

## Paper

Communication using print is a multi-level experience melded into a seamless message. Design elements, text, and images rendered via ink or toner on a substrate provide both mental and tactile stimulation. The right combination can entertain, enrage, enlighten, educate. It can move us to attend, purchase, vote, donate, and more.

We hold the printed piece. Its surface, its color, its weight influence us without our knowing. The substrate is integral to the message, and paper is the most common print substrate. Therefore, understanding paper and picking the right stock is essential to successfully designed communications. Paper also represents a substantial cost item in a printed job, from as much as 20 percent to 50 percent, so a poor choice is also an expensive one and a disservice to the client.

Papermaking is a complex industrial process that uses various scientific “recipes” to produce stocks with performance and appearance characteristics appropriate to their intended use. It’s important then, to understand the help you can get in selecting papers, some paper basics, and where to go for further information.

### Paper Selection

#### House Sheets & More

Unless you work for a large magazine publisher or cataloger, chances are you purchase paper from your printer as part of your print project. For most buyers, even those who represent very large companies but whose print projects are not all on the same stock, this is both the most economical and the safest way to pick paper. It’s economical because chances are the printer is buying enough of your stock to get a quantity price. It’s safer because the printer assumes responsibility for the care and storage of the stock and deals with the paper mill or merchant when there are issues of any kind.

Buying through the printer doesn’t mean that you have a limited selection. Certainly, printers have a specific number of stocks they designate as house sheets. These are the ones they buy in quantity and these will be your most economic choices. And, because they are house sheets, printers are familiar with these papers and their characteristics and how they run on their presses.

That being said, almost all printers will be happy to purchase and use the paper you specify for your job. Their sales representatives will be able to offer you swatchbooks to look over and can also contact local paper merchants or mill representatives for samples. Merchants keep large selections on their floors and can satisfy almost all your aesthetic requirements. Should you find that the only paper that can possibly do is termed a “mill order,” because it’s not carried regularly, be sure that it can be delivered to your printer within your deadline.

In addition, keeping up with current paper offerings can inspire your own creative process. Paper mills go to enormous effort to make sure that their swatchbooks and samples are highly designed and beautifully printed. Getting copies is usually as simple as requesting them from your local merchant, calling an 800 number, or visiting a website.

What’s more, paper merchants are typically equipped with the necessary finishing machinery to be able to offer you, at no charge, blank, fully bound dummies of your project on stocks that interest you. If they can’t do it in house, chances are the mills can.

#### Characteristics to Understand

Most paper today is still manufactured on fourdrinier machines. The fourdrinier was brought into production from 1801-1803 and has a rather colorful and complex history ending with the bankruptcy of the Fourdrinier brothers after whom it’s named. Basically, the machine, which in world-class

mills can be city blocks long, uses a continuously moving wire mesh belt to form liquid pulp into long rolls or webs of paper.

Whole books are easily devoted to the paper-making process and its results, but designers need not be steeped in paper knowledge to make successful selections. However, you do need to understand how paper is classified in the U.S. and worldwide and certain paper characteristics, especially grain, appearance, and runnability.

#### Grades and Basis Weights

Printing papers are classified as a grade and manufactured and identified by their basis weight. Grade is a method of categorizing by end use, size, weight, and even pulp composition. There are hundreds of different paper grades and subgrades. Basis weight, on the other hand, is the weight of 500 sheets of paper cut to a basic size. Therefore, 500 sheets of 25" x 38", 60# offset will weigh 60 lbs. That’s why two similar sheets of different grades may have very different basis weights, for instance, 24# bond and 50# offset.

Getting even more specific, you can’t necessarily keep the same weight when you switch grades. For example, since coated papers are more compressed (calendered), you may have

#### Symbols

- # – pound designation for paper
- CS1 – coated one side
- CS2 – coated two sides

#### Basis Weight

The weight of a ream (500 sheets) in a standardized, that is, basic, size for a grade.

Grade	Basic Sizes
Bond	17 x 22 inches = 374 square inches
Book & Offset	25 x 38 inches = 950 square inches
Tag	24 x 36 inches = 864 square inches
Index	25.5 x 30.5 inches = 778 square inches
Vellum Bristol	22.5 x 30.5 inches = 686 square inches
Coated Cover 1S/C2S	24 x 36 inches = 864 square inches
Coated Cover C2S	20 x 26 inches = 520 square inches
C1S Label	25 x 38 inches = 950 square inches
Opaque Cover	20 x 26 inches = 520 square inches

to go from a 60# uncoated to a 70# coated sheet if you want to keep the same thickness. That's why papers are usually referred to by weight and grade.

The table on page 1 shows the basic sizes for some of today's more popular commercial printing grades in inches and square inches. Below is a list of those typical grades used in offset printing and examples of common basis weights for these grades.

### Typical Grades and Weights

#### • Bond or Writing

Usually used for letterheads, business forms and photocopying.

Usually 16# for forms, 20# for copying, and 24# for stationery.

#### • Book & Offset

The most commonly used coated and uncoated papers for printing.

Coated Book usually goes from 30# to 70# for web, 60# to 110# for sheetfed.

Offset is usually a 50# to 70# stock.

#### • Text

High-quality sheets in a variety of surfaces and colors.

Ranges in weight from 60# to 100#, but the most common weights are 70# or 80#.

#### • Cover

Used when greater bulk is required such as book covers, postcards or inserts. Available in a wide variety of surfaces and colors.

Comes in 60#, 65#, 80#, or 100# weights (typical).

#### • Tag, Bristol, and Index

Smooth surface papers, mostly uncoated, except for bristols. Uses include displays, file folders, and tickets.

Within each grade, there are other distinctions, based on brightness, opacity, and fiber content. For instance, there are matte, premium, and ultra gloss finishes to coated paper. In uncoated book, there are #1 Offset, #3 Offset, Opaque, and Lightweight. Text papers are distinguished by finishes like smooth/vellum, felt/embossed, laid, and linen.

### Grammage

Since most countries use the metric system, U.S. designers and buyers should be aware of how paper weights and sizes are designated

in this system. What's more, some printers are using sheets they describe in metric weights, particularly for printing on digital presses. You need to know that an 80gsm sheet is not even close to an 80# sheet.

In the metric system, grammage is defined as the weight in grams of a square meter of paper and is expressed in grams per square meters ( $\text{g}/\text{m}^2$ ). Today, it's also common to see grams per square meter expressed simply as gsm. Grammage is not, however, tied to a certain paper size, as is basis weight.

Below is a table with conversion factors for some of the most common U.S. parent sheet sizes.

In addition to having a working knowledge of weight conversions, designers and buyers for

multinational companies may have to adjust a single design to metric sizes. The basic sizes of paper in the metric system are known as the A Series and the B Series. There are also paper sizes set by the International Standards Organization known as ISO Paper Sizes. The sizes all maintain a constant width-to-length ratio of 1:1.414 and A and B Series papers do conform. There are also special envelope sizes. Below are the A Series sizes. Note that the A4 corresponds closely to U.S. 8 1/2" x 11".

Paper companies are aware that designers need help to cope with global specifications. Therefore they have included far more detailed conversion tables and other helpful information on their websites (see page 7).

### Basis Weight and Grammage Conversion Factors

"lb." means "pounds" (i.e., basis weight);

"gsm" means "grams per square meter" (i.e., grammage)

Basic Size (Trade Size)	Basis Weight to Grammage	Grammage to Basis Weight
17" x 22"	3.760 x lb. = gsm	0.266 x gsm = lb.
20" x 26"	2.704 x lb. = gsm	0.370 x gsm = lb.
24" x 36"	1.627 x lb. = gsm	0.614 x gsm = lb.
25" x 38"	1.480 x lb. = gsm	0.675 x gsm = lb.
25.5" x 30.5"	1.808 x lb. = gsm	0.553 x gsm = lb.
1000 sq. ft.	4.831 x lb. = gsm	0.205 x gsm = lb.
3000 sq. ft.	1.6375 x lb. = gsm	0.614 x gsm = lb.

Ex: 130 gsm offset x 0.675 = 87.75 or 90# paper

### "A Series" Metric Paper Sizes

A#	Size (in.)	Size (mm)	Area (m <sup>2</sup> )
A0	33.1 x 46.8	841 x 1189	1.0
A1	23.4 x 33.1	594 x 841	0.5
A2	16.5 x 23.4	420 x 594	0.25
A3	11.7 x 16.5	297 x 420	0.125
A4	8.3 x 11.7	210 x 297	0.063
A5	5.8 x 8.3	148 x 210	0.031
A6	4.13 x 5.83	105 x 148	0.016
A7	2.91 x 4.13	74 x 105	0.008
A8	2.05 x 2.91	52 x 74	0.004

### Grain

Grain refers to the position or direction of the fibers that make up the paper. During the papermaking process, fibers in the pulp typically align themselves with their length parallel to that of the machine and their width running across the machine. So, the grain of the sheet is in the machine direction; the other dimension is called the cross direction or cross grain. A sheet may also be described as grain short or grain long.

Designers and printers need to be conscious of grain direction because it makes a difference. Paper folds smoothly with the grain and will crack when folding cross grain. This is an important consideration when planning a printed piece. Paper is also stiffer in the grain direction. It expands or contracts to a greater degree in the cross direction when exposed to moisture. For this reason, sheetfed offset lithography typically (but not always) runs papers grain long. This helps to control four-color register since the only expansion or contraction in the sheet will be across the width of the press. Books, manuals, catalogs, etc. should be printed so that the grain direction is parallel to the binding edge. Otherwise, the pages will not lie flat or turn easily.

If you're not sure whether your printer is running grain long or grain short, be sure to ask. Design your projects with grain direction in mind.

### Finish

In addition to size and weight, one of the most distinct divisions among papers is whether they are uncoated or coated. Within each of these categories there are also a number of finishes that relate primarily to how smooth the sheet will be.

Coatings are a suspension of pigments in binders and are applied either on the machine during the papermaking process or on a separate coating machine. They are coated for a number of reasons that can be either functional or to improve appearance or both. Coating adds gloss, smoothness, high density, better color, printing detail, and printing brilliance. However, the two most important reasons for using coated papers are printing ink holdout and smoothness. In other words, the printing ink film will sit on top of a coated

sheet and apply more evenly as well. Coated paper finishes range from dull to glossy.

On the other hand, designers often use uncoated stock with rougher finishes to achieve what they have in mind. Since ink sinks into uncoated papers, the look is quite distinct. According to International Paper's *Pocket Pal*, typical finishes for uncoated book papers are, in order of increasing smoothness: antique, eggshell, vellum, and machine finish. The calender roller on the paper machine can produce all these finishes. Supercalendering, another process to obtain an even smoother finish, is done off-machine. Uncoated papers may also be embossed with a special machine roller. Common patterns are linen, tweed, and pebble. Watermarked papers are formed and marked right on the fourdrinier by special rollers called the Dandy Roll or a rubber stamp roll called a Molette.

### Appearance

Other attributes, like color, brightness, opacity, gloss, and texture are called appearance characteristics of papers. Each of these works in conjunction with the others to deliver the message the designer has in mind. And each, with the exception of opacity, ultimately devolves into a matter of taste.

For example, color paper for printing usually means a choice between a natural (yellow or cream) white and a blue-white paper. Each has its own appeal. Four-color subjects may appear warmer or softer on a natural white, while most subjects have more "pizzazz" on a blue-white sheet. The creator asks, "What am I trying to achieve?" "What will my audience respond to?" "What works for this subject?" "What supports my client's brand image?"

Opacity, however, relates to the "show through" of the printed image from the opposite side of the sheet. Lack of opacity in two-sided printing will spoil a project by making it unattractive and illegible, no matter how perfect the actual printing might be. Since the thickness of the sheet as well as which fillers may have been used and whether it is calendered affect how opaque it is, always look at printed samples of stocks you are considering.

### Runnability & Printability

When used to describe paper, the terms

runnability and printability mean pretty much what you would suspect they would. Runnability means the ability of the paper to get through the output device (press, inkjet machine, digital press) and printability means the quality of the image expected when applied to the particular paper.

The thickness of paper affects runnability and is referred to as caliper. Caliper is measured in mils or thousandths of an inch. In book manufacturing, however, the bulk of the paper will determine how thick the book is. According to IP's *Pocket Pal*, bulk for book papers is expressed as the number of pages per inch (ppi) for a given basis weight. The example given notes that the bulking range for a 50-pound book paper can be from 310 to 800 ppi.

Stiffness, porosity, slipperiness, curl, and more all affect runnability. In this area, designers need to rely on their printers for advice. If you are considering a paper that one or more printers say doesn't run well or takes special care to run, you need to consider the potential impact on your project's appearance or cost. Printed samples would be especially important here.

### Current Paper Topics

#### Digital Papers

By digital papers we don't mean virtual sheets on an e-reader. We mean actual papers that have all the same characteristics as any other printing papers, but are also compatible with a specific digital press or presses. In the United States, the Rochester Institute of Technology runs a testing program for mills that want their stock certified or scripted for one or more digital presses. For obvious reasons, mills will often use this certification in their marketing materials directed to printers, but not necessarily to designers.

In this section, digital presses are defined as production devices that output directly from a printed file without imaging a plate, either on or off press. They can be monochrome or full color—including four-color process with additional colors. Today's predominate digital presses are typically electrophotographic or inkjet, although there are other imaging technologies in use as well.

Electrophotography and other processes like electron beam imaging use toner to fuse an image onto paper. Inkjet distributes its special inks through nozzles in individual printheads. Both require compatible papers that are formulated and manufactured to work with these processes. For example, electrophotographic machines need papers that will stand up to the heat employed in their fusing process.

Today, paper mills are developing full lines that either work for these processes and offset lithography as well or coordinate with their offset lines. They understand that designers with brand-conscious clients want to protect and project that brand in everything, from large-format billboards and point-of-purchase displays to short-run personalized print to long offset runs.

### **More Than Process**

Always be sure that the paper you specify is right for the process that will produce your job. Also be sure that it's right for the end use of the printed piece. It is important that you, as the buyer, tell the printer how you intend to use the printed piece. Paper merchants will also be able to advise whether the paper you selected is compatible for your intended uses. Do not assume that all papers that are OK for a process can be used for all projects.

For example, certain inkjet papers are suitable for indoor display but will not withstand outdoor elements. Your printers can advise you on the right combination of inks, substrates, and finishing requirements for your intended use. When it comes to stationery, you need to be especially careful. It should not be produced on an electrophotographic machine because toners will melt when subsequently run through desktop laser printers or office printer/copiers. Here's one area where papers that work for offset and digital presses come in very handy. You can run corporate identity pieces that will be imprinted again on laser printers using offset and other pieces, like business cards, using a digital press, and maintain a consistent appearance.

The same caveats apply to certain offset inks. Inks containing certain waxes and some other ingredients will soften as a result of the heat generated in a laser printer or copying machine. Again, let the printer know how your printed piece will be used.

### **Recycled Papers**

Our ongoing national waste disposal challenge has led to the increasing use of recycled papers. Paper companies have met the demand with offerings in all paper grades and basis weights. And, today many recycled sheets, particularly those used for catalog printing, cost the same as virgin stock.

Quality, particularly runnability on press, was an issue years ago but is not a problem today, with offerings from reputable mills and their merchants. However, at this time there are still differences in definitions associated with recycled papers, and concerned buyers need to consult the EPA (Environmental Protection Agency) guidelines, your individual State and Federal definitions and possible legal requirements, and environmentalist as well as paper companies' literature to make informed judgments.

### **Tree-Free Papers**

Trees from tree plantations are the source for almost all of the virgin pulp used in modern papermaking. Environmentally conscious designers can rest assured that paper manufacturers are not harvesting old growth forests for their raw materials. Instead, companies that own plantations invest heavily in forestry expertise because they consider those trees their renewable resource.

Still, the history of papermaking tells us that fibrous plants other than trees, like cotton rags, grasses, vegetables, and more have been used successfully to make pulp and ultimately paper. Some of these pulp sources are still used today for certain products. Fine cotton rag stationery comes instantly to mind. There are also art papers handmade from vegetables, grass, and cotton that are made in the United States and are available for purchase on the Internet.

For commercial printing, the Italian papermaker Favini introduced its Eco-favini line in 1991. At the time, it consisted of papers made of seaweed harvested in the Venice Lagoon; or from corn fiber; or from a combination of algae, corn, and other plants. On its website today, Favini still lists *Alga Carta*, the seaweed paper, as a regularly available product and also offers to create specialty papers for buyers.

### **Agripulp**

Agripulp is another papermaking alternative. It is a process that combines an agricultural fiber pulp and waste paper so that new fiber portions are replaced by agricultural fiber rather than the virgin wood pulp. Residues of grain stocks like wheat, oats, rye, barley and even things like corn stalks can be used. For more information visit [www.agripulp.com](http://www.agripulp.com).

### **Kenaf**

Overall, it's fair to say that cotton and vegetables are not likely to become the major pulp sources for papers for high-speed lithographic or digital presses. Kenaf, however, is a somewhat different story. A member of the hibiscus family (*Hibiscus cannabinus* L), kenaf is related to cotton and okra, and grows well in many parts of the United States. Kenaf also grows quickly, rising to heights of 12-14 feet in as little as four to five months. It has a base of supporters who believe they can prosper with this crop.

According to Vision Paper, a kenaf paper distributor, U.S. Department of Agriculture studies show that kenaf yields of six to 10 tons of dry fiber per acre per year are generally three to five times greater than the yield for Southern pine trees, which can take from seven to 40 years to reach harvestable size. (Southern pines are one of the favorites for commercial forests.)

The stalk of the kenaf plant consists of two distinct fiber types. The outer fiber is called "bast" and comprises roughly 40 percent of the stalk's dry weight. The refined bast fibers measure 2.6mm and are similar to the best softwood fibers used to make paper.

The whiter, inner fiber is called "core," and comprises 60 percent of the stalk's dry weight. These refined fibers measure 0.6mm and are comparable to hardwood tree fibers, which are used in a widening range of paper products.

Upon harvest, the whole kenaf plant is processed in a mechanical fiber separator, similar to a cotton gin. The separation of the two fibers allows for independent processing and provides raw materials for a growing number of products including paper, particle-board, animal bedding, and bioremediation

aids. In addition, kenaf fibers can be mixed with virgin or recycled wood pulp to enhance certain characteristics. Kenaf papers have also been in circulation long enough now so that recycled kenaf pulp is also available.

Specifications listed for kenaf papers suggest that at this point, available brightness would be an issue for many typical high-end projects. However, buyers should be aware of this alternative because they may have just the right product or customer to use it for. It also appears that kenaf development has the potential to be economically viable enough to be more than an intriguing specialty like hand-made seaweed stock that would only be used for an unusual project or special occasions. For more information, start with the American Kenaf Society website at [www.kenafsociety.org](http://www.kenafsociety.org).

#### Further Research

For buyers and designers needing to spec or learn more about printing papers, the Web is an absolute bonanza. As they have in the past with their printed pieces, mills have carefully developed handsome but practical websites sparing no expense. Uniformly, it's easy to locate a local distributor, find and read about the company's products, and order samples and swatchbooks. Many have calculators for metric conversions. What's more, several have also gone to the trouble to add superior education sections with valuable basic and sophisticated information.

Following is a partial list of mills in the United States and Europe that manufacture printing papers, both recycled and virgin stocks, and specialty papers. For example, the three indicated with an asterisk (\*) had especially helpful tools when we visited in the summer of 2003. Fox River Papers had a movie on papermaking and a great tips section. Neenah offered a Resource Center that includes tips and a competitive chart that helps designers understand similar papers. Sappi Fine Paper offered a CD on papermaking.

*Textbook Credits:* The GATF Encyclopedia of Graphic Communications (1998); Paper Knowledge, MeadWestvaco (*The Mead Corporation*) (1990); Pocket Pal, A Graphic Arts Production Handbook (1995).

#### Mills

Appleton Papers	<a href="http://www.appletonpapers.com">www.appletonpapers.com</a>
Arjobex	<a href="http://www.polyart.com">www.polyart.com</a>
Arjo Wiggins	<a href="http://www.arjowiggins.com">www.arjowiggins.com</a>
Boise Cascade	<a href="http://www.bc.com">www.bc.com</a>
Crane & Company	<a href="http://www.crane.com">www.crane.com</a>
Curtis Fine Paper	<a href="http://www.curtisfinepapers.com">www.curtisfinepapers.com</a>
Domtar	<a href="http://www.domtar.com">www.domtar.com</a>
Eastern Papers	<a href="http://www.easternpaper.com">www.easternpaper.com</a>
Favini Group	<a href="http://www.favini.com">www.favini.com</a>
Finch Paper	<a href="http://www.finchpaper.com">www.finchpaper.com</a>
Fox River	<a href="http://www.foxriverpaper.com">www.foxriverpaper.com</a> *
Fraser Papers	<a href="http://www.fraserpapers.com">www.fraserpapers.com</a>
French Paper	<a href="http://www.mrfrench.com">www.mrfrench.com</a>
Georgia-Pacific	<a href="http://www.gp.com">www.gp.com</a>
Gilbert Paper	<a href="http://www.gilbert.com">www.gilbert.com</a>
Grays Harbor Paper	<a href="http://www.ghplp.com">www.ghplp.com</a>
Gruppo Cordenons (Intermills)	<a href="http://www.gruppocordenons.com">www.gruppocordenons.com</a>
International Paper	<a href="http://www.internationalpaper.com">www.internationalpaper.com</a>
Accent, Beckett, BrightHue, Carolina, Great White Hammermill, Springhill, Strathmore, Via	
MeadWestvaco	<a href="http://www.meadwestvaco.com">www.meadwestvaco.com</a>
Mohawk Paper Mills	<a href="http://www.mohawkpaper.com">www.mohawkpaper.com</a>
Monadnock Paper Mills	<a href="http://www.mpm.com">www.mpm.com</a>
Neenah Paper	<a href="http://www.neenahpaper.com">www.neenahpaper.com</a> *
Potlatch (Sappi)	<a href="http://www.potlatchcorp.com">www.potlatchcorp.com</a>
Sappi Fine Paper	<a href="http://www.sappi.com">www.sappi.com</a> *
SMART Papers LLC	<a href="http://www.smartpapers.com">www.smartpapers.com</a>
Stora Enso	<a href="http://www.storaenso.com">www.storaenso.com</a>
Wausau	<a href="http://www.wausaupapers.com">www.wausaupapers.com</a>
Weyerhaeuser	<a href="http://www.weyerhaeuser.com">www.weyerhaeuser.com</a>
Wyndstone Specialty Products	<a href="http://www.wyndstone.com">www.wyndstone.com</a>
Yupo Corporation (synthetic papers)	<a href="http://www.yupo.com">www.yupo.com</a>
Zanders (m-real)	<a href="http://www.zanders.com">www.zanders.com</a>

*Websites used as sources appear with an asterisk (\*).*