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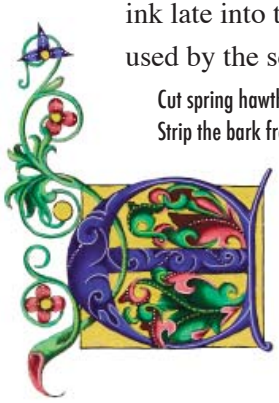
One in a series of monographs about our products and services designed to inform, guide and illuminate

On Inks: From Soot and Spit to Synthetics

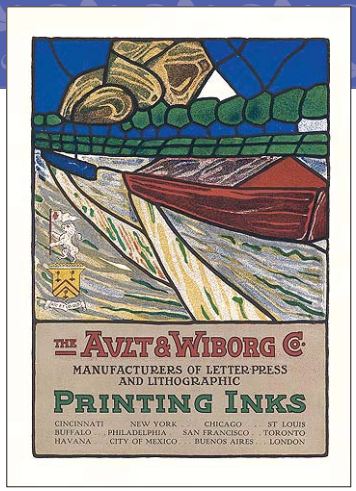
If paper is the background for virtually all printing projects, then ink takes center stage. Some form of ink has been around for as long as 40,000 years. Well before the invention of paper, early humans were pressing their ink-covered hands against cave walls and stone cliffs. These earliest inks were made from the mineral oxides in dirt or the carbon black in charcoal, mixed with saliva, animal fat, urine or blood. There is evidence that ancient peoples traveled great distances to obtain hematite (the source of many iron oxide pigments) that produced the rich red color we can still see today.

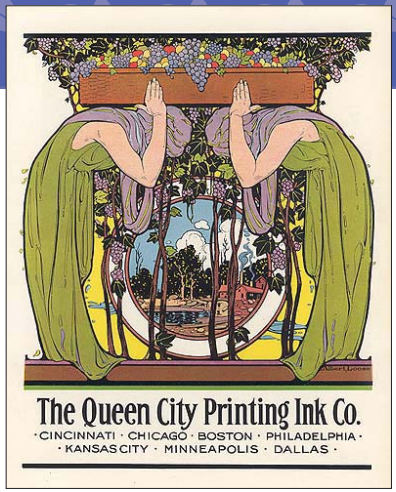
This cave painting of a bison in Altimira, Spain, was made approximately 17,000 years ago.

For tens of thousands of years, these were the inks, or paints, that people used to make images of special significance. It was not until about 5,000 years ago that the Chinese began using ink for writing. Even at that time, the ink they used, much like those of the cave-dwellers, was a mixture of carbon and animal matter. The Chinese were also the first to produce a solid stick of ink that could be shaved and mixed with water – it has been in use ever since and is often called Chinese or Japanese ink. Black ink made from carbon is called India ink, even though it too was developed in China. Throughout the world, many cultures discovered that a wide range of colors could be produced by using plant, animal and mineral ingredients. In the 1100s, iron gall inks became popular, although they were highly corrosive and over time damaged the paper they were used on. A major change in the evolution of ink came with the invention of the printing press in the 15th century. Handwriting inks did not adhere properly to the metal printing surfaces; eventually oils were added to the recipe that solved the problem. Printers made their own ink late into the 19th century. Here is a method used by the scribes of medieval Europe:



Cut spring hawthorn branches, leave to dry.
Strip the bark from the branches.
Soak in water for eight days.
Boil the water until it thickens and turns black.
Add wine.
Pour into bags and hang in the sun until dry.
Mix dry material with more wine and iron salt.
Cook over a fire.





Ink company posters from the early 1900s often used well-known illustrators such as Will Bradley and Henri Toulouse-Lautrec.

With this laborious process, one wonders how much wine actually made it into the ink.

The inks used today are of two classes: writing inks and printing inks. Writing inks commonly use dye rather than pigments to avoid clogging the pen tip. Dyes are organic colorants that are highly soluble, while pigments are both organic and inorganic colorants that do not dissolve and remain intact – though in extremely small particles – in the solution. Dyes offer brilliant color but fade much more quickly than pigments. Fountain pens work with a water-based dye, as do felt-tip pens. Ballpoint pens use an thicker oil-based system, which is faster drying and better suited to a multi-directional capillary action. Printing inks, which comprise ninety percent of the total ink manufactured, are divided into two general areas: ink for conventional impact printing, including letterpress and offset, and ink for non-impact digital imaging.

Conventional Printing Ink

Modern inks are made from complex oil-based formulas that include pigment, a vehicle (binders), solvent to carry the color, and additives that control various properties of the ink, including drying time, adherence to and penetration of the substrate, and amount of body. Metallic inks are produced by suspending metal particles in the vehicle – the silver color is made by aluminum flakes and gold is made mostly from brass and copper. The ink used in letterpress and offset printing (traditionally the way in which most commercial materials such as brochures, pamphlets, posters, and books are produced) is a paste with several properties that are of great importance to its performance on the press.

- **Tack** is a measurement of how well the ink holds together and sticks to the paper. If it is too tacky, the ink will tear fibers off the surface

of the paper as the impression is made. If it is not tacky enough, the image it makes will be blurry. All inks are tack-graded. This not only informs the printer of the appropriate paper stock to use, but in which order to lay down the colors. If a higher-tack ink is printed on top of a lower-tack ink, it could possibly pull the first ink layer right off the paper.

- **Drying time** is a critical factor in the speed of the printing process. There are several very different ways in which ink dries, and this determines when a particular ink is used. In absorption, the vehicle is soaked into the substrate while the pigment remains on the surface. Evaporation uses heat to dry some of the vehicle, and the rest of the vehicle and the pigment are left behind in a solid film. This provides a more smear-resistant finish than absorption. Oxidation is the drying method required by most offset and letterpress printing inks. Oxygen in the surrounding air dries the vehicle, and special ingredients then cause the ink to harden.

Letterpress inks are of a medium tack, and because a thick film of ink is required to stick to the raised printing surface, the amount of pigment needed is less than that for the offset process. Offset inks are called lithographic inks in reference to the use of oil and water in traditional lithography ("stone writing" in Greek), in which oil-based ink adheres to a greased area on a stone but not to the areas that are wet with water. Today a printing plate takes the place of the stone, and the image is first offset onto another surface before being transferred to the paper. The roller action of the press reduces the viscosity and tack of these inks to produce a thin, even flow onto the plate. In addition to these types of impact

Lithographics inks ready to be used on an offset press

Toner cartridges for a commercial large-format laser printer

printing inks, there are many variations on this basic formula used for newspapers, magazines, packaging, metal and plastic products – all adjusted for the specific method of printing and the material being imprinted.

Digital Printing Ink

Digital imaging these days consists almost entirely of non-impact inkjet and laser printers. A major difference between them is that inkjet ink is a fluid, and laser ink is in a powder form. Both, however, use the basic process colors of cyan, magenta, yellow and black to build images. As technology has advanced, more inks have been added to widen the color range, including red, green, blue, and several types of black.

Inkjet Inks

These are either water- or solvent-based inks that are carefully structured in order to be harmless to the fragile inkjet print heads. Use of dyes is giving way to use of fade-resistant pigment for color, but the particle size of the pigment needs to be extremely small to avoid clogging up the machine. Since the ink is forced from the ink cartridge, either by heat or an electrical charge, through nozzles onto the paper in tiny droplets, the ink must be of very low viscosity. The composition of inkjet inks varies according to the specific technology of the printer in use.

Laser Printing Inks

The dry, powdery inks used by a laser printer are called toner. While liquid inks are made of pigment, vehicle, and additives, toner inks are made of styrene acrylate copolymers or polyester resins – beads of plastic – along with the pigments. The toner is given an electrical charge, and is attracted to a drum by the oppositely charged image portions on the drum's surface.The image is then transferred to paper using the same principle. Pressure, heat, and/or light cause the plastic beads to melt and the toner to fuse to the paper.

Please call us with any questions you may have about our monographs. We are providing this information to increase your understanding of the printing process and its terminology. We look forward to working with you on your projects for truly outstanding results.

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3735 Kimwell Drive, Winston-Salem, NC 27103
336-760-0099 Fax: 336-760-5880 www.keiger.com