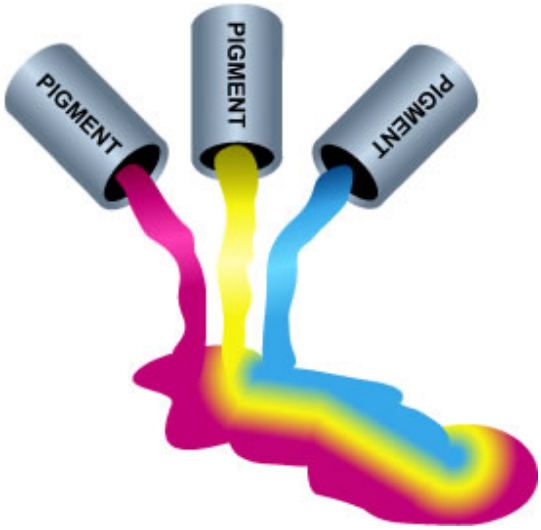
A. Inks and Coatings

1. Ink Ingredients

Ink ingredients fall into three main categories: pigment, vehicle, and modifiers/additives. Because there are so many different types of printing processes and print applications, the ingredients used in these three categories may vary widely. For example, for offset lithography, ink requires a higher degree of pigment than many other processes. This is because nearly half of the ink used in the offset process does not reach the printing surface. In direct printing methods, such as letterpress, a much higher percentage of the ink reaches the substrate.

a. Pigment

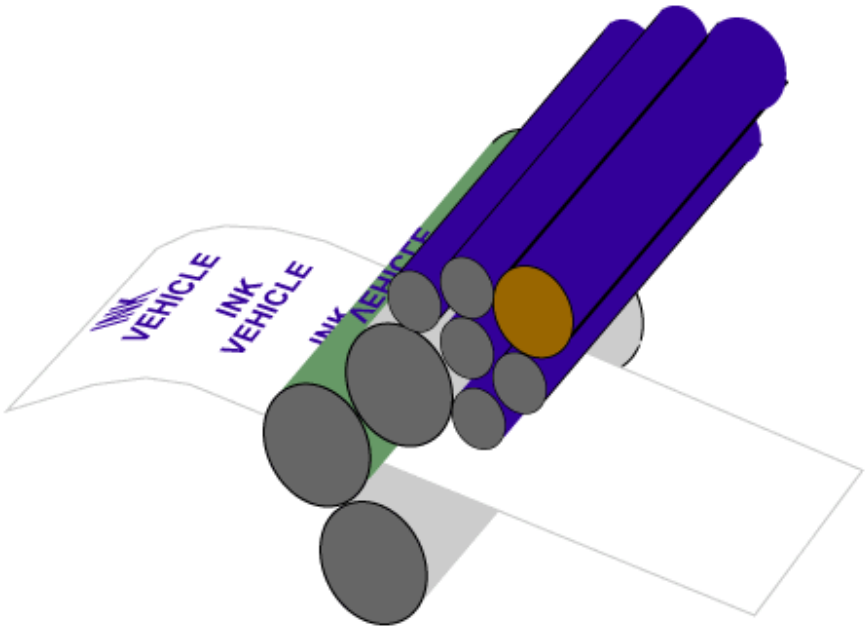
The ingredients that comprise the color of the ink are referred to as pigment. The pigments are formulated from substances that create a desired color when the substances are blended together in specific proportions. Some of these substances may be ingredients found in nature or they may be produced synthetically. The substances can be in the form of dyes, powders, liquid dispersions, or concentrated pastes.



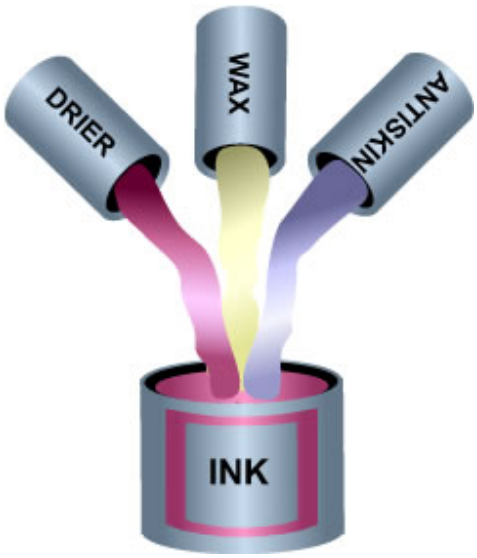
Pigments for printing inks are chosen for certain characteristics that make them suitable for use on printed products. For example, it is desirable for many print applications to be printed with inks that have a high degree fade resistance (light fastness), while other applications, such as food packaging, may be printed with nontoxic ink because of the possible contact with food items.

b. Vehicle

The vehicle is the substance in the ink mixture which carries the pigment and binds it to the printed surface. The vehicle can be formulated from petroleum or vegetable oils, solvents, or water. The vehicle must have the ability to be in a liquid form during the printing process, but dry rapidly when it reaches the printing surface. The illustration below shows how the vehicle carries the pigment through the roller train of a press and transfers it to the paper.



c. Modifiers and Additives



Modifiers and additives change the properties of the ink so that it can be used properly for different types of print processes and applications. Modifiers and additives may include the following:

- ***Driers***: speed up the ink drying process.
- ***Waxes***: reduce the possibility of ink from the front of one sheet transferring to the back of another sheet (setoff). The wax improves slip and scuff resistance of the ink. It is not possible to apply varnish to a printed sheet that has been printed with ink containing wax additives.
- ***Antiskinning agents***: keep the ink from drying too rapidly and skinning over in the ink fountains of the printing press.
- ***Extenders***: increase the coverage of the pigment in the ink.
- ***Distillates***: improve the flow of ink.

2. <u>Ink Characteristics</u>

a. Body

The body refers to the consistency of the ink. The consistency of the ink may vary from the beginning of a press run to the end of a press run because of external factors, such as prolonged exposure to the air and the increase in heat produced by the roller train of the press.

b. Tack

The tack refers to the stickiness of the ink. The tack is determined by the resistance of the ink film to "split". Splitting occurs when the ink from a printing plate is transferred to the printing blanket. During this process, only some of the ink is transferred, which splits the ink film. If the ink does not have the proper tack, the print quality will be poor because the improper quantity of ink is transferred to the printed surface.

c. Viscosity

Viscosity is the degree that ink resists flow when it is under force, such as in the roller train of a printing press. If ink does not flow easily, it has a high viscosity, and if it flows easily, its viscosity is low. As with body, the viscosity can change as it is used on a press, because of the friction and heat generated by the roller train. Viscosity is measured with an instrument called an inkometer.

d. Length

Length is the ability of ink to flow and is sometimes confused with viscosity (the degree to which ink resists flow under force). It is necessary for the ink to move properly through the roller train of the press in order to achieve the best results. The friction and heat produced by the press may change the length of the ink.

e. Opacity

Opacity refers to the covering power of ink. Different pigments have different degrees of opacity because of the substances used to produce the pigments. Opacity is sometimes referred to as color strength.

f. Tinting Strength

Tinting strength is the ability of an ink color to produce a tint with the addition of white pigment and is also referred to as coloring power.

g. Permanency

The degree in which printed ink resists the fading power of light is known as permanency. Inks that have a greater proportion of their volume as pigment tend

to fade more slowly. The rate that an ink fades is known as the degree of lightfastness and is especially important when printed items, such as an outdoor billboard, will be exposed to a high level of light.

3. Ink Types

Nearly all types of ink can be placed into one of two main categories:

a. *Standard Printing Inks:* web offset ink (heatset and non-heatset), sheet-fed ink, soybean based ink, process ink for color printing, and others.
b. *Specialty Inks:* metallic, fluorescent, security, phosphorescent, and others.

Standard Ink Types

Web Offset Non-Heatset Ink

The non-heatset variety of web offset printing ink is a common type of ink used on web presses for newspaper and business forms printing. Non-Heatset ink is printed on absorbent, uncoated paper stock. Coated stocks should not be used with this type of ink because the paper will not completely absorb the ink, resulting in excess smudging and smearing.

Web Offset Heatset Ink

The heatset variety of web offset ink contains special varnishes that help the ink dry when heat is applied. Heatset presses are equipped with drier units for this purpose. Due to the varnishes, the ink printed on the paper is highly flammable, so the drying units must be specially built and properly maintained to avoid potential hazards. The main advantage of heatset ink is a printed product with a higher degree of quality.

Quickset Ink

Quickset ink contains a special varnish to speed the drying process. Unlike heatset ink, quickset ink does not require a heat source for proper drying and curing. The ink will not dry out on the press, but will dry quickly after it has been printed onto the substrate.

The are four basic processes that allows quickset ink to dry depending on the formulation: evaporation, absorption, oxidation, and polymerization. Newer types of quickset ink have a greater proportion of antioxidants and higher boiling-point distillates, which evaporate more slowly, so the absorption process plays a greater role with the newer inks. All four processes share equally in the ink curing process with older ink types.

Uncoated paper stocks are best suited for quickset ink. This is because the low viscosity distillates and antioxidants are quickly absorbed by the substrate, which leaves the remaining pigment and vehicle to dry quickly on the surface.

Sheet-fed Ink

Sheet-fed ink is manufactured specifically for sheet-fed presses and usually has a higher tack than web offset inks. The reason for this is that most sheet-fed presses run at slower speeds than web presses and a higher tack is necessary to provide the necessary quality.

Rubber-base Ink

Ink formulated with a rubber base is a good choice when flexibility in the printing process is important. Rubber-base ink can be printed on coated and uncoated paper and it dries quickly. It is most often used on small sheet-fed presses.

Soybean-base Ink

Soybean-base ink is becoming a popular alternative to petroleum-base ink because of the ease in which it is used and because it is environmentally friendly. Soy-base ink prints and handles similar to petroleum-base ink, but it is much less toxic because of the soybean oil. The soybean ink is biodegradable, meaning that it is eventually broken down and is much less hazardous to the environment. Some soy inks may contain petroleum additives, so if a client requires 100% soy-based ink for a print application, it is important to be fully informed on the type of soy ink that is used.

Water-base Ink

Water-base ink has been around for awhile, but it is still not as popular as other ink types. The usage of water-base ink may increase as environmental laws get tougher on the acceptable VOC (Volatile Organic Compounds) emissions generated from petroleum-base ink. Water-base ink emits no VOC's. It is safe to work with and the print quality is comparable to other ink types. Water-base ink is used mainly in flexography and gravure printing. It is a good choice for printers and customers who want their projects manufactured with nontoxic materials.

Laser Ink

Laser ink is specially formulated to withstand the extreme heat of the laser printer. If conventional ink is used for the preprinted portion of a document (such as an invoice or statement), the ink will melt in a laser printer because of the excessive heat produced by the laser printer. This results in damage to the preprinted document and possible damage to the laser printer because of ink adhering to the internal parts of the printer.

UV (Ultraviolet) Ink

Ultraviolet ink is formulated to cure and dry when exposed to a UV light source, unlike conventional ink, which dries through evaporation and absorption. Instead of being absorbed into the paper, the UV ink remains on the surface until it is exposed to the UV rays, which instantaneously transforms the ink into a hard film. UV ink can be applied to many types of

substrates including paper, metal, vinyl, and glass.

Process Ink Colors

Process ink colors are used in **Four Color Process Printing**. Cyan, magenta, yellow, and black (CMYK) are the colors necessary for this process and are formulated differently for different types of printing processes.

High-Fidelity Ink Colors

High-fidelity ink colors are use in an advanced form of color printing, combining the standard four process colors of cyan, magenta, yellow, and black, with two more colors - usually orange and green. This allows for a greater color range, increased subtlety in the gradations of color, and additional vibrancy.

Specialty Ink Types

Non-porous Ink

Non-porous ink is used for printing on substrates, such as metal or plastic, that do not allow ink to be absorbed into the material. Because the printing surface of these materials is nonabsorbent, the ink dries solely through oxidation rather than absorption.

Metallic Ink

Metallic ink provides a distinctive look to a variety of print applications. The ink is produced by blending different types of metallic powders into the ink mixture, such as aluminum powder to create a silver appearance and bronze powder to create a gold appearance. Some metallic inks can nearly duplicate the look of foil on some applications without the need to purchase the additional equipment required for foil stamping.

Metallic ink is more challenging for the press operator to control than conventional ink. One reason for this is that the metallic powder blended into the ink mixture cannot be ground as fine as other pigments because the metallic ink will lose its luster. The larger particles create problems on the press, especially with the offset lithography process. To overcome some of the special print problems, some printers do a double hit (running the piece through the press a second time to apply another coat of ink to strengthen the coverage).

Most printers require an upcharge for the use of metallic ink on an application because the ink is more expensive to produce and makes the print job more time consuming. Metallic ink tends to have a much shorter shelf life than standard ink.

Magnetic Ink

Magnetic ink is comprised of a petroleum-base ink blended with magnetic iron oxide particles. The magnetic iron oxide particles allow documents printed with this type of ink to be read and

sorted by electronic scanning equipment. Checks are an example of a document printed with magnetic ink. The MICR (Magnetic Ink Character Recognition) number at the bottom of the check is the only portion of the check printed with the magnetic ink. The remaining copy on the check is printed with standard ink to ensure that no other printed area on the check interferes with the ability of the scanner to read the magnetic MICR number.

Fluorescent Ink

Fluorescent is another type of ink that can provide a distinctive look for a variety of print applications. Fluorescent ink colors are most often printed on labels, posters, and signs that are used for alerting people to hazards or attracting their attention to advertising pieces.

There are several points to consider when using fluorescent colors. The ink tends to fade quickly, so they should be kept out of direct sunlight. Because of their tendency to fade, fluorescent inks have a short shelf life. Another point to consider is that fluorescent ink is very transparent, so it may require a double hit (a second run through the press) in order to achieve the desired results. In spite of this potential problem, fluorescent ink is a good choice for creating emphasis and increased visibility.

Phosphorescent Ink

Applications printed with phosphorescent inks acquire a "glow in the dark" property after the phosphorescent area has been exposed to light. The length of time that an application will glow in the dark depends upon the ink ingredients and the length of time that the application is exposed to light. In some cases, a 10-30 minute exposure to light can yield an afterglow of up to 12 hours. The ingredients of phosphorescent ink are nontoxic and are free of radioactive additives. It is very useful for road signs, sporting goods, exit signs, safety products, toys, and novelty items.

Pearlescent Ink

Pearlescent ink is a specialty ink that is used to add highlights and depth to the printed area of an application. It is able to provide an almost 3-dimensional effect to some applications.

Edible Ink

Edible ink is used on print applications that may come into contact with food or the ink may be part of the food product and therefore it must be made of totally nontoxic ingredients. An example where edible inks are used would be in the monogramming found on some confectionery items. Because the inks are used on food items, they are strictly regulated by the government.

Scratch and Sniff Ink

Also known as a microencapsulated ink, scratch and sniff ink releases a fragrance when the microcapsules are broken. The scratch and sniff ink is commonly used in magazines for

perfume advertisements. When the consumer scratches the surface of the designated area of the ad, the capsules are broken, releasing the fragrance.

Medical Device Ink

Ink used for printing on medical devices is made of nontoxic ingredients so that direct printing on noninvasive surgical and medical disposable items is possible.

Moisture Resistant Ink

Moisture resistant ink is most often used for different types of packaging or for applications that may be used outdoors.

Security Ink

There are a variety of inks that provide added security features to print applications. Some security inks allow documents to be created that are tamper proof, while the use of other types of security inks prevent documents from being copied. Security inks include the following varieties:

- Coin Reactive
- Bleeding
- Erasable
- Heat Reactive
- Visible Infrared
- Optically Variable
- Pen Reactive
- Penetrating
- Photochromic
- Solvent/Chemical Reactive
- Thermochromic
- Water Fugitive
- UV Invisible Fluorescent

Desensitizing Ink

Desensitizing ink is a transparent ink that is applied to the face of CF (Coated Front) and/or CFB (Coated Front and Back) carbonless paper in order to deactivate the CF coating. The use of desensitizing ink is important when an application requires that handwritten or imprinted data not be transferred through the various pages of a carbonless form in specific areas.

Electronic Ink

Electronic ink can be transformed from bright white to dark and then back to bright white again with a small electrical charge. The ink consists of plastic microcapsules that contain both dark dye and white ink chips. The microcapsules are sandwiched between thin layers of flexible

material, which substitutes for traditional paper. When an electrical charge is applied, some of the white chips float to the top of some capsules to create a white surface and in other capsules, the white chips remain at the bottom allowing the dark fluid to remain visible. Different characters are created by applying the electrical charge under different combinations of capsules. After the initial electrical charge is applied, no further charge is required to hold the image in place, (unlike a computer monitor, which requires a constant stream of energy in order to display an image). The content of the flexible page can be changed instantly and then be held on the page for as long as necessary. Although, this technology is still being perfected, it could be a major advancement in variable imaging and in the reduction of paper usage for some print applications.

4. Coating Types

When coatings are applied as an off-line process over dry ink, they create a bold effect, but when applied as an on-line process, they create a much more subtle effect over ink that is still wet. Among the most popular coatings are overprint varnishes, aqueous coatings, UV coatings, and EB coatings.

Overprint Varnish

Applied during the printing process or as an off-line process, overprint varnish is much like a solvent-based ink. The different varieties are usually colorless, but sometimes they are tinted to achieve a desired effect. Varnish can be applied as an all-over coat or in spots to highlight a specific area of a printed piece.

Overprint varnish is available in glossy, dull, or satin finishes. Gloss varnish creates a smooth surface over the paper, filling in any voids or irregularities that may be on the surface. Dull varnish also fills in irregularities to form a smooth surface, but it diffuses light that reflects back to the eyes, which creates a dull appearance. A nearly 3-D effect can be created by applying gloss varnish to a subject and dull or satin varnish to the background. The subject will appear to jump off the page. In addition to applying varnish as a solid coat, it can also be printed as a halftone (series of dots) in order to provide subtle effects and to provide printed objects with an increased dimensional appearance. The effects that can be achieved are endless when using different combinations of varnish, paper, and ink.

Besides design effects, another important aspect of varnish is the protection it provides. A coating of varnish over a printed piece protects it from the wear and tear that is part of every day handling, allowing the document to remain intact for a longer period. An all-over coat of satin varnish will protect the printed surface without drawing attention to the fact that varnish was used for protection purposes.

A disadvantage of varnish is that many of them are solvent-based. Solvent-based means that they emit VOCs while they are being applied, which can be a health hazard for the press operator unless the proper safety precautions are followed. Another disadvantage is that varnishes tend to yellow over time if they are formulated with tung or linseed oil. Varnishes with

alkyd formulations will not yellow, but they are not as glossy or as hard as tung or linseed oil.

The use of varnishes on print applications should be planned early in the design process. They should not be applied as an afterthought in order to try to cover-up a poor choice in paper, ink, or design.

Aqueous Coating

An aqueous coating is usually applied during the printing process and can be applied as an all-over coat or in patterns or spot coatings. Like varnishes, an aqueous coating offers protection for the printed document and provides numerous effects for print applications. Aqueous coatings are available in gloss, matte, and satin finishes. Among the advantages that aqueous coatings have over solvent-based varnishes is that they will not yellow over time and they are less toxic and emit fewer VOCs.

UV Coating

UV coatings come in a liquid or paste form and remain as a liquid or paste until exposed to ultraviolet light. The printed page is covered with the UV coating and is then exposed to the UV light, which causes photoinitiators within the coating to immediately react, creating a hard protective finish. Ingredients called monomers give the coating its gloss and hardness characteristics. UV coating, which is also known as an Energy Curable coating, provides the best surface properties and protection for printed surfaces. Some of the benefits include:

- Greater opacity.
- Color stability.
- Deeper and more vibrant colors and color tones.
- Sharper graphics.
- Higher gloss.
- Uniform surface to give labels a more vibrant look.
- Scuff resistance.
- Instantaneous curing.
- Allows for in-line die cutting.
- Chemical resistance.
- Better outdoor endurance.
- Environmentally safe - No VOCs (Volatile Organic Compounds) are produced.

EB Ink/Coating

Like UV inks/coatings, EB (Electron Beam) is an energy curable coating, but it is hardened with the use of a concentrated beam of high energy electrons. EB inks/coatings do not contain photoinitiators because the high energy electron beam is all that is necessary to cure the surface.

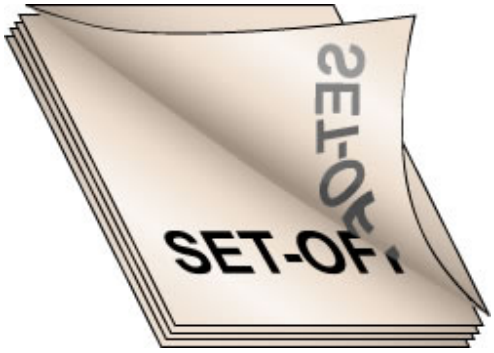
Other Coatings

Other types of coatings include clay coatings to add strength and gloss to paper, whitewash

coatings which are used as a finish coat for such items as Kraft paper, and grease resistant coatings used on applications for industrial and scientific uses.

5. Ink Related Printing Problems

Setoff



The transfer of ink from one sheet to the next sheet is known as setoff and is usually caused by too much ink being applied to the substrate and/or ink that is slow drying. The ink can be transferred from the front of one sheet to the back of the next and vice versa.

Slow Drying

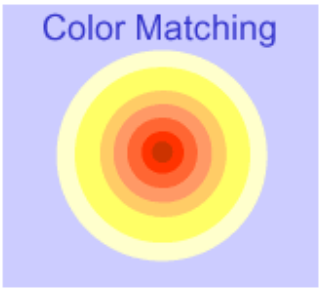
One of the most common printing related problems is ink that dries too slowly. When ink dries slowly it may smudge and smear on the printed surface. The ink may also transfer from the front of one sheet to the back of the next one (setoff) and vice versa. Setoff is usually the result of too much ink being applied to the paper because of improper press settings. Both high humidity in the production area and high moisture content in the paper affect the ability of the ink to dry properly.

Poor Binding and Rub

This condition is sometimes confused with slow drying. With poor binding and rub, the ink is actually dry but the pigment can be easily rubbed off the surface. This can be caused by ink that does not have adequate bonding properties for the type of paper on which it is being printed. An excessive amount of the vehicle soaks into the paper leaving all of the pigment on the surface with nothing to hold it there. It is possible to salvage a print application with this problem by applying a coat of varnish to seal the pigment.

Ink Adhesion

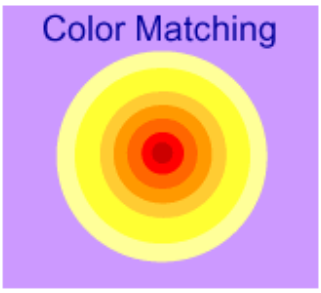
Ink adhesion is actually the result of setoff and slow drying ink, which in turn are usually the result of poorly adjusted press settings. The quantity of ink applied to the sheet or web can be so excessive that the ink acts as an adhesive, causing the sheets stick together. A printed document with any of the printing from the front showing up on the back and/or the printing from the back showing up on the front, is a definite sign that the press settings were not adjusted correctly for the type of printing surface, the type of ink used, or the coverage area.



Mottling

Mottling is a condition referring to an uneven appearance in the solid portions of a printed document, which can be caused by uneven absorption of ink, nonabsorbent papers, the wrong ink for the particular paper used, or faulty press adjustments.

Fill-in



Fill-in can cause a muddy look in printed screens and halftones and a speckled appearance in highlight areas. Areas of detail may disappear entirely. The causes of fill-in are contamination of the ink with paper fibers, lint, dirt and dust; substandard ink; the wrong choice of ink for the job; and/or improper press settings.

Misting

Misting occurs when an ink with too much length is used on high-speed presses. Poorly adjusted ink rollers also contributes to the problem. The ink actually turns into a fine mist and if the problem is significant, the mist may create a fog in the press area. The mist makes contact with everything in the area, including the surface of the printed application. Misting can give the finished product a speckled and dirty appearance and create health hazards for press operators.

Piling

If a printed document has blotchy areas that are outlined by a non-printed line, it can be the result of piling. Piling is usually caused by faulty paper or ink. The paper may contain excessive paper dust or a poor coating. The coating may be partially removed as it passes through the press, adhering to the printing blanket and plate, causing the blotchy appearance. The vehicle in the ink may not carry the pigment properly, which allows the pigment to pile on the plate and blanket of the press.

Color Matching

Occasionally, a color that is printed does not match the color that was intended. As with many printing related problems, improper press settings can be the cause, but other variables may also contribute to the problem. Some of the variables are listed below.

- The color and texture of the paper changes the printed colors, so the choice of paper must considered early in the planning stage of the project.
- Some of the ink colors can change slightly as they age, which may cause large color shifts, especially when older inks are mixed together to produce other colors.
- Lighting conditions influence the appearance of color, which is why it is very important for the customer and printer to have a good proof to work from.

Trapping

Trapping refers to the alignment of colors on a printed document, such as a document printed with four-color process printing. Trapping may be required to correct the registration of colors on a print project. Successful trapping depends a great deal on the tack of the ink. The first color printed on the sheet should have a higher tack than the second color printed, and so on. This will greatly improve the trapping abilities.

Show Through

Show through is a term used to describe when the printed area of a document shows through to the other side of the sheet. Show through is especially annoying when there is printing on both sides of the document. This is usually caused by the use of paper that is too thin or transparent or ink that is applied too heavily on the printing surface.

Pantone Matching System®

The **Pantone Matching System®** is the industry standard for selecting, matching, and mixing color. The Pantone Matching System® Color Guide is an indispensable tool for printers and designers. The guide contains swatches and formulas for all of the colors that can be attained using the Pantone System. Also included in the guide are the process colors used in 4-color process printing and a variety of fluorescent and metallic colors.

The Pantone Matching System®uses 11 basic colors to achieve over 1000 color mixtures that are used by printers and art departments. The basic colors that are used are: yellow, warm red, rubine red, rhodamine red, purple, violet, reflex blue, process blue, green, black, and transparent white, which appears clear.

Each of the mixed colors are assigned a PMS number. The first number assigned for a mixed color is 100 and the numbering proceeds up from that point. The instructions for mixing the color are listed below the color swatch. The mixing instructions include the number of parts of the specific base colors that are necessary to mix a particular color, as well as a percentage of the total volume for each of the colors that are required. For example, to mix the color, Pantone 198 (a red color), the mixing instructions are listed as follows:

- 6 parts (37.5%) Rubine Red
- 2 parts (12.5%) Yellow
- 8 parts (50%) Trans. White

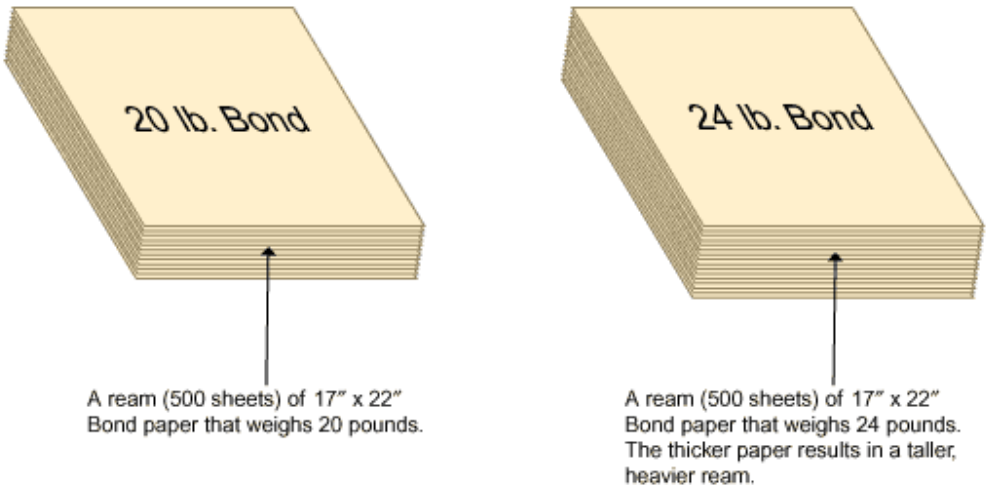
By using the various ink formulas found in the swatch book, ink manufactures and printers can mix colors to exact specifications. Pantone also issues a digital color guide for electronic publishing which lists the color formulas in a format necessary for the colors to be displayed on a computer screen.

Note: Pantone Color Guides should be replaced after one year because the printed colors in the swatch book will shift or fade and will no longer be a true representation of the actual colors.

Basic Size and Basis Weight

The basis weight refers to the weight in pounds of 500 sheets of paper when it has been cut to that paper's standard basic size. For example the basic size for Bond paper is 17 x 22 inches. If 500 sheets (a ream) of Bond is cut to its basic size of 17 x 22 inches and weighs 20 pounds, it is classified as 20 lb. bond. If a 17 x 22" ream of Bond paper weighed 24 pounds it would be called 24 lb. Bond, and so on. The chart below contains some common paper types and their basic size.

Paper Type	Basic Size
Bond	17" x 22"
Ledger	17" x 22"
Offset	25" x 38"
Book	25" x 38"
Cover	20" x 26"
Index Bristol	25-1/2" x 30-1/2"
Vellum Bristol	22-1/2" x 28-1/2"
Printing Bristol	22-1/2" x 28-1/2"
Tag	24" x 36"



ISO Size Standards

The International Organization for Standardization (ISO) has established standards for paper sizes based on the metric system (millimeters). The standards have been grouped into three different series of requirements: "A-series", for general printing, "B-series", for posters, and "C-series", for envelopes, postcards, and folders. The "A" series is the most commonly used with sizes ranging from A0, which is the largest, down to A8.

The A-series sizes are all represented as a part of the area of one square meter with a length to width ratio of 1.414. The size A0 is equivalent to the area of a square meter with each smaller size being 50% of the size of the preceding one. A1 is 50% of the area of A0, A2 is 50% of A1, and so on. Another way to look at it is that when an A0 sheet is cut in half, two A1 sheets are produced, and when an A1 sheet is cut in half, two A2 sheets are produced. Some of the sizes for the A-series are shown in the illustration below.

Sheet Sizes Based on ISO Standards

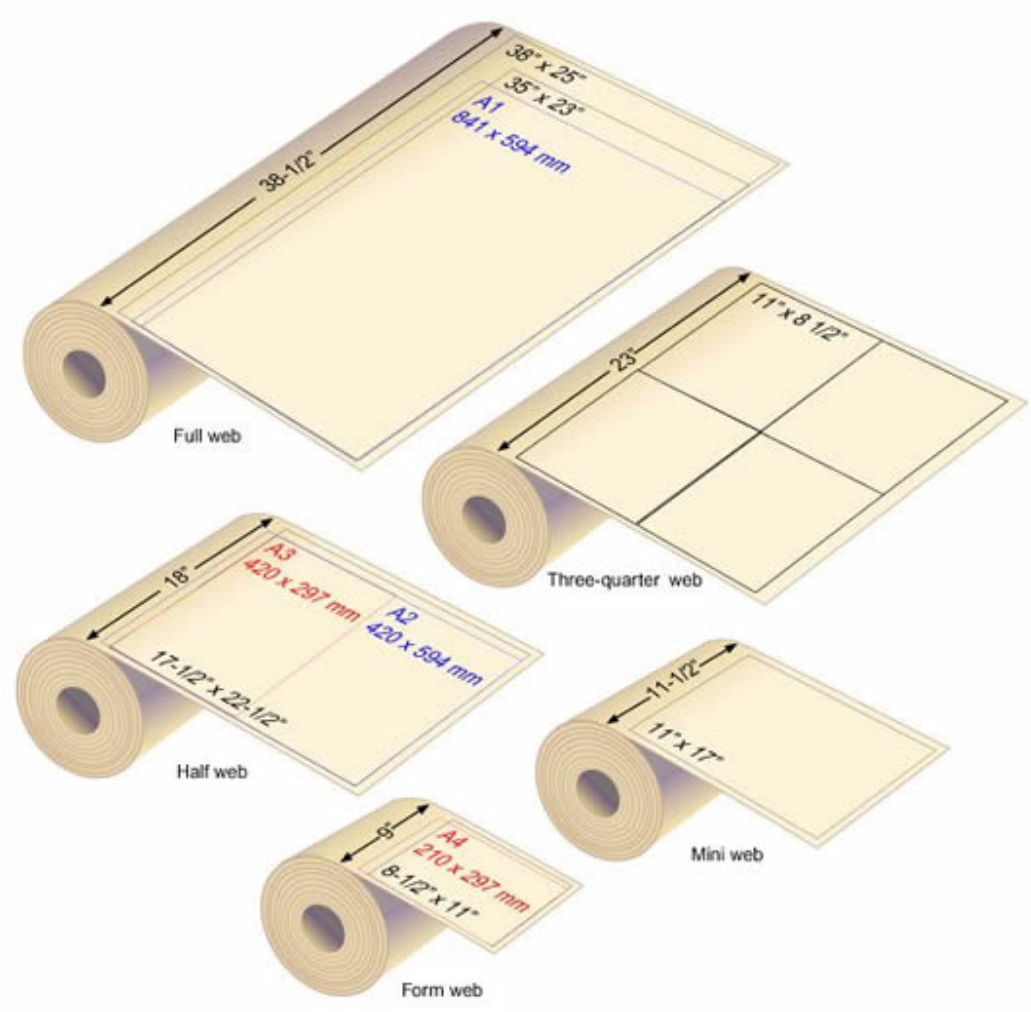
North American Size Standards

Although the ISO size standards are common in many parts of the world where the metric system is the established standard for measurement, North American sheet sizes are based on inches and are shown in the illustration below.

Sheet Sizes Based on North American Standards

Universal Web Sizes

The paper rolls shown below are the standard widths used on web presses. The illustration also shows the standard ISO sheet sizes and the standard North American sheet sizes that can be obtained from each roll width.



Caliper Readings

The chart below shows the actual thickness of various weights and grades of paper. The readings are taken with a caliper or micrometer gauge, which measures the thickness of the paper in thousandths of an inch.

Paper Type	Thickness	Paper Type	Thickness
15 lb. Bond 20 lb. Bond 24 lb. Bond	0.003 0.004 0.0045	100 lb. Tag 125 lb. Tag 150 lb. Tag	0.0075 0.009 0.0107
28 lb. Ledger 32 lb. Ledger 36 lb. Ledger	0.005 0.00525 0.00575	4 Ply Railroad Board 6 Ply Railroad Board 8 Ply Railroad Board	0.018 0.024 0.03
50 lb. Regular Offset	0.004	50 lb. Gloss Coated Book	0.0025

60 lb. Regular Offset 70 lb. Regular Offset 50 lb. Smooth Offset 60 lb. Smooth Offset 70 lb. Smooth Offset	0.0045 0.005 0.0025 0.003 0.004	60 lb. Gloss Coated Book 70 lb. Gloss Coated Book 80 lb. Gloss Coated Book 100 lb. Gloss Coated Book 120 lb. Gloss Coated Book	0.003 0.0035 0.004 0.005 0.006
90 lb. Index 110 lb. Index	0.007 0.0085	50 lb. Coated Cover 60 lb. Coated Cover 100 lb. Coated Cover	0.00475 0.006 0.0095
57 lb. Vellum Bristol 67 lb. Vellum Bristol 125 lb. Plate Finish Printing Bristol 150 lb. Plate Finish Printing Bristol	0.07 0.0083 0.0097 0.012	15 lb. CB Carbonless 20 lb. CB Carbonless 15 lb. CF Carbonless 20 lb. CF Carbonless	0.003 0.004 0.003 0.004

Finish

The finish refers to the surface characteristics of the paper such as how the paper feels...is it smooth such as glossy cover or rough with an antique finish? Does the paper have a glossy appearance such as coated glossy papers or is it dull like bond paper. Does the paper enhance the look of the printed piece similar to watermarked paper or is it purely functional like newsprint? Does the paper have a high ink absorption rate as does Vellum or poor absorption such as on coated papers?

Finishes can be applied to paper during the manufacturing process or produced offline. A finish such as Laid can be created while it is being manufactured with the use of a marking roller that forms the pattern in the paper while it is still wet. Paper finishes provided offline are usually accomplished with steel rollers that press the pattern into the paper. The offline finishes are known as embossed finishes. Some common paper finishes are described below.

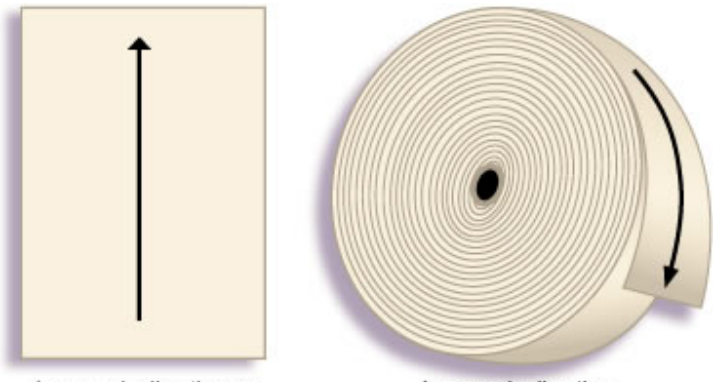
- **Cockle** - A cockle finish simulates characteristics of hand made paper with a wavy, rippled, puckered finish. The effect is obtained by air drying the paper under minimum tension.
- **Felt** - Felt is a soft texture on uncoated paper that is created during the papermaking process with a either felt covered roller or with a rubber roller with a felt pattern that creates the finish. It can also be accomplished as an offline process. The felt finish does not affect the strength of the paper.
- **Gloss** - A gloss finish produces a shiny and reflective surface on one or both sides of certain coated papers. A higher gloss is usually seen on higher quality coated papers. The gloss finish is produced from compounds added during the paper making process.
- **Laid** - A laid finish has the appearance of translucent lines running horizontally and vertically in the paper. It is produced during the papermaking process with a special roller that creates the pattern in the wet paper.
- **Linen** - Linen finished paper resembles linen cloth and is usually produced after the papermaking process as an offline embossing process.
- **Matte** - A finish on certain coated papers that is smooth but gives a dull appearance. A

matte finish, as well as other types of coated paper, are good choices for print jobs in which high quality is required.

- **Parchment** - A paper finish that has an old or antique appearance and is the result of washing sulfuric acid over the paper and then quickly neutralizing the acid wash. This process melts the outer paper fibers which fill the voids in the rest of the paper. Parchment is very durable and grease resistant.
- **Smooth** - A smooth finish is the result of the paper passing through sets of rollers during the papermaking process. This process is known as **calendering**.
- **Vellum** - A vellum finish has an eggshell appearance and is consistent and even but not as much as a smooth finish. Vellum is one of the most popular uncoated finishes and paper with this finish has a high ink absorbency rate.
- **Wove** - An even finish in uncoated paper with a slight texture made by a felt roller covered in woven wire.

Grain

The grain of the paper refers to the direction of the fibers in a sheet of paper. Long grain paper refers to paper in which the fibers run in the same direction as the longest measurement of the paper. On rolls of paper for web presses, the grain runs along the length of the web. Short grain paper refers to paper in which the fibers run in the same direction as the shortest measurement of the paper. When paper is torn, it will tear easier and straighter when torn parallel with the grain. It will also fold easier parallel to the grain and produce a cleaner fold than if folded across the grain. Laser printers require long grain paper for the best results. Short grain paper may not feed properly into a laser printer and the heat produced by a laser printer may result in the sheets curling as they come out of the printer.



Whiteness

The whiteness of paper is the measure or its ability to reflect the colors of light equally. The more evenly a paper reflects all colors of the spectrum, the whiter the sheet. Some papers may reflect slightly cool colors back to our eyes and give the illusion that the sheet is actually brighter than white paper. If white paper has a slight warm appearance it will not appear as bright as a sheet that reflects a cool color, however warm colors printed on a warm sheet will appear stronger than when printed on a cool sheet. Cool colors printed on a cool white sheet are

also enhanced in the same way. There is no such thing as a pure white sheet of paper, since the white that we see is always influenced by the lighting of our environment and the reflections from surrounding objects.

Grade

The grade of a paper refers to the type or category of the paper contents which provide a level of brightness or surface characteristics used to determine the grade level of the finished paper stock. Grades are classified from "Premium" at the highest level to "5" at the lowest level. Some text and cover stocks are listed simply as A or B grades since fewer grades of the text and cover stock are produced. A **table** illustrates the grade levels of paper according to the degree of brightness.

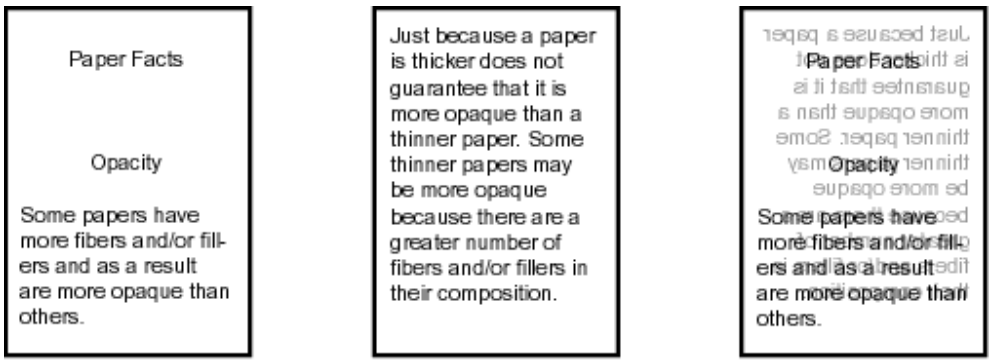
Brightness

Brightness refers to the percent of light reflected back from a sheet of paper as measured by a light meter reading. Contrast is reduced and highlights are not as strong when paper with a lower brightness is used for a printed piece. The quality and brightness of paper is organized into six categories:

Paper Brightness			
Premium	Quality	=	88.0 to 95.0 Brightness
Number 1	Quality	=	85.0 to 87.9 Brightness
Number 2	Quality	=	83.0 to 84.9 Brightness
Number 3	Quality	=	79.0 to 82.9 Brightness
Number 4	Quality	=	73.0 to 78.9 Brightness
Number 5	Quality	=	72.9 and below

Opacity

Opacity is the measure (percent) of the amount of light passing through a sheet of paper. Some papers have more fibers and/or fillers and as a result are more opaque than others. Papers containing more fibers and fillers have the ability to hold a printed image without showing through to the backside as easily as papers without as many fibers and fillers. Just because a paper is thicker does not guarantee that it is more opaque than a thinner paper. Some thinner papers may be more opaque because there are a greater number of fibers and/or fillers in their composition.



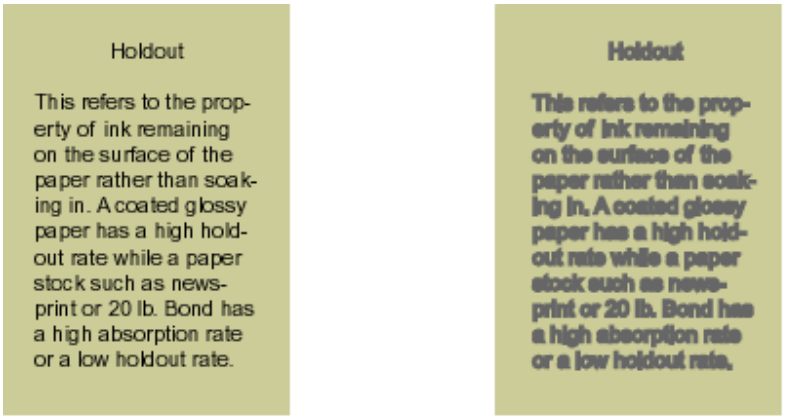
The illustration on the left shows the front side of a typical 8-1/2" x 11" sheet printed with black text. The middle illustration shows text that will be printed on the back side of the sheet. The illustration on the right shows what can happen if the paper used for this example is not opaque enough to prevent the backprinting from showing through to the front.

Smoothness

The smoothness level is a measure of the surface characteristics of paper. The flatter or more even the surface, the higher the level of smoothness. With a smoother surface, the stock can provide a fully shaped ink dot resulting in a sharper and higher quality image.

Holdout

Holdout refers to the property of ink remaining on the surface of the paper rather than soaking in. A coated glossy paper has a high holdout rate while a paper stock such as newsprint or 20 lb. Bond has a high absorption rate or a low holdout rate.



The illustration on the left shows how a printed page might look using a paper with a high holdout rate (low ink absorption). The text is still sharp and the ink gloss is still present. The illustration on the right shows how a printed page might look if the paper used has a very low holdout rate (high absorption). The printed text has spread out on the page (dot gain) and the black ink has lost all of its gloss. Making some adjustments to some of the press settings can help alleviate this problem.

Acidity/Alkalinity

The pH (potential for Hydrogen) measurement of paper determines the degree of acidity and

alkalinity in the stock. The pH scale has readings of 0 to 14 with 7 being neutral. Readings below a pH of 7.0 are acidic and above are alkaline. Each single digit actually equals a measure of 10, so a stock measuring 4.0 pH is 20 times more acidic than one measuring 6.0 pH. Paper can have an acid base, an alkaline base or it can be neutral with a pH of 7. Most paper manufactured in the 20th century was of an acid base. Acidic papers deteriorate in a relatively short period of time, and should never be used for printed items that are intended to last for many years. Since the 1970's, most of the paper used for book publishing and other printed materials where permanence is of importance, has been alkaline paper, which lasts much longer than acid based paper. Alkaline paper is manufactured with fillers such as calcium carbonate, which bring the pH above 7. An acidic paper like newsprint has a pH around 4.5 which becomes lower once it is printed. The acid level tends to break down the paper and it can deteriorate rapidly, which is why newspapers tend to yellow and fall apart in time. Alkaline paper (a pH above 7) is said to be permanent, but papers that have a neutral pH are still best for preserving items like photographic albums and as matte boards for artwork.

Conditioning

Paper is very sensitive to changes in temperature and humidity. Excessive moisture will cause flat sheet paper to curl. The edges of roll paper for web presses will become slack if excess moisture is present. Many printing companies have temperature and humidity controlled environments to lessen the effects of changing weather conditions. It is almost impossible to print with paper that has curled or stretched because of poor conditions in the printing facility. Paper should always be ordered with enough lead time so that the paper has a chance to become acclimated to the temperature and humidity conditions of the printing facility. If you unload paper from a truck that has been in freezing temperatures and then bring it directly to a press to be printed upon, you could have problems. Once the paper is unwrapped in the warmer environment, it will immediately begin to pick up moisture if it has not been allowed to become conditioned to the humidity and temperature of the building. Some of this moisture will disappear as the paper becomes warmer, but the edges of the paper will still be damaged. It is necessary to leave the paper in its original wrapping and let it remain unopened until it becomes conditioned to the humidity and temperature of the pressroom and is ready to be used. The amount of time necessary for the paper to be conditioned properly can range from a few hours up to several days depending on the amount of paper and the difference in the temperature and humidity levels between the pressroom and the environment where the paper had been sorted previously. The chart below shows the number of hours necessary for this conditioning.

Number of Hours Necessary for Proper Conditioning

Paper Quantity (Cubic Feet)	**Difference in Temperature** (From Transit to Pressroom)					
	10° F	**15° F**	**20° F**	**25° F**	**30° F**	**40° F**
6	5 hrs.	9 hrs.	12 hrs.	15 hrs.	18 hrs.	25 hrs.

12	8 hrs.	14 hrs.	18 hrs.	22 hrs.	27 hrs.	38 hrs.
24	11 hrs.	16 hrs.	23 hrs.	28 hrs.	35 hrs.	48 hrs.
48	14 hrs.	19 hrs.	26 hrs.	32 hrs.	38 hrs.	54 hrs.
96	15 hrs.	20 hrs.	27 hrs.	34 hrs.	41 hrs.	57 hrs.

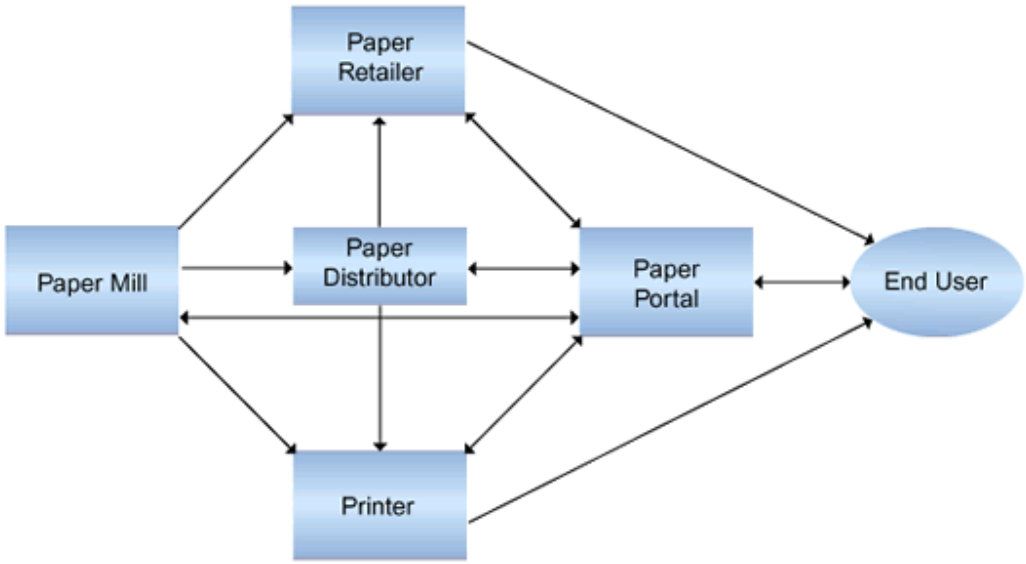
Recycling

Paper recycling has become an increasingly important industry. Every year the percentage of paper that is recycled increases compared to the percentage that ends up in landfills. In fact, in 1993 and every year since, more paper has been recycled than ends up in landfills. The larger quantities of wastepaper available have helped to reduce the costs of recycling and provide a greater array of recycled paper and paper products.

The process begins with collection, which is still one of the most expensive aspects of paper recycling. Besides collecting, the collection process involves sorting the paper into categories, baling, and transporting the paper to a facility that will manufacture the wastepaper into pulp. The first step for the paper at one of the repulping facilities is to be put into large vats where it is soaked, reducing the paper into fibers. Reducing the paper into fibers process is known as repulping. When ink starts to separate from the fibers, chemicals are added to prevent the ink from reattaching to the paper fibers. The ink is then removed from the pulp in a deinking system, which is a series of screens that remove ink and additives. Then the pulp is cleaned several times with heat and chemicals, which removes additional ink. The pulp then enters a floatation device, where a chemical mixture containing calcium soap is introduced. Air bubbles form in this pulp and chemical mixture which cause any remaining ink to float to the surface where it can be skimmed away. After the deinking process, the pulp is ready to be manufactured into paper and related products the same as if it were pulp that had been freshly made from wood chips.

Suppliers

Paper is available from a variety of paper suppliers, however, not all suppliers provide paper to the end user. The following diagram illustrates how the distribution channel works for purchasing paper stocks.



The Paper Mill sells larger volume orders direct to the Paper Retailer, Distributor, or Printer who then resell the product. The Paper Distributor handles full and partial carton orders, which are considered smaller orders, to fit the needs of the Paper Retailer or Printer when the End User places an order for paper that is not considered to be at a volume level that a Paper Mill will sell directly to the Printer or Retailer.

The newest entry to the paper distribution channel is the Paper Portal which enables Printers, Retailers, and Paper Mills to source paper needs to a wider network of potential buyers and sellers via the Web, regardless of whether they are Paper Retailers, Paper Distributors, Printers, or End Users. Buyers and sellers of paper access the portal and use it as a marketplace to locate paper, to negotiate pricing, and to complete the transaction of either buying or selling.

Listings have been provided to help direct you to primary paper distributors and mills that carry the type of paper you are looking for. Each list is headed by a paper type and listed below it are the distributors and mills that sell or manufacture that particular type. The listings are intended to provide you with paper sources with a national market. There are many more sources that may have a local or regional market that are too numerous to list here. To view the listing of paper suppliers, see **Industry Library - Materials and Supplies**.
