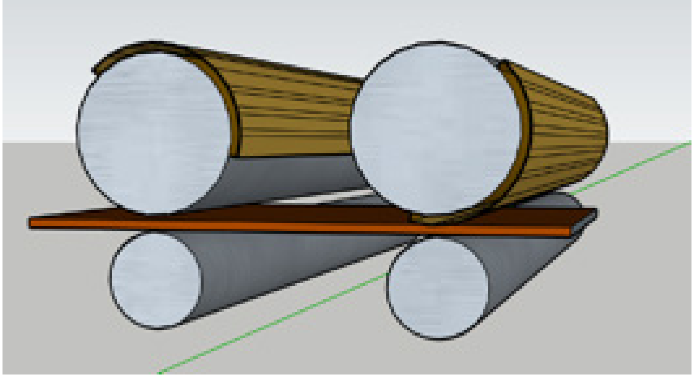


Figure 1: *Printing plate over the tool cylinder.*

In addition to these two cases of stretching, a third can be found due to the nature and size of the image to be printed.

We agree with Forcadell A. (2008), when printing a solid, it usually stretches more than when printing small details or texts. The larger the solid (in printing direction), the greater the stretch.

When you want to print jobs with 2 or more colors and these colors have a different nature (solid, detail, text) or have very different sizes, each of the colors will have different deformations or elongations causing a problem of offset or registration between colors.

First, it is possible to play with the pressures, as we have described in the first case of stretching. This resource is very limited, if the pressure is reduced, it will not sufficiently cover the area of the valleys of the corrugated sheet, appearing new defects in the printing and wash-boarding. If we increase the pressure, defects such as halo around the print, deformation of characters and lines will appear.

Another way to try to contain the problem is to apply shims of different thicknesses between the plate and the tool cylinder, this method varies the total diameter and changes the footprint in a print unit. This method can be mastered with practice and experience but it is usually a costly method due to the loss of time involved in mounting and dismounting the stereos to modify the shim's thickness.

On modern flexo presses, this problem is easily solved as each color print can be stretched or shrunk independently. These presses have direct control technology for each printer with servo motors and "drives" that can individually control each printing unit.

In the case of old machines, they are normally driven by a main motor that transmits the movement to the different printing units, and it is not possible to vary the stretch for each color individually.

The main objective of this technical paper will be to develop a method that helps to correct the stretching problems of the different colors of a job, when the lack of registration is due to differences in the nature or size of the colors. It is a correction method for old flexographic presses, or those that do not have direct drive technology.

This method will solve or minimize the problem described in the process of pre-printing and manufacturing of tools (printing plates). In this way, it will be possible for these elements to reach the press in the best conditions in order to lose as little time as possible in setting up the press. Representing the size of images with greater fidelity will avoid print-to-die-line fit issues.

Methodology

1. For the investigation, two sets of stereos of two colors each were designed.

The first set had a print development close to the maximum of the machine and the second had a development of about half the machine. This measure was chosen because with designs less than half of development, it is usual to place more formats to take advantage of the printing surface.

This was intended to analyze how size influences the distortion of prints.

Each of the two sets had 2 colors, one of the colors was designed with a rectangle with the side in the same direction as the machine print of the half development size (solid) and the other color with two small rectangles at the ends of the same development as color 1 (detail).

In the second set, the same was done but the development of the two colors was close to the maximum development of the printer.

This was intended to analyze how the nature of the impression, solid or detail, influences the distortion of the impression.

The general deflation coefficient calculated for the machine, 98.9%, was applied to the two sets of printing plates. (Formula 1. Appendices: Sources review)

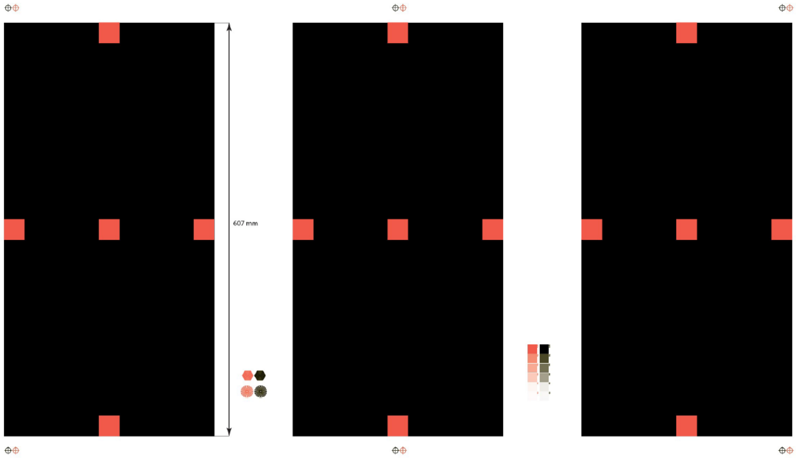


Figure 2: *Test 1. File with printing close to half of the machine development (607mm)*

Figure 3: *Test 2. File with printing close to the maximum of the machine development (1050 mm)*

2. The two jobs were set at the printing machine and printed adjusting the registration between colors. To do this, the first side of the solid rectangle was aligned with the side of the first detail rectangle.

It was done the same way with both sets of stereos. Both works were printed on the same quality of substrate (same papers and same flute in the corrugated), to apply the same plate-cardboard pressure in both works and minimize the variability of the test.

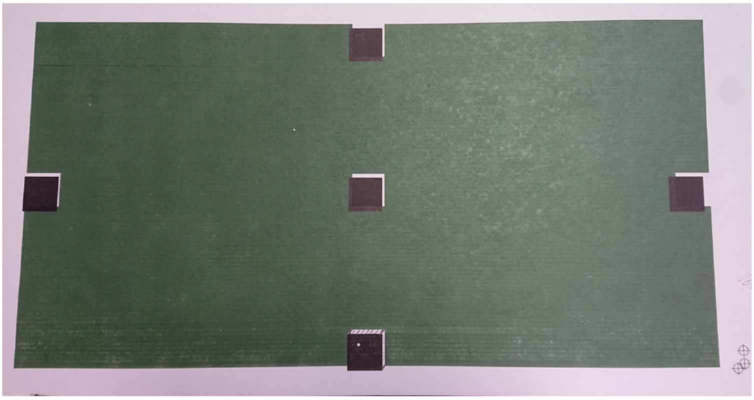


Figure 4: *Printed Test 1.*

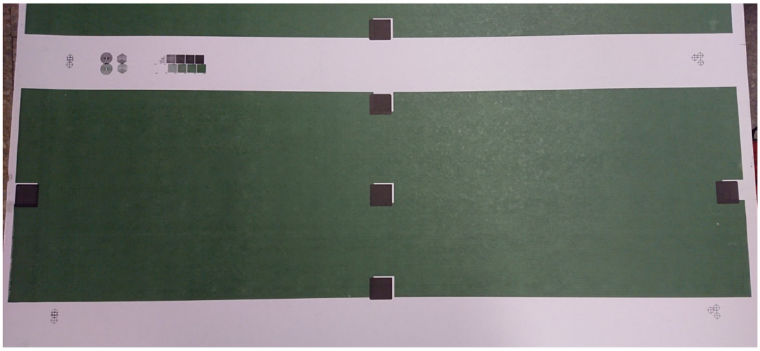


Figure 5: *Printed Test 2.*

3. External measurements of the solid rectangle and the two detail rectangles were taken in both papers and compared with the measurements on the original design. Placing the measurements in an Excel table.

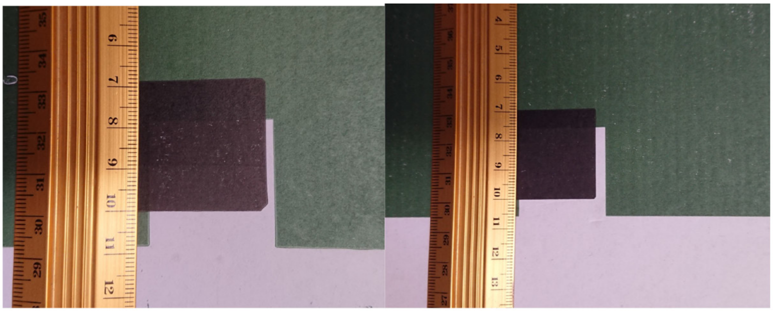


Figure 6: *Left detail Test 2. Right detail Test 1.*

Figure 6 On the left, Test 2, with more development and more difference between the solid and the detail. Figure 6 On the right, Test 1, with less development and less difference between solid and detail.

Two graphs were plotted, one for the detail data and one for the solid data. The trend line was drawn in each of the graphs, obtaining the formulas of said lines. One formula for the masses and another formula for the details.

From these two formulas it was possible to calculate the predicted stretching for different sizes of solid-type and detail-type images.

Results

After carrying out the two printing tests, called test 1 for the impression of half development and test 2 for the impression of maximum development, the measurements obtained were shown in the following table:

Print Type	Test	Original (mm)	Measured (mm)	Distortion (mm)
Solid	Test 1 Half Development	607	609.8	2.8
	Test 2 Max.Development	1050	1055.7	5.7
Detail	Test 1 Half Development	607	605.4	-1.6
	Test 2 Max.Development	1050	1047.3	-2.7

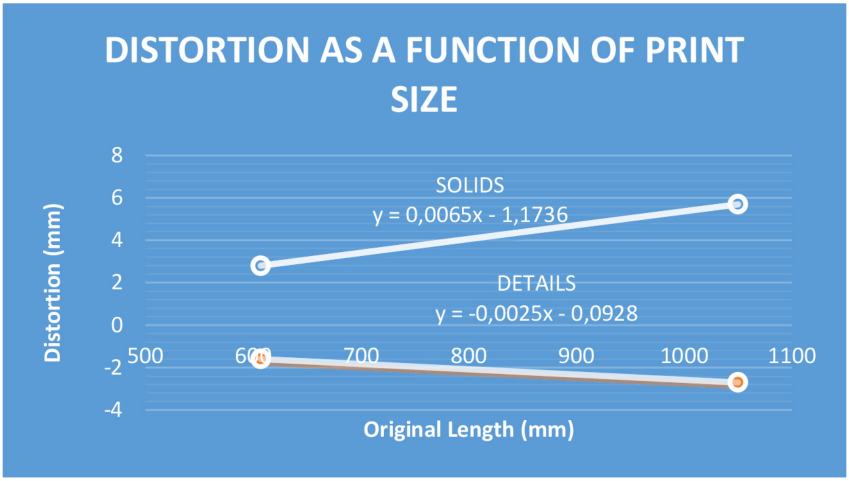
Table 1: *Measurements from Test 1 and 2*

Each of the two tests had one color representing "solid" and another color representing "detail".

The measurement taken for the "solid" is the measurement taken in the print direction.

The measurement taken for the "detail" is the external measurement (detail 1 + detail 2 + separation between details) taken in the printing direction.

With the data in the table, two lines are drawn, one represents the data of the "solids" and the other represents the data of the "details". These straight lines relate the distortion that has occurred when printing, with the size of the printed image (original measurement).



Graph 1: *Distortion as a function of print size.*

From the data represented in the graph we obtain the formulas that relate distortion based on the size of the print for each of the types of print.

Natute of Printing	Predicted Distortion Formula
SOLIDS	Distortion = 0.0065 x (Original) – 1.1736
DETAILS	Distortion = - 0.0025 x (Original) – 0.0928

Table 2: *Predicted distortion formula.*

Conclusions

After analyzing the data obtained, it can be deduced that: taking into account the theoretical formula for calculating the deflation coefficient and applying said coefficient in the manufacture of the printing plates in general (98.9% in the case of study), the Distortion that occurs when printing on a flexographic press varies with the size of the image in the forward direction of the machine.

It also follows that said distortion also depends on the nature of the impression, having distinguished between solid-type impressions and detail-type impressions.

These two deductions are reflected in the following observed facts:

In solid-type prints, the distortion has a positive sign, therefore the print is elongated in relation to the original model, and said elongation is greater the larger the size of the model to be printed.

In detail-type prints, the distortion has a negative sign, therefore the print is shortened in relation to the original model, and this shortening is greater the greater the separation between the details of the model to be printed.

Therefore, for any work that combines printing of solids and details, it follows that applying the specific deflation coefficient of the press, when mounting the plates on the machine and printing, a good registration between the colors that represent the solids and the colors will never be obtained. The colors that represent the details, as the solids will stretch and the details will shorten. Fact that will require the extra work of the printers to correct these imbalances, causing the machine set-up time to lengthen considerably and in the most extreme cases, making it impossible to reproduce the work on the press.

We also deduce that in single color jobs, be it mass or detail, if the specific deflation coefficient of the press is applied, the reproduction of said job will also be inaccurate, such accuracy becoming visible when the print approaches the cutting lines or creaser lines.

To solve the inaccuracies observed, it is deduced that: **applying the deflation coefficient tailored, instead of the general theoretical one, in the manufacture of each color of a set of clichés, better results will be obtained in the reproduction.**

METHOD FOR CALCULATING THE SPECIFIC DEFLATION COEFFICIENT FOR EACH COLOR:

1. With the formula of the solid and detail lines, the expected stretch (in millimeters) is calculated for the different colors of the printing plates set.
2. The plate measurement (in millimeters) is obtained by applying the deflation coefficient of the press (98.9%).
3. From this measurement (point 2) the expected stretching (point 1) is subtracted to obtain the actual measurement of the plate (in millimeters) that is needed to compensate for the distortions mentioned above (distortions depending on the size and nature of the images).
4. The result of point 3 is divided by the actual measurement of the image and multiplied by 100 to calculate the new specific deflation coefficient for each color (as a percentage).

These 4 steps are applied for each color of the same job.

The method is summarized in the following tables:

Table for the calculation of colors of nature SOLID				
Original Image Size (mm)	Expected stretching according to the straight line obtained for solids (mm)	Cliché measurement with the press's own deflation coefficient 98.9 (mm)	Actual plate measurement minus expected stretch	Specific deflation coefficient for the plate (%)
O	DIS	A	B	C.D.ESP
Data	DIS=0.0065xO-1.1736	A=Ox98.9/100	B=A-DIS	C.D.ESP=(B/O)x100

Table 3: *Calculation for SOLID colors.*

Table for calculating colors of nature DETAIL				
Original Image Size (mm)	Expected stretching according to the straight line obtained for details (mm)	Cliché measurement with the press's own deflation coefficient 98.9 (mm)	Actual plate measurement minus expected stretch	Specific deflation coefficient for the plate (%)
O	DIS	A	B	C.D.ESP
Data	DIS=-0.0025xO-0.0928	A=Ox98.9/100	B=A-DIS	C.D.ESP=(B/O)x100

Table 4: *Calculation for DETAIL colors.*

From the above, the following consequences and applications can be deduced:

- In flexography jobs that require images with solids and details in different colors, different deflation coefficients may be applied to each plate of each color depending on its image size and the nature of the image to achieve a better registration between colors and a result more faithful to the original image.

- The same method will be applicable to single color jobs, obtaining more accurate results and easier to adjust to the die line.

- The set up time at the beginning of each job will be considerably reduced by obtaining a better record from the first adjustment, avoiding trial and error to fit printing plates on the tool cylinders.

- Better print quality as it is not necessary to vary pressures to correct distortions to the detriment of print quality.

Trials.

Once the calculation method has been obtained, it has been tested with two real jobs.

ITEM 19569:
It is a single color job, in which the print must be very well adjusted to the die line.

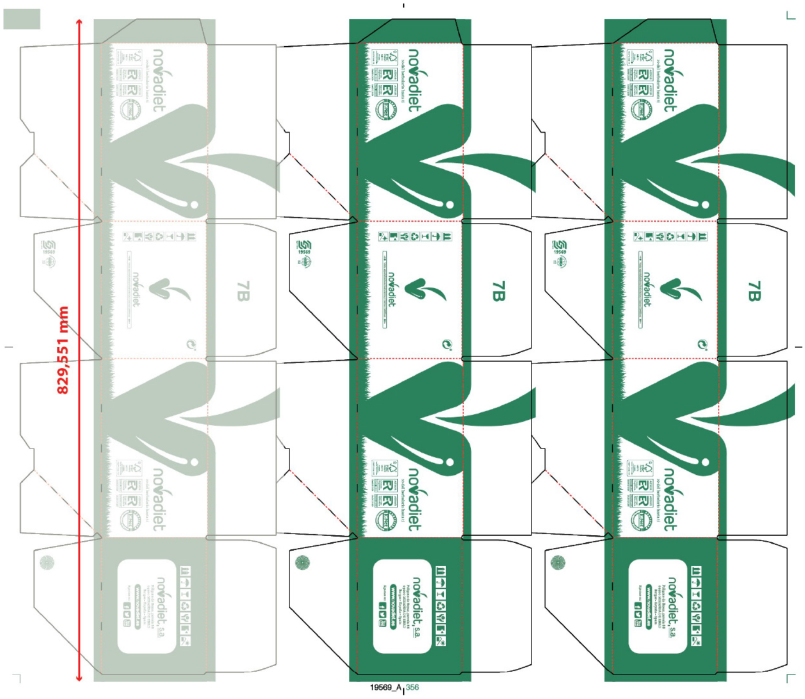


Figure 7: *Trial 1, 1 color.*

Table for the calculation of colors of nature SOLID				
Original Image Size (mm)	Expected stretching according to the straight line obtained for solids (mm)	Cliché measurement with the press's own deflation coefficient 98.9 (mm)	Actual plate measurement minus expected stretch	Specific deflation coefficient for the plate (%)
829.6	4.2	820.4	816.2	98.4

Table 5: *Calculation Trial 1.*

Initially reproducing the job by means of the plate made with machine deflation (98.9%), we got a measurement of 834mm, making it impossible to fit the print to the die line.

When applying the 98.4% deflation to the printing plate, the 831mm measurement was obtained, making it possible to adapt the print to the die line.

ITEM 24483.
It is a three colors job, which must be perfectly registered between colors.

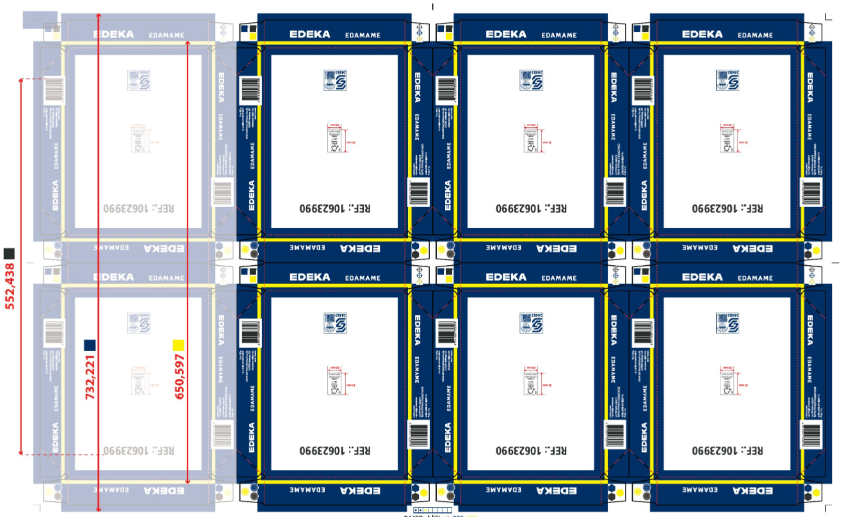


Figure 8: *Trial 2, 3 colors.*

Table for the calculating blue SOLID				
Original Image Size (mm)	Expected stretching according to the straight line obtained for solids (mm)	Cliché measurement with the press's own deflation coefficient 98.9 (mm)	Actual plate measurement minus expected stretch	Specific deflation coefficient for the plate (%)
829.6	3.6	724.1	720.6	98.41

Table for calculating black DETAIL				
Original Image Size (mm)	Expected stretching according to the straight line obtained for solids (mm)	Cliché measurement with the press's own deflation coefficient 98.9 (mm)	Actual plate measurement minus expected stretch	Specific deflation coefficient for the plate (%)
552.4	-1.5	546.3	547.8	99.17

Table for calculating yellow DETAIL				
Original Image Size (mm)	Expected stretching according to the straight line obtained for solids (mm)	Cliché measurement with the press's own deflation coefficient 98.9 (mm)	Actual plate measurement minus expected stretch	Specific deflation coefficient for the plate (%)
650.6	-1.7	643.4	645.2	99.16

Table 6: *Calculation Trial 2.*

First, the work was reproduced with the plates manufactured with the deflation of the machine, obtaining the following measurements: Blue 735mm, black 551mm and yellow 649mm.

Afterwards, the trinkets manufactured with the different deflations were used, obtaining the following reference measurements: Blue 732mm, black 553mmand yellow 650mm.

It is demonstrated that by means of the developed method, the reproduction in machine is faithful to the design.

Particular case

In the specific case where the study has been carried out, there are two flexographic presses. One of them, that of the case study, is older and without the possibility of modifying the dimensions of the print electronically and independently in each printing unit. The other press, more modern and with the possibility of modifying the size of the prints independently in each printing unit (direct control technology). Until now, due to the difficulty of registering some works that combine solids and details in the old press, these works were limited to the most modern press, with more and more works being done in the modern press and less in the old press, having sometimes overload of the modern press.

A similar phenomenon occurred with prints that were very close to the die line. The new method allows many jobs that had been excluded from the old press to be reproduced without increasing setup time.

Another circumstance that has happened until now was the increase in the trapping between colors to hide the small imperfections of registration between colors in the old press, a phenomenon by which less clean prints were obtained and with visible overlap lines.

By improving the registration between colors, it is intended to reduce the trapping between colors of different nature.

It is important to note that the formulas obtained are only applicable to the flexographic press in which the printing tests have been carried out.

New investigation lines

After the obtained results, it is possible to imagine that in other flexographic presses of different brands and models, the distortion will behave in a similar way.

It will be the object of successive studies to analyze this method in different presses, with different tool cylinder diameters. As well as relating the results with this data and with the thickness of the used plates. With the ultimate objective of finding a formula that, in addition to the size of the print and the nature of the print, has as variables the tool cylinder diameter and the printing plate thickness. Extending the validity of the method to any flexographic printer.

Acknowledgments

The different tests were printed in Cartonajes Santorromán, Calahorra. In the model Emba 244 Flexographic press. Acknowledgments to the staff who collaborated in the production process.

The stereos for the different tests were manufactured in the Cartonajes Santorromán stereos manufacturing workshop. Acknowledgments to the staff of said workshop, especially to its Manager, Angel María Gutierrez, who helped to make the measurements in each of the printed tests, the measurements of the tool cylinder diameters, and also contributed his knowledge and experience in the deflation coefficients calculations and their application in the filming of negatives.

The graphic sheets and test designs were drawn in the Technical Department of Cartonajes Santorromán. Acknowledgments to Adrián Celorrio, who designed the test files, and to Elena Martínez, who collaborated in the different machine tests and tests with real jobs.

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Appendices

Media and Materials

All the tests were carried out on the same flexographic press, using its different printing units with different screen counts. The last print unit (5th) was reserved exclusively for applying overprint varnish.

Liquid photopolymer plates mounted on a blanket previously fixed to the tool cylinder were used. The blanket was fixed with the help of double-sided tape and sealing in the areas that did not affect printing. All the tool cylinders have the same diameter. The stereos were done with the same equipment.

Although it is an analog press, we tried to work with similar working pressures between plates and cardboard.

The Tables 7, 8, 9 and 10 show the specifications of the different materials and equipment used:

Negative films printer: Liberator XE 5412, thermo printing system.	Image width: 136.55cm Registration Accuracy: 0,01% Resolution: 600x600dpi & 1200x1200dpi. Speed: 156mm/min a 600dpi 78mm/min a 1200dpi	The Thermo printer system prints the picture in negative directly over the film without chemicals.
Plate maker (Insolating): APR Model AWF-110E	Size max.: 30”x50” Thickness from 1.7mm to 8.0mm, intervals 0.01mm. Thickness accuracy: +/- 4/100mm for 6.35mm. Wave width: 300-400nm	The AWF equipment is designed to manufacture plates for corrugated cardboard, directly from a negative and using resin (liquid photopolymer). The insolating equipment is responsible for making the plate by exposing the resin to ultraviolet light through the negative.
Washing machine: APR Model AWF-W	Size max.: 30”x50” Thickness from 1.7mm to 8,0mm, intervals 0.01mm.	The washing machine is responsible for removing the excess resin (not solidified) for its recovery, washing and drying the plate.
Resin tanks: APR Modelo AWF-110T	Resin temperature: 30-32°C Tank capacity: 2 x 90 liters.	The resin tank keeps the resin tempered to feed the exposure machine, it also collects and filters the excess resin from the cliché when it enters the washer.

***Table 7:** Cliche manufacturing workshop equipment*

Negative Film: film Thermolm-pressionTM XP Film (for thermos printing systems)	4.0 a 5.0 UV Dmax Sharp dot quality.05 Dmin. Dimensionally stable. Flatness stability before and after the exposure.	Negative printed film with thermal printer machine. Later used to let light pass in the areas where the resin must harden in the insolator.
Resin: Liquid photopolymer APRTM F400	Hardness: +/- 27 Sh Repro: 3%-90% 120lpi Washing solution: 98% H2O, 2% neutral soal, 0.2% defoamer. Compatibility: Water based inks (máx. alcohol 6%), oil based inks.	The resin solidifies by exposure to ultraviolet light through the photolithography forming the printing plate.
Poliéster: POLY-ES-FILM B-2153, standard coextruded.	Thickness: 250 µm, 0.25mm Performance: 2.9 m^2/kg Tensile strength: 1600kg/cm^2 Contraction (150°C/30min): 2,5%	Polyester sheet used for the base of the plate. The resin solidifies on this base. Holes are made on the polyester sheet for fixing the cliché to the tool cylinder.
Double sidez tape DC-202. Base PVC transparent and natural rubber adhesive.	Thickness: 200µm, 0,2mm Adhesion to steel: 13.25N/25mm Shear over steel: 70 hours. Tensile strength: Min255, Max408 kg/cm^2 Elongation to break: Min50, Max120 %	The double-sided adhesive is used to reinforce, together with another layer of polyester, the fixing area to the bolts. It can also be used to mount larger clichés than the exposure machine can produce on a polyester sheet. Usually this thickness does not affect printing.

Table 8: *Printing plates manufacturing materials*

Flexographic press: EMBA 244	Max. Sheet format: 1.100x2.400mm Max print development: 1.050mm. Feed register accuracy: +/-1mm. Colors register accuracy: +/-1mm. Gauge: 4,40mm (Plate 2.37mm + Blanket 2,03mm)	Flexographic press that was the object of the study and with which they developed the tests.

Table 9: *Equipment used printing test*

Stereo: Liquid resin	Thickness: 2.37mm Composition: polyester 0.25mm + resin 2.12mm	The stereo is fixed to the tool cylinder by means of the bolt system and with the help of tape.
Blanket: Foam: R-bak SF (blue) (Supported Film) with polyester support layer to ensure dimensional stability.	Density: 320 kg/m^3 Compresion máx. (73°F): 1,3% Hardness (Shore O): 24Sh	The blanket used to coat the tool cylinder on the flexo press. The blanket works in accordance with the plate that works on it.
Corrugated board: Microflute (E) Quality: XPR-2	Thickness: 1.71mm Flute features (pitch x height): 3.70 x 1.39 mm Liner 1: (X) White bico 135g/m^2 Fluting: (P) Medium 85g/m^2 Liner2 (ext): (R) Testliner brown 110g/m^2	Quality of cardboard on which the printing tests were carried out.

Table 10: *Materials used in the printing tests*

Sources Review

For the tests and data collection, the plates were manufactured with liquid photopolymer using the method explained below and using the deflation coefficient formula for the preparation of originals.

This coefficient is applied in the manufacture of the plates to correct the elongation that occurs in the printing process, specifically during the filming of the negative. The formula is the one used in Cartonajes Santorromán for the manufacture of plates for its different flexographic printers, with different diameters of tool cylinders.

The case involved is the calculation of the distortion coefficient (or deflation) for the printer in which the tests were carried out. Printer model Emba 244, with a tool cylinder diameter of 356.2 mm.

$$\textit{Coeficiente de Distorsión}\ \% = \frac{d + (2 \bullet (m + p))}{d + (2 \bullet (m + cl))} \tag{1}$$

Where: d = tool cylinder diameter = 356.2 mm.
m = blanket thickness (foam) = 2.03 mm.
p = polyester thickness = 0.25 mm.
cl = printing plate thickness (resin + polyester) = 2.37 mm.

Deflation coefficient = 98,8%
In practice at Cartonajes Santorromán this value has been close to 98.9%. Therefore, this value has been used for the preparation of the test plates.

This is the value that was applied directly when the negative film was thermos printed, prior to insolation.

The origin of the formula used comes from the theoretical formula for calculating distortion:

$$\%\,Distorsión = \frac{Xd}{Yd} \tag{2}$$

Where: Xd = tool cylinder diameter with blanket, tape and polyester.
Yd = tool cylinder diameter with blanket, tape, polyester and printing plate.

We agree with iFlexo Visión Gráfica (2022) there are two other ways to calculate the coefficient of deflation or distortion:

DISTORTION METHOD WITH THE REPEAT LENGTH.

In order to find the percentage of distortion having the repeat length (RL), it must be understood that the repeat length is the perimeter of the circle of the plate at the top when it is mounted on the tool cylinder (top perimeter).

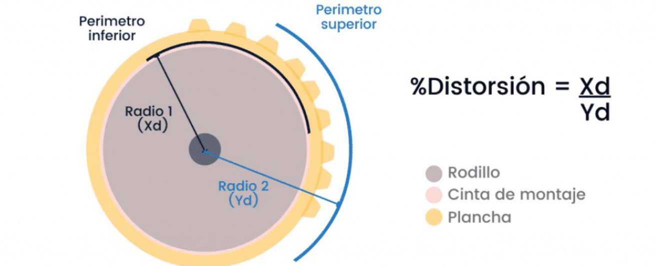

Figure 9: *Repeat length method.*

With RL we can find the radius of that circumference which is Yd.

$$\text{RL} = \pi\,(d + 2 \bullet M + 2 \bullet P) \tag{3}$$

Where: RL = Repeat length (mm).
d = Tool cylinder diameter (mm).
M = Polyester base thickness (mm).
P = Plate thickness (mm).

To find Xd, we have to subtract from Yd the plate height, (the plate thickness (P) – polyester base thickness (M)).

$$\% \; Distorsión = \frac{\left[\frac{RL}{2\pi}\right] + (M - P)}{\left[\frac{RL}{2\pi}\right]} \tag{4}$$

Where: RL = Repeat length (mm).
M = Polyester base thickness (mm).
P = Plate thickness (mm).

DISTORTION METHOD WITH THE DISTORTION FACTOR.

This is a simpler and more practical calculation method with an elongation constant depending on the caliber of the printing plate.

Said constant or Factor K is summarized in the following table.

K Factor	
Plate Thickness	K
0,76 mm	3,76
1,14 mm	6,07
1,70 mm	9,9
2,54 mm	15,17
2,84 mm	17,08
3,94 mm	23,95
4,32 mm	26,34
5,00 mm	30,65
5,50 mm	33,85
6,00 mm	37,04

Table 11: *Costant or Factor K.*

The K Factor comes from this formula:

$$Factor \; K = (2 \bullet \pi) + (M - P) \tag{5}$$

Where: M = Polyester base thickness (mm).
P = Plate thickness (mm).

$$\% \; Distorsión = \left[1 - \left(\frac{Factor \; K}{RL}\right)\right] \bullet 100 \tag{6}$$

Where: RL = Repeat length (mm).

THE PRINTING PLATE. MANUFACTURING AND ASSEMBLY.

We agree with Cartonajes Santorromán (1999) about the following statements:
In flexography, stereos are the vehicle for transporting the ink to the support to be printed. The fidelity of reproduction of the original depends very much on the quality of the printing plate. The plates are glued with adhesives on a polyester base generally called MYLAR, to give the factory the color registration already made and to facilitate machine setup.

The type, hardness and thickness of the printing plates are generally assumed by the photoengraver depending on: the job to be printed, the cardboard or support and the printing machine's characteristics.

Photopolymer plates:

Photopolymer plates are used by most flexo printers, they are suitable for fine screens, fast manufacturing, uniform thickness and excellent dimensional stability.

There are liquid photopolymer and solid photopolymer plates. Both have as a manufacturing principle the sensitization of a synthetic material by the effect of ultraviolet light, through negative films.

In this particular case, liquid photopolymer cliches were manufactured for the study.

This type of plate is made from liquid resin (polymer).

The negative film is placed on the glass of the isolator and covered with a very thin transparent protection sheet (cover film). The liquid photopolymer is deposited on this sheet, laminating it in a uniform layer and then covering it with a polyester sheet that will serve as the base support for the plate.

After closing the machine, the two faces of the cliché are exposed almost simultaneously to the action of ultraviolet lamps; the dorsal exposure is intended to fix the resin to the polyester base. When the operation is finished, the uninsulated parts have not been hardened and must be removed.

The next operation consists of washing the plate, for which the cover film sheet is previously removed. The unhardened resin is recovered and reused to make other plates. Washing is done in an aqueous solution with detergent and antifoam, which removes all the non-hardened resin that could not be recovered.

Finally, the printing plate receives a new exposure to ultraviolet light that will give it the final curing, before going to the drying oven where the process ends.

Mounting of stereos:

The last stage in the plate manufacturing chain is the pre-assembly or fixation on a polyester sleeve to fit the colors between and ensure the adjustment of the impression with the box (correct positioning in the machine).

In the majority of plates whose size does not exceed the manufacturing limit of the isolator machine, it is not necessary to fix the polyester on another polyester for its assembly, in this way the double-sided tape does not intervene either.

The plates and the shirt must be cleaned with alcohol prior to gluing to ensure the same, avoiding poorly fixed areas that may cause the formation of blisters. To fix the plate to the polyester, double-sided adhesives (0.1 to 0.2 mm thick) are generally used. You can also stick a layer of foam whose thickness will depend on the plate caliber. The mission of the foam is to serve as a cushion to balance the possible differences in the calibration of the plate and absorb the irregularities of the corrugated cardboard in the print run.

It is also possible to fix the foam layer to the tool cylinder and mount the plate on it. It is recommended to seal the edges of the plate and the polyester with silicone, to prevent detachment and entry of water or foreign particles.

The stereo is manufactured flat and then in a machine they work curved on a cylinder. The passage from flat to curve produces an elongation depending on the thickness of the cliché. To correct it, when manufacturing it flat, the measurement must be corrected by the appropriate percentage, so that when it is curved, the desired measurement remains. This phenomenon is called deflation.

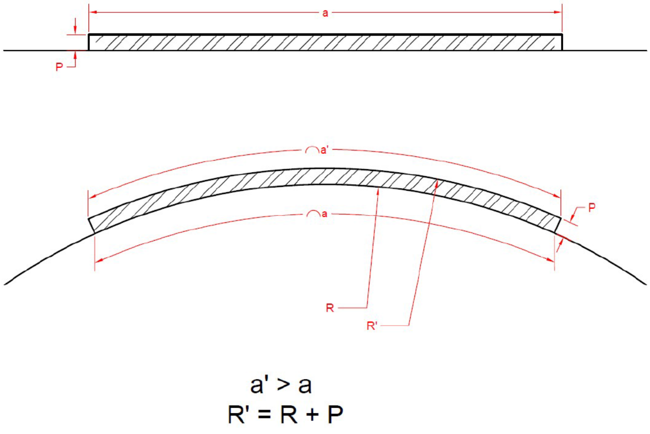

Figure 10: *Plate surface elongation when it is curved.*

In the case of the test, the deflation or distortion coefficient was calculated with the first method mentioned and this factor was applied to the image when printing the negatives films.

Cartonajes Santorroman (1999) published, there are three ways to fix the stereos to the tool cylinder:

FIX system.
MATTHEWS system.
Bolt system (C. Santorromán).

In the case of the printed tests, the Bolt system developed at Cartonajes Santorromán was used. This system eliminates the use of rods and tensioners, using a bolt system that guarantees registration. The fastening of the shirt to the plate holder roller is done with adhesive tape after having introduced the holes of the polyester in the tool cylinder pins.