Line Shade and Shadow: The Role of Ink in American Architectural Drawings Prior to 1860

Lois Olcott Price

INTRODUCTION

Ink is the defining medium in most architectural drawings made prior to 1860. It was a versatile, durable, and accessible media that could produce drawings that functioned on several levels— as utilitarian images required to execute construction of a building; as sales documents designed to persuade a client; and as works of art created to enhance the architect's professional position. During the eighteenth and the first half of the nineteenth century, the role of architectural drawings changed, evolving from simple utilitarian documents often worn out or discarded at the completion of a project, to works of art hung in public exhibitions. The type and number of drawings created for a particular project became increasingly complex and varied, moving from linear orthographic projections created in the eighteenth century to the rendered perspective drawings of the mid-nineteenth century.

While the style of architectural drawings changed dramatically between the eighteenth century and 1860, the role of ink remained constant. Iron gall ink was the media of choice for most eighteenth century drafters while India ink from a variety of European and Oriental sources had become standard by 1860. Ink was used to create both the linear and tonal structure of a drawing using methods described in British and American architects' and builders' manuals. These methods evolved during the period in response to the changing role of the architect and the development of watercolor technique. A reliance on shadowless tinted elevations gave way to an increasingly sophisticated use of shadows and graduated shades that more fully articulated the building as well as enhancing the drawing. Relying on manuals, trade catalogs and drawings, this presentation will explore the use of ink in architectural drawings during this period and some technical aspects of its production.

The early drawings, composed of thin, uniformly inked ruled lines, were generally done to a small scale and included very little detail. Some included dimensions and indications of material, but many did not. Decisions like the profile of moldings, the trim around windows and doors, and the design of decorative brick work were left to the discretion of the builder or made during the construction process through informal consultation. This abbreviated design process was possible because of the nature of eighteenth and early nineteenth century aesthetic assumptions and building practices. Construction technology for all types of structures and the design of vernacular buildings were based on traditional building practices that required little explanation among the parties involved. The design principles that guided more formal Georgian and Federal architecture were based on Palladio's theories of symmetry and hierarchy enriched with classical elements chosen from English design manuals and pattern books. These principles and sources were well understood and familiar to both client and builder.

All this began to change by 1800 with the work of Benjamin Henry Latrobe, a fully trained English architect, who began practice in this country in 1798, and routinely produced sophisticated perspective drawings with a surrounding landscape fully rendered in watercolor. Beside his drawings, the work of native American builders appeared naive, but traditional attitudes and practices changed slowly. In urban areas like Philadelphia where competition was keen and professional architects were available, local practice changed much more rapidly than in more conservative cities and rural areas.

With the emergence of the architectural profession by 1830, the design and construction functions became increasingly separate and fewer decisions were left to the discretion of the builder. With changes in style, building technology and craft practices, the assumptions of the eighteenth and early nineteenth centuries that had united the master-builder and client in a single vision no longer existed. Therefore, in addition to making presentation drawings for the client, architects began to execute detailed construction drawings for the builder that included framing, window sashes, heating and ventilation systems and other functional and decorative elements. Unlike the earlier informal sketches in builders' notebooks, these drawings were executed to scale on good quality drawing paper, neatly inked-in and often tinted with color.

With this very brief stylistic history in mind, I am now going to turn to the techniques used to actually produce these drawings.[1]

INKING-IN THE DRAWING

After a drawing was laid-out in pencil, the lines were inked-in to create a clear and durable image using specialized drafting instruments. The work horses of the architect's tool case were the ruling pen, pricker and compass. Physical evidence of the use of these tools is often present in the drawings, evidence that must be carefully preserved.

Ruling pens used during the period were very similar to those available today. The pen was used for drawing straight lines with a straight edge as a guide. Ink was placed between the nibs of the pen with a brush and the set screw was adjusted to control the width of the line. In raking light, the impressions caused by the nibs of the ruling pen are often clearly evident. The pricker was a pointed needle-like instrument used in copying drawings and evidence of its use, expressed as pricked outlines in the drawing, are common. The compass was used for drawing circles and curves, and most had one fixed leg with a point and one interchangeable leg that could be fitted with a point, a ruling pen or a pencil holder.[2] In transmitted light, the pricks caused by the use of the compass and pricker can usually be clearly seen. In addition, one also frequently finds erasers and corrections on architectural drawings expressed as clearly defined thinned areas that were created with a pen knife or scraper.

In the early years of this period, iron gall ink, commonly used as a writing ink, was the most available media. It was regularly employed by house carpenters executing simple plans and elevations, although Thomas Jefferson also used it exclusively for his architectural drawings such as those for the University of Virginia. Black carbon based inks, known as India inks, were mentioned in European artist's manuals of the seventeenth century and increasingly used by the emerging architectural profession in England during the eighteenth century. English architects like Joseph Horatio Anderson, working in the American colonies during the later half of the eighteenth century, used a black carbon ink for his drawings, although he frequently noted dimensions and textual information in iron gall ink.[3]

With the increased availability of classes in drafting, the publication of builders' manuals and the example of professional architects like Benjamin Latrobe, common practice began to change and carbon ink became the standard medium for drafting by 1830. As early as 1805, Owen Biddle in The Young Carpenter's Assistant, published in Philadelphia, warned his readers about their choice of ink for drafting noting that: "It may be proper to observe, that no kind of ink should be used except Indian ink."[4]

The authors of successive manuals all emphasized the use of India ink although William Minifie, as late as 1854, still felt it necessary to caution inexperienced readers against using common writing ink for architectural and engineering drawings.[5] In spite of the near universal adoption of India ink for drafting, however, many architects, including sophisticated professionals, continued to make numerical and textual notations in iron gall ink throughout the first half of the nineteenth century.

India ink was available in solid sticks that the drafter prepared as needed. R. G. Hatfield in The American House Carpenter, published in 1849, described the procedure for preparing ink in detail:

> With a drop or two of water, rub one end of the cake of ink upon a plate or saucer, until a sufficiency adheres to it. Be careful to dry the cake of ink; because if it is left wet, it will crack and crumble in pieces. With an inferior camel's-hair pencil, add a little water to the ink that was rubbed on the plate, and mix it well. It should be diluted sufficiently to flow freely from the pen, and yet be thick enough to make a black line. With the hair pencil, place a little of the ink between the nibs of the drawing-pen, and screw the nibs together until the pen makes a fine line. Beginning with the curved lines, proceed to ink all the lines of the figure; be careful now to make every line of its requisite length. If they are a trifle too short or too long, the drawing will have a ragged appearance; and this is opposed to that neatness and accuracy which is indispensable to a good drawing. When the ink is dry, efface the pencil-marks with the india-rubber. If the pencil is used lightly, they will all rub off, leaving those lines only that were inked.[6]

Variations in inking included the use of shadow or shade lines. These slightly wider lines were used to create a sense of depth and were placed on the side of an elevation or plan opposite an imaginary light source in the upper left corner striking the image at a 45 degree angle. The heavy black outline of a plan, known as the poche' was often filled in with a brush, sometimes using an ink that had been enriched with sugar or gum to make it more dense and glossy. By mid-century, drawings that were going to be shaded in ink or color were often inked-in using light grey lines of dilute ink rather than black lines to avoid a sharp or hard appearance in the final drawing.[7]

SHADOW, TINT AND SHADE

After a drawing was inked-in, the drafter had the option of continuing to develop the image by adding shadows, monochromatic shades and tints, or local color. The addition of properly cast shadows to an elevation increased the information in the drawing by defining the depth of various projections; the addition of monochromatic tints and shades increased the clarity of the image; local color suggested the materials to be used in the structure and all these elements increased the visual appeal and artistic appearance of the drawing. The progressively sophisticated use of these elements from the late eighteenth through the mid-nineteenth century paralleled the growing sophistication and professional consciousness of architects as they made the transition from craftsman-builder to professional designer.

Shadows were laid out in pencil on a drawing whose lines had already been inked-in. The light was assumed to strike the building at a 45 degree angle from the upper left, entering over the left shoulder of the spectator. Using the rules of geometry, the plan of the building and the scale of the drawing, the drafter determined the dimensions and angle of every shadow and cast it accordingly. Dilute ink washes were used to fill in the shadows, often as part of an overall scheme for tinting and/or shading the building.

The terms tint and shade were sometimes used interchangeably, but many authors drew a subtle but clear distinction. Tinting was characterized by the application of dilute ink washes to produce flat areas of tone without reference to light. An example might include tinting each major element in an elevation, such as the main block of a building and its projecting wings or roof, with a different dilution of ink.

Shading was characterized by the application of dilute ink washes to produce graduated areas of tone to suggest the modeling of three dimensional forms or the affect of light. To create the graduated affect of shading, architects traditionally relied on flat tints of a single dilution of ink evenly applied in layers over a decreasing amount of the area to be shaded.[8] This technique resulted in clearly defined areas of tone progressing from light to dark.

By the mid-nineteenth century, innovations in artists' watercolor techniques, particularly the use of continuously graduated washes, influenced architect's approach to their drawings. Among most architects, continuously graduated or soft tint shading, using the techniques developed by watercolorists, became increasingly common. In a book written for draughtsmen in 1854, William Johnson noted that there are two methods for laying in shading on geometric forms; flat tint shading and graduated or softened tint shading. In introducing softened tint shading, Johnson explained that:

> This system of shading differs from the former [flat tint shading] in producing the effects of light and shade by imperceptible gradations, obtained by manipulation with the brush in the laying on of the color: this system possesses the advantage over the first, of not leaving any lines, dividing the different degrees of shade, which sometimes appear harsh to the eye, and seem to represent facets or flutings, which do not exist.[9]

COLOR

Color was the final consideration of the architect in completing his rendering and watercolor was the medium of choice throughout the period. In standard watercolor technique of the eighteenth century, colored washes were laid in over washes executed in various dilutions of India ink. Ink washes established the tonal relationships and gradations within the picture while color tints expressed the local color. The final picture was a tinted drawing rather than a painting, and the ink washes muted the local color giving the overall composition a subdued tone. While unsophisticated builders of the eighteenth and early nineteenth century tended to apply color boldly and directly with out underlying ink washes, architects consistently used color washes over ink rendering. Only toward the end of the period did architects begin to use some of the direct color techniques watercolor artists had been using for decades.[10]

INK TECHNOLOGY

In any discussion of India ink, it is important to note that the term does not refer to one predictable and constant material. This media was originally imported from the Orient during the seventeenth century and known as India, Chinese or Japan ink. It was highly valued for the dense black lines and luminous washes it could produce. By the eighteenth century, European ink manufacturers like Ribaucourt of Paris and Eisler of Holland had begun to fabricate a European version, but the quality of the original was difficult to imitate. European ink sticks tended to be gritty and to produce an inferior ink with a distinctly brownish tint. The European product was designed to closely resemble the Asian product, however, even to the point of inscribing the sticks with Chinese characters. Given this situation, India and Chinese ink became generic terms for black carbon inks generally.[11]

Regardless of their geographic origin, India inks are commonly composed of a finely ground black carbon pigment, usually lamp black, and a glue or gum binder. Most imported India ink was manufactured in China. The most common source for the finest Chinese lamp black was tung oil. According to one account, the lampblack was produced by burning the oil in wick lamps over which terra cotta cones with polished inner walls were suspended. The soot from combustion of the oil collected on the smooth walls of the cone and was removed hourly with a feather, care being taken not to collect the resinous by-products which were also deposited on the cone walls. Only the very smallest particles of lamp black were suitable for fine inks. Some manufacturers sorted the particles during combustion by channeling the smoke through various tubes, chambers and partitions. The purity and fineness of lamp black was critical to the quality of the final ink. The presence of resinous or oily-by products from incomplete combustion produces an ink that has a brown tint and may turn browner with time until it resembles iron gall ink.

The lamp black is kept in aqueous suspension with a binder that prevents the finely divided particles from coalescing and precipitating. The binders in Chinese ink sticks are most commonly glues from fish and animal sources or gums, especially gum arabic. A clear gelatin from fish skins was used for particularly fine inks. Mucilaginous substances such as agars and alginates from seaweed were also occasionally used. To prepare the ink sticks, glue or gum was pored through a sieve onto the lampblack pigment. This mixture was heated over steam and then pounded in a mortar until it became pliable. Additives, particularly musk and/or camphor were added to the ink and served as insecticides and fungicides as well as satisfying certain religious and cultural requirements. The ink was then molded into sticks and dried slowly.[12]

The European product was produced by combining lamp black from the soot of a variety of sources including burning oils, resins or resinous woods, charcoal, twigs, bones, ivory and seeds or stones of various plants and fruits. The soot was finely ground and mixed with a binding media of water and one of a variety of glues and gums. Gum arabic was the most common choice according to most recipes.[13]

One should note here, to avoid confusion, that bottled waterproof inks commonly referred to as India inks and still in use by modern drafters, illustrators and artists, were developed about 1790, but were probably not widely adopted by American architects for at least another half century and are not mentioned in trade catalogs or manuals until 1870. They consisted of lamp black in an aqueous suspension with a binder of shellac or a resin dissolved in borax or a similar soap.

A study of the trade catalogs of American companies has been useful in establishing what inks were available to drafters during the nineteenth century. When N.D. Cotton of Boston published his catalog of artist's supplies in the 1840's, only one type of ink was available, India ink in sticks described only by shape, including Octagon, Large Square or Oval Lions Head.[14] This description provided little guidance regarding quality for the consumer. Manuals of the period advise that ink sticks be rubbed against the teeth to test for grittiness or slightly dampened to see if they had a smooth, soft feel. Ox gall was available as an additive to help the ink flow, particularly across oil impregnated tracing papers.[15]

Cotton's catalog of 1855, and Goupil and Co.'s catalog of 1857, listed a similar assortment of ink sticks as well two types of black bottled inks.[16] Liquid India ink may have been an early waterproof ink or more likely, a ground India ink prepared by the colormen to save the architect the trouble. Hogan & Thompson's Jet Black Ink was, according to the text in Cotton's catalog, produced by the chemical combination of new material with the gallate of iron to produce an ink that was permanent in nature and fluid from the pen. Hogan & Thompson's Jet Black Ink was probably what became known as Japan ink, an oxidized iron gall ink composed primarily of ferric tannate with large amounts of gum added to keep the pigment in suspension. It produces a very dense and glossy line, but has the reputation of turning slightly brown with age and tending to clog in the pen during use. Inks of this type were probably used for the dense black outlines habitually used in plans and known as poche'. A clue to its identification is ink that has a slightly brown and crusty appearance and that causes the transfer staining typical of iron gall inks.[17]

In an effort to further define the black inks used by American drafters before 1860, a group of fourteen representative drawings were subjected to elemental analysis using X-ray Fluorescence Spectroscopy (XRF).[18] This analytical instrument cannot detect carbon or the compounds found in most organic pigments, but it can detect most of the elements present in inorganic pigments. Of the nine drawings done before 1840, five showed significant amounts of iron in the black pigment areas. Only one of the five drawings done after 1840 had iron. Five of the earlier drawings, including three that also had iron, exhibited significant amounts of calcium, probably indicating the presence of bone black. This pigment is a more likely component of European than of Chinese inks.

The iron in the black pigment areas could have two major sources. The ink could be a carbon base ink mixed with an iron containing pigment such as Prussian blue. The Prussian blue would have masked the slightly brown tone many carbon inks, particularly those of European manufacture, tended to have. If this is the case, indigo, a frequently used pigment in these drawings, may also have been added to some of the inks for the same reason, but this pigment is organic and cannot be identified with XRF. Manuals note that ink washes were frequently tinted with various water color pigments to warm or cool the tone of the ink, so the use of pigments to adjust the tone of inked lines and washes is not unexpected. A second option, particularly in dense black areas, such as poche's and windows, would be the use of Japan black, the oxidized iron gall ink described above.

These results suggest that the India ink in many drawings, particularly those done before 1840, may have come from European sources and that watercolor pigments, particularly blues, may have frequently been added to the ink to adjust its tone. Since the European inks may be less stable, and pigments such as indigo are moderately fugitive, the media in these drawings may be more vulnerable to deterioration and light damage than is commonly assumed.

CONCLUSION

As this study shows, ink was the defining media in most architectural drawings made before 1860, although its composition and use changed over time to adjust to stylistic trends and the emerging role of the professional architect. In studying and treating these drawings, conservators need to be aware of the physical evidence left by drafting instruments and the many possible variants in ink application and composition.

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NOTES

1. Much of this summary history was drawn from Jeffrey A. Cohen, "Early American Architectural Drawings," Drawing Toward Building: Philadelphia Architectural Graphics, 1732-1986 (Philadelphia: Pennsylvania Academy of the Fine Arts) 1986, pp. 15-116.

2. For a thorough discussion of drawing instruments see Maya Hambly, Drawing Instruments 1580-1980 (Sothbey's Publications: London) 1988.

3. Drawings of Joseph Horatio Anderson of Whitehall and the Maryland Statehouse are found in the Downs Collection of Manuscripts and Printed Ephemera at the Winterthur Museum, Winterthur, DE. Jefferson's drawings for the University of Virginia are found in Alderman Library, University of Virginia. Many conclusions drawn in this paper are based on the examination of a large number of architectural drawings that has helped document when particular types of supports and media were used.

4. Owen Biddle, The Young Carpenter's Assistant (Philadelphia: Benjamin Johnson) 1805, p. 5.

5. R.G. Hatfield, The American House Carpenter, 3rd ed. (New York: John Wiley) 1849, p. 7. John Hall, Modern Designs for Dwelling Houses (Baltimore: John Murphy) 1840, p. 32. William Minifie, Essay on the Theory of Color and Its Application to Architectural and Mechanical Drawing (Baltimore: William Minifie) 1854, p. 150.

6. Hatfield, pp. 7-8.

7. William Johnson, The Practical Draughtsman's Book of Industrial Design (New York: Stringer and Townsend) 1854, p. 122.

8. The Rudiments of Architecture or the Young Workman's Instructor (Dundee, England) 1799, p. 60.

9. Johnson, p. 102.

10. "Washing in Painting," The Cyclopedia; or Universal Dictionary of Arts, Sciences, and Literature, ed Abraham Rees, v. 39 (Philadelphia: Samuel F. Bradford) 1810-24, n.p.

11. James Watrous, The Craft of Old Master Drawings (Madison, WI: The University of Wisconsin Press) 1957, p. 67-68.

12. James Stroud, "Inks on Manuscripts," Unpublished typescript, pp. 42-45. John Winter, "Preliminary Investigations on Chinese Ink in Eastern Painting," Journal of Archeological Chemistry, 2(Winter), pp 207-225.

13. Hambly, p. 62.

14. N. D. Cotton's Catalogue, (Boston) 184-, p. 13

15. Appleton's Cyclopedia of Drawing, ed. W. E. Worthen (New York: D. Appleton & Co.) 1857, p. 41. Hatfield, p. 5.

16. N. D. Cotton's Catalogue of Drawing Materials, Stationary (Boston) 1855, p. 80. Goupil & Co., Catalogue and Price List of Artist's Materials (New York) 1857, p. 37, 57.

17. Sigmund Lehner, Ink Manufacture (London: Scott Greenwood & Son) 1926, p. 44.

18. The analytical work cited here was undertaken by the Conservation Analytical Laboratory at the Winterthur Museum.

Lois Olcott Price
Conservator of Library Collections, Winterthur Museum, Winterthur, DE