

# The Printing Process

Sheetfed and heatset web offset  
printing technology



sappi

**The Printing Process, the sixth technical brochure from Sappi Idea Exchange**



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# The Printing Process

## Sheetfed and heatset web offset printing technology

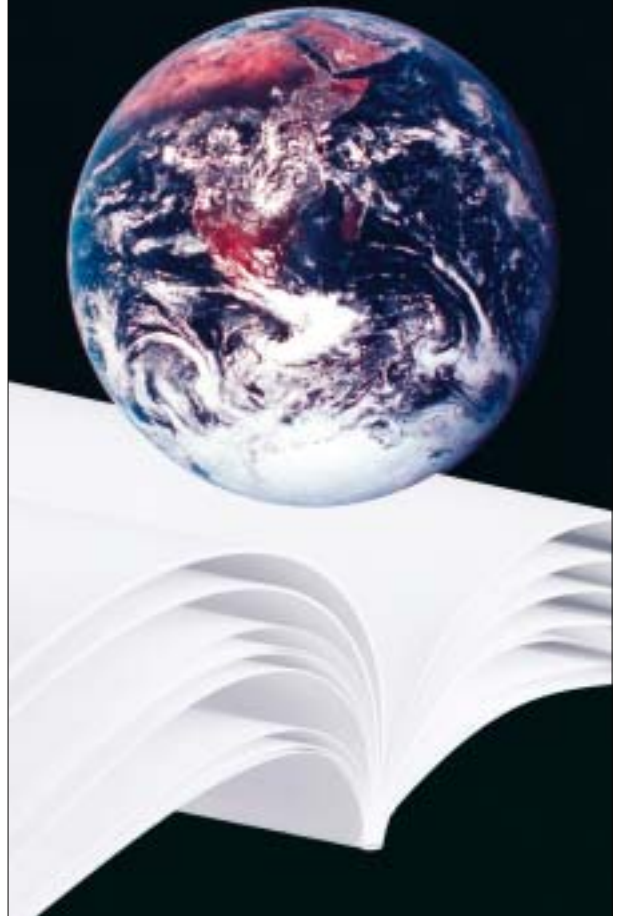
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# sappi

The word for fine paper



## I Vision

Though we may take it for granted, paper is always with us, documenting and reminding us of the limitless possibilities of life.

The printed page is immediate, its message cutting across cultures; a tactile experience that demands attention and creates desire.

It is a passport to knowledge, a storage medium, a persuasive tool and an entertaining art form.

Paper is a sustainable resource and a permanent document. It is the universal medium on which we chronicle our everyday history. Paper carries the past. It is the canvas on which we live the present and the blueprint upon which we design our future.

The printed word touches the lives of every individual on this planet, and at Sappi, we never stop thinking about this fact.

We are proud that Sappi is the world's leading and most innovative supplier of coated fine paper to the printing industry. Each of our brands has the perfect characteristics to meet the exacting demands of our print customers.

Our paper grades are printed on sheetfed presses and web offset presses.

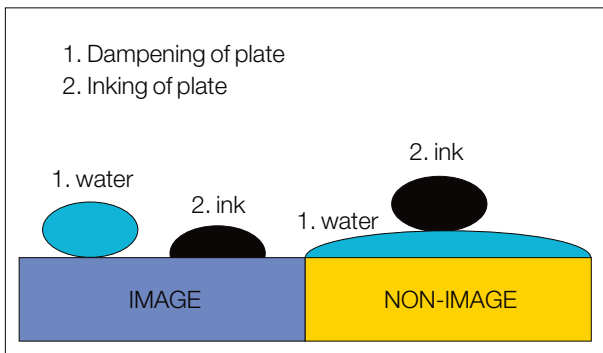
## II Printing

### Printing principle

Although the principle of offset printing is the same for both, the processing of sheets and reels differs considerably. In this brochure, we are going to explain to you the sheetfed and web offset printing processes.

The basic principle of printing is the mutual repulsion of grease and water.

The printing plate consists of water receptive parts and ink receptive parts. The printing image itself is ink receptive; the non-printing parts are water receptive.

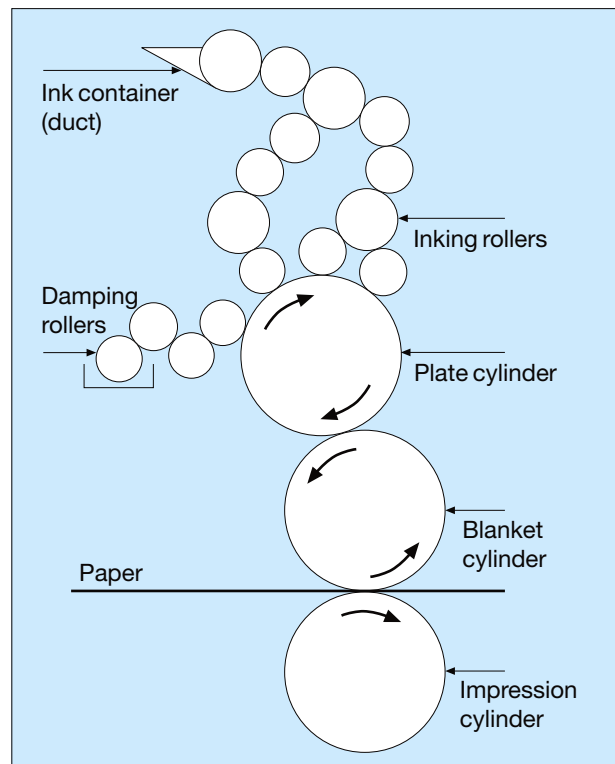


*Inking of the printing plate*

With each revolution, the printing plate passes first the damping rollers, which apply water to the non-printing areas of the plate. The presence of water means that those areas cannot accept ink. Now the plate passes the ink rollers, which apply ink to the water-resisting areas of the plate.

The inky images are transferred from the printing plate to the “blanket” cylinder. The blankets are made of rubber and transfer the images onto the paper – the cycle being repeated with each revolution onto fresh paper.

Full colour print involves the same paper being overprinted four times, each with a different colour on a separate printing unit.



This sketch of a sheetfed press shows the sequence of four single-colour printing units with their main components:

- an ink container (duct) with ink rollers,
- a fountain container with damping rollers,
- a plate cylinder,
- a blanket cylinder and
- an impression cylinder.

### Prepress

In order to be able to print, we need a printing image.

Images can be delivered to the prepress department in various forms – on CD-ROM or via ISDN for example. In the prepress department, the images are checked and edited. Page layout is done by computer.



*On this equipment, the image is transferred to the printing plate*

### III Sheetfed offset

#### Preparation of a printing plate

From a central warehouse, the pallet of paper is moved to the press, normally in a size ready for print. The paper is only unwrapped just before printing – to minimise the effects of humidity changes – and the pallet label is kept for reference.

Counting tabs are useful to estimate print quantities but must be carefully removed to avoid being taken into the press where they can cause blanket damage.

The prepared pallet is now wheeled into the press and lifted into place. Presses can usually be adjusted to deal with several sheet and pallet sizes and modern presses do this automatically.

#### Construction of a sheetfed press

A sheetfed press consists of three main parts:

The **feeder and lay system** ensures that the sheets are fed into the press one by one in exactly the same position.

The **printing units** each contain a plate cylinder plus ink and damping rollers, a blanket cylinder and the impression cylinder. Each unit prints a single colour on only one side of the paper.



Printing unit with printed sheet on the impression cylinder:  
1 Plate cylinder  
2 Blanket cylinder  
3 Impression cylinder with a printed sheet

In a 4-colour press, all 4 units are needed to build the multi-colour image on one side of the paper.

There are also presses with more than 4 units, even up to 8 units or more. An 8-or 12-colour press can print both sides of the paper in one pass by means of a perfecting cylinder between the 4th and 5th or the 6th and 7th unit, which re-aligns the paper for the second side.

Finally, the **delivery system** receives the sheets from the press and stacks them in a pile on the delivery board.



Heidelberg Speedmaster SM 102-12-P, Six over Six

## Sheet transport

Every sheet must be printed perfectly and consistently throughout the print run. To begin with, it is vital to feed sheets into the press one by one. The feeder uses air-blast and suction devices to separate the single sheets from the pile as they pass into the press.

Each sheet is blown free at the front and sides before being picked up by suckers and transferred to the feeder table. On some modern presses ionised air is used to avoid problems with static electricity.

Double sheet detectors help avoid jams by measuring sheet thickness. They automatically lower onto each sheet and stop the paper supply if doubles are detected.



*Double sheet detector*

It is vital that each sheet is positioned correctly lengthways and sideways. To avoid sheets being printed crooked they have to sit correctly with the front edge touching two front lays. Photoelectric cells scan the sheet's front edge and stop the paper supply if it is fed incorrectly.

Corresponding side lays pull each sheet sideways into the exact same position to ensure perfect register of each printed image.

Grippers – mechanical 'fingers' - now transport the sheet into the first printing unit, which usually prints in black, using the sequence of wetting, inking, blanket, and impression cylinder we explained earlier.

Further grippers then move the sheet to additional print units as required, in the sequence: cyan then magenta and finally yellow. These four colours, printed in small dots next to each other, build a complete multi-colour printed image.

## Sheet delivery

When the sheet has passed the last printing unit, the gripper system transports it to the delivery section. This stacks the sheets into a pile. At this moment, the ink is still wet, which might cause the sheets to stick together.

To avoid this, a very fine powder is sprayed onto the freshly printed sheet, called anti set-off powder.

Finally, complete printed piles are wheeled from the press.

## **Ink setting**

Although the printer mounts fixed plates onto the plate cylinders in the press, there is other information about the image which comes separately from prepress equipment. These data are used for initial adjustment of the ink supply.

On the ink supply control panel, each row of lights represents a certain position on the ink roller and therefore also a section of the image. Flashing lights mean the ink quantities are being adjusted. The printer must fine-tune the settings manually and can adjust the ink feed for each separate section.

Looking more closely, you can see the changes on the ink roller: at first it shows an even colour, but then a pattern emerges where certain sections become less or more intensely saturated.

Once the ink is set up, the plates are mounted on each colour unit, either by hand or automatically. Extreme care is needed because even small scratches on the plates would be visible in the printed image.

## **Printing plate make up**

The plates must all be in accurate register so that the image of each separate colour will be in exactly the same position on the sheet. Every plate has register holes to locate it precisely and consistently on both the machines where it is first made and then on the printing press. This ensures accurate register on the press.



*Automatic plate mounting*

## **Computer to press**

Modern presses can also be equipped with computer-to-press-technology, which does not need printing plates. The computer transfers the images directly to the special print-form-cylinder. A part of these machines can print waterless that means without dampening of the printing plate.

## Register position

The press is now ready to produce the first print and the printer immediately starts making colour and register corrections. He keeps on correcting and adjusting until the desired optimal printing result is achieved.

Although the plates are mounted very accurately on register pins they can still need fine adjustment to be perfectly aligned.

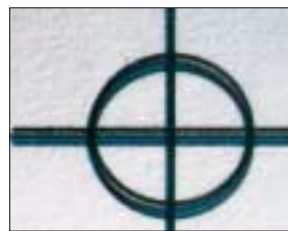
To correct an image where the colours are far apart, the printer uses the so-called register marks, for correcting the plate positions until the register marks appear correctly.



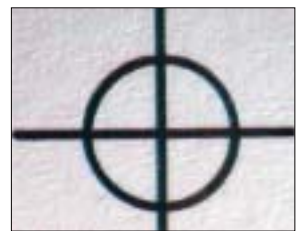
*Register differences*

This is an exaggerated out-of-register sheet with the four colours clearly not lined up properly.

After adjustment, the colours are printed in exactly the same position and the picture becomes clear.



*Register differences*



*Exact register*



*Densitometer*

## Control during the print run

Colour control is achieved using a densitometer or scanner to measure the control strip, which you see here in detail. Measurement results for each colour tell the printer whether to give more or less ink in a certain area.

The print must match the original or the fixed system data as closely as possible. Sample prints are scanned and analysed against the original data. By fine-tuning the ink supply, the results come closer and closer to this colour model. Settings can then be stored in integrated software or recorded on computer tapes for optimal print and re-print runs.

As soon as the prints satisfactorily match the original and the colours register perfectly, the real print run starts. However the press operator continually takes sample sheets to monitor and maintain ongoing colour and register throughout the run.



*Operating console of a sheetfed press*



*Folding machine*

## Finishing and folding

The printed sheets are folded according to the required end result on a folding machine in a separate print-finishing area, in this case on a three-fold unit, ready to be assembled into the pages of a publication.

## IV Web offset

Although the transfer of print to paper follows exactly the same principles in both sheet- and reel-fed presses, the layout of a **heatset web offset press** is very different from a sheetfed press.

The printing units of a heatset web offset press are similar to those of a sheet offset press. One unit consists of two printing couples. Each couple has its own ink tray duct, dampening rollers, ink rollers, plate cylinder and blanket cylinder, but no impression cylinder.

This is because in heatset web offset printing, both sides of the paper are printed simultaneously. This is called blanket-to-blanket printing. The web runs between two blankets, each printing opposite sides of the paper.

A heatset web offset press usually consists of four printing units, on which 16 pages of A4 can be printed. There are also many 24 and 32 page presses and the trend is towards even bigger presses that can print 48 and even 64 pages.



MAN LITHOMAN, 4/4 - colour heatset web machine

## Unwinding unit

The paper must be fed into the press through a reel splicer. The splicer enables the press to work non-stop at high speed, as successive reels are unwound and spliced together while the 'web' of paper is kept at the proper tension.

As with sheet pallets, the reels are stored in a warehouse until just before the intended print job goes on press, so that they stay in top condition.

At the press, the reel is unwrapped, checked and registered. Again the label is cut out and kept until the reel has been printed successfully. The outer windings are discarded in case of damage which might cause a web break in the press. The reel is then lifted into place and aligned.

As the first reel runs through the press, a second reel is mounted, and a splice is made ready using double-sided tape. The newest presses are equipped with devices which do this automatically. Controlling the removal of damaged outer windings and correct positioning of the reel in the reel-stand may be automatic as well.

The splicer displays readings for data such as the identification number and weight of the reel, the number of prints remaining on the reel, time remaining before the next reel is pasted and so on.

The web edge guide guides the paper web, so that it stays in the correct position. The system works with an optical web guidance mechanism that keeps the reel central.

The next spliced reel automatically starts when a pre-determined amount of paper is left on the rest reel.

The infeed produces the required webtension through the printing nips up to the chill stand.



*Double sided printing in a printing unit*

## Heatset web offset

Heatset inks dry by evaporation of binding agents in the ink, and to do this, the printed web is heated by hot air in a drying oven. This oven consists of several compartments, each with its own temperature.

Usually, the first compartment has the highest temperature, with each following compartment set to a gradually lower temperature. The final temperature of the web as it leaves the oven is usually between 100 and 130°C, depending on the paper quality, the paper grammage and the ink coverage.

Dryers can be 12 or more meters long, depending on the maximum printing speed of the press. As a rule, the paper must remain in the oven for at least 1 second, in order to dry properly. In other words, if the press operates at a printing speed of 10 meters per second, the oven needs to be at least 10 meters long.

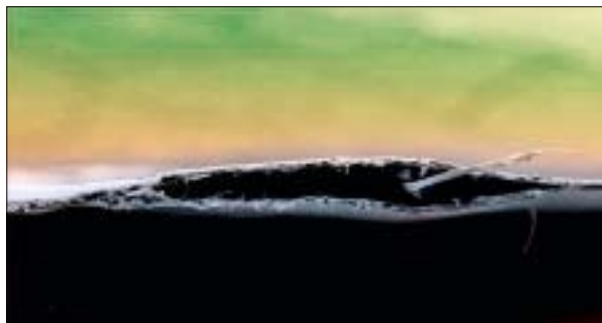
The evaporating binding agents are burdening to the environment and are therefore burnt at approximately 900°C in an integrated or separate afterburner installation.



Hot-air jet dryer

## Blistering

As the ink dries, so does the paper. If the paper is sensitive to blistering, or if the drying temperature is too high, blistering may occur in areas with heavy ink coverage.



Blistering in the paper

## Breaking at the fold and re-moistening

When the paper dries out in the oven, the fibres become brittle, making the paper sensitive to breaking on the fold. To avoid this and to keep overall fibre strong, some presses have special re-moistening installations which add moisture to the paper after it leaves the drying section and before it enters the folding section.



Breaking at the fold

## Shrinking of the paper web

Re-moistening also compensates to a large extent for the shrinkage caused by the drying oven. Sheets do not have this problem, since they are not dried at high temperatures. This is a particularly important issue when reel and sheet jobs are processed together to produce a single end product such as a magazine, creating differences in page size if not corrected.



*Re-moistening*



*Chill roll*

## Chill rollers

Chill rollers are used to cool the paper and ink from web temperatures of over 100°C down to around 25 to 30°C. The sudden temperature drop causes the ink to settle down and makes it tough enough to endure the forces applied by subsequent guiding rolls and the folder.



*Silicone application*

## Silicone application

When the web has cooled, a thin layer of a silicone-water mixture is applied on both sides. This produces a smooth surface and prevents the ink from smearing in the folder. It also prevents static electricity occurring. An excess of silicone, however, will cause stains on the printed image.



*Operating console of a web offset press*

## Operating console

Sheetfed offset presses are frequently halted during their runs to allow small adjustments, but web offset presses are run at continuous high speed, so all adjustments have to be made while running. The register is checked by a stroboscope and computer controlled monitors allow the operators to fine-tune the printing process.

The latest generation heatset web offset presses achieve maximum printing speeds of 80,000 to 100,000 copies per hour and most current presses average 50,000 copies per hour.

Adjustments therefore have to be made quickly to minimise wastage. The number of prints wasted before reaching production quality varies from 3,000 to 7,000, depending on the printed image and press pre-setting.

After printing, the paper web must be folded to page-size ready for cutting and binding.

## Folding process

Depending on the required end product, the web may be split into 2 separate halves before folding. The turner-bars guide the web according to the desired folding method and some designs use a compressed air cushion to prevent damage to the printed image. Alternatively, the full paper width can be folded uncut.

The first fold is usually applied on the former folder, which also uses compressed air.



*Former fold*



*Fold-Softening*

To make folding easier, a narrow strip of water can be applied in the so-called **fold-softening** unit.

The second fold is usually a **cylinder fold**, followed by a third, or so-called **chopper fold**.



*Cylinder fold*



*Chopper fold*

## Stacker

Books and magazines are printed and bound in sets of 8, 16, 32 or more DIN A 4 size pages, called 'signatures' in printers' jargon. As each is printed and folded, the signatures are laid out partially overlapping onto a stacker. The work at the stackers can be a manual or a semi automatic process.



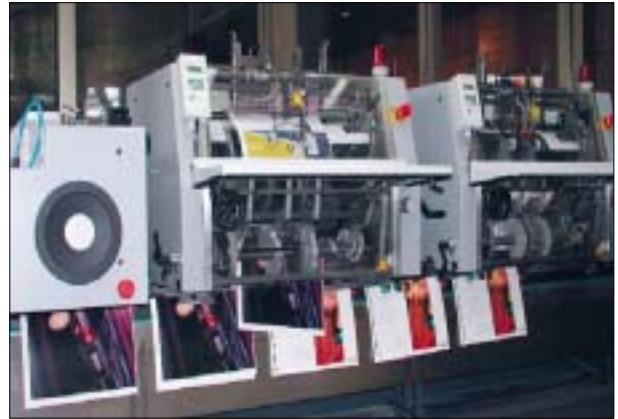
*Stacker*



*Sheeter*

## **Sheeter**

Manufacturers of printing presses offer a lot of different folding layouts. But sometimes the number of combinations is limited or the paper weight is too high for the required folding. For heatset web offset printing of the higher grammages, presses must have a sheeter installation which cuts the paper web into sheets after it has been printed. These sheets are then folded on a separate folding machine.



*Stitcher-gatherer*

## **Stitcher-gatherer**

Whether the folded signatures come from reel-fed or sheet-fed presses, the final step is the same: the stitcher-gatherer assembles the different signatures in the right sequence, with cover sheet if required, to create the finished publication. Each assembled set of pages is then stitched or glued together and cut to the final published size.

## V Concluding remarks

In a world driven by knowledge and creative ideas, paper always has been, and always will be, a powerful communication medium. Even in this electronic age, the printed word continues to motivate, educate, enthrall, inspire and document our lives.

At Sappi, we are relentlessly innovating and developing new standards of excellence for our products, ensuring that they meet the stringent demands of the print industry. With the annual Sappi Printer of the Year awards, we encourage printers around the world to share this continuous quest for the very best printed products.



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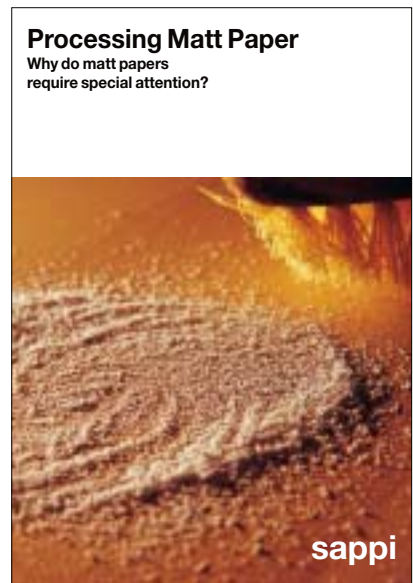


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The Printing Process video and the other technical brochures are freely available at our knowledge bank:

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