LOIS OLCOTT PRICE

In the Black: Ink-like Photo-reproductions on Tracing Cloth

ABSTRACT

Photo-reproductive processes for copying architectural and engineering drawings first became common in the 1880s with the introduction of the blueprint. While processes on paper have become increasingly identifiable in recent years, those on cloth remain less familiar.

Tracing cloth is a plain woven, heavily sized fabric used as a durable and translucent support for ink tracings. Because of its translucency, the tracing could be used as a master to produce additional prints in varying processes. For this reason, black ink images on tracing cloth often served as the primary record set in many architectural offices. The original drawings on paper were frequently discarded.

Tracing cloth was also used as a support for photo-reproductive processes. Two black line techniques are particularly significant because they were viewed as permanent and durable facsimiles of original drawings that could serve as primary record sets. The carbon-based technique known as gel lithography and the silver-based technique know as the CB process are often mistaken for ink drawings. Both processes were introduced about 1920 and continued in use through the 1950s. They are often mistaken for ink tracings. Accurate identification of these images as photo-reproductions is important since misidentification can lead to inappropriate storage and preservation decisions.

This paper will review the nature of tracing cloth used for drawings and photo-reproductions and then examine the characteristics and preservation needs of these two processes.

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INTRODUCTION

Black line images on tracing cloth are among the commonest drawings in collections of architectural records. While many are attractive graphics, they functioned as utilitarian working drawings necessary to spell out the construction details for a building. Most were created by laying the translucent cloth over an original drawing and then tracing the image directly onto the cloth with a ruling pen and India ink. This traced image became the master for producing blueprints and other contact printed photo-reproductions as well as, frequently, becoming the drawing of record retained by an architectural office or client after completion of a project. The tracings became increasingly valuable as buildings needed repairs, alterations, and additions that required consultation and reproduction of the original working drawings. Consequently, the interest in producing facsimiles on tracing cloth grew as architects and building engineers watched others lose their archives to floods, fires, and other misfortunes. Given the cost of retracing drawings, the demand for a viable photo-reproduction process grew, resulting in the introduction of two major black line processes between 1900 and 1920.

While these processes could be printed on paper as well as tracing cloth, the goal of reproduction often differed significantly with the choice of support. Black line prints on paper were used as outlines for rendering and further design development and as legally acceptable prints for deposit with some governmental regulatory agencies and patent offices. Many offices and building inspectors, however, would only accept the more durable tracings or prints on cloth. In addition, the translucent nature of tracing cloth allowed it to serve as a printing master for blueprints and other inexpensive photo-reproductions. Therefore, before exploring the photo-reproduction processes in detail, it is necessary to understand the history and nature of the fabric support.

TRACING CLOTH

The first patent for a tracing cloth was filed in Prussia in 1824, but commercial development awaited Charles Dowse's British patent of 1846 and the exhibition of Dowse's cloth in 1851 at London's Great Exhibition. While the Prussian patent utilized a linen base, Dowse's patent called for cotton and subsequent fiber analysis has routinely identified the base fabric as cotton. Regardless of historical and scientific fact, tracing cloths became known as linens among drafters and archivists and that remains common terminology.

Tracing cloth became commercially available in the 1850s and functioned as a far more durable support for traced images than tracing paper, the other alternative. Its first appearance in an American trade catalog occurred in 1855 when N. D. Cotton of Boston listed "Patent Tracing or Vellum Writing Cloth." Cotton described it as "Adapted for every description of Tracing, as well as for Copper-plate and Letter-press Printing; being a substitute for paper where Transparency, durability and strength are required." Appleton's *Cyclopedia* of 1857 mentioned tracing cloth as being similar to oiled tracing paper but preferable for its toughness and durability.

To produce a drawing on tracing cloth, the drafter secured the cloth over the original drawing on his drawing board. He prepared the surface with powdered chalk, commonly known as pounce, to help the slick surface take the ink. Using a ruling pen and either bottled or freshly ground India ink, he traced the original drawing using a straight edge, compass, and other drafting tools. Finally, watercolor could be added to the verso of the tracing where it would show through the translucent support.

Most brands of tracing cloth were manufactured in Britain, primarily in Lancashire, and they continued to dominate the market throughout the nineteenth and early twentieth centuries. The largest manufacturer was the firm of Archibald Winterbottom of Manchester, which began production after 1853 and was best known for its "Imperial" cloth. According to M. J. Wipple's trade catalog of 1860, however, there was at least one unnamed American manufacturer producing "A new and superior article, which for many purposes is preferable to the Tracing Cloth in general use, being much more transparent." This may have been the Interlaken Company which was purchased by Winterbottom, the largest British producer, in 1883. By 1880, Holliston Mills, an American manufacturer known for its book cloth, was also producing tracing cloth. By 1900, American trade catalogs listed various house brands such as Par Excellence, Arkwright, and Prudence, but the British cloths, particularly Imperial, remained the standard of excellence by which tracing cloths were judged. Frank Lloyd Wright, among others, favored Imperial tracing cloth for his working drawings.

With the commercial expansion that followed the Civil War, the use of tracing cloth increased markedly and accelerated again with the introduction of blueprinting and other photo-reproductive processes after 1880. The emergence of blueprinting as a cheap, easy process for producing multiple copies changed the role of tracing cloth drawings in many offices. Rather than being produced as durable copies for workmen to use on-site, tracing cloth drawings became the masters used to make expendable blueprints for workmen. The tracings on cloth were retained as valuable masters. The original drawing, often smudged and heavily worked pencil drawings on inexpensive paper, were discarded.

Companies continued to develop new varieties and formulation of cloth for different applications. Cloths suitable for pencil had been introduced by 1900, suggesting that an increasing number of original drawings and/or tracings were being done in pencil and not inked-in. These mat cloths for use with pencil became increasingly popular after1925 with the introduction of the diazo which reproduced pencil drawings effectively and cheaply. By 1936, Keuffel and Esser listed tracing cloths under three different categories: ink tracing cloths with one side glazed and the other dull, pencil tracing cloths with one side prepared for graphite, and a drawing cloth named Columbia, described as a heavy, opaque, smooth surfaced cloth, suitable for original drawings in both pencil and ink. Tracing cloths continued to be used into the 1950s, when they were replaced by less expensive polyester film (Mylar) supports.

While the preceding history of tracing cloth was drawn from many sources, the following information on its production comes from three major sources who receive credit here. Chief among them is the unpublished thesis submitted to the University of London in 1989 by Barbara Lynn Hamann, now a paintings conservator at the Carnegie Museum of Art. Textile manuals, particularly those dealing with the finishing of cotton fabrics have also been helpful, particularly once they led me to the fact that book cloths and tracing cloth are closely related products produced by the same companies using most of the same materials. In William Tomlinson's monograph, *Bookcloth 1823-1980*, published in 1996, he describes the production of both book cloth and tracing cloth since Winterbottom, the firm for which he worked, produced approximately equal amounts of both of these closely related products. Finally, Janice Carlson, senior scientist in the conservation analytical lab at Winterthur, contributed the results of some preliminary analytical work on tracing cloths.

Tracing cloth is produced from a plain woven cotton fabric commonly known as lawn. Lawn is a lightweight, shear, plain weave fabric that was made in a variety of grades primarily for use in women's and children's summer dresses and in sash curtains. In a plain woven fabric the warp and weft are arranged in a simple over-under pattern.

The lawn used for tracing cloth had to be graded and inspected closely to insure that it was free from slubs and weave irregularities that would be reproduced when the tracing was used for blueprinting, potentially obscuring the image. Lawn was woven from unbleached threads, known as gray yarn, and the finished fabric was bleached as necessary for its end use. Lawns used for garments were usually heavily sized with starch and calendared to produce a smooth, slightly glossy fabric. They were often tinted to light shades of blue, ecru, green, etc. with direct colors added to the starch.

The lawn used for tracing cloth followed a slightly different path. First the gray cloth was singed to remove lose fibers, and then it was bleached. Following these steps, Dowse's patent described materials and methods commonly applied to paper. The prepared fabric was saturated with a resin dissolved in spirit followed by alum, which would have precipitated the resin onto the fibers of the fabric. The fabric was then surface-sized with starch and dried by passing over steam heated rollers. Finally, the surface was glazed "in a manner similar to paper glazing" by pressing between plates or rollers.

Subsequent nineteenth-century patents experimented with gums, oils, and waxes to function as plasticizers, improve translucency, or render the cloth waterproof. Deliquescent substances like glycerol, glucose, magnesium chloride, and calcium chloride were added to increase flexibility and prevent brittleness. The metallic salts reacted with the oils to form carboxylic soaps.

The glazing process also became more sophisticated as the industry developed. Manufacturers introduced calendaring machines specifically for tracing cloth. Calendaring used heat, friction, and pressure, applied by metal rollers, to flatten and polish the fibers and produce a more compact weave by closing the spaces between the threads. This produced a more transparent cloth with a glazed surface.

According to William Tomlinson, the lubricants used in tracing cloth in the twentieth century included various combinations of bone grease, palm oil, coconut oil, and oleine oil. Other sources add poppy, castor, and mineral oils to this list. In more recent years the industry substituted synthetic plasticizers. Less expensive book cloths and tracing cloths were commonly sized with starch and oil mixtures that included china clay or, occasionally, barium sulfate. The china clay provided an inexpensive filler that used less of the more expensive starch and oil ingredients.

While early cloths and those produced up until the 1880s usually had an off-white or natural color, an increasing number of cloths produced after 1880 had a distinctly bluish tint. The colorant was added to increase their transparency to the actinic light needed to produce blueprints and other photo-reproductions. The blue colorant used appears to be a finely ground pigment mixed with the starch sizing. Preliminary analysis of a limited sample of cloths has identified artificial ultramarine as the colorant. Interestingly, the same colorant appears in cloths that do not appear blue although in smaller quantities. As with paper, it was probably added to make the cloth appear whiter. The sensitivity of this colorant to acidity caused by mold or other mild acidic sources may explain the characteristic white blotches commonly found on tracing cloth. Because the ingredients in the cloth, such as the starches and carboxylic soaps, attract moisture as well as providing a nutrient source, tracing cloths are particularly susceptible to mold.

The quality of the finished tracing cloth was judged by several criteria: the uniform texture and transparency of the foundation cloth, the ability of the surface coating to take ink and produce a sharp, crisp line, even after several erasures, and its durability and resistance to the effects of age. The heavy sizing and calendaring applied to tracing cloths made the finished product less resistant to tearing than the original cloth, but it was still expected to possess a certain degree of toughness. The heavy sizing also produces a paper-like stiffness and rattle, although this could be significantly reduced by exposure to moisture or high humidity. Moisture could also significantly reduce the transparency of the cloth.

Water-resistant cloths (advertised as waterproof) that could be used for photo-reproduction processes were introduced in the 1890s. These cloths used albumen mixed with oils and plasticizers to provide a water resistant coating. Later cloths substituted casein and formaldehyde for the albumen and oil formula. By 1904, Winterbottom had begun using viscose dope, wood pulp dissolved in caustic soda and carbon disulfide with castor oil as a plasticizer. Many patents of the 1920s dealt with the addition of a cellulose derivative, such as cellulose nitrate to waterproof the cloth. By the mid-1930s, Winterbottom produced water-resistant book cloths impregnated with pyroxylin (nitrocellulose), cellulose acetate, and benzyl cellulose. These same coatings were applied to tracing cloth.

Now, having taken a passing look at the support, we turn to the imaging material. There are two major black line photo-reproduction processes that took particular advantage of tracing cloth, one carbon and one silver based. Both were introduced between 1910 and 1920 and continued to be used into the 1950s.

GEL-LITHOGRAPHS

The first of these processes, the gel-lithograph, was also known by numerous other names including Fotol Printing, Cyanotype Gelatin, Ferro-gelatin, Fulgar Printing, Ordoverax, Graph Process, Jelly Print, Lithoprint, True-to-Scale, Perfect Scale. Its development was preceded by several other short-lived carbon-based processes, the most successful of which was the Direct Carbon or Permanent Carbon Black process which was used commercially in Britain until replaced by the gel-lithograph.

Gel-lithos are characterized by black ink lines on a clear ground. This process had two major advantages: it produced a positive image in printing ink on any support and the image was true to the scale of the original drawing because the print required no aqueous treatment.

Architects and engineers could have gel-lithographs printed on drawing paper, which allowed them to render over the image in watercolor or other media, producing a finished product almost indistinguishable from an original drawing. Or, they could have gel-lithographs printed on tracing cloth resulting in an image almost indistinguishable from a hand traced example. An image could also be printed on the verso of an inked tracing cloth drawing. The printed image appeared gray from the recto, contrasting effectively with the black-inked image. This was an effective method to illustrate proposed changes superimposed over existing structure.

In addition, a gel-lithograph on a translucent support could be used as a reproducible, or printing master, in the same manner as an ink tracing on cloth. Thus, multiple reproducibles could be made quickly, accurately, and inexpensively from a single original drawing. Gel-lithograph reproducibles could therefore be sent out to bidders or contractors who used them to print as many plan sets of blueprints as they needed. This saved the originating office considerable cost and trouble.

The history of gel-lithographs began in 1904 when Felix J. Dorel of England licensed the secret process to several firms. Ordoverax became the best known version. In 1910, the details of the process became public and its use increased rapidly.

In 1921, B. J. Hall noted that it was one of the four major processes used to reproduce architectural drawings and that it had replaced several other direct line processes including the Pellet, Negrographic (a powdered carbon process), and Permanent Carbon Black. Its use was limited in tropical or semi-tropical areas, such as the southern United States, however, because the gelatin involved in the process became too tacky in hot weather, requiring the installation of special cooling systems and refrigerated tables. The process was still in use in the 1950s, particularly for certain government and patent offices that required that gel-lithograph copies be submitted on a particular grade of Bristol board or paper.

To produce a gel-litho, the tracing to be copied was first contact printed on a slow blueprint paper in the usual manner. The fresh undeveloped print was laid face down on a slightly damp gelatin pad, known as a graph, and squeegeed into intimate contact. The graph consisted of a strong gelatin solution to which glycerin, ferrous sulfate, ox-gall, an antiseptic, and a yellow or white pigment were added. This mixture was melted then poured out on a slab to a thickness of one-tenth inch. After approximately fifteen seconds, the undeveloped blueprint was removed and the graph was immediately rolled with a greasy ink which adhered only to the areas of the graph corresponding to the unexposed areas of the blueprint, the white lines. A print could then be pulled on a well sized paper or tracing cloth using the inked graph as the printing surface.

Light reduced the ferricyanide in the exposed areas of the blueprint to ferrocyanide. When the ferricyanide remaining in the unexposed areas of the undeveloped blueprint was absorbed by the gelatin, it oxidized the ferrous salt in the jelly to form ferric ferrocyanide (Prussian blue). This ferric compound tanned and hardened the gelatin allowing it to retain the greasy ink rejected by the damp, untanned areas. On average, a graph could be inked and used to reproduce about twenty-five prints before the printing surface deteriorated.

Before printing, fairly extensive corrections could be made to the exposed blueprint by painting out unwanted lines and marks with gum arabic. Corrections could also be made on the jelly; marks caused by creases, breaks and stains as well as unwanted lines could be removed with a damp sponge. Additional adjustments could be made after the inked print was pulled. If the lines were weak and the print was to be used as a reproducible, they could be strengthened by covering them with bronze powder, which adhered to the wet ink. These prints are also known as gold backs, but I have only seen them in Britain. Finally, for color work, the graph could be inked and tinted with aniline colors. Although it does not appear to have been done frequently, multicolor prints could be made if a separate drawing and blueprint were produced for each color. The graph could be used in the same manner as multiple lithographic stones to print multicolor images, although registration was a challenge.

CB PRINTS

The other black line process, which competed directly with gel-lithos, was first known as a CB Print. Alternate names include Wash-off Process, See-B Process, Edco, Dupro Process, Photoprint, and Photo-Litho.

The CB print was designed to produce an "ink-like" substitute for the original ink drawing on tracing cloth. Although they required chemical processing, the use of waterproof drafting cloth as the support insured that there was no change in scale during processing. These prints were made for one of several reasons: to produce security copies of valuable tracings, to replace damaged, soiled or discolored originals, or to make revisions of the original. Revisions could be made on the Vandyke negative used to make the final print or inked onto the finished print in the usual manner.

Uniquely, however, erasures to the CB image could be made during or after processing of the print, which provided a flexibility no other process offered. The ability to remove lines from the finished print with a dampened eraser earned the CB and similar processes the generic name of wash-off prints. For example, a draftsman could complete the original drawings for the plan of a building by hand, make CB prints from that tracing, delete any unwanted lines and then add the detail for the electrical, plumbing, and other schedules to the CB prints. This avoided retracing the plan repeatedly and resulted in a full set of reproducible plans on tracing cloth.

The process was probably developed about 1920 by Charles Bruning Co. of Chicago, Illinois, one of the largest drafting supply firms of the period, hence the original name, CB, although the Frederick Post Co. of Chicago also claimed credit. With minor variations, the process continues to be used today but is known as a silver slick or wash-off Mylar because the support is polyester rather than tracing cloth.

The process was described in the 1921 catalog of New York Blue Print as a new and innovative process that produced prints on tracing cloth almost indistinguishable from a new tracing where "the black lines appear as though made by hand." The advertisement emphasizes the savings in having tracings duplicated compared to the cost of having it done by hand and the security of having two sets of original tracings stored in two separate locations. This practice guaranteed "a protection against loss or damage by fire or other catastrophe that cannot be covered by insurance of any sort. Money cannot replace lost records."

The CB process required that a Vandyke print first be made from the original tracing. Briefly, a Vandyke print functions as a full size paper negative that is produced as a contact print of the original tracing. Light will pass through the clear lines of the Vandyke print while the brown background, composed of finely divided metallic silver, effectively blocks the light.

To sensitize the CB support, a silver halide sensitizing agent and an alkaline-activated developer were applied to the tracing cloth in a gelatin emulsion. After the sensitized support was exposed under the Vandyke negative, it was immersed in a highly alkaline activating solution, such as potassium hydroxide, which allowed the developer to harden and develop the image. Non-image areas remained soft and were easily removed by rinsing the print in warm water. While in the final bath, the surface could be wiped with cotton or a camel hair brush to remove any lingering emulsion from highlight areas and undesirable marks caused by smudges or creases in the original. Unwanted parts of the image could also be removed at this point. The print was then hung to dry. Directions provided by some manufacturers, such as Keuffel and Esser, advise that that the wash be followed by a fixer to further harden the image and remove any residual emulsion in non-image areas. To protect prints during use in a damp environment or from the moisture of a drafter's hand, a finishing lacquer was provided as an option.

Many CB prints created as reproducibles exhibit reversed images. The Vandyke print used to produce the CB print was often printed face down in direct contact with the sensitized CB cloth to produce a sharper, though reversed, image. This reversed image CB print was then placed face down and used to produce other prints, such as blueprints or diazos, in the correct orientation. By reducing light scatter through the thickness of the support, this practice produced sharper final prints.

IDENTIFICATION

Obviously, CB prints and gel-lithos are easily confused, but their identification is important to both their interpretation and preservation. Gel-lithos are frequently identified as original ink drawings or tracings. Because changes in the form of erasures and additions can be made during processing, however, it may be critical for a researcher to know that the print is *not* the original tracing.

These prints are characterized by black ink lines on a white ground, although any color line is possible. Because it is a lithograph-like process, the ink has a flat character and sits on top of the support. Under magnification, the lines lack the character of a ruled ink line. Prints on tracing cloth with a starch size often exhibit a loss of gloss on the surface in the area where the cloth was in contact with the damp graph. The edges of the cloth, which curled away from the graph, retain their gloss. The carbon based ink image is quite stable.

CB prints have a more photographic character and are less often misidentified as original drawings, but they are also seldom identified and are treated as silver halide images with a minimally hardened gelatin emulsion. Of particular concern is their interfiling with diazo prints and sepias that have often been treated with an anti-oxidant that attacks the silver image.

CB prints are distinguished by black lines in slight relief on a white ground and are usually printed on medium-weight glossy tracing cloth. By the 1950s, they may also be found on vellum tracing paper and polyester film (Mylar). The image sits on top of the surface of the support and may have a slightly metallic sheen. Under magnification, the lines lack the character of a ruled ink line and appear embedded in an emulsion that is broken or minimally present in non-image areas. The background sometimes has little flecks of black from residual emulsion that was not thoroughly washed off during processing. The images were often printed in reverse since CB prints were frequently used as reproducibles.

Once you start looking for these tracings and photoreproductive processes in collections, you find them everywhere. In fact, after working on this paper, the old riddle, *What is black and white and read all over?* has come to have new meaning.

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LOIS OLCOTT PRICE
Senior Conservator Library Materials
Winterthur Museum
Winterthur, Delaware
lprice@winterthur.org