A Brief History of Carbon Printing

Ponton’s Discovery to the Alternative Process Revival
The early interest in the carbon process grew out of the public concern with the major flaw of early salted paper prints - their tendency to fade. A. M. Marton’s 1905 manual *A New Treatise on the Modern Methods of Carbon Printing*, put archival permanence at the forefront. In his preface, Marton observes,

“It is a sad fact, but an undeniable truth, that to be confronted with a faded and yellow photograph, (which is getting to be a matter of frequent occurrence), is a source of great mortification to the photographer whose name is associated with or appears on the mount of such a picture.

If we look at the work of leading professionals of today we find that the pictures they stake their reputation on, are all printed in carbon.”

However, decades before carbon came into its own as a printing method, research began in the nineteenth century with observations of the effects of dichromate salts on colloids (gelatin, gum, albumen, casein, fish glue, etc.), when exposed to light. In 1839 the Scottish scientist Mungo Ponton observed the light sensitivity of paper treated with dichromates. Ponton did not mix the dichromate or treat the paper with gelatin or other colloid. However, in 1840 the French scientist Alexandre-Edmond Becquerel repeated Ponton’s experiment and noted that the internal colloid sizing of Ponton’s paper played a role in the effect. In 1852 Henry Fox Talbot also observed that dichromated colloids exposed to light became insoluble, and included his discovery as part of his patent of photoglyphic engraving.

The first application of these discoveries in a pigment printing process is credited to Alphonse-Louise Poitevin, a noted French chemist. As such, Poitevin is regarded as the inventor of carbon printing.

In 1856 a noted French agronomist, Honor d’Albert, Duc de Luynes, a member of the Société Française de Photographie, established two awards: one to be given for the discovery of a permanent method of chemical printing; the other for a superior method of photomechanical reproduction. Poitevin was awarded the gold medals by the Duc de Luynes in both categories for his discovery of the carbon and collotype processes.

In his process, Poitevin mixed a carbon pigment into a mixture of dissolved gelatin and potassium dichromate. This mixture was applied to a sheet of paper, which was then exposed to light through a negative. The exposed sheet was then developed in warm water. The water dissolved the unexposed gelatin, leaving behind the exposed and insoluble gelatin to form a positive image.

Poitevin’s discoveries, patented in 1859 and based on earlier research by Ponton and Becquerel, are at the heart of all subsequent methods of pigment printing, hand and mechanical. They form the theoretical base for carbon transfer, direct carbon (Artigue, Fresson, etc.), and gum bichromate. Collotype, a technique for printing with lithographic ink from photographically prepared colloidal surfaces, is almost identical.
to the oil and bromoil transfer printing methods made famous by the great French pictorialist Robert Demachy in the early 1900s.

All pigment processes depend upon the fact that colloids (gelatin, gum, albumen, casein, fish glue, etc.), when applied to a suitable support, sensitized with a dichromate salt (commonly ammonium or potassium dichromate), and activated by exposure to light (or through the chemical bleaching of a silver print), change their physical characteristics in proportion to the intensity of the chemical or light.

This process, called tanning or hardening, produces three principal changes in the colloid:

- it becomes insoluble
- it loses its surface tackiness
- it loses its ability to absorb water and swell

Although there are quite literally dozens of variations on this theme, there are but two major classes of pigment processes:

1. Those that produce as the final image a pigmented colloidal relief
2. Those that produce unpigmented reliefs to which inks or powders must be applied

In the first instance, a colloid is pigmented and a relief image is produced by washing away the soluble gelatin in hot water; carbon transfer, carbro, direct carbon, and gum bichromate are processes supported by this procedure. In the second case, the relief is unpigmented, and must be inked with a brush or roller, or dusted over with powder, to produce a final image. Processes which follow this model are oil, bromoil, and the powder processes.

Oil and bromoil work on the principle that oil-based inks will adhere to hardened gelatin (those areas rendered insoluble), but are repelled by the soluble gelatin in the highlights of the print. In oil and bromoil transfer, the ink is then transferred to a final paper support. Because considerable pressure is required for this transfer to take place, an etching press is necessary to produce large prints.

The powder process works because tanned or hardened gelatin loses its surface tackiness. Powder dusted over the surface of the colloid will adhere only to those areas where the light has not acted to harden the gelatin.

Photogravure and Woodburytype are two other pigment processes that use a colloidal relief to define a printed image. However, they fall somewhat outside the classifications defined above.

Photogravure uses a gelatin relief developed on a copper plate as a resist to etching baths that etch the image into the copper plate in proportion to the amount of gelatin resist on the plate surface. Here the process relies on the insolubility of the gelatin and its reduced absorption to provide the etching resist. Once the plate is etched, the carbon relief is removed and discarded and the plate is inked and run through an etching press.

In the Woodburytype process, a developed gelatin relief is hardened and mechanically forced onto a plate of material, such as a lead sheet, at very high pressure. Through the application of pressure, the gelatin relief is transferred to the sheet of material. This negative relief is then filled with pigmented gelatin, which is subsequently transferred to a final paper support to create the image.

In both photogravure and Woodburytype, the gelatin relief is an incidental means to produce a final relief to which a pigmented material is applied. In more modern methods, such as photopolymer gravure, the gelatin relief has been replaced by other photosensitive materials.

**Refinement of the Carbon Process**

Pigment prints made according to Poitevin’s original discoveries suffered from one major shortcoming: they lacked half-tones. The result was an image of high contrast, short tonal range, and lacking detail.
A Brief History of Carbon Printing

Laborde, who had been conducting experiments in a related field, reasoned correctly that the colloid-pigment layer was rendered insoluble beginning from the outer surface and working its way downward as exposure increased, only reaching the surface of the paper in the print’s shadows. In the half-tones a layer of soluble colloid was left beneath the image, which would wash away during hot water development. When this layer washed away the half-tones would be undercut and lost.

Once the problem was understood, the solution seemed obvious: expose the pigmented colloid coating from the back so that the hardening action would begin at the point of contact with the paper surface. During 1858-59, experiments along these lines were carried out by Joseph W. Swan, C. J. Burnett, and William Blair. Burnett and Blair, who applied a pigmented gelatin coating to a paper support, succeeded in producing half-tones, but their method of exposing from the rear required long exposure times, and degraded image sharpness, both resulting from the texture of the paper and the diffusion of the light passing through the paper. Another solution envisioned was the transfer of the sensitized and exposed colloid-pigment layer from its original support to another surface, with the original outer surface now on the bottom, allowing the developing action to begin on the soluble gelatin of the inner surface.

Fargier was the first to conduct experiments along these lines. He coated a plate of glass with a pigmented gelatin solution that, after drying, was exposed to light through a negative. Following exposure, he placed the exposed gelatin-pigment surface in contact with a sheet of paper covered with a layer of hardened gelatin. After a few minutes in hot water, the inner surface of soluble gelatin would separate from the glass and the development of the image, now firmly attached to the paper support, could continue.

This procedure worked in practice, but yielded a reversed print. Any text in the image was mirror-imaged, which caused concern for the print viewer. Fargier also experimented with a transfer procedure in which the exposed gelatin was coated with a thick layer of collodion;
A Brief History of Carbon Printing

Unlike Fargier, Swan used a paper support that was coated on one side with a pigmented-gelatin solution. After sensitization and exposure, this carbon tissue was transferred to a temporary support for development. After drying, the resulting pigment image was then transferred to its final paper support by a second wet process. This double transfer, from the tissue to the temporary support and from the temporary sup-

when the collodion dried the pigmented gelatin was placed in hot water, where it soon separated from its glass support. However, the fragility of the gelatin-collodion combination made the process extremely difficult to manipulate, thus limiting its use to the production of very small photographs.

A breakthrough, and a process that resembles current carbon printing methods, came in 1864 when Swan received patents for the manufacture of carbon tissue as well as for a modification of the transfer procedure. Another innovation was Swan’s addition of sugar to the tissue as a plasticizer, which rendered his carbon tissue flexible and aided in the penetration of the dichromate sensitizer. Sugar is still a key ingredient in tissues made today.

Advertisement for Autotype carbon printing tissue

Adolphe Braun. Musée du Louvre, Bosio. 1866. Carbon print
A Brief History of Carbon Printing

Negative, a condition that in an era of decreasing camera size came to be perceived as a major drawback.

Thomas Manly’s Ozobrome process, introduced in 1905, solved the problem of enlargement, and at the same time provided a much easier method of exposure control. Based on a finding by A. Marion, Manly had marketed in 1899 a process called Ozotype. Ozobrome, however, is quite different and had its origin in the discovery made by E. Howard Farmer in 1889 that dichromate salts, in the presence of gelatin, port to the final support, also had the effect of correcting the horizontal orientation of the image for a final print in which the image was not mirrored and lettering in the print was once again right reading.

The term “tissue” is still used today to describe the combination of the pigmented gelatin and the support which carries it from sensitization through the first transfer. The term “tissue” probably came into use to describe the disposable nature of the carrier material once used, but the name is somewhat misleading since it does not resemble a thin delicate tissue paper. Pigmented gelatin can be coated on a wide variety of materials, including paper as well as durable and reusable polypropylene Yupo sheets.

Swan began marketing carbon materials in 1866, offering his ready-made tissue in three colors: black, sepia and purple-brown. In 1868, Swan sold his patent to John Robert Johnson and Ernest Edwards who formed the Autotype Company. In the years that followed, Autotype continued research and development into the carbon process and manufactured carbon printing tissue in a wide variety of colors. Autotype was also the dominant manufacturer of pigmented gelatin tissue for photogravure until it was discontinued in 2009.

Carbon as a Commercial and Fine Art Process

The greatest initial use of the carbon process was to make reproductions of paintings and drawings by the Old Masters. This was the specialty of Adolphe Braun of Alsace, who in the 1870s operated a huge carbon printing service with a daily output of some 1500 prints. Carbon was the preferred process of the top echelon of commercial photographers, especially in France and Great Britain, where most considered it the aristocrat of all printing processes.

Because sensitized gelatin is far less sensitive than silver salts, carbon tissue must be exposed by contact printing with a bright UV source. In practice, this limits the size of the final print to the dimensions of the negative, a condition that in an era of decreasing camera size came to be perceived as a major drawback.

are reduced when placed in contact with silver, causing the gelatin to be rendered insoluble.

Ozobrome offered significant working advantages over carbon, primarily in eliminating the need for a large negative. In this process a silver bromide print is used to chemically activate the pigmented gelatin.

In 1919 H. F Farmer improved the process, and it was marketed by the Autotype Company of London as Carbro (CARbon + BROmide), a name that aptly conveys its hybrid origin. The differences between carbon and carbro are entirely in the development procedures, and the appearance of finished prints made with the two processes is in every way indistinguishable.

Color Carbon

Because of the flexibility in pigment selection and the ability to layer multiple transfers onto a final support, carbon has always been capable of producing full color tricolor and prints with subtractive CYM processes. However, because of the need for enlargements from separation negatives and the complexity and precision of the materials required, color carbon only came into wide use with the development of carbro.

Carbro became the premier color printing system in the 1920s and 1930s, and materials for its use were widely marketed as late as the early 1950s. However, as a result of competition from the dye transfer process, the market for carbro materials disappeared in the 1950s, and by the end of the decade most of the major suppliers had abandoned the process. An exception was Hanfstaengl of Germany, a company that produced small quantities of carbon tissue and transfer papers for monochrome and three-color work as late as the 1980s.

Color carbon saw a brief revival in the 1990s with the UltraStable Color System invented and developed by Charles Berger. UltraStable was a CYMK process that was unique in using a diazo sensitizer instead of dichromate. Used in high-end fine art printing, UltraStable ceased production as a commercial product in 1999. However, some of the techniques and materials have been carried on by its early practitioners, including Tod Gangler of Seattle Washington. For more information on the history of color carbon processes and its brief revival in the 1980s and 1990’s see the chapter on color carbon.

Artists Working in Carbon

Notable artists with work printed in carbon or carbo include, Adolphe Braun, Julia Margaret Cameron, Thomas Annan, William J. Stillman, Paul Outerbridge, Man Ray and Sarah Moon. In many instances these...
A Brief History of Carbon Printing

processes, whose image characteristics are closely linked to the inherent characteristics of the process, (i.e., the softness of gum, the limited color range of platinum, the surface qualities of silver, etc.), carbon is capable of presenting images with a wide range of image characteristics, of virtually any color or tone, and on a wide variety of surfaces.

Carbon prints can be made to look virtually indistinguishable from silver gelatin prints. In fact, some early commercial carbon tissues were designed to mimic the look of silver prints. However, what attracts most contemporary carbon printers to the craft is the ability to manipulate a range of aesthetic qualities and variables unavailable in other processes. This creative freedom is enhanced by the necessity for most carbon printers to manufacture their own printing tissue and prepare their own final supports as this process lends itself to individual experimentation and expression.

Pigments

Because carbon tissue can be manufactured with virtually any pigment, carbon prints can be made in a wide variety of colors. The Autotype Company once supplied carbon tissue in over 32 different colors, not counting duotone and three-color papers. The hand manufacture of carbon tissue makes it possible to produce images in literally any color imaginable. Pigment choices can range from simple carbon black pigment in India ink to exotic and experimental handmade pigments. Tissues for color carbon prints can also be made for tricolor and CMYK based processes.

Choice of Final Support

There is an almost unlimited choice of final supports because carbon and carbro images can be transferred to any suitably prepared surface: watercolor papers, fixed out photographic papers, canvas, even glass. Surface preparation of the final support merely involves coating with a layer of hardened gelatin to receive the print.

works are editions of images that were printed for the artist and were also printed in other processes. For example, Thomas Annan’s series Glasgow Streets and Closes was originally printed in albumen editions and later in carbon and photogravure. As mentioned previously, Adolphe Braun largely based his business on carbon reproductions of classic art and antiquities.

Some notable exceptions include Paul Outerbridge and Richard C. Miller. Both produced color carbo prints from their own negatives in the 1930s and 40s. Outerbridge’s carbro’s included commercial work in addition to his more avant garde work. Richard C. Miller is known for his images of actors and his work in Hollywood.

Aesthetic Qualities of Carbon Prints

There is no “superior” printing process. However, in versatility and range of possibilities, carbon is a superb process. Unlike all other
Relief

Carbon prints have a discernible relief that gives them a unique dimensional quality, especially prominent when the photograph is held at a slant to the light. Relief is effected by two qualities the carbon printer can take advantage of: dimensional relief and gloss differential.

The tonalities of a carbon print are formed by varying thicknesses of pigmented gelatin left on the surface after development. This physical relief of a carbon print is a hill-and-valley pattern, the hills formed by a thick build-up of pigmented gelatin in the shadows, the valleys consisting of the paper base of the highlights.

Exaggerated when the print is freshly developed and the gelatin is relatively swollen, dimensional relief is a unique and delightful sight to see. This quality lessens as the print dries. When the image is transferred to a smooth surface, such as glossy photo paper or glass, enough dimensional relief remains after drying to be seen, and even felt. Even on less smooth surfaces a carbon print with high relief will have often have enhanced edge acutance and sharpness, particularly in areas where there are sharp transitions in contrast between shadows and highlights.
Carbon printers can also exploit the difference in gloss between the pigmented gelatin that forms the print and the surface of the final support. Different pigments and additives can be used to change the gloss of the gelatin that forms the image. For example, carbon black pigment typically renders deep blacks and a glossy finish, while bone black and other paint pigments render a more shallow black with a matte finish. Similarly, varying amounts of gelatin sizing on watercolor papers, additives, and supplemental coatings of albumen sizing can enhance or reduce gloss, as can the use of hard and smooth final supports, such as glossy photo paper and white aluminum.

The image contrast and the dimensional quality is enhanced in prints that have a juxtaposition of glossy shadows and matte highlights, or vice versa.

**Tonal Range**

Carbon has a long tonal scale and excellent straight-line characteristics. These qualities allow the use of fully detailed negatives with long density ranges. This results in an even distribution of tones from the highest lights to the deepest shadows. The shadows of carbon prints are unmatched by any other photographic process. The separation is outstanding and the maximum reflective density, the Dmax, can be as great as that of silver bromide papers.

**Sharpness and Acutance**

Carbon is sharper than most other historical processes with a high degree of acutance enhanced by the surface relief of the pigmented gelatin. Indeed, because of their discernible relief, carbon images that have been transferred to smooth surfaces often have even greater apparent sharpness than silver or inkjet prints. Images of high detail, and those that exhibit generous amounts of micro-contrast, exploit the unique qualities of carbon best.

**Archival Quality**

The archival qualities of carbon prints are unmatched. When suitable pigments are used, the stability of carbon is limited only by the gelatin carrier and its paper base, making it the most stable of all photographic processes. The hardened pigmented gelatin is not affected by water,
A Brief History of Carbon Printing

Preparing one's own materials and making prints with these extraordinary processes.

Collectors should be aware that carbon prints are far less common on the antiquities market than silver prints and, because they are capable of the same degree of detail, are sometimes difficult to identify. Characteristics which help in their identification include: unusual colors, visible pigment particles (especially in highlights), glossy shadows contrasting with matte highlights, and discernible relief. Gelatin crazing, which resembles the surface cracking of tempera paintings, is sometimes seen in very old carbon prints - particularly where the print has been flexed.

Working in Carbon

When compared with other historic and alternative printing processes, the carbon process does have some disadvantages. It is a complicated process that requires great attention to detail and proper working conditions. The sensitivity of carbon tissue is affected by a variety of factors: the temperature and the humidity of the working environment, quality of the sensitizer, age of the pigmented tissue, and the type of light used for exposing the tissue.

Like most other historic processes, the sensitivity of dichromated colloids limits the carbon process to contact printing, which means that the dimension of the print is limited by the size of the negative. In the past, a large or ultra large format in-camera negative for carbon, or the use of an enlarged silver bromide “printer” for carbro printing, were required. With the advent of digital negatives, obtaining a large high quality negative from a digital file or scan of a small format film negative has become much simpler.

The preparation of carbon printing materials requires a significant skill and investment of time. Besides the creative freedom this affords, carbon materials are relatively inexpensive compared to other processes such as platinum/palladium. This is especially true for larger prints. The incremental cost for larger prints is very small as it only requires more material made of inexpensive ingredients such as pigment, gelatin and sugar. There is also significant enjoyment to be derived from preparing one’s own materials and making prints with these extraordinary processes.