A guide to wallpaper printing

The available design styles and finished printed looks of wallpaper are so numerous that it would be almost impossible to fully detail all of the printing permutations available. This is easy enough to accept once it is understood that wallpapers can be printed with water or solvent based inks. They could be part printed on one print process and then transferred to any one, or more, of the other available processes. The paper grade also affects colour and so plays its own part.

For purposes of explanation and understanding, the individual print processes have been explained in detail on the following pages. Each of the processes are, or have been, the most commonly used for the mass production of wallpaper within the industry over the last 500 years. They have been sequenced in date related order as they were introduced for wallpaper printing.

1 BLOCK PRINTING
2 FLOCK (BLOCK PRINTED)
3 PAN (TROUGH) PRINTING
4 SURFACE PRINT
5 FLAT-BED SCREEN (LONG TABLE)
6 ROTARY SCREEN
7 FLEXOGRAPHIC
8 GRAVURE

It is important to note that no print process is superior to any other, they are just different. The desired finished effect being individually tailored to suit a particular client or marketplace.

It does naturally follow that as technology has advanced over the years the more recent processes will produce more technologically advanced wallpaper. However, this isn’t always the desired option as, in particular, processes such as Block and Screen printing are desired because of their idiosyncratic character. Perfect butt joins from Block printing are no more achievable today than they were 450 years ago and the flaws and blemishes produced by the crude method are very much a part of the charm.
Now, regardless of which print process is utilised, the design itself is built-up in one of two ways, or possibly a combination of both. In simple terms it will either be

**In-register, Fall on or a combination of both.**

**THE FALL-ON DESIGN**

The fall-on route continually prints each colour either fully or partly on top of the previous colour, building up the complete design as it does so.

Unlike ‘in-register’, more care and skillful consideration has to be given to the choice and subsequent use of colours, as any colour falling on top of another will almost certainly change both of them.

This is due to most printing inks, particularly **solvent** based ones, being semi-translucent.
THE IN-REGISTER DESIGN

An in-register design is where each colour is ‘registered’ to sit tight against the previously laid down colour without any overlapping. This would apply to all the subsequent colours laid as the design is progressively built up.

The beauty of this route is that it allows the achievement of very strong, bright colours. This is because a hole is left in the first print colour to allow all the other colours to print onto clean white paper. (This cylinder is called the choke cylinder).

Printing onto a white background means that the subsequent colour is not influenced by the previous underlying colour. eg: if you print the colour red onto white - it remains red, whereas if you print red onto yellow, it will appear orange.
Note no overall background colour. Each subsequent colour is ‘fitted’ inside the previous one, the first colour being referred to as the ‘choke’.
1 Block printing

The first known method of wallpaper printing. Recorded as having been used as early as 1509. Prior to this plain paper was pasted to the wall and then hand drawn and coloured in by artists. Continued as the only ‘real’ means of printing wallpapers until the introduction of the ‘Printing machine’ some 300 years later.

**WHILE TECHNOLOGY MAY HAVE REVOLUTIONISED THE PRINT INDUSTRY LIKE NO OTHER, IT HAS FAILED TO PRODUCE ANY METHOD THAT MATCHES THE TACTILITY OF HAND BLOCK PRINTING. ITS SIMPLISTIC BEAUTY COULD NOT BE DEMONSTRATED ANY BETTER THAN IN THE MANUFACTURE OF THESE TRADITIONALLY PRINTED WALLPAPERS.**

Historically, the wood of fruit trees, such as cherry and pear, has been used for the printing blocks as this timber offered the right balance between durability of use and the practicalities of cutting the block. Softwoods, such as pine, could not withstand the pressures put upon them by the press; whereas harder woods, such as oak or maple, whilst having excellent wear qualities, were simply too hard for cutting by hand.

However, in recent years there have been limited developments whereby other more modern materials, such as Linoleum, plastic and metal, have become available. Given that these materials are inherently more stable than wood that can twist, warp and crack, it would be a fair bet that had they been available 400 years ago, they would certainly have been used.

The look of block printed wallpapers, peculiar to itself, is not necessarily created by the materials used to make the block, but from the ‘splodge’ created by the vacuum as the printing block is pulled away from the paper.
For the process of printing, the craftsman utilises a table, padded with blankets, on which the paper is laid. Next to the table is a wooden, wall-sided tray, inside of which there is an absorbent blanket that is saturated with the coloured pigment.

The printer colours the block by lowering it down onto the colour tray, and once sufficiently inked is lifted and manoeuvred over to the paper by an arch lever system (crane) before being pressed down to create the print. Pins on the side of the blocks guide the printer in placing the block exactly into position. Accuracy and strength of colour is effectively governed by the printer’s ‘gut feeling’ on how much pressure needs to be applied to the back of the block.

After each individual colour has been laid the paper is ‘festoon’ hung for 4-5 hours to let the thick water-based inks dry, before the next colour is applied. Once all of the colours have been printed the wallpaper is PVA lacquered for protection, before being manually trimmed and individually hand wound.
Believed to have been introduced in the late 17th Century, possibly inspired by the flocked canvas hangings popular in Holland. The grandest designs of this period would have had a 6 or 7 ft pattern repeat, made up of 3 or 4 blocks. Originally the flock would have been a by-product of the wool industry, however, this was later replaced by rayon fibres. Rayon fibres, when subjected to static electricity, stand erect giving a plush velvet type feel. Rayon also, compared to wool, made the wallpaper spongeable – this was to prove an important step forward.

FLOCK WALLPAPERS ARE TRADITIONALLY PRODUCED USING THE BLOCK PRINTING METHOD. (SEE PAGE 44). THE SUBTLE DIFFERENCE BEING THAT ONE (OCCASIONALLY TWO) OF THE COLOURS ARE SUBSTITUTED FOR RAYON OR WOOL FIBRES THAT GIVE THE PRINT A SOFT VELVET-LIKE FEEL TO THE TOUCH.

To achieve this the printer progresses in the normal block print way, except that instead of using a colour pigment he will substitute it for an adhesive. This adhesive is very tacky and is comparable in looks to white gloss paint. It can be tinted using pigments to mimic the colour of the flock being used, this adding to the dramatic effect of the finished paper.

Once the paper has been printed with glue, the length of wallpaper is drawn across a canvas bed where the fibres are traditionally scattered, normally by hand, from above. Wooden canes or battens
constantly beat the underside of the canvas bed, making the rayon fibres rub together as they jump up and down. It is this rubbing that is the key to good flock printing. As the paper is beaten static electricity is created, which has the desired effect of making the rayon fibres stand on end, like iron filings on a magnet, whereupon the glue sets hard, holding the fibres in the erect position.

The paper used for flock printing is heavier than standard wallpaper, normally by around 25-35%. There are two reasons for this, firstly because flock is very heavy and a standard paper would not hold the weight. And secondly, the paper has to withstand a lot of abuse during the beating stage and a thinner, lighter paper would tear easily.

Because of the slow drying speed of the glue the paper is festoon hung to dry, which can take 2-3 days for each flock colour used.

1 An example of a double-flocked wallpaper
2 Block printing of the glue for the second colour of flock on a double-flocked paper
3 Flock being hand-scattered from above whilst the canvas bed, that the paper is lying on, is beaten from underneath
3 Pan (trough) printing

Introduced mid 1500's as a means of evenly colour-washing backgrounds for block printing onto, this previously having been done by hand. This process was first documented in 1798 as having been used by a company called Harwoods of Old Bond Street, London.

PAN PRINTING IS A SIMPLE PROCESS. IT IS ONLY THE VISCOSITY (FLUIDITY) OF THE INK THAT GOVERNS HOW MUCH IS APPLIED TO THE PAPER. THE PRINCIPAL OF PAN PRINTING IS BASED ON A SIEVE, WHEREBY INK IS ALLOWED THROUGH THE BASE OF AN ELONGATED TROUGH THAT COVERS THE WIDTH OF THE PAPER.

At the bottom of the trough is a steel sheet that has holes drilled through it to create a thin strié stripe as the paper is drawn, by motor, underneath it.

To create a wide stripe an elongated channel would be cut. Alternatively, it could just be a single thin long cut across the full width of the trough, thus allowing a complete and even coverage of the paper with ink, for use as a background colour.

Whilst pan printing is a process in its own right, creating deep, rich, tactile stripes or strié type prints, it is more often used as a backdrop to other processes, the most common of these being block printing.

The process of printing is simple enough. The tray is continually filled with the water-based inks that are released through the sieve-like plate underneath the trough, which sits above, and almost touches the face of the paper.

The paper is drawn through at a controlled speed, ensuring an even and consistent distribution of ink. If only a small amount of ink was required then the width of the groove would be cut very thinly; thus restricting how much can get through. For a richer, deeper colour, the groove would be cut much wider, thus ‘dumping’ more ink onto the paper.
Like **block printing**, once the paper has been printed it is festooned onto a track suspended from the ceiling and allowed to dry.

The inks have to be fully cured before the paper can be taken down and re-rolled, ready to be put through the process again for the next colour, or moved on to a second print process.
4 Surface print

Magnified shot of Surface printed wallpaper. It shows the ‘smudging’ together of the inks as they are laid wet on wet. The result of this is an overall ‘soft’ look to the design.

Invented 1839. Continued as the only mechanised means by which to print wallpaper for the next 100 years. It was responsible for making wallpaper available to the masses and its immediate success marginalised block printing.

THE SURFACE PRINT MACHINE IS THE OLDEST OF THE MECHANISED PROCESSES AND IS PREDECESSOR TO THE RELIEF PRINTING FLEXO MACHINE.

Its construction is very reminiscent of a flexo machine in that it has a large drum cylinder, approximately 1.5 metres in diameter, with print ‘stations’ spaced around the circumference; the major difference being that the Surface machine generally has between twelve and twenty stations against the flexo’s six.

The print cylinders themselves are made of a very hard ‘ceramic’ type rubber and the area that you don’t want to print is cut out from it, leaving the printing surface ‘proud’ on the cylinder.

The inks are water-based and transferred via a rotating woollen or felt blanket. The blanket is soaked with ink at one end, whilst the other end is touching the back of the print cylinder. As the conveyor belt type blanket rotates it picks up the ink from the tray and delivers it onto the back of the print cylinder; the ink is then impressed directly onto the paper as it’s rotated. The amount of ink transferred onto the cylinder is determined by the absorbency of the blanket. The more porous the blanket, the more ink; the harder the blanket, the less ink.

Because water doesn’t evaporate in the same rapid way as solvent does, it is still wet when that part of the printed paper reaches the next print station. This process of wet ink falling on wet ink creates an effect whereby the colours lightly ‘bleed’ into each other, giving a very soft visual finish.
Surface printed papers are very distinctive, identified by the soft reticulation of inks and the dark lined edge around each separate colour, created as the ink is squeezed out under pressure from the cylinder.
5 Flat-bed screen printing (silk screen printing)

Introduced as a means for printing wallpaper in the early to mid 1940’s – later being introduced into Britain, from America, in the late 40’s. Short run lengths were again possible. Although it was slow to produce, low origination costs and cheap labour at the time made this a cost effective proposition. Particularly useful at the time for printing full-wall murals with no regular pattern repeat.

Traditionally, screen printing was called ‘silk screen printing’ because, rather obviously, the stencil screens were made of silk. This term has carried over into modern times even though nylon is commonly used. It is a relatively simple process that produces wallpaper with a wonderfully rich depth of colour.

The screen is a rectangular frame with a fine polyester nylon woven mesh stretched across it. To create the design it is first necessary to completely coat the screen with a photosensitive polymer, the stencil of the design is then placed flat onto the mesh before the screen is ‘photo-exposed’ under special lighting.

This exposure hardens the polymer into an impenetrable lacquer. The area that was masked by the stencil remains fluid and once the screen is washed the stencilled off area once again becomes open mesh. This allows the printing inks through.

To print the screen is placed face down onto a long flat table that has a length of wallpaper laid tight against it from one end to the other. A typical table would be 2 metres in width and 31 metres in length. (Because of this rolls of
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Wallpaper are often supplied as a single ‘ triple’ roll that is three times the length of machine printed roll; 30 metres instead of the standard 10).

The thick water based inks are applied to the back of the screen and are drawn across the mesh using a rubber squeegee (imagine a car windscreen wiper blade), forcing the ink through the areas of open mesh in the shape of the design. Once the colour is laid the screen is lifted and moved along to the next position, where the process is repeated. It is important that the inks are allowed to fully dry before any subsequent screens are placed on top, this is to prevent the screen potentially picking off the previous colour laid down, smudging the design. To counter this potential problem it is normal to print every alternate screen, before going back and filling in the gaps once the inks have dried.

The opportunity to use a limitless amount of strong, rich opaque colours, make these wallpapers very desirable.

However, the process is labour intensive and demands constant vigilance. As such, wallpapers produced this way tend to be comparatively expensive and are therefore generally aimed at the top end of the market.

1 Typical double screen
2 The print tables at Anstey are 30m long so 3 standard rolls can be printed at a time
3 Ink being drawn across the mesh using a squeegee
Rotary screen printing

Introduced soon after ‘Flat’ screen printing in the early 1950’s. Taking advantage of improvement in inks the process allows a similar look to flat table printing whilst offering the advantages of ‘continuous printing’ manufacturing costs.

Rotary screen printing is a relatively recent development of flat bed screen printing. It can print a continuous web of moving paper, upwards of 3000 metres long, as opposed to the limiting length (normally 30 metres) of flat screen printed wallpaper.

The screen would have a width of up to 68cm and be between 64 and 100cm in circumference, thus allowing relatively large pattern repeats.

A typical rotary screen print machine would have an in-line configuration with upwards of seven or eight print stations available, each printing one colour. The cylindrical printing screen itself is a very fine ‘honey combed’ type mesh.

The screen is produced by photochemical means, in that a photopolymer coating is applied to the surface of the screen before photographic exposure causes it to harden on the mesh. Therefore to create the design it is just a question of ‘masking off’ the mesh with a stencil in the desired shape. The areas of the mesh that have been hardened will not allow ink through. Therefore as the ink is squeezed, under pressure from the inside of the cylindrical mesh, by way of a
rubber squeegee, it exits through the open mesh that was masked during the photo-exposure. The inks used in this process are quite opaque, and rich colours are achievable. It is important that the ink is fully dry before the paper reaches the next print station, thus ensuring no show through or smudging of the inks from the colour underneath. This is done by hot air dryers between each print station.

Whilst rotary screen may principally be similar to flat bed screen, it does have the benefit of being cheaper, due chiefly to it being a continuous print process.
7 Flexographic printing

Introduced into Britain in the early 1960’s. Similar in principal to (and a development of) **Surface printing**. This proved a very cost effective way of printing at a time when production costs and performance were particularly important in a competitive market.

**FLEXOGRAPHIC PRINTING, OR 'FLEXO' AS IT IS MORE COMMONLY REFERRED TO, IS A RELIEF TYPE PRINT PROCESS THAT USES A RELATIVELY SOFT RUBBER PRINT CYLINDER WITH A 'RAISED' PRINTING SURFACE. THE AREA YOU DO NOT WANT TO PRINT IS CUT OUT OF THE ROLLER, LEAVING THE RAISED AREA FOR ACCEPTING THE INK, IN A SIMILAR WAY TO A HAND HELD RUBBER STAMP IS CUT.**

The print stations are equally spaced around the outside of a large cylindrical drum that carries the paper, face out, around it. This drum is approximately 1.2 metres in diameter, however, a **flexo** machine can, if room permits, have an ‘in-line’ configuration, as a **gravure** machine does.

The print roller itself will be typically 52cm in circumference and between 52 and 68cm.

The ink is transferred from the ink tray to the print roller via an ‘anilux’ roller, the purpose of which is to both even out and determine how much ink is transferred onto the cylinder.

A deeply cut anilux roller will transfer more ink than a shallow cut one. As the print cylinder rotates the ink is transferred directly onto the paper as it’s squeezed against the large cylindrical drum.
This process will readily accept the use of either solvent or water-based inks, although like gravure, solvent based inks are considered more stable for printing purposes.

**Flexo** printing is such a versatile print process that, along with the wallpaper industry, it is used extensively in the packaging industry, for printing such things as plastic bags, crisps packets, cardboard boxes, etc.

In keeping with most relief type print processes **flexo** cylinders lay down a single flat colour, therefore if numerous tones of the same colour are required, for say, shadowing purposes, then each colour would require an individual cylinder. Although in recent times advances in cylinder cutting technology have resulted in **flexo** rollers that now produce a reasonable degree of tonal work.

1. Close up of **Flexo** cylinder showing ‘raised’ print motif

2. The **flexo** print machine showing the ink transfer from the ink tray via an anilux roller onto the print cylinders
8 Gravure printing

Introduced c.1954 as a development of photochemically etching a design onto a copper plate that was then wrapped around a base. Its introduction into Europe in the early sixties, along with flexo printing, almost entirely ousted the current technology of the time.

The tiny recessed chambers really need to be viewed under magnification to fully appreciate how shallow they are, being as they are, only microns deep. These recessed indentations are referred to as ‘cells’ and it is not unusual for there to be, dependent upon the complexity of the design, tens of thousands per square inch. The depth and width of each cell determines how much ink is applied to the paper, and subsequently the strength of colour. The shallower the cell, the lighter the colour; the deeper the cut, the more ink is applied and the stronger the colour.

On the print machine the cylinder sits partly submerged in an ink trough, whereupon the engraved cells ‘fill-up’ with ink as it rotates. Before the cylinder can release this cargo of ink the excess, which is laying on the surface of the cylinder, has to be removed. This is done using a razor sharp ‘Doctor blade’ that runs the width of the cylinder. The acutely angled blade...
skims the surface of the cylinder scraping the ink that is not stored in the cells, back into the ink tray.

The print cylinder is then squeezed against a rubber roller with the paper as its sandwich. During the high-speed rotation of the cylinder the cells release the ink onto the face of the paper.

The major benefit of Gravure printing is the ability to print fine tonal work and gradation of colour using a single cylinder. This gradation of colour, governed by the depth and width of each individual cell, can be from a solid colour through to anything as subtle as a 20% tint.

Combine this with the fact that a typical Gravure machine may have 8 or more cylinder stations, it is easy to appreciate that the perceived amount of colour achievable is extensive.

WHilst Water-based inks can be used for Gravure, it is more usual to use solvent based inks, as these tend to give better controllability and continuity of colour. A printing benefit of using solvent inks over water based ones is the speed with which they dry. Water based inks require substantially more heat to achieve the same rapid speed of drying of solvent-based. Solvent inks need only a minimum amount of heat, if any at all, to ensure the ink is dry before the next colour is applied.
A general misconception when it comes to **PVC vinyls**, is the belief that the paper is printed in the conventional way and then a thin layer of **PVC** (polyvinyl chloride) is spread on the surface afterwards for protection.

This is not the case. **Vinyl wallpaper** enters the start of the print process with a smooth layer of PVC laid onto a backing layer, normally paper.

Whilst at this stage the **solvent** based ink pigments adhere well to the PVC, it is not until the whole sheet has been heat embossed does it become ‘fused’, effectively making the inks a part of the coating itself.

An **embossing machine** is not a part of the print process but is a process in its own right. It principally has three stages of process; heat (for softening the PVC layer), impression (textured steel roller impressed into PVC) and cooling (to help form the new shape).

**Heat embossing printed vinyls**

The purpose of heat embossing a **vinyl** is to convert a smooth plastic wallcovering into a wallcovering that has a third dimension; that of feel. This textured ‘relief’ may be something as smooth as a light sand emboss, (the intention of which is only to scatter the light into all directions, thus ensuring the vinyl does not look shiny under light), or it could be a heavily textured ‘rough’ emboss that has a visual and tactile effect that works equally as well as an effect in its own right, as it does as a support to the print.

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**The heat embossing machine**

**THERE ARE GENERALLY TWO TYPES OF VINYL**

1. **SOLID PVC VINYL**
2. **BLOWN PVC VINYL**

**BLOWN PVC IS SUB-CATEGORISED INTO TWO TYPES**

A. ‘MECHANICALLY’ BLOWN VINYL
B. ‘CHEMICALLY EMBOSSED’ BLOWN VINYL

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**1 SOLID PVC VINYL**

The printed reel is loaded on to the emboss machine and the paper works its way through a series of rollers that keep the paper taught and perfectly in line. It progresses through a heating section that gradually warms up the PVC to high temperatures, (c.190°C) whereupon the vinyl layer becomes soft. (The correct temperature is essential, as to under heat it wouldn’t soften the vinyl layer enough to impress into, and to overheat it would scorch and destroy the PVC vinyl layer). The paper is then immediately squeezed between two rollers, a rubber one underneath the paper, called the impression roller and the critical ‘emboss’ bowl above it.

The emboss bowl is a cylindrical roller having a typical circumference of between 50-70 cm. Made of steel it has a raised textured surface that is the negative of how the finished vinyl will look. The raised peaks of the emboss bowl become the valleys of the PVC layer, comparable with impressing a piece of sandpaper into a layer of flat, soft plasticene.

Upon exiting the impression roller, the paper needs to be immediately cooled to ensure the ‘new shape’ of the PVC layer becomes fixed.

To achieve this the paper progresses, print face out, around a series of large hollow steel drums. These drums have ice chilled water constantly flowing through them to ensure that the temperature of the cooling drum is constant. If the cooling drum was to warm up, due to constantly being heated by the warm paper, it would then ultimately affect the hardening of the PVC layer that would fail to hold its new shape.

Once the paper is safely through the cooling process it can be either immediately converted into finished rolls or be re-reeled for conversion at a later date.