
THE IMPACT OF FORMING FABRIC STRUCTURES ON PRINT QUALITY

Considerable work has been done over the past years to investigate the influence of forming fabric structures on the quality of the final print. The conclusion formed from this extensive work is that during the formation of a sheet of paper on a forming fabric structure, density differences are forced to occur. These density differences are increased during pressing, drying and calendaring to the point that when a uniform layer of ink is applied to the surface of the sheet of paper, the ink will penetrate at varying rates, depending on the density of the sheet at the point of contact. This variation in penetration will result in variations of gloss, offsetting and strike-through, to name but a few.

The worldwide trend to recycling, higher paper machine speeds, lighter basis weight, higher printing press speeds, lower printing press pressures, higher quality demands on advertising and the use of four-color printing, on not just one side but two sides of the sheet, will put even greater demands on the need for better density uniformity of the sheet to be printed.

On many occasions we have been asked, as a last resort, to study complaints about two-sidedness because normal laboratory paper tests show only the degree of difference in smoothness or ink absorbency top to bottom. They do not define the cause of the problem. Our photographic studies of these complaints often show that their causes can be traced back to the forming fabric structures on which the sheets were made and to one particular side on a twin-wire or top-wire former.

We have concluded that micro density differences on the surface, resulting from the knuckles of the yarns in the forming fabrics, are the main cause of the problems. This was the subject of two previous papers.

The total amount of micro density differences in a sheet formed on a twin-wire former is made up of the density differences in each of the two separately formed sheets. When the sheet is split in half, one can see how each fabric has dictated the structure of each side of the complete sheet.

The center two photographs in Figure 1 show, at 4.5X magnification, the density differences in a twin-wire formed sheet after it has been split. The left hand photograph shows the sheet side formed on a single-layer fabric, while the photograph on the right shows the sheet side formed on a double-layer fabric. The outer photographs are of the surfaces of the fabrics on which the two sides of this twin-wire sheet were formed. If one now relates the surface of the fabrics to the sheet, it can be seen that the knuckles in the fabrics have created light areas in the sheet, while the heavy areas in the sheet correspond to the holes in the fabrics. From these photographs, it can be seen how fabric structures create density differences in each side of a sheet formed between two fabrics.

The bottom halves of the center photographs show at the same magnification the ink dots (70 lines/inch) that make up the half tone in a print example.

Note the dimensional relationships between the light and dark areas in the sheets in the top halves of the center photographs and the ink dots – which make up the print – in the bottom halves of the center photographs.

The perfect print is one where all ink dots are perfectly round, and all are exactly alike and absorb into the sheet at the same rate. This will only happen if the surface of the sheet, on which each dot falls, is perfectly uniform. The photographs in Figure 1 show that in these cases the surface is far from uniform and that there will be differences in both contact and

absorption of each dot. This will depend on whether it lands on a light area over the knuckle or in a heavy area over a hole.

Figure 2 illustrates what we believe is happening when the sheet of paper is being printed. First, you can relate the size of the half tone printing dots, which are shown at the same scale as the illustration of a cross section of a sheet of paper with heavy wire marks.

Now, let us assume that all of the ink is transferred to the sheet. In the areas of the sheet formed over the knuckles of the fabric (A), there is a low density due to light basis weight areas in the sheet and also a low concentration of fines. When the ink hits this area, it penetrates very easily into the sheet and, if the volume is sufficient, will strike-through on the other side. However, in area (B) over the holes in the fabric, there is a high concentration of fines and high density due to the sheet being heavier. This high concentration of fines and high density restrict the penetration of ink. There is, therefore, a difference between these two areas caused by the basic fabric structure on which the sheet was formed. To achieve the best print, the printer has to modify his printing conditions to strike a balance between the two extremes.

Figure 3 shows photographs of a printed and unprinted sheet, which was formed on a twin-wire former and was the subject of a complaint from the printer. His complaint was that the sheet quality was not equal on both sides.

The top two photographs show an unprinted sheet at two levels of magnification. They show the look-through (formation properties) of the whole sheet – the part of the sheet formed on fabric A and the part of the sheet formed on fabric B. Note how the knuckles of the fabric show up in the look-through

of the whole sheet and also in side B but not in side A.

The bottom photographs show how the fabric knuckles on side B have adversely affected the print quality due to missing half tone dots, compared to the uniformity of half tone dots in both prints of side A.

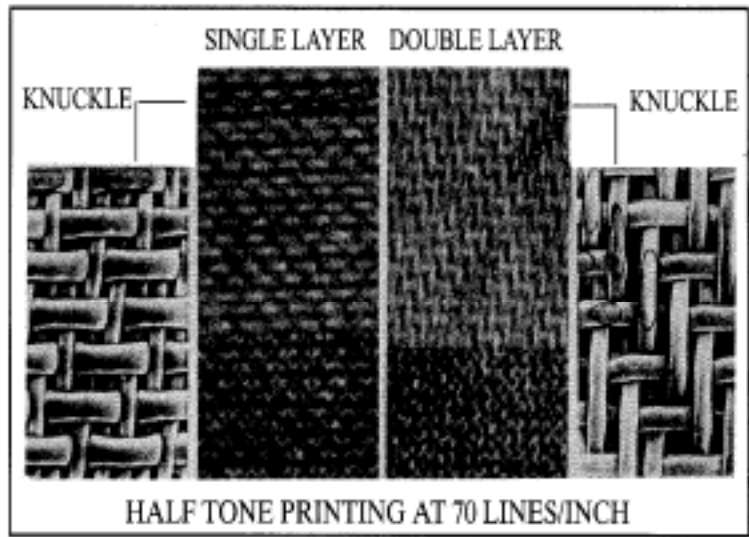


Fig. 1. Density difference in a twin-wire formed sheet.

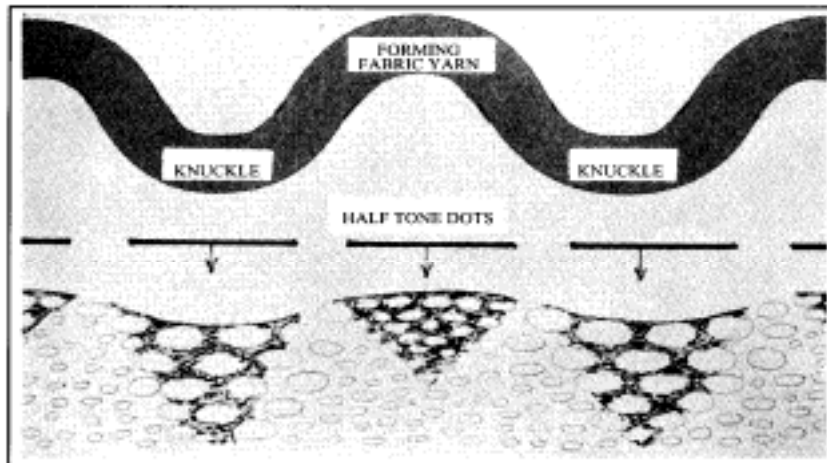


Fig. 2. Ink penetration into a sheet.

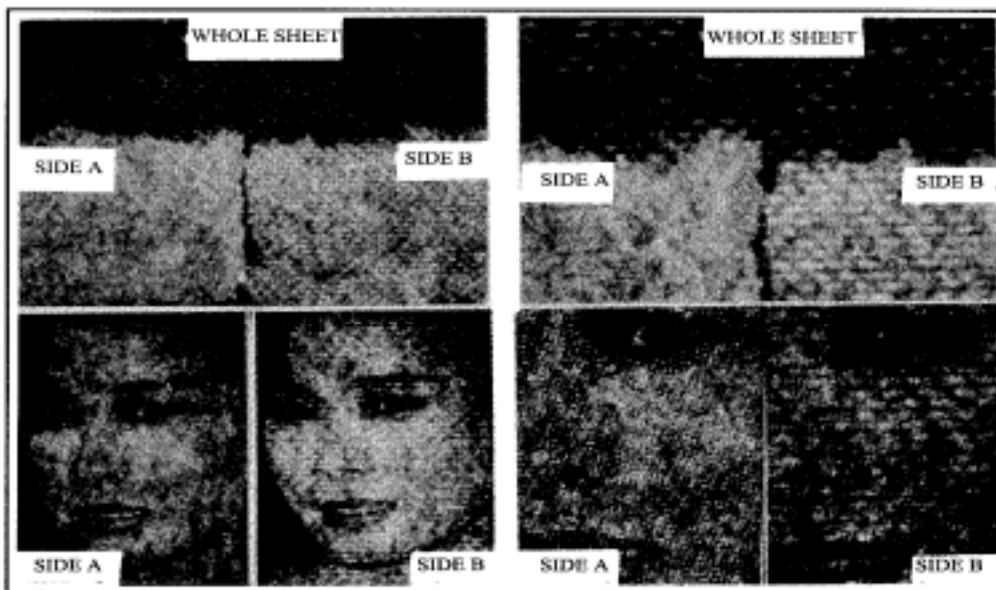


Fig. 3. The effect of two-sidedness on print quality.

The look-through photographs in Figure 4 show the typical density difference patterns of sheets formed on single-layer, standard double-layer, "x"-pick double-layer and triple-layer fabric structures. They also show, at the same magnification, the size of half tone printing dots at 70 lines/inch.

Particular note should be made of the relationships between the sizes of the dots that make up the half tone area of the print and the light and heavy areas in the sheet caused by the knuckles of the fabric structure.

The need to look at print quality on both sides of the sheet

is driven by the printers' customers' customers who pay large sums of money on advertising.

Figure 5 illustrates how variation in density on the surface of the sheet of paper will impact on dot spread, print gloss and strike-through.

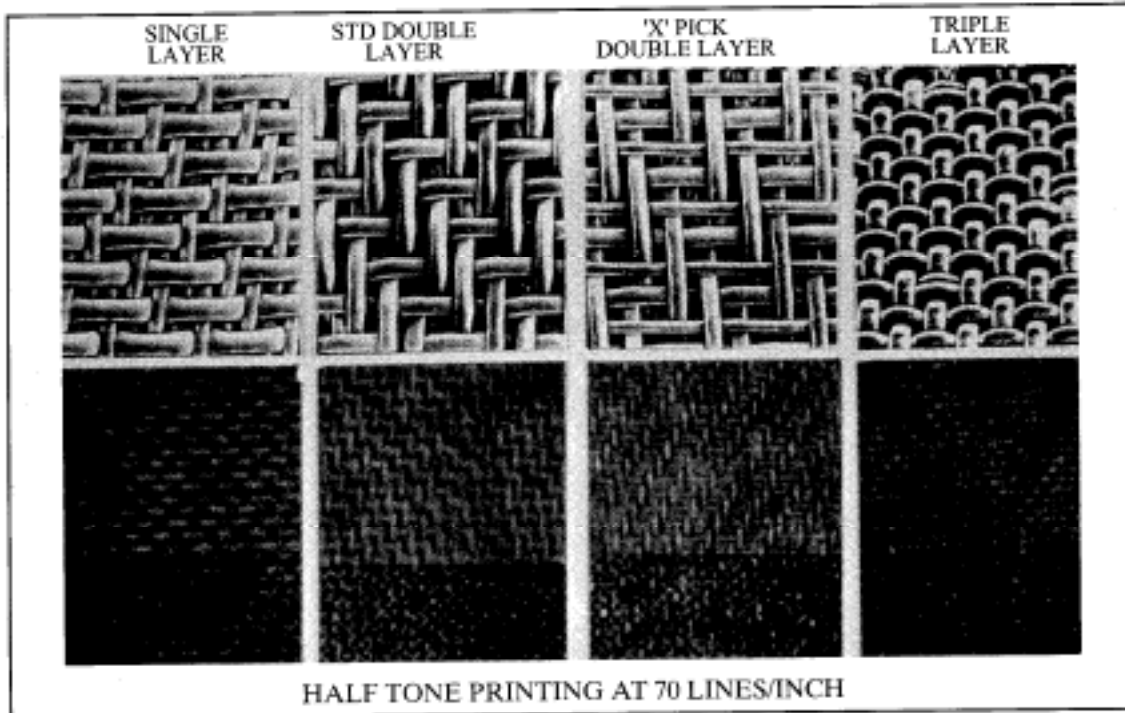


Fig. 4. Sheet density difference caused by different fabric structure

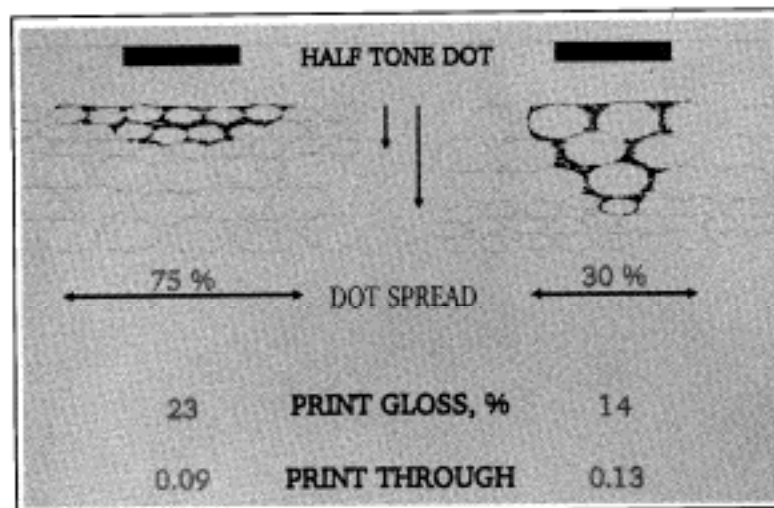


Fig. 5. Illustration of effect of sheet density on final properties of print.

Figure 6 is an example of print strike-through. It shows the backside of a sheet, which has been printed very heavily with a low viscosity ink. The pattern that can be seen is that of the knuckle pattern of the forming fabric structure on which the sheet was formed.

Figure 7 is a classic case where the printer simply said to the paper supplier that the print on the

left was unacceptable, while the one on the right was acceptable. The printer gave no reason why and the laboratory at the paper mill showed all tests to be within a reasonable range. It was not until we split the sheet and compared the resultant ink strike-through to the center that it showed that there was a non-uniform strike-through on the one compared to the other, and that strike-through on the left

had a very definite pattern which we knew to be that of a particular fabric structure and weave pattern. A close examination of the print surface reveals that the unacceptable print is caused by gloss variation on the surface resulting from variations in ink penetration. These variations stem from the inherent density differences caused by the fabric structure.

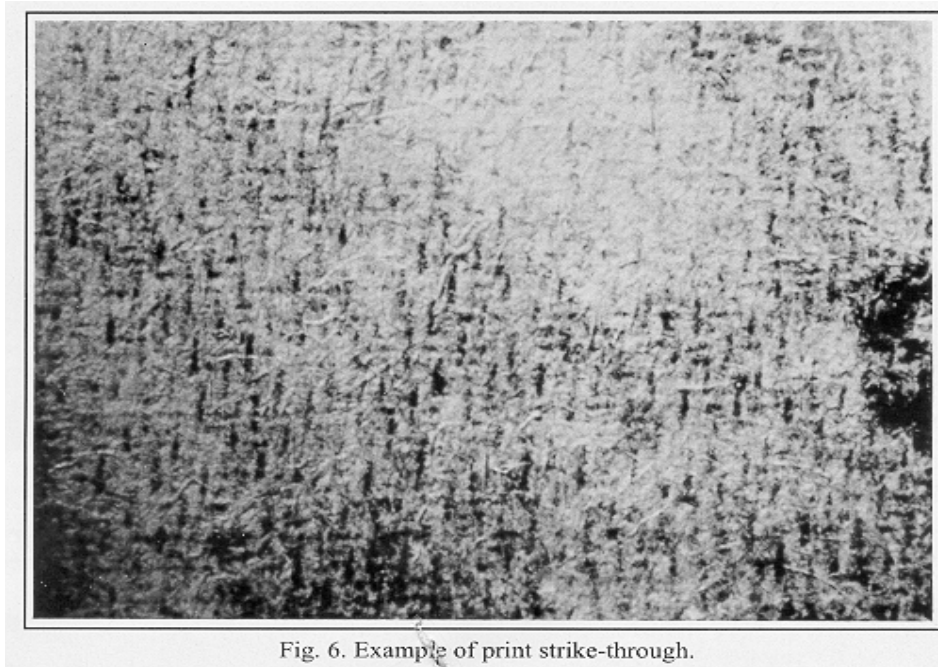


Fig. 6. Example of print strike-through.



Fig. 7. Printer's complaint. Split sheet analysis showing strike-through.

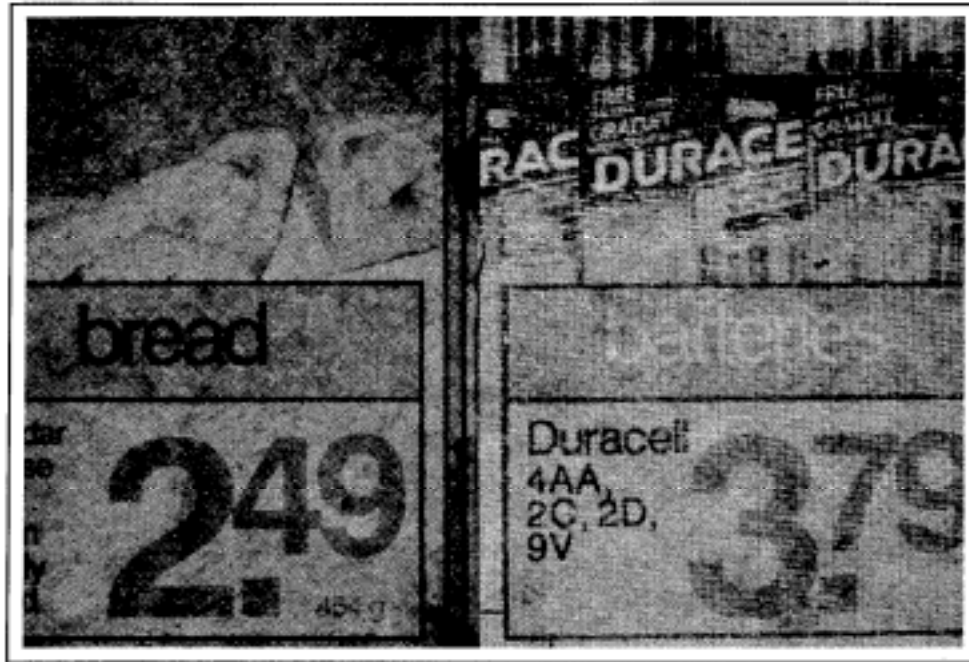


Fig. 8. Print quality on both sides of same sheet

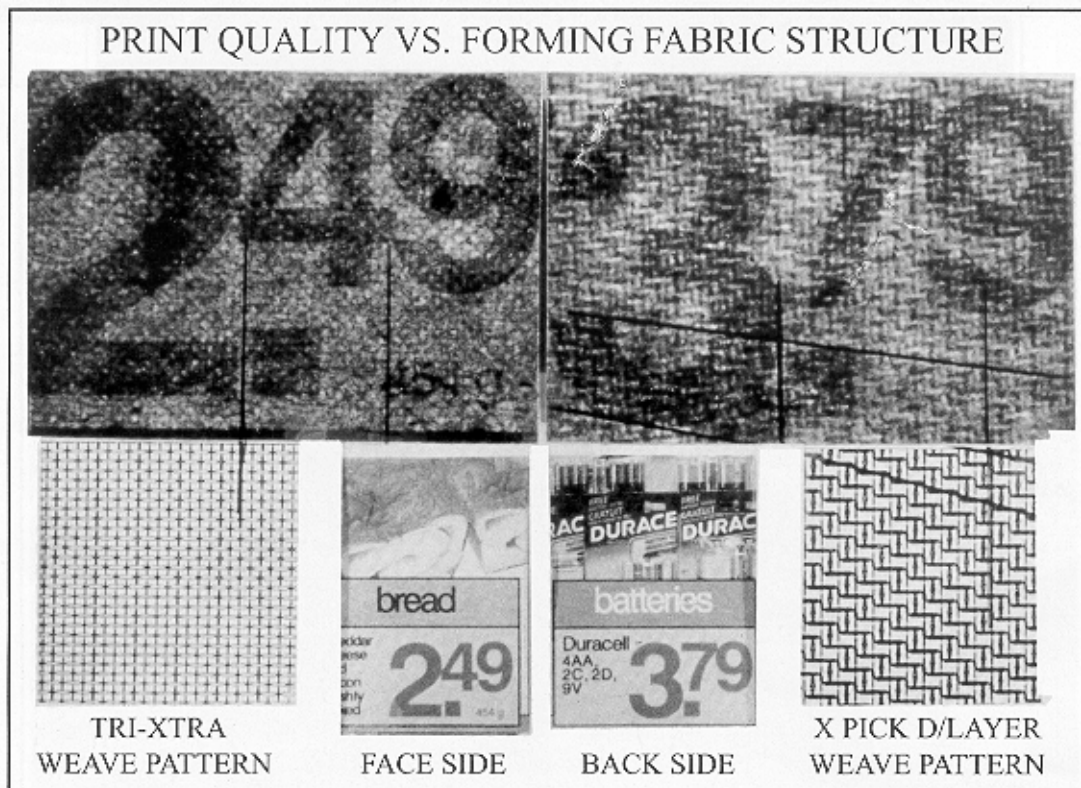


Fig. 9. Print quality directly affected by forming fabric structures used on the two sides.

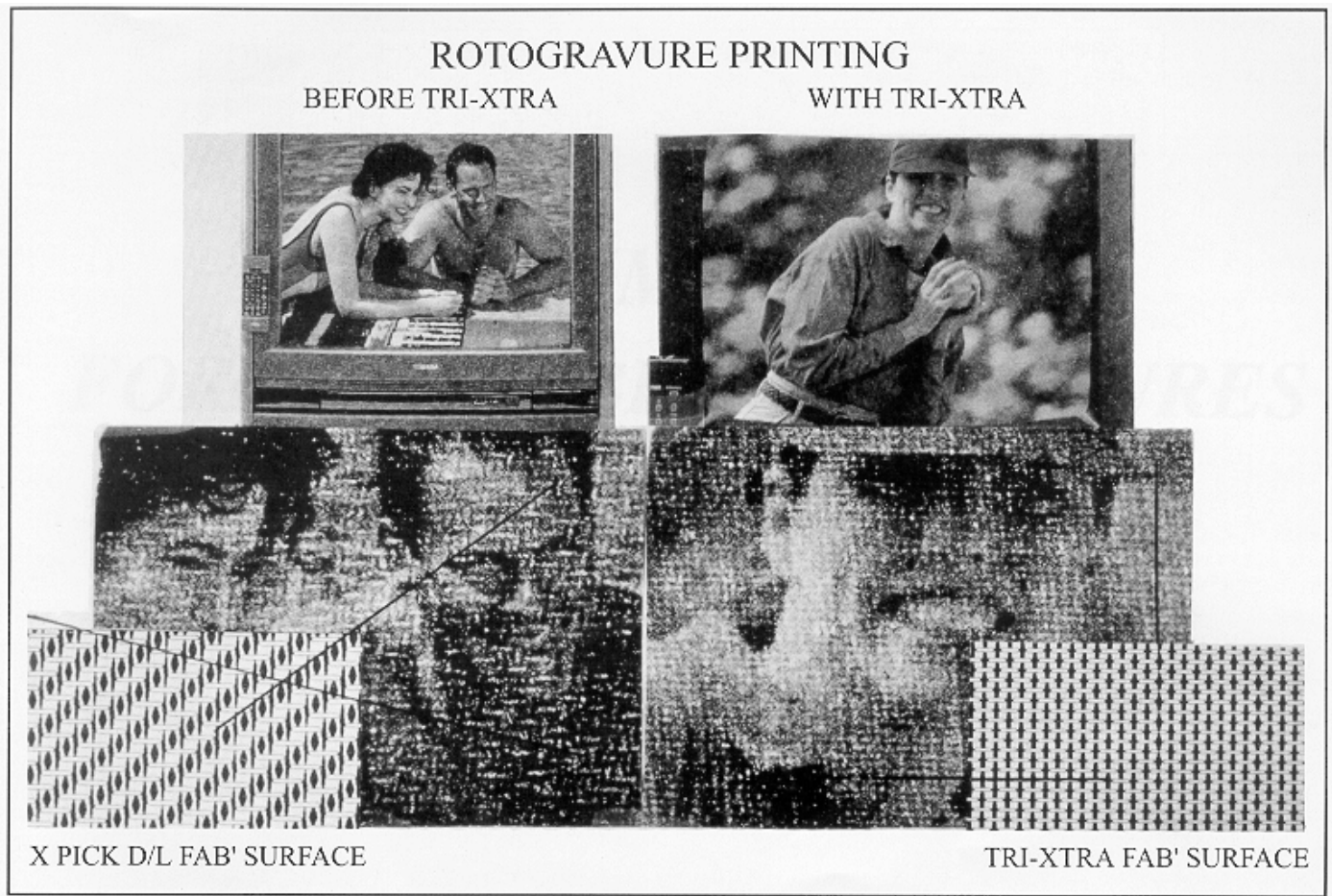


Fig. 10. Rotogravure printed samples from sheets made on the same paper machine - but with two different forming fabrics.

The result of our extensive work is that we now have all the information required to design a fabric structure, which would minimize these density differences and, hence, allow the papermaker to improve the printing qualities of his sheet. Figure 8 shows the end result of considerable dollar and time investment to achieve this end. The two prints in Figure 8 show the results of sheets made on the same paper machine but with different forming fabric structures. The print on the left shows the “2.49” and surrounding

areas to be very uniform compared to the “3.79” and surrounding areas on the right. Figure 9 shows these same printed areas together with magnified photographs of the “2.49” and “3.79” areas. Also shown at the same magnification is a computer reproduction of the surface of the forming fabric on which each sheet was made. From this example, it can be seen that the new improved forming fabric structure (TRI-XTRA) has produced a much more uniform density in the base sheet, resulting in a considerably more uniform and superior print quality.

Figure 10 is another example of how the new TRI-XTRA fabric structure dramatically improves print quality. The BEFORE and AFTER prints are on the **same side of the sheet** off the **same paper machine**. Figures 8, 9 and 10 demonstrate that forming fabric structures can have a considerable impact on the end product of our customers' customers' customer “the advertiser” – the person paying the bills at the end of the day.