OBSERVATIONS ON THE MATERIALS AND TECHNIQUES USED IN 19TH CENTURY AMERICAN ARCHITECTURAL PRESENATION DRAWINGS

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INTRODUCTION

This study of architectural presentation drawings from roughly the last quarter of the nineteenth century will be focused on materials and techniques. In spite of what appears to be a narrowly defined topic, the subject has not been dealt with before and this is intended as a rough overview of the terrain, rather than an in-depth analysis. Much of what is known is in the visual memories (in rare cases notes) of paper conservators and curators; more is to be gained by examining many more objects and by ferretting out key pieces of the puzzle from archives and trade catalogues of the period. The work presented here is based on my interviews with curators, conservators, archivists and special collections librarians. Related published source material was supplemented by my own observations of a few examples in the conservation laboratory as well as a visual survey of some of the (many) drawings by Richard Morris Hunt in the archives of the American Institute of Architecture.

This research was stimulated by three drawings from the Smithsonian collection accepted for treatment at CAL. In order to understand the historical significance of these drawings within the tradition of architectural renderings, it was thought necessary to examine that tradition, to ascertain the "state of the art" during the latter part of the 19th century. My expectation was that there would have been some standards of size, format and materials reflected in the drawings produced, standard textbooks or references for architecture students, specifications and conventions established by tradition. My somewhat narrowly defined problem has yielded a Pandora's Box of amorphous material. Beyond the comfort that the lack of uniformity was a discovery itself, there are some observations that are worth sharing.

I. ARCHITECTURE AS A CHANGING PROFESSION

While this discussion is limited to a narrow spectrum of American architectural drawings, it is useful to mention the European sources which influenced architectural education in America. "In France architectural education had retained its early association with the fine arts. The Ecole des Beaux Arts was an independent unit, although much of the actual instruction took place in independent private studios. In Germany, architecture was a division of scientific and technical education, but within the polytechnics its curricula were both inclusive and integrated. By contrast, Great Britain, homeland of the Industrial Revolution, paradoxically was content to leave technical training to the so-called pupilage system, by which architects gave office instruction in return for pupils' fees, and the supplementary courses offered by private schools. In none of these countries before 1894 did the traditional institutions of higher education, the universities, play the slightest part." [1]

The earliest buildings in the American colonies had been designed by craftsmen/builders relying on their own experience supplemented by European publications. The scarcity of trained architects made it very difficult for aspiring architects to find competent masters. The use of formal apprenticeships or pupilages was rare. More routinely, one became an assistant in the architect's office, gaining technical training and experience in all aspects of design, and usually receiving a small wage. Although in-office training persisted throughout 19th century America as the chief method of architectural education, it slowly began to be supplemented by formal education in architecture and engineering, either in the US or abroad. [2]

During the first half of the 19th century, some architectural students obtained valuable supplementary training through courses offered by newly-established technical schools. The earliest was the Military Academy at West Point, which opened in 1802 and offered the first organized technical (as distinguished from purely architectural) curriculum in the country by 1817. That the 1803 act of Congress establishing the peacetime Corps of Engineers specified the appointment of a teacher of drawing [3] is one indicator of the importance attached to drawing skills in the years before the development of reproductive processes. An "Historical Sketch of the Department of Drawing", written in 1896 [included in "The Centennial of the United States Military Academy at West Point, New York, 1802-1902"] provides a revealing picture of the training in drawing that the young cadets were given.

"During the early period of the Academy--from 1802 to 1810--the course in drawing,like that of other departments, appears to have been of very elementary character, confined to the use of instruments (such as they were) with a little topography and fortification drawing." [4] The scope and character of the department changed and expanded with successive administrations. Robert W. Weir, a distinguished American artist and influential teacher, was among those who left his mark during a long career (1834-1876) at the Academy. His method of instruction included figure drawing, landscape sketching, "the art of shading and finishing geometrical figures with India ink, sketches from nature, and elements of topography with the pen and pencil, and with India ink and colors." [5] As with a studio art education of more recent times, attendance in drawing was a daily requirement until 1839, modified slightly after 1857. [6]

Other technical programs included those founded at Philadelphia's Franklin Institute (1824), the University of Virginia (1836), Harvard University's Lawrence Scientific School(1847), Rensselear Polytechnic Institute (1849), Yale (1852), University of Michigan (1852), New York University

(1854), and the University of Wisconsin. It was not until the 1860's, however, with the impetus provided by the Morrill Land-Grant Act, that the first American schools of architecture, MIT, the University of Illinois, and Cornell University were founded. [7]

For the American architectural profession the three decades from the mid-1860's on through the early 1890's was a period of immense change. Architecture as a profession became more firmly entrenched and the architect began to create a self-image as the businessperson/designer. [8] As American cities grew and architectural firms expanded to meet the demand, "firms established a hierarchical division of labor so that designers, draftsmen, and engineers each tended to specific aspects of a building's design and construction. This pragmatic approach was encouraged as well by changes in the education of architects." [9]

Advances in technology had profound effects on architectural practices. By the 1880's photomechanical methods had been developed so that it was both possible and economically feasible to publish original drawings in magazines and books.

"All these changes [in education and technology] decidedly affected the uses to which architectural drawings were put. It was in the 1870's and 1880's that the threefold division of architectural drawings became fully solidified... The first two aspects of drawing--preliminary sketches and especially presentation drawings--continued to have a loose tie with High Art [sic] drawing and painting..."

"...In the larger offices the principal(s) would supposedly produce the underlying concept of the building through sketches. After this had been worked out, formalized prsentation drawings would then be made by a skilled draftsperson in the office or by an itinerant delineator; and when this had been approved by the client, working drawings would be produced...It became increasingly advantageous to employ professional renderers who could produce impressive formal drawings used to sell the product to the customer and/or to advertise the firm through publications." [10] [11]

It is not possible to differentiate the independent ("contract") renderer from the staff specialist. While it may be tempting to assume that unsigned drawings were executed by someone on the staff there is no basis for doing so. We do know the names of some delineators, [12] mostly from their signatures. "The name of the architect or of his office is shown in the right bottom of the drawing, and that of the renderer at the left bottom; and if only one name is shown, then the architect is also the renderer or vice versa. [13] It would be useful to know at what point in the development of architectural practice this tradition became the "rule" (if indeed it did).

One independent delineator, Jules Guerin (1866-1946), was greatly in demand and received international acclaim. Born in America and trained at the Ecole des Beaux Arts, he executed renderings for some of the most famous architectural firms ofthe early twentieth century,including D.H. Burnham and Co., and McKim, Mead, and White. [14]

It is important to keep in mind that not all buildings were designed in architectural offices. That carpenter/builders remained active is evidenced by the magazines (such as The Builder and Woodworker [begun in 1868] and Carpentry and Building [founded 1877]) geared to this market. These publications followed the same pattern as the more professional "The American Architect and Building News". Similarly, training in drawing and rendering was not confined to formal classes. The tradition of "how to" manuals is an old one in America. It is likely that manuals such as Magonigle's Architectural Rendering in Wash and the publications of the American School of Correspondance (cited frequently below) were used both for reference and instruction, and that they reflect what had become, by the time of their publication, the general "state of the art."

II PRESENTATION DRAWINGS: USES

In this discussion the term "presentation drawing" will be used to include the formal finished drawings intended to "permit the reader to anticipate what will be seen and, to some extent experienced when the building is completed.... The most common...is the perspective [drawing] which...offers possibilities for understanding the implications of a building's design in relation to its physical context--both the man-made and the natural..." [15] Consciously excluded from consideration here are preliminary sketches (so called "napkin sketches"), developmental drawings made during the evolution of a design, and working drawings from which blueprints are made. It should be mentioned that presentation drawings are not limited to images of entire buildings. For some projects, a client might be presented with a meticulously rendered drawing of a room or detail.

The main purpose of a presentation drawing is usually to 'sell' the architect's idea to the client, or to some person or lending institution in order to finance the building operation, or to the judges of a competition. Since the architect is communicating with people not directly involved with architecture or construction, presentation drawings are the most accessible to the layperson; they are 'pictures'. [16] "A rendering, however good it may be in technique, if it is not an effective presentation of the design, fails in its main

purpose. Effectiveness is the big thing, preferably combined with truthfulness." [17]

III MATERIALS AND TECHNIQUES

INTRODUCTION

Information presented in the sections on materials and techniques was gathered from discussions with various museum professionals, as well as my own observations. In addition to the usual practice of footnoting published sources, oral sources will be indicated with last names in brackets []. I am especially grateful to Kendra Lovette for her generosity in sharing her observations on presentation drawings, particularly on underdrawings and techniques. The visual "survey" of the drawings of Richard Morris Hunt held by the American Institute of Architects (AIA) was an unsystematic and unscientific perusal. It did however, yield some useful (if tentative) generalizations.

SUPPORTS

Many (if not most) presentation drawings from the last quarter of the nineteenth century were executed on drawing papers, or what might be described as watercolor papers. Numerous examples bear the watermark of Whatman Turkey Mill [Ashe]. The lack of uniformity of sheet size may be due to a number of factors: as was the tradition in watercolor painting of the period, drawing paper for architectural rendering was often prepared by wet mounting to a drawing board, then cut within the tacked margins when complete; some drawings (including at least one of the Smithsonian examples as well as several noted in the AIA collection) were done on drawing paper cut from a large roll. As early as 1846 Winsor and Newton offered "cartoon, or continuous colossal drawing cartridge paper" for sale. [18] Standardization, if it existed at all, was probably confined to within a firm, because of the lack of uniformity in training profession-wide.

Whatman drawing papers were considered "by far the best" (according to the 1912 cyclopedia of the American School of Correspondance), with hot pressed recommended for pencil and very fine line drawing, cold pressed for watercolor drawing and the rough for tinting. [19] In Magonigle's influential Architectural Rendering in Wash, admittedly from a much later 1929, he specifically recommends Whatman's cold pressed paper as the best. [20] He suggests using older Whatman sheets, "the older the paper the better dried out and seasoned it is. Some thoughtful persons lay down a few sheets a year as our forebears laid down wine to ripen and mellow." [21] Magonigle also

suggests using roll papers for very large drawings. He refers almost wistfully to "eggshell [which] was the best roll paper; it had texture, would stand hard usage and come up smiling to take a wash beautifully," [22] implying that by 1929 it was no longer available. This seems to be contradicted by a sample book from the New York Blue Print Paper Company from around 1931. It contained a sample of "eggshell" which was described as "a medium rough drawing paper...[with a] good surface for rendering and [which] is very good for elevation and perspective drawing." It is listed as being available in rolls 36", 42", and 58" wide. The sample has a pebbled surface and appears to be the same as several examples from the Hunt collection at the American Institute of Architects as well as the Smithsonian drawing by Gray that was the impetus for this study.

Presentation drawings were sometimes executed on watercolor or other drawing paper which was mounted to fabric. The paper would have been applied in the studio or, alternatively, purchased already mounted. Pre-mounted papers may have been available as early as 1885/90 [Lovette]. In the 1931 sample book referred to above it advertises, "any of the unmounted papers in this section can be mounted to order...[on the] best quality muslin." Visual evidence, in the form of regular striations caused by the pasting machine, may be helpful in identifying pre-mounted sheets.

Other examples of presentation drawings were done on very thin, transluscent "tissue" papers. In the collection of Richard Morris Hunt drawings, these tissues were sometimes found to be mounted on watercolor paper. It would appear from examining the different textural qualities within a particular drawing, that, at least in some cases, the drawing had been executed, then mounted on the rough-textured paper before applying the final "decorative" or "atmospheric" washes. This visual speculation was confirmed by examining a watercolor backing paper which had been removed earlier: the watercolor wash extended beyond the primary support of the tissue onto the backing paper.

Other Hunt drawings on tissue were adhered to fabric (probably linen), or to poor quality board (off-white or sometimes grey). Hunt's presentation drawings on the light-weight tissue were not always applied to a mounting material; some remain unmounted.

Although many of Hunt's drawings were done on the above described tissue, Hunt also executed presentation drawings on watercolor paper (sometimes mounted on linen), or on a very smooth drawing paper (ressembling hot pressed) which in turn was mounted to board. Since the Hunt drawings were the only collection surveyed, it would be premature to assert that his use of tissue was either typical or anomalous, or to suggest how his training at the Ecole des Beaux Arts was reflected in his choice of materials.

UNDERDRAWINGS

There were a number of techniques used for underdrawings of architectural presentation drawings. To be sure, many were done first in pencil. Some used such time-honored techniques as metal point (on cartridge paper) [Lovette], while others utilized the latest reproductive techniques available.

Tracing cloth, recommended in Frederick Camp's Draftsman's Manual of 1882, was sometimes used. Tracing cloth is also mentioned in an 1891 account of architectural office practices. [23] as the material of choice for the engineer's original drawing. Wax residue has been detected on presentation drawings of the period [Lovette],supporting the assumption that this type of tracing aid was employed, since the material was described as a semi-transparent (linen) fabric prepared with wax and turpentine. [24]

Transfer papers of various kinds were used. In some cases, a sheet of paper covered with graphite (pencil rubbings) was used to transfer a design. Examination with magnification should reveal whether what appears to be a pencil stroke is, in fact, a transfer effect. Another method of transfering a pencil study, called "frothing" (from the French, "frotter", to rub), is mentioned by Magonigle. "The final study is made on tracing paper..., turned over face down on the final paper, and rubbed on the back with the edge of a key top, or of a smooth coin or something of the sort until the pencil rubs off; the human thumb-nail is probably the best instrument. Dampening the paper slightly will asist the process of transfer...A piece of tracing cloth should be interposed between the rubbing instrument and the study. The rubbing damages the surface of the paper and frequently causes ridges or hollows which will never come out." [25] Other early (French) transfer sheets were red/brown in color. [26] For many centuries, sanguine (red chalk) was the standard material used in the transfer of drawings. It was more legible than black (chalk) and its slight greasiness was an advantage in the transfer of an image onto an etching plate. [Cohn]

Special inks could also have been useful for transfering a design to be used for an underdrawing. By adding hygroscopic substances such as sugar, dextrine or crystallized calcium chloride, an ink could be made usable as a copying ink. The inked line would then remain moist enough for a copy to be made by applying dry or dampened paper to its surface, and subjecting it to more or less pressure. [27]

One ink in particular, Knaffl's copying ink [28], is mentioned as being "of special value to architects and engineers, since without moistening the original drawing or the copying paper, it yields copies of such sharpness that the finest lines of the

original are reproduced. To be sure, the ink is rather expensive, but that is of but little importance, since from drawings, building plans, etc., executed with it, two or three copies can be readily produced." [29] Instructions for use include placing a thick, very smooth paper on the original, covering it with a smooth board and weighting it uniformly to achieve strong pressure. "In the course of three to five days the drawing will be reproduced in its original sharpness." [30]

Transfer techniques known to have been used by architects for other purposes may also have been used to provide underdrawings for presentation pieces. These included photographic and mechanical processes, such as blueprints and hektographs. [31] In his 1891 account of office practices Perkins describes the making of a hektograph: "As everyone knows, the original [drawing] is inked in in various colored aniline inks, the sections are all colored in aniline colors, and the original when finished is taken to the pad [a flat layer of gelatin] and from twenty-five to forty copies are struck off within an hour... Hektographs do fade on the building, but they are cheap, and extra copies are made to cover this contingency. The hektograph is not accurate enough for framing plans, so the old blue-print process helps out here." Hektographs can be identified by their characterisitc purple ink; they are frequently found on poor quality paper. [32]

A wide variety of light- and chemically-sensitized papers and cloths producing blue, brown, and even black prints (the blue and brown being more common for underdrawing) were available as of a 1931 sample book, and the processes were well established by the late 1800's. Visual evidence of the brown-toned processes may be difficult to detect, since the pigment is known to fade.[Lovette]

One photomechanical process known to have been used for underdrawing was the heliotype. This process involved exposing light-sensitive gelatin under a negative, transferring this layer to a metal plate, then making an intaglio print. [33] "The heliotype...allowed architects to obtain multiple copies of a drawing. Because the heliotype provided a monochromatic copy of very delicate detail, it was often used as the base for further development of the design, or for illustrating the different aspects of a building's design... The heliotype process was also used for the publication of architectural designs of the period." [34] In the single case referred to by Bates Lowry [35], the monochromatic line was allowed to stand unreinforced by ink before the application of watercolor washes.

INKS: LINES AND WASHES

Many, though not all, presentation drawings combine the use of ink lines with water color washes. Inks were also applied in wash form. An 1875 book on drawing for students of architecture and building includes instructions for choosing ink: "The quality of the ink maybe tested...by rubbing the end of the cake against the teeth; if it feels `gritty' the cake should be rejected, and one which rubs perfectly smooth should be chosen. The ink should be bought at a respectable colourman's, and a good price be paid for it; it is mistaken economy to buy cheap ink or indeed colours of any kind." [36] In his 1882 manual Camp recommends stick India ink, "The best is cheapest". Magonigle, on the other hand discourses at length about choosing the best (i.e. Chinese) India type for washes. "It varies greatly in quality and quite a bit in color. The softer, poorer grade sticks are usually warmer in color than the more expensive. If you can find a hard, high grade stick of a warm tone, hide it. It is worth keeping for yourself. The trouble with buying ink is that you can't try it out before purchase, for it is beautifully gilded all over...Get as expensive a stick as you can afford...As to the tone, it doesn't much matter at all because you will tone it anyway." [37] Toning of ink was done by adding water colors.

Colored inks, especially red and green, were sometimes used in place of watercolor washes. These had the advantage of not pooling so much as the watercolors. [Saliga] The ink washes have been known to present difficult solubility problems for conservators. [Ash]

For inking in lines Magonigle recommends Higgins' Waterproof Ink in varying dilutions, with watercolor pigments added to achieve the desired tone. [38] His recommendations for toning include the following admonitions: "For the plane furthest back the ink should be lighter and colder; the planes in advance of this should be successively darker and warmer....The Higgin's Ink may be cooled by the addition of a little blue--Cobalt or Ultramarine--never Prussian or any of the green blues. There is nothing so unpleasant as a greenish black line or wash. The ink...may be warmed by the addition of Burnt Sienna and a touch of Carmine." [39] Curators and conservators have reported observing a range of ink colors, from sepia-toned, through browns and a variety of blacks. Some inks, such as those used on two drawings signed Cluss and Schultz, display a definite shine. This may be due to the addition of various materials, including sugar, added to the ink by the renderer [40], or as a constituent of the watercolor preparation [41] added for toning. Another possible explanation is an excess of gum binder.

TECHNIQUES

In addition to providing hints to the draughtsman on the choice of materials, period sources include instruction in the handling of tools and the execution of a finished drawing. Rather than attempting to summaraize the material here [42], what will be presented are specific techniques whose use may have influenced the appearance or behavior of the materials as the objects have aged.

ERASURES

The noted architect, H.H. Richarson, said that "an eraser is a draughtsman's best friend." [43] Various techniques are mentioned in the literature, and their results can be observed. In addition to the abraded surface which might be expected, crumbs from the bread [44], erasers, and wash leather cloths used are sometimes found embedded in the surface fibers. Remnants of sandpaper used to sharpen the point of the pencil into the desired wedge shape [45] are also sometimes detected in the surface fibers.[Lovette]

The so-called steel eraser, which was an instrument used to actually excise the line (and inevitably disturbed the surface fibers), was sometimes followed by the use of an alum or sugar wash to regain a good surface. What may have been an effective technique at the time, appears (with differential aging) as a line or a swath of different paper. It is often fairly wide, and appears lighter and whiter than the tone of the (aged) original paper. [Lovette]

LAYING WASHES AND LINES

Draughtsmen are repeatedly admonished to eliminate the particles from their ink washes either by allowing them to settle out and decanting [46], or by passing the liquid through a cloth [47]. The observation of such particles would indicate that the renderer was either sloppy or a beginner. Other indicators of inexperience would include irregular thickness in the line or other unevenness in execution. The manuals are replete with advice to keep practicing!

When used with even a slight excess of pressure, the ruling pen could break surface fibers, causing creases in the paper. If the paper were a short-fibered one, these creases might eventually become cuts. This effect of the ruling pen was sometimes used to manipulate the flow of the washes; it was intended that the flow would stop at the incised line.

Techniques used by draughtsmen to apply watercolor washes do not seem to have differed greatly from those used by their more artistic counterparts. Although watercolor artists used their

medium in more adventurous ways, the basic techniques were the same [48]. One technique which was particularly suited to creating textural effects in architectural rendering was "piquage". This wash over wash technique was used for localized texture, taking advantage of the sharp edge effected by the use of a very wet application. To give a stone wall texture, for instance, it might be used by "passing tones of varying value over individual stones leaving a narrow light line along the top and left-hand end of [each] stone." [49]

There were certain color conventions employed by architectural draughtmen to designate specific materials. In an 1874 source it states: "The colours used in finishing architectural drawings depend much upon the taste or the notions of the draughtsman...The following may be taken as a few indications of those generally used. Stone--yellow ochre, sepia, burnt umber; if for sections, the tints or shades of those should be darker than those used for the elevations. Brick,ordinary kind--Lake, mixed with a little light red or burnt sienna; for brick in section, a deeper shade. Concrete--sepia with dots, short dashes, or markings of a deeper shade. Wood--yellow ochre, with short dashes of a deeper tint. Cast iron--Indigo, with a little Indian ink; in section, a deeper tint. Lead--Indian ink, very pale, with short dashes of pale indigo. Slate--A mixture of indigo and lake. Tiles--Red. Plaster--Lines of a pale blue." [50]

OBSERVATIONS ON THREE SMITHSONIAN EXAMPLES

After completing this study of materials and techniques, it can be said that the three Smithsonian objects, which were the impetus for the study, are well within the mainstream of architectural presentation drawings of the period.

The drawing of the Smithsonian Arts and Industries Building, dated 1878, and signed by Cluss and Schultz (S.I. #73.157), is executed in watercolor washes with brown/black ink lines over a ruled graphite underdrawing. The support, which measures 51.5 cm (high) x 110 cm (wide), is a rag-fibered, cream-colored wove paper with a relatively smooth surface texture for a watercolor paper.

The second example (S.I. #73.155) is another image of the Arts and Industries building by Cluss and Schultz, dated 1878; this one is an interior view. Unlike the drawing of the exterior, the image area of this drawing extends to the very edges of the sheet. In this example, the entire surface of the paper is covered with a somewhat thick application of watercolor. The graphite underdrawing is still apparent, and the lines are ruled

in what appears to be the same brown/black ink. The support is a mixed (cotton and linen) rag wove paper measuring 68.5 cm (high) x 50.1 cm (wide).

The third Smithsonian drawing (S.I. 73.156) is an exterior view of a proposed Natural History Musuem done by W. Bruce Grey in ca. 1885. The paper support is a watercolor paper composed of a mixture of cotton and straw with some bast and wood fibers present. The paper, which has a rough pebbled surface (similar to that described by Magonigle) and is adhered overall to a linen backing. It measures 59.4 cm (high) x 91 cm (wide) and appears to have been cut from a larger sheet or roll. The image is executed in watercolor washes and black ink over a graphite underdrawing.

CONCLUSIONS

Presentation drawings from the late nineteenth century are diverse in their formats, materials and techniques employed. With the exception of the requirements for drawings done for Federal government projects [Lowry], there do not seem to have been specific parameters given, even for designs entered in competitions. The diversity reflects the lack of standardized training and practices which characterized the profession of architecture at that time. It is the purpose for which these drawings were created--persuading the client of the beauty and/or appropriateness of the design and demonstrating the skill (if not the genius) of the designer--that unifies the objects.

Further investigations into this topic should include a careful survey of a much larger population of presentation drawings. The archives of some of the older architectural firms might yield records of materials and equipment ordered. In addition, relevant trade catalogs should be examined to determine when specific materials and devices were available.

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-Nancy Ash, National Gallery
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FOOTNOTES

[1] Bannister, "Development of Education in the U.S.," p. 93.

[2] Ibid., p. 94.

[3] "Historical Sketch of Department of Drawing," p. 291.

[4] Ibid., p. 292.

[5] Ibid., p. 294. The detailed program of instruction dated June 1896 is included as an appendix.

[6] Ibid., p. 296.

[7] Bannister, op. cit., pp. 94-96.

[8] Gebhard and Nevins, 200 Years of American Architectural Drawing, p. 40.

[9] Pauline Saliga, "The Types and Styles of Architectural Drawings," p. 20.

[10] Gebhard and Nevins, op. cit., p. 40.

[11] It is curious that in the secondary literature, references (such as cited above) are made to so-called itinerant delineators, Looking at articles written in the 1890's describing the practices used by architectural offices at that time, no mention of hiring delineators on contract was found. "A City Architect's Office," The Inland Architect and News Record, June 1890, pp. 85-86. "System in Architects' Offices," The Inland Architect and News Record , February 1892, pp. 3-4.

[12] Manly N. Cutter, Frederick C. Graether, Chauncy G. Graham, George B. Phelps, George R. Pohl, Oscar Wenderoth, Harry C. Wilkinson and John Young,are all listed in Lowry's "Notes on Plates", Building a National Image, pp. 218-221.

[13] Kemper, Preface to Presentation Drawings by American Architects, unpaginated.

[14] Zukowsky, "Connoisseurship in Collecting Architectural Drawings," p. 105.

[15] Nevins and Stern, The Architect's Eye: American Architectural Drawings from 1799-1978, p. 13.

[16] Ibid., p. 18.

[17] Clute, "Drafting Room Practice", p. 83.

[18] Krill, private correspondance. The drawing paper was offered in rolls 4'8" wide and "of any required length." This is Krill's earliest reference to rolls of drawing paper.

[19] Kenison, "Mechanical Drawing," p. 12.

[20] Magonigle, Architectural Rendering in Wash, p. 4.

[21] Ibid., p. 7.

[22] Ibid., p. 4.

[23] Perkins, "System in Architects' Ofiices," p. 3.

[24] Camp, Draftsman's Manual, p. ?.

[25] Magonigle, op. cit., p. 16.

[26] Ibid., p. 16.

[27] Lehner, The Manufactura of Ink, p. 92.

[28] The recipe for this ink included pyrogallic acid, cupric sulphate, ferric chloride and acetate of uranium. Lehner, op. cit., p. 92.

[29] Ibid., p. 95.

[30] Ibid., p. 95.

[31] The hektographic process involved transferring an image drawn with inks containing aniline dyes to a flat layer of gelatin. The image was transferred by rolling another support over the gelatin. Prints could be made until all the dye deposited on the gelatin had been used. McFadden, "A Glossary for Architectural Records," p. 9.

[32] Saliga, "The Types and Styles of Architectural Drawings," p. 25.

[33]"The heliotype was introduced by a London portrait photographer, Ernest Edwards in 1869. Edwards formed his sensitized gelatin, hardened with chrome alum, on a waxed glass plate. After exposure under a negative, the gelatin was stripped off and briefly exposed on the reverse to harden it. It was then attached to a pewter plate with rubber solution and developed in a water and glycerine bath. (The glycerine helped keep the unexposed areas moist.) Edwards used two printings, one for shadows and one for half tones." Price, "Nineteenth Century Photomechanical Reproductive Processes," p. 21.

It is important not to confuse the heliotype with the

heliograph, a photomechanical process which grew directly from Nicephore Niepce's earliest photographic experiments. Taking advantage of the fact that bitumen is made insoluble by exposure to light, a metal plate is created, then used for the intaglio printing.

[34] Lowry, Building a National Image, p. 219.

[35] Ibid., p. 219.

[36] "The Finishing of Drawings," p. 22.

[37] Magonigle, op. cit., p. 27.

[38] Ibid., p. 17

[39] Ibid., pp. 17-18.

[40] Ibid., p. 105.

[41] Cohn, Wash and Gouache, p. 54.

[42] The best sources for this material are "The Finishing of Drawings," Magonigle, and the Cyclopedia (vol.5)

[43] Bourne and von Holst, "Architectural Drawing," p. 199.

[44] Kenison, op. cit., p. 14.

[45] The Venus Pencil in Mechanical Drafting, p.6.

[46] Bourne and von Holst, op. cit., p. 231.

[47] Magonigle, op. cit., p. 28.

[48] Consult Cohn, Wash and Gouache for a review of watercolor techniques.

[49] Magonigle, op. cit., p. 78.

[50] "The Finishing of Drawings," p. 23.

APPENDIX

From: "Historical Sketch of Department of Drawing," Centennial of the United States Military Academy at West Point, New York, 1802-1902, Washington, D.C., Government Printing Office, 1904.

COURSE OF TECHNICAL AND FREE-HAND DRAWING.

First year.—Plane and descriptive geometry—topography—color reconnaissance.

[September to January.]

Instruction in the course of the first year is as follows:

1. Problems of construction in the applications of plane geometry, ranging from the laying out of angles and polygons to the construction of the various plane curves, including the ovals and conic sections. Drawn in pencil. (4 sheets.)

2. The conventional signs of topography. Drawn in pencil and in ink. (2 sheets.)

3. Determination of lines of screen and construction of sections and gradients on contoured map. Explanation of contours and study of terrain. (1 sheet.)

4. Exercise in hachure work. Explanation of scales of shade. Drawn in ink. (1 sheet.)

5. Exercise in contouring from dictation. (1 sheet.)

6. Construction of scales of distance. Diagonal scales. Verniers. Explanations of their uses. Drawn in ink. (1 sheet.)

7. Plotting of triangulation for completed map from field record. General explanation of triangulation methods and measuring of bases. (1 sheet.)

8. Plotting of details of completed map from traverse notes. Explanation of methods of field notes and contouring. Inking and finish of completed topographical map. (1 sheet.)

[January to June.]

1. Theory of color. Color standards and constants. Color tests. Laying of washes. Complementary colors. Hues, tints, and shades laid in water colors. (2 sheets.)

2. Construction of problems in Descriptive Geometry. Shades, shadows, and perspective. (9 sheets.)

3. Topography in colors. Conventional signs. Completed map in colors. (1 sheet.)

4. Field reconnaissance and sketching. Methods and materials. Instruments and their use. Descriptions and explanations. Practice sketch from dictation. (1 sheet.)

5. Work in the field. Reconnaissance map of position with hand level, prismatic compass, and clinometer. Drawn on regulation form prescribed by General Orders, Headquarters United States Army. (1 sheet.)

Second year.—Free-hand drawing—memory drawing—mechanical, architectural, and ordnance construction drawing.

Free-hand drawing.

[September to January.]

1. Lectures on form, light, and shade. Proportion, outline, technical and pictorial art, practical and aerial perspective. Drawing from wood blocks in outline in pencil. (7 sheets.)

2. Shaded drawing from blocks and plaster. (2 sheets.)

3. Drawing from memory. Originals—first, flat; second, blocks; third, buildings. (8 sheets.)

4. Mechanical free-hand drawing. Dictated. Parallels, angles, proportional parts, polygons and stars, frets, gear teeth. Isometric working drawings to scale. Isometric building to scale. Cavalier projections. Cavalier machine casting to scale. No ruler or implements allowed. (6 sheets.)

5. Free-hand drawing from flat. Figure outline. (2 sheets.)

6. Free-hand drawing from flat. Figure and landscape. Pen and ink and pencil. (2 sheets.)

Lectures on the above from time to time.

Technical drawing (architectural, mechanical, and ordnance construction).

[January to June.]

1. Project. Plan, section, and elevation of barrack for a company of infantry—drawn to scale, printed specifications and data furnished. Finished in ink. Measurements figured. (1 sheet.)

2. Working drawings to scale of steam engine and principal parts. (1 sheet.)

3. Working drawings to scale of parts of buildings. (1 sheet.)

4. Elevation and working drawings to scale of ordnance constructions. (1 sheet.)

5. Plan, section, and elevation drawings of civil and military engineering constructions. (1 sheet.)

All of the above in color or ink alone, according to character. Nos. 2, 3, 4, and 5 occupy the time remaining after completion of No. 1. No. 1 is taken by entire class. The others are assigned according to Corps to which Cadet will probably be assigned on graduation. Engineers, No. 5; Ordnance and Artillery, No. 4; line corps, Nos. 2 and 3.

6. Fifteen to twenty short lectures on the graphics of building construction and forms; methods and drawings in the planning and construction of buildings; the steam engine and its essential parts; machine drawings. These are accompanied by diagrams and models and the use of the stereopticon.

Sheets of data, working drawings, blue prints, and photographs used

for data in the foregoing are from the following sources: Corps of Engineers and Report of Chief of Engineers, U. S. Army; Ordnance Bureau and Reports of Chief of Ordnance, U. S. Army; Pneumatic Gun Carriage and Power Company, United States; Baldwin Locomotive Works, United States; Krupp's and Gruson's Werke, Prussia; Canet System, Forges et Chantiers de la Méditerranée, France; Maxim-Nordenfelt Gun and Arms Company, England; Construction Details, Austrian Military and Geographical Institute, Vienna, Austria; Notes on Building Construction, South Kensington, London, England; Details of Building Construction, Professor Chandler, Boston Institute of Technology; Senior Course in Mechanical Drawing, Professor Thorne, Franklin Institute, Philadelphia. Ordnance material and models in relief also used as models.

The third class attends daily, Saturdays and Sundays excepted, from 2 p. m. to 4 p. m. until November 1, after which day the class is divided into two sections—the first section, until January 1, consisting of the odd numbers in general class standing, the second section of the even, these sections alternating in attendance. After January 1 the division of the class is similarly obtained from the standing in drawing at that examination, and alternation continues until March 15, after which daily attendance, Saturdays and Sundays excepted, is resumed until the end of the term.

The second class alternates in sections throughout the term, being divided into two sections of odd and even numbers, obtained from the standing in drawing at the end of the third-class year. Its hours of attendance are from 2 p. m. to 4 p. m. For the better preservation of order the third class when attending daily is divided into four sections, which at the close of attendance are dismissed and retire separately under charge of separate section marchers, who are responsible for infractions of discipline.

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