Dialectics of Drafting: The Social Differentiation of Mechanical and Architectural Drawing in the Early Twentieth Century

GEORGE B. JOHNSTON
Georgia Institute of Technology

In the introduction to their 1924 drafting textbook *Architectural Details*, authors Louis Rouillion and Charles Ramsey set the objectives of their book, "to acquaint the student with the best prevalent practice in the technique of architectural drafting."[1] Rouillion, a mechanical engineer and director of the New York Mechanics Institute[2] and Ramsey, an architect and drafting instructor and future co-author of the epochal—*Architectural Graphic Standards,* had joined forces in the creation of an instructional text for the instruction of day laborers and night school students in the subject of architectural drafting. Differentiating architectural from mechanical drafting by virtue of their respective subject matters, Rouillion and Ramsey noted that:

> The former is concerned with buildings, and the latter covers the rest of the field of instrumental drawing and has a number of specializations, such as machine drafting, ship drafting, topographical drafting, topographical drafting, carriage drafting, sheet-metal drafting, and patent-office drafting.[3]

While this distinction may seem self-evident, it is important to recognize that there are significant differences separating these two genres of what the authors call "instrumental drawing." They differ by the uses to which they are put, by the types of objects that they designate; but they also differ by virtue of the agents who make them and those who put them to work and by the chain of relations of those parties in the production of buildings and machines. The division and specialization of labor in Fordist and Taylorist approaches to industry that reduces all productive tasks to minimal units of skill and complexity reserves to management the overarching function of planning and coordinating the efforts of the many workers in the shop and on the construction site.[4] Rouillion and Ramsey implicitly accepted this reordering of labor as fundamental to design practice and recognized that "instrumental drawing is the graphic language by which the designer conveys to the artisan instructions for manufacturing or building. It also serves the designer in the process of designing."[5] But even considered as a common graphic language having "a technique of its own, consisting of conventions and methods of presentation," instrumental drawing was divided into dialects by trade, dialects which vied for professional legitimacy and monopolistic control in the areas of their specialization.

The Mechanics Institute offered both mechanical drafting and architectural drafting in its curriculum, and Rouillion had authored several mechanical drawing texts early in his career, *A Course in Mechanical Drawing for Evening Schools and Self-Instruction* (1896) and *The Drafting of Cams* (1903). Mechanical drawing was typically considered a pre-requisite for enrollment in architectural drawing courses at the school, and progress in the latter assumed some mastery of the former. The school's annual report of 1896 explained that:

> The Mechanical Class is more properly a preparatory to the more advanced study of Architecture; as here are taught the laying out of plans, the use of different lines, the simple parts of machinery or such work

> as relates to the branches of a trade a pupil is engaged in during the day.[6]

The move from mechanical to architectural drafting entailed more than a change of subject matter, however. It required an attitudinal shift from the engineering precision of the machinist's abstract description to the expressive fullness of the architect's artfully inflected lines. Mechanical drawing courses focused students' cognitive and manual skills to the task of describing physical objects—screw threads, springs, clamps, wrenches, valves, cams—through an objectifying system of lines. Within the machinist's and engineer's logic:

> A drawing has one great purpose, and that is to be useful. To this end lines may be added or left out, shading may be used, or notes may be put on. As an expression in the engineering language each drawing should have only one meaning, and should state that meaning with the least possible chance for misinterpretation.[7]

On the other hand, architectural drawing as conceived in the early-twentieth century deliberately exuded the atmosphere of context that the other genre excluded, immersing the object of representation in the play of light, the texture of surface, the feeling of depth. While mechanical drawing wrenched the object out of its context in order to isolate it, describe it, quantify it to the eye of the detached observer, architectural drawing took the same descriptive graphic conventions and tweaked them to the purpose of pulling the viewer into the perceptual surface of the drawing as if into a field of experience.[8]

Employing linguistic terms, we might distinguish between the denotative function of mechanical drawing and the connotative function of architectural drawing.[9] Such characterizations would not be far from the opinions of early-twentieth century authors of drafting manuals who regularly advanced arguments for understanding drafting as a universal language. Treatises on mechanical drawing tended to stress the communicative function of drawings and their mediating role in a process of production rather than their value as ends in themselves. One writer on the design of machines observed that:

> The theoretical man has learned how to do a thing, while the practical man does it, and between the two is a great gulf fixed. To the student it seems as if the chief end of the designer was to make a satisfactory drawing while to the mechanic the drawing is only a means to an end. It is necessary first to get rid of the idea that mechanical drawing is an art. It is a means of expression the same as writing and a competent designer need not be an artistic draughtsman any more than an author or an editor need be a skillful penman. The real skill lies in expressing one's meaning clearly and distinctly and is the skill of the mind rather than of the hand.[10]

Emphasis upon precision of expression and transparency of meaning in the language of mechanical drawing led professors of drawing to stress students' mastery of the representational'"grammar" of this abstract system of lines, for it was believed "the more perfect and uniform this language can be made the better it must be for all concerned."[11]

An essay published in *Engineering News* in 1904 proposed the establishment of a "universal dictionary of mechanical drawing."[12] Though no such definitive lexicon of drafting resulted, the effort to articulate a rationale for the venture demonstrates the lengths to which the linguistic comparison was pursued. It also foreshadowed by seventy years efforts to translate the conventions of drafting into a coherent computer language. Analogizing mechanical drawing with the English language, the author attempted to correlate elemental units of drawing with linguistic units. For example, lines were considered analogous to letters, views to words, projected views to sentences, drawings to chapters, and sets of drawings to books.[13] The proposed dictionary was conceived as a means of bringing uniformity to communicative elements of drawings such as line weights, conventions, and symbols of representation, all those graphic expressions which tended to vary from office to office with each office having "its own pet 'dialect', or more than one; new draftsmen being generally expected to learn the practice of a 'room' by observing existing drawings and doing likewise."[14] By standardizing and systematizing these drawing conventions in an authoritative manner analogous to the grammatical rules of a written language, it was hoped:

> to make it easier for all concerned to read tracings and shop prints, and thus to save time every time a drawing is referred to. This is the immediate practical gain to be looked for from the general adoption of a drawing dictionary. There is also a gain of another and no less important kind: Mechanical drawing will cease to be something to "pick up," like bicycle riding, and will take its proper place as a universal language to be systematically studied; so that whether it is the draftsman that draws or the someone else that reads, there will be as little chance as possible for the misinterpretation or partial understanding of something that ought to be as plain as day.[15]

While architectural drawing shared the basic conventions or rules of mechanical drawing, authors of drafting manuals in early years of the century recognized architectural drawing's relative freedom of technique and expression as the essential difference between the two. In these vocational courses, architectural drawing's association with art and freehand drawing was cemented, thus distinguishing it from the stark abstraction that motivated the engineer's and the mechanic's graphic representations. Rouillion and Ramsey referred only briefly to this essential trait of architectural drafting, noting that'"in architectural drafting it is customary to allow end lines to carry over slightly and not attempt to stop them exactly. This practice tends to give a touch of freedom to the drawing and also saves much of the draftsman's time."[16] In mechanical drawings, by contrast, lines must exactly terminate at intersections in order to emphasize the precise limits of the object of representation. Where the engineering draftsman must intensely control his pencil at the origin and destination of each line, the architectural draftsman is allowed to "overshoot" his target, as it were, in the names of speed and expressiveness. That casual overlap of lines became, in fact, a studied effect in the hands of many architectural draftsmen, a semantic signifier in its own right of the distinctively "architectural" drawing.

While Rouillion and Ramsey did not expand upon the significance of this draftsman's flourish, they pointed their students to a number of other drafting textbooks that did.[17] In one of those books, *Architectural Drafting*, Greenberg and Howe elaborated upon the contrast between architectural and mechanical drawing:

> Architectural drawing is characterized by a freedom and "snap" totally alien to mechanical drawing. The latter must be absolutely exact, rigid, and drawn with a very hard pencil. Once having decided upon the shape of a piece of machinery, it must be worked up with a precision which admits of little originality in the design of its constituent elements....No such limitations hamper the architectural draftsman. However definite the problem at hand, he may exercise his originality in a number of ways….

The impression, however, must not prevail that architecture is inexact. *Architecture is a science as well as an art* and as such must be exact; but it is an exactness that admits of some freedom, provided of course, that it is exercised on the side of safety.

Architectural drawing combines the principles of both mechanical and free-hand drawing. The draftsman in the preliminary stages of a problem uses a soft pencil with which he does a considerable amount of sketching. In the gradual development of the design, he makes less use of freehand and more of mechanical drawing; in no stage of the work, however, entirely abandoning either.

The mechanical element in architectural drawings aids in the development of manual dexterity, while sketching assists in the training of observation and memory.[18]

Greenberg and Howe described architectural drawing as a hybrid form combining mechanical and freehand elements and approaches: exactitude combined with freedom, rigidity with originality, a melding of the hard and the soft. Those characteristics were assigned to genres of drawings, but they also implied contrasting disciplinary traits and intellectual proclivities and a gendering of vocational orientations as variable as the densities of pencil lead. By extension of Greenberg and Howe's argument, the incremental range of graphite grades from hard to soft, say from 4H to 4B, metonymically suggested the masculinity of the engineer's scien-

tific descriptions as compared to the feminine fluidity of the artist's evocative line work. Engineers drew with hard leads and artists with soft, and the architect's representations were considered a hermaphroditic hybrid, sharing essential traits of both.[19]

The "snap" of architectural lines epitomizes the self-conscious difference that the architectural draftsman struck with his cohort mechanical draftsman, and that same expressive supplement opened the architectural draftsman to the engineer's or mechanic's disdain. Where this practice of crossing and emphasizing the intersection of drawing lines originated is impossible to establish, but analogous practices in the field of construction suggest probable antecedents for the gesture which this draftsman's graphic ritual reenacts. For example, the process of establishing the limits of construction on a building site even today commences with the act of driving stakes into the ground beyond the perimeter of the prospective excavation and then stretching strings between those stakes, called batter boards. Where the strings overlap and intersect, the corners of the construction site are established, and a plumb bob suspended at each of those points helps accomplish the leveling or terracing of the ground. Likewise, to'"snap a line" in the parlance of the construction site means to literally snap a taughtly stretched chalk-covered string against a horizontal or vertical surface in order to inscribe a mark useful for guiding construction. These evocative practices embody the reciprocal relation between drawing and building, one that is embedded at the construction site and allegorically replayed in the marks of the draftsman.[20]

Manuals on architectural drawing of the period regularly offered advice on the making of "snappy" drawings. A correspondence course advised that "lines at outer angles may be carried slightly across each other, giving a firm intersection, instead of stopping just at the junction." The book suggested that this approach was "best for sparkling snappy drawings."[21] Greenberg and Howe treated this practice as a "technique of expression" meant "to give a drawing character," but advised that "this practice should not be carried to excess; the lines should never project more than 1/32 of an inch."[22] And in a similar vein, another book confirmed that:

> it is possible to gain speed in making drawings by allowing lines to over-run at intersections. Short lines are made with a single stroke of the pencil without any attempt to be exact. Such drawings when made with a natural "swing" or "snap" have what is called a distinctly architectural character. They are quickly made, easily read and pleasing in appearance. The amount of over-run must, of course, be adapted to the scale of the drawing in order to preserve the primary requisite of legibility.[23]

Still another cautioned that:

> In beginning architectural drafting in school, this method should not be attempted at first, as the transition from the exactness of mechanical drawing, with its absolute meeting of lines, is too abrupt. The student is apt to overdo the matter and become careless in his work. As he gains more knowledge of his subject and further experience in drafting, he may then adopt the freer style.[24]

Whereas architectural drafting texts tended to extol the artistic effect of this technique as well as the speed to be gained from this looser exercise of the drafting pencil, authors of mechanical drafting and engineering graphics texts tended to treat the practice with scorn. One author deemed "the present day fad of over running corners…a rather senseless affectation."[25] Writing on the topic of architectural drawing for carpenters and builders, another author commented that:

> This almost universal practice among architectural draughtsmen does not represent carelessness due to haste, but is a studied effort on the part of the draughtsmen to produce what they call a "crisp, snappy" drawing. Some one originated the idea, then another imitated it, and they all thought it was the thing to do. The author fails to see anything "crisp" or "snappy" about this mode of drawing and does not recommend it. Also, it has the appearance of a method to employ inexperienced labor.[26]

Such subtle and not-so-subtle "digs" at the expressive techniques employed by architectural draftsmen, while seemingly innocuous, are evidence of deeper antipathies within the general ranks of draftsmen. Unified by the common language of instrumental drawing, they nonetheless became socially striated by professional orientations and by associations across the cultural divide of art and science. Architectural drawing was described by some as embodying the surplus dimension of "art" which elevated it beyond the instrumental utility of mechanical drawing; yet, seen from the other perspective, the artistic posturing of architectural drawing—and by extension, of architectural draftsmen—was seen by their drafting cohorts as a conceit.

Beyond these stylistic nuances, however, there were also significant differences in the ways the architectural and engineering disciplines approached the conceptual role of drawing in the process of design, whether of buildings or machines. In architectural drawing, the process itself was considered co-extensive with the design process such that drawing was a mode of thinking, a medium for imagination and visualization. W.B. Field, writing in a drawing book that Rouillion and Ramsey referenced in their own, was particularly articulate on this point, describing this creative ability in the production and use of drawings as the architect's "constructive imagination." He wrote that:

> The architect is essentially an artist, keen in appreciation as well as facile with the pencil, and with a strongly developed constructive imagination. He must be able to think in three dimensions, to visualize the appearance of a proposed piece of work and see the picture of it in his mind's eye as clearly as if it were standing erected before him….The architect walks through a building whose proposed plan lies before him on the table just as surely as he will walk through the actual structure later when it has been built. The plan to him is not simply a diagram showing the location and arrangement of rooms. He feels himself in the house, sees the vistas, the heights of the ceilings, the proportions of rooms, and the prospects from the windows. He visualizes the color scheme which he would propose, the furniture and fittings, then by sketches and drawings conveys his thoughts to client and contractor.

Architectural drawing is the graphic language by which the architect develops and records his ideas, and communicates his instructions to the builder.[27]

More directly put, Field asserted that "the architect thinks on paper." Architectural imagination was not some isolated mental process that transpired in reverie; rather, it was constructed in contact with the medium of drawing, and the result was both a record and the exposition of that process. It was in this sense that he insisted that "architectural design and drafting are inseparable." Field did not claim, however, that every architectural draftsman was an architect; rather, he maintained that "all architects begin as architectural draftsmen." He made a clear distinction between the two, bringing the draftsman under the supervision of the architect but ascribing to him alone the ability to bring the architect's concepts to fruition through the methodical development of plans, elevations, and details that clearly communicate the guiding intentions to the builder.[28]

For the mechanical or engineering draftsman, drawing also provided a graphic means of working out solutions to practical problems and thus also played a cognitive role in the design process. Louis Rouillion's explication of the process of drawing machine cams methodically applied the geometrical order of the drafting board to problems of applied physics in determining the shapes and relations of moving mechanical parts.[29] Yet, writers on mechanical drawing tended to go to some effort to distinguish the emphasis and purpose of mechanical drawing from artistic drawing. For example, Carl Svensen who authored several books on architectural as well as engineering drawing maintained that "the value of drawing as one of the working tools to be treasured and used during a lifetime in the most useful of professions, ENGINEERING [original emphasis], should be realized. It is as an aid in the study, and later use of engineering knowledge, that drawing finds its place."[30] An instructional paper on mechanical drawing from the American School of Correspondence emphasized that "drawing is a method of showing graphically the minute details of machinery; it is the language by which the designer speaks to the work-

man; it is the most graphical way of placing ideas and calculation on record."[31] Writing for engineers, Jordan and Hoelscher further explained that mechanical drawing deliberately eschewed the phenomenological realm of sensory experience in order to directly, if abstractly, convey the objective parameters of their engineered solutions. They argued that in contrast to the artist who focuses upon the sensorial effects of the reality he represents, "the engineer must not only show form, proportions, and the nature of materials, but he must give the exact sizes of the parts, their finish, and the clearances to be maintained. Ordinarily, he has nothing to do with shades and shadows."[32] The shades and shadows by which the artist or architect conveyed the depth of surface, immediacy of experience, and nuance of meaning was replaced in the mechanical drawing by "exact and positive information regarding every detail of the machine or structure existing in his imagination."[33]

From the extended discourse and dialectic on the purposes put to architectural and mechanical drawing found in drafting manuals and other instructional materials of the early-twentieth century, it is clear that architectural draftsman had invented a hybrid genre of drawing inclusive of both the denotative intents of engineers and mechanics as well as the expressive and evocative aspirations of Romantically-inspired artists. This differentiation of expressive means and intents was intertwined with a process of professional distinction from other building-oriented trades whereby the architect could assert his exclusive domain of professional expertise. Further, this hybridity of representational objectives reflected the division of labor within architectural offices as they continued to respond to the increases of scale and complexity of commissions. Architects, at the pinnacle of office organization, relied upon a shorthand of sketches to communicate their intentions to two classes of architectural draftsmen, those trained through either academic or vocational means. They in turn produced either elaborate renderings meant to convey artistic effects in presentations to clients or competition juries; or else detailed working drawings for the edification of builders, drawings which while objectively describing physical relations through the basic conventions of mechanical drawing nonetheless exuded a sparkling effect through the architectural draftsmen's self consciously snappy line work. The conception of architecture as a corporeal entity bound up with the symbolism of Beaux-Arts classicism thus showed in the drawings of architectural draftsmen. This was in stark contrast to the stripped-bare effects of mechanical and engineering drawings, a machined expression for a machined reality that would ironically provide in coming years both a formal and a graphic paradigm for the delineators of architectural modernism.

NOTES

[1] Louis Rouillion and Charles George Ramsey, *Architectural Details* (New York: John Wiley & Sons, 1924), ix.

[2] Established in the early nineteenth century by the General Society of Mechanics and Tradesmen of the City of New York primarily as a free school for members' children. Over the years, with the advent of public education in New York City in the mid-nineteenth century, the Mechanics Institute evolved into a night school catering to the advancement of the working classes, those tradesmen and mechanics without access to post-elementary education but who possessed the desire and ambition to advance in their fields. Drawing was among the core subjects in the Free Drawing School of the Mechanics Institute and by the last decade of the nineteenth century included topics of architectural drawing, mechanical drawing, cabinet work and drawing, freehand drawing, modeling in clay, and machine drawing. The Mechanics Institute is still in operation today.

[3] Ibid.

[4] David Harvey, *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (Cambridge, Mass.: Blackwell, 1990), 125-140; Frederick Winslow Taylor, "The Principles of Scientific Management," in *Scientific Management, Comprising Shop Management, the Principles of Scientific Management [and] Testimony before the Special House Committee* (New York: Harper, 1947), 35-38.

[5] Rouillion and Ramsey, ix.

[6] "One Hundred and Tenth Annual Report of the General Society of Mechanics and Tradesmen of the City of New York for the Year Ending December 31st, 1895," (New York: Nathan Brothers, 1896), 12-13.

[7] Carl L. Svensen, *Essentials of Drafting: A Text and Problem Book for Apprentice Trade and Evening Technical Schools* (New York: D. Van Nostrand Company, 1918), viii.

[8] John K. Brown, "When Machines Became Gray and Drawings Black and White," *Industrial Archaeology* 25, no. 21999): 33.

[9] Saussure, Barthes

[10] W.H. Sargent, "As Seen by a Designer: The Genesis of

Machine Design, with Applications," *Machinery (NY)* 6, no. 7 (March 1900): 194-195.

[11] Warren E. Willis, "Standard Drawings: Suggestions for Drawing Room Standards," Ibid.8, no. 12 (August 1902): 380. See also Thomas Ewing French, *A Manual of Engineering Drawing for Students and Draftsmen*, 1st ed. (McGraw-Hill, 1911), 1-3; Harvey Herbert Jordan and Randolph P. Hoelscher, *Engineering Drawing*, 2d ed. (Wiley; Chapman & Hall, 1928), 1-3.

[12] George H. Follows, "A Proposed Universal Dictionary of Mechanical Drawing," *Engineering News (NY)* 52, no. 2 (July 14 1904).

[13] Ibid.: 29-30.

[14] Ibid.

[15] Ibid.: 32.

[16] Rouillion and Ramsey, 6.

[17] Rouillion and Ramsey advise their students to make the following books part of their personal drafting library: *Architectural Drafting* by Greenberg and Howe; *The Architects and Builders' Handbook* by Frank E. Kidder;'*Architectural Drawing* by Wooster Bard Field; *Architectural Details* by William A. Radford; *The Art of Lettering* by Carl Lars Svensen; and *Essentials of Lettering* by French and Meiklejohn. See Ibid., 7.

[18] Abraham Benton Greenberg and Charles B. Howe, *Architectural Drafting*, ed. J.M. Jameson, 1st 1st thousand. ed., The Wiley Technical Series for Vocational and Industrial Schools (New York: J. Wiley & Sons, 1913), 1-3.

[19] Drawing leads are rated in terms of their degree of hardness or softness and are so designated by a systematic code consisting of a number and a letter. For example 4H, 3H, 2H, H, F, HB, B, 2B, 3B, 4B represents a range from very hard to very soft.

[20] Thanks to Harris Dimitropoulos and Monica Ponce de Leon for the contribution of their insights on this matter.

[21] Frank A. Bourne, H. V. Von Holst, and American School (Chicago Ill.), *Architectural Drawing Part I* (American School of Correspondence, 1905), 8.

[22] Greenberg and Howe, 11.

[23] Carl L. Svensen and Edgar Greer Shelton,*Architectural Drafting* (New York: D. Van Nostrand Company, 1929), 56.

[24] Franklin George Elwood, *Problems in Architectural Drawing*, Rev. ed. (Peoria, Illinois: Manual arts press, 1935), 14-15.

[25] French, 214.

[26] Frank Duncan Graham and Thomas J. Emery, *Audels Carpenters and Builders Guide; a Practical Illustrated Trade Assistant on Modern Construction, for Carpenters—Joiners—Builders—Mechanics and All Wood Workers*, 4 vols., vol. 2 (New York: T. Audel & Co., 1928), 717.

[27] Wooster Bard Field, *Architectural Drawing* (New York: McGraw-Hill, 1922), 1.

[28] Ibid., 2-3.

[29] Louis Rouillion, *The Drafting of Cams* (New York: The Derry-Collard Co., 1903).

[30] Svensen, *Essentials of Drafting: A Text and Problem Book for Apprentice Trade and Evening Technical Schools*, vii.

[31] Ervin Kenison, Edward B. Waite, and American School (Chicago Ill.), *Mechanical Drawing; Instruction Paper* (American School of Correspondence, 1918), 1.

[32] Jordan and Hoelscher, 2.

[33] French, 1.