Drawing and Constructing Wood Frame

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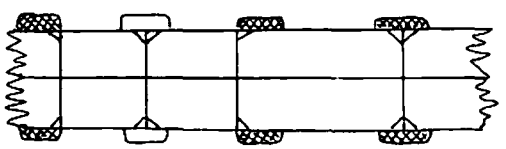

Figure 1. Drawing representing builders' marks. Bequet Ribault House, Ste. Genevieve, Missouri. Drawing from Melburn Thurman's book.[1]

Today, an architect's "working drawings" show very little explanation of wood-frame construction when compared to the same architect's working drawings of steel or concrete buildings. Typically, these drawings of light-wood frame do not proscribe the details of construction nor do the building contracts specify precise details and materials. (Figure 1) There are quite a few reasons for this: there are understood conventions operating between the designer and the builder that transcend any contemporary pressure for legal contract documents; the best practices of light-wood framing allow for local variation; and there is a low degree of contractual jeopardy and public liability for both designers and builders. As Pierre Bourdieu says: "One can formulate the general rule that the more dangerous the situation is, the more the practice tends to be codified. The degree of codification varies in proportion to the degree of risk"[2] As a result, wood framing as a practice has a different set of tolerances than most other methods of construction.

Until the mid-nineteenth century, architects' drawings usually show very little explanation of construction.[3] In their drawings of cross-sections through buildings, the plane of the sectional cut contains no information except its outline or profile. As in drawing light-wood frame today, these architects knew that the number of materials and the variation of building methods were few and were locally consistent.[4] For instance, the influence of Asher Benjamin was evident in building elements such as doorways and fireplaces. If an artisan worked from one of Asher Benjamin's drawings, it was assumed that he had the training and the expertise in geometry and carpentry to manufacture them. Eugene Ferguson has termed drawings like those of Benjamin "generic."[5]

No generic drawing included sufficient instructions to enable an inexperienced artisan to build directly from the drawing. In the nineteenth century, even in the industries considered to be the most technologically advanced, artisans built from generic drawings, or no drawings at all.

> From our present vantage point, it seems self-evident that detailed drawings would have been essential to the production in the 19th century of hundreds and thousands of muskets and rifles, grain harvesting machines, and sewing machines. Yet ... the artisans who made the parts and assembled the muskets had no drawings to guide their work. Instead they used metal jigs and fixtures that located the workpiece with respect to a cutting tool and gave the artisan the necessary guidance in producing individual parts.[6] (Figure 2)

In a sense, using jigs preempted the necessity for laying the work out on paper and allowed for incredible accuracy of up to one thousandth of an inch using hand tools.[7] This would have applied to buildings as well, as early as the seventeenth century the construction of building elements and roof

trusses was often done in shops rather than on site.[8]

The generic drawing was understood culturally; this is borne out by examples from building contracts. The language of building contracts contain 'inexact' terminology and uncertain detail. A contract's very lack of specification is a documentary equivalent of generic drawing. Occasionally, as popular architectural books became increasingly numerous and influential, client and builder included reference to a published example in their agreement. Previously, these references had been to houses built nearby.

> In 1848 ... [builders] agreed to erect ..."a Cottage house with a basement to design III, plates 13 and 14 of Ranletts Architect." The contract then specified in detail the elements of the house from basement to roof, making frequent references to the building being "wrought according to the above design."[9]

Of course, this puts the teacher and the author of an explanatory book about building in an awkward position. For their purpose is didactic; generic drawings will not serve. In *The Modern Architect*, Oliver Smith described a reader's reaction to architectural books.

> It is too common a practice among builders, when an architectural work falls into their hands, to examine the plates, and then decide on the merits of the work, with scarcely a passing notice of the suggestions, directions, explanations, and opinions of the author ... [thus] they will not readily understand the lines, or even the intent and purpose of the author, in many simple figures they now believe themselves to be very stupid, or consider the work to be an intricate and blind treatise on the very subject they are most anxious to have knowledge of, and, therefore, close the book, disappointed and discouraged.[10]

He apologized for the "prolixity of my directions for enlarging tracery."[11] Smith was clearly a teacher (he ran 'academies' in Jamestown and Buffalo). Smith was particularly good at explaining things fully, no way an innate quality of nineteenth-century instructive literature. For example, farmers receiving a disassembled reaper

> ...who did not fully comprehend words such as pulley, shaft, butt, or key were in trouble for the McCormick instructions did not define them. While a mechanic might have been familiar with such terms, it is not so certain that every farmer would have found them in his lexicon. Similarly, the text assumes a familiarity with geometry and measuration...[12]

Today, drawings guide consumers in the assembly of many everyday items. Intermediary mechanics became necessary and the culture of "maintenance relations," the intermediary role of repair and assembly required by factory products, emerged. Fully explanatory drawings are necessary for the repair of industrial production, during the elaboration a new technique, or the training of the trade.

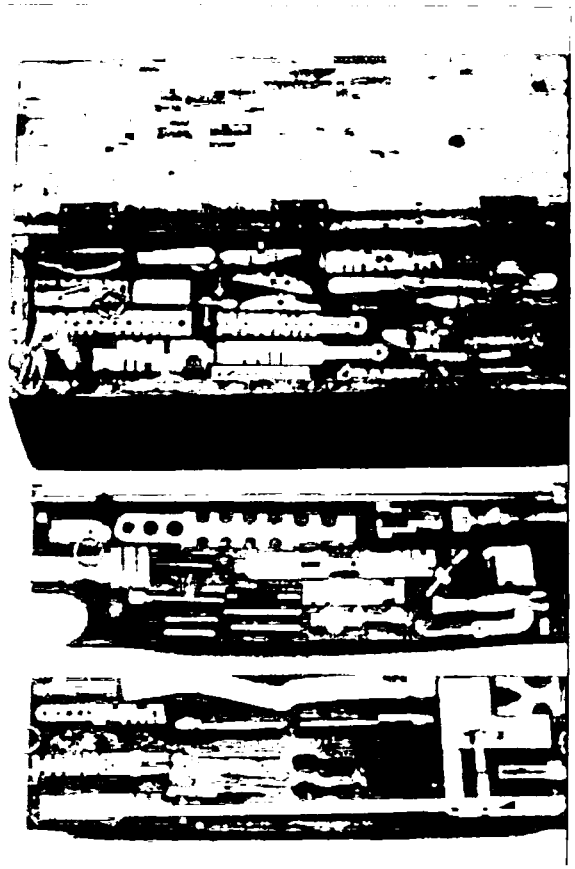

Figure 2. The jigs for measuring the accuracy of Springfield rifles. Photograph from Robert Gordon's article.[13]

Books are some of the best documentary evidence of building in nineteenth-century North America. Historians' comments on them

form a significant component of architectural history and material culture.[14] Generally, the simple collection of technique into a book was, in itself, a rationalization. The reproduction of the process of building in written sequences of instruction muted many tangible and human qualities.[15] Writing and publishing supported societal tendencies to rationalization and abstraction. The author and the authoritative tone masked uncertainty and reduced variation. Many authors, distant from actual experience, sampled previous works, lifting entire sections, reinforcing existing explanation of techniques. Technique, once variable, oral, and local, was collected and overlaid, reinforcing certain external biases and internal repetitions. Rationalization and abstraction occurred in the process of identification (separation into elements and practices), of naming (definition and removal of variation), of organizing the narrative (format and structuring of narrative sequence), of repetition (association and creation of logical similarities), of establishing voice (assumption of 'high' or 'low' language), and of extraneous association (education and scientific incentive).

> One of the virtues (which is also a vice...) of formalization is that, like all rationalization, it allows for economy of invention, improvisation and creation. A formal law ensures calculability and predictability (at the cost of abstractions and simplifications... From the moment the rite is retold, it changes meaning and you pass from a mimetic practice, from a bodily logic oriented toward functions, to a philological relation: the rites become texts which have to be deciphered, they are pretexts for decipherment. The need for coherence and logic appears, linked to communication, discussion, and comparison. The analogical meaning which resolves problems one by one, one after another, yields to the effort to keep together analogies that have already been made....[16]

Building guides emphasize how-to-build to a presumed readership of young carpenters. This emphasis on technique forms the core of the book (the title often refers to a new simplified building process). Early building guides contain the remnants of traditional apprenticeship and, often, a qualifying "master-piece" such as the layout of a freestanding staircase. The eighteenth-century carpenter and joiner traced the patterns of geometry as important examples of the mastery of his craft. It had instrumental purpose such as the cutting of stair winders, the laying out of wooden banisters, and the jointing of roof members. As well, the trace was often a description of the path of the body of the artisan or of the building that was analogically human. The tracing of geometry on the building site was an important rite invested with cultural meaning.

Until the nineteenth century all building guides used in North America came from England or France. David Yeomans outlines the history of those published in Britain. Their proliferation depended on the "demand for technical knowledge. The intense publication years of 1731 - 1735 produced the two most frequently used builders' manuals, long on geometry, arithmetic, and structural members, but with no plans and few designs for architectural embellishment."[17] Francis Price's *The British Carpenter* showed "the most approved methods of connecting timber together, for most of the various uses in building, with rules necessary to be observed therein." [18] To these he added plates on the construction of domes and staircases, rules for squaring timbers for 'twisted' stair rails, a table for timber scantlings, and general recommendation on strength in construction and spacing of joists. "He claimed that his plates were so clear that no other information was required, and he was certainly a valuable guide to country workmen trying to follow city fashions."[19]

Often, instructions substituted a deeper and scientific authority. The design of timber structures based on theories of the strength of materials was first seen in the guides of Peter Nicholson. The books of Nicholson and William Tredgold were popular and derived from Peter Barlow's *Essay on the Strength of Timber,* 1817. He provided new experimental evidence and many samples from previous French, German, and British experiments. He charted the relative strengths of timbers that then enabled Nicholson and Tredgold to provide rules for calculating the sizes of members of different species. "The science of the strength of materials or theory of structures hardly existed in the 18th century... Indeed, at first there was some confusion about whether

timbers of softwood should be larger or smaller than those of oak."[20]

The best writers of building guides were operating between practice and the logic of practice in ways that associated construction with building science (strength of materials and structural engineering). So while conventions of practice can exist without theoretical knowledge, practice was influenced by an increased respect for science.[21] In the trend toward the balloon frame, certain new theories of the strength of wood and wood joints were instrumental in arguments for the national acceptance of light-wood framing.

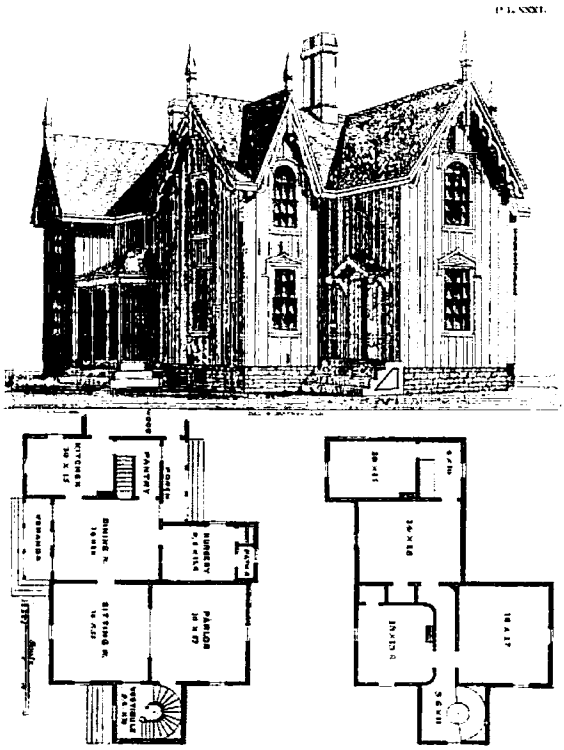

Figure 3. Perspective and related plans. From Oliver Smith, *The Domestic Architect.*

During the nineteenth century, writing moved from a insignificant to a major influence on North American houses. The earliest building guides in the United States were Asher Benjamin 1806, 1811, 1820; John Haviland 1818 - 1821; and Benjamin Hale 1827. mid-By the 1840s architectural books were written expressly for house consumers rather than builders.[22] The historian Henry Hitchcock identifies these consumer oriented "pattern books" as describing what-to-build instead of the how-to-build of building guides. In his bibliography, the building guides dominated the first half of the nineteenth century, and the second half was dominated by pattern books. Historians have described this as a progression in concerns for appearance and plan augmented by a new preoccupation of building set in landscape.[23]

This may be partly true, but there was a significant bifurcation into consumer-oriented books and those for producers. The expanded reading public coincides with the rise of the pattern book; nevertheless, the story of a historical progression from the building guide to the pattern book is incomplete and misleading. Many pattern books of the mid-century concentrate on appearance to the exclusion of material, technique, and detail. Building guides get published with less frequency. However, at mid-century, the builder still bought books, and building guides continued to be published. Modes of discourse multiplied; exhibitions, lectures, and trade instruction become regular parts of association. After a period of bifurcation (and to some extent during this period) there was a general movement to reintegrate the what-to-build with the how-to-build. For various reasons explained elsewhere, this used the integrative power of technology to establish a massive system of wood production and consumption.[24]

In 1816, Timothy Claxton started "The Mechanical Institute" in London for three years at "Horne's celebrated library." He moved to Russia and then to Boston, starting Mechanics Institutes, Lyceums, Apprentice libraries. "I had some taste for drawing; but found it difficult to make such progress ... Gaudy pictures were much more easily made than correct representations: however, by perseverance, and having a better chance as I grew older, I succeeded in mechanical drawing to my wishes; and also tolerably well in the ornamental department."[25] Two out of three articles in a typical issue of *The Boston Mechanic and Journal of the Useful Arts and Sciences*, are full of exhortations related to learning and advancement.

> [In Lombardy] Boys above twelve years of age, who have left the elementary schools, and become apprentices or journeymen, receive instruction for two or three hours every holiday; and thus not only retain what they have before learned,

> but make still further advancement. They are taught drawing, as applied to the mechanical arts, the principles of architecture, etc. The holiday schools are also frequented by grown up artisans, who have not had the advantages of elementary education in their youth.[26]

Hitchcock identifies Oliver Smith's book of 1852 as transitional still in the building guide tradition yet adopting the new pattern book formats; however, I view it as an early attempt to integrate production and consumption. He explains to builders a variety of methods of construction used on the frontier and illustrates details and styles of outward appearance. In his magazine of 1854, *The Modern Architect* combined an article on the choice of styles proposing the bracketed Norman style modified by deeper cornices after surveying the recent history of the Grecian, Gothic, Rural Gothic, Italian, and Romanesque. He detailed brackets and explained how to translate drawings by grid enlargement on to a wooden template for cutting the bracket. Here he anticipates the later nineteenth century direction of domestic architecture.

Smith explained advances in the structural understanding of wood such as the improved capacity of a deeper narrower wood beams. George Woodward, in his book of bracket details and house plans of a decade later, explains:

> If, in erecting a building, we can so use our materials that every strain will come in the direction of the fibre of some portion of the wood work, we can make inch boards answer to better purpose than foot square beams, and this application of materials is one reason of the strength of Balloon Frames.[27]

He elaborates this understanding of structure in an article specifically on the balloon frame:

> ...the timbers of a balloon frame are so arranged and fastened that many of them perform a double duty. The floor beams, ceiling joists, plates, lining, etc., all become ties, and do duty in direction of their fibre. ... The spikes that are driven through the joist are pointed not only downwards, but towards the center of the building, so that they form a claw for each joist at its end. ... The single nail, like the single strand of cable, is comparatively weak, but in numbers there is strength."[28]

Woodward calculates the strength of joist, stud and siding, ledger, and the total distributed strength of the entire structure. He assumes that "compressible and tensile strength of timber is considered equal. The neutral axis of a beam exposed to a cross strain is said to be in the center, the fibres above being compressed and those below being separated at the same time."[29] Some building guides displayed new understandings of strength and were critical of joinery that cut holes weakening the joint (today's glues have reversed this). Joiners geometrical cuts were in direct conflict with structure. 'Heaviness' was reconsidered as dead weight rather than as resistance and the balloon frame was described structure not geometry.

The transition from instruction in geometry to instruction in structures redirected the content of building guides and teaching; at the same time, drawing was being transformed. The simple elevation and plan drawings of the Palladian tradition were challenged by the introduction of perspective, surroundings, and sophisticated drawing techniques introduced by architectural immigrants such as Benjamin Latrobe.[30]

Smith continued to offer instruction to improve skills of the reader, he argued that

> ...our mechanics should have the requisite knowledge of drawing and fitness in decoration: they should have some means that will enable them to select and execute suitable and appropriate decorations - when their employers refuse to employ professional skill, to furnish them with plans and specifications for their buildings.[31]

Notice the idea that owners might employ carpenters directly, though this seems to be in contravention of an ideal practice of employing "professional skill," presumably a builder architect like Smith. Also, it appears that plans and specifications did form part of an ideal process of building a house on the frontier.

Figure 4. Perspective in a catalogue by George and Charles Palliser. From *George & Charles Palliser's Model Homes*.

In the last third of the century, both builder and public were the audience for a new entrepreneurial class of professional architects that anticipated and catered to the expansive building market. They took the earlier forms of the building guide, the pattern book, and the building contract integrating them with an emerging idea of "plans and specifications." These architects used the form of a mail-order catalogue and associated it with some very sophisticated strategies of production and consumption.

The representation of houses in pattern books sold to the public attained the goal of apparent visual variety for the consumer. At the same time the producer used the same arrangements and methods of construction. By the United States centennial, the Pallisers, brother architects, had perfected this. In a slight of hand, they made a selling point of minor changes to stock plans and house forms. Their pitch was: every client is different, customize your house plans, start from a standard plan and the Pallisers will customize it to meet your desires. It was standardization with the persuasive rhetoric of custom, individual tailoring.

The Pallisers offered training in construction drawings to artisans and clerks alike. This was actually base level employment in their office. Drawings mailed out by the Palliser brothers, and competitors like Shoppell, have the "instructive" qualities of drawings today; readers and draughtsmen are instructed in the conventional language of orthographic projection and specification, and builders are expected to follow the instructions in the drawings forcing them into an intermediary role, described above as maintenance relations. Of course, the specifications read substantially the same for every house. The drawing helped determine the limits of construction and the organization set up by the Palisers determined what could be produced.

Other mail-order architects sold both wholesale and retail. Shopell gave builders a price break. Client house owners negotiated contracts with builders with full knowledge of the costs, the specifications, and even the possibility of a loan. On the other hand, in "portfolios" specifically directed to client builders, the quantities, materials and cost estimates were itemized separately. The builder would then assign a price to each design in the portfolio.

This was a point of contention for the Pallisers, they apparently refused to sell to builders without full disclosure to the client – no wholesale price to the building trade. "Please bear in mind that we are not in the ready-made plan business, and in our experience serving as we have upwards of two thousand clients all over the United States by correspondence, we have not found two persons wanting to build just the same house..."[32] As a result, the reach of the Pallisers was greater, extending from the consumer to the producer and integrating this technological organization through the medium of drawing from perspective to the drafting of contract documents.

In most other areas of industrial design, the introduction of drawing had the effect of influencing the technology. "Technical constraints hampered the design of patterns for the newly mechanized textile trades ... this tendency to linear simplicity, flatness, and close repeat remained a stylistic desideratum even when no longer technically necessary. ...This linearity and flatness did not simply appear; it had to be taught in the design schools."[33] Drawing here acts as inertia, contributing to what Thomas Hughes describes as a tendency for technological systems to resist change. While recalling that light-wood frame was not drawn or specified as precisely as other forms of construction or manufacture, nevertheless its association with the appearance of visual variety remains with us.

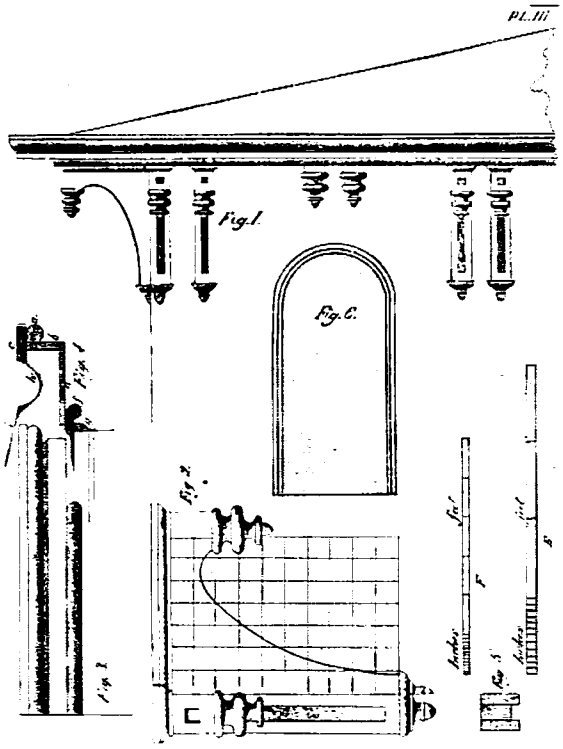

Figure 5. Drawing of brackets and grid for builders. From Oliver Smith, *The Modern Architect.*

In North America, by the turn of the twentieth century, the content and scope of a method of residential construction was well defined. With the adoption of the balloon frame as conventional practice, developments in construction method appeared to stop. The balloon frame had proliferated to become dominant, almost a monoculture. Domestic building adopted an expedient vernacular. This period has been described as the era of the "material culture of capitalism" when buildings made by one group are lived in by another, the direct knowledge of production of a generation earlier became the mediated knowledge of consumption, and our values became highly variable and subject to the trends of fashion.[34]

Despite this new orthodoxy and massive technology of organization, individual agency was not eliminated, simply displaced. In other words, the locus of creativity shifted. This view is held by many who study culture, such as Pierre Bourdieu, Michel de Certeau, and Homi Bhabha. Similarly, in architectural history, local variation was necessary for material and environmental reasons. For example neoclassical architecture was a teaching "...whose unchangeable ordinance allowed the greatest range of sober variety within the hoary tradition." [35] Classicism, as well, had its "...famous 'rules,' which are supposedly valid for all places and all times, are in fact localized in time and space..."[36]

At a general level, this new locus of agency becomes inscribed within the broad economics of the balloon frame as applied to U. S. nation-building (as described by Daniel Boorstin); within the refinement of a new systemization of building process (as Sigfried Gideon describes in order to further modernism); within the parameters of the innovative technique itself (as Tom Peters describes in the culture of its construction); within the slippage between orthodoxy and application (as described by Joseph Rykwert and Pierre Macherey); or repositioned from building into its appearance and the surrounding circumstances (as architectural historians who describe the "battle of the styles" of the last half of the nineteenth century would have us believe). At the level of building practice, this includes the dispersion and specialization of agency into the disparate operations of the architect, building component designer, pattern-book author, general contractor, artisan, and owner. If this interpretation about the scattering of agency is correct, then distributed creativity becomes one more condition that can be used to describe the increase in "system" identified in studies in the history of technology.

> The Balloon Frame is one of those innovations, which, like the sewing machine, the husking machine, and the apple-parer, is destined to put an end to those social gatherings, which, in by-gone days, assembled to accomplish by united efforts that which by the advent of machinery is now performed with far greater ease and rapidity. Balloon Framing is not, however, a manner of effecting by machinery what has formerly been done by hand, but embraces a series of improvements in the art of building which time and experience have shown to be thoroughly practical - that which has hitherto called out an entire neighborhood, and required vast expenditures of labor, time, noise, lifting, hoisting, and the attendant danger can, by the adoption of the balloon frame, be done with all the quietness and security of

> an ordinary day's work. A man and a boy can now attain the same results with ease, that twenty men would on an old fashioned frame.[37]

Woodward appears fully aware of the profound change in social practice that this simpler way of building implied. The balloon frame did represent the break down of traditional conventions and craft, but in a manner quite distinct from other modern revisions in production. It is a displacement (for better or for worse) of creation, invention, and discovery to different points in the process of building and to different variations in contemporary building form and appearance. For Hughes, this condition can be found in the North American culture as a whole.

> The values of order, system, and control ... have become the values of modern technological culture. These values are embedded in the artifacts, or hardware. ... [and] applied to such other realms of social activity as politics, business, architecture, and art.[38]

It is this association of drawing, wood construction, and wood production that hides architectural choices in standard house construction. There are ethic positions to be taken.

Notes

1 Melburn Thurman, *Building a House in 18th Century Ste. Genevieve* (Ste. Genevieve, Missouri:Pendragon Press, 1984).

2 Pierre Bourdieu, *In Other Words* (Cambridge, U.K.: Polity Press, 1990), p. 78, 79, and 65.

3 There were exceptions such as the plans of the Neue Museum in Berlin. Tom Peters, pers. comm.

4 For the increase in materials see Ezio Manzini, ed., *The Material of Invention* (Cambridge, Mass.: MIT Press, 1989), and for the increase in materials in a typical wall section of a building see Edward Ford, *The Details of Modern Architecture* (Cambridge, Mass.: MIT Press, 1990).

5 Eugene Ferguson, "La foundation des machines modernes: des dessins," *Culture Technique* 14 (juin 1985), 182 - 207, taken from the 'original' English version, MS, collection of Euleutherian Mills, Greenville, Del.

6 Ibid, p. 185. He refers to David Hounshell, "From the American System to Mass Production: The Development of Manufacturing Technology in the United States, 1850-1920" (Newark, Del.: University of Delaware, 1978).

7 For a detailed description of the exceptional tolerances created by hand tools used with jigs see Robert Gordon, "Who Turned the Mechanical Ideal into a Mechanical Reality?" *Technology and Culture* 29/4 (1988).

8 Robert St. George, lecture, Winter Institute, Winterthur Del., January 17, 2000.

9 See Catherine Bashir, "Good and Sufficient Language for Building," *Perspectives in Vernacular Architecture* 4, p. 49-50. In another example: "In each case, the client knew, assumed, or hoped that the artisan possessed basic skills that enabled him to apply lessons of experience and example to the job. Both parties assumed that they held, as members of the community, some shared definition of the type of building required, so they needed to define only the particulars ... Often, however, novel elements were described in familiar terms by reference to existing models. In Salisbury, North Carolina, Andrew Murphy employed Michael Davis in 1853 to build for him a frame house that was to be "finished from foundation to the comb ... in the best manner." For most elements, specifying "the neatest and most fashionable kind" was sufficient. For the unfamiliar, however, such as the broad eaves of the hip roof, it specified that "the eaves to project over at least two feet or more and to have bracketts and be finished off something like Robert Murphy's house."

10 Oliver Smith, *The Modern Architect,* (Buffalo: Oliver P. Smith & Son, 1852), p. viii. See also Jean-Christophe Agnew, *Worlds Apart: the Market and the Theatre in Anglo-American Thought 1550-1750* (New York: Cambridge University Press, 1986), p. 69. The author's "very effort to transport the reader behind the ...rhetoric of mutuality and through his or her logic of instrumentalism merely reenacted, where they did not in fact deepen, the reader's sense of estrangement - of distance...."

11 Smith, *The Modern Architect*, p. 14.

12 Joseph Corn, "Textualizing Technics: Owner's manuals and the reading of objects," in Ann Smart Martin and J. Ritchie Garrison, eds., *American Material Culture: The shape of the field* (Knoxville TN: Henry Francis du Pont Winterthur Museum, University of Tennessee Press, 1997), p. 177.

13 Brooke Hindle and Steven Lubar, *Engines of Change* (Washington, D.C.: Smithsonian Institution Press, 1988), p. 231.

14 Henry Russell Hitchcock, *American Architectural Books: a List of Books, Portfolios and Pamphlets on Architecture and Related Subjects Published in America before 1895* (expanded ed.; New York: Da Capo Press, 1976), p. iii.

15 See Bourdieu, *In Other Words*, p. 100-01. "From the moment the rite is retold, it changes meaning and you pass from a mimetic practice, from a bodily logic oriented toward functions, to a philological relation: the rites become texts which have to be deciphered, they are pretexts for decipherment. The need for coherence and logic appears, linked to communication, discussion, and comparison."

16 See Bourdieu, *In Other Words*, p. 84, 100-01.

17 "These two manuals, according to the number of [U. S.] references found in this study, appeared in 1733 and 1734, Francis Price's *The British Carpenter* and William Salmon's *Palladio Loninensis.*" David Yeomans, *The Architect and the Carpenter* (London: RIBA Heintz Gallery, 1992).

18 ibid. Quote is from Francis Price, *The British Carpenter.*

19 ibid. A new language for construction was a project of the Enlightenment (after all, Diderot's *Encyclopedie* is full of didactic depictions of various building artisan shops) and advanced rapidly in the eighteenth century.

20 ibid, p. 38-40.

21 See also Mario Bunge, "Toward a Philosophy of Technology," in Carl Mitcham and Robert Mackey, *Philosophy and Technology: Readings in the Philosophical Problems of Technology* (New York: MacMillan Publishing, 1983), p. 67.

22 Robert Guter and Janet Foster, *Building by the Book* (New Brunswick, N.J.: Rutgers University Press, 1992), p. 3.

23 See, for instance, Dell Upton,. "Pattern Books and Professionalism: Aspects of the Transformation of Domestic Architecture in America, 1800 - 1860," *Winterthur Portfolio* 19 (1984): 107-50; Linda Smiens, *Building an American Identity: Pattern Book Homes & Communities* (Walnut Creek, Calif.: Alta Mira Press of Sage Publications, 1999); and James Garvin, "Mail-Order House Plans and American Victorian Architecture," *Winterthur Portfolio* 16/4 (1981): 309 - 34.

24 See the work of Ted Cavanagh, Andrew Feenberg and Thomas Hughes.

25 Timothy Claxton, *Memoir of a Mechanic* (Boston: George W. Light, 1839): p. 24

26 "Instruction of Apprentices" in *The Boston Mechanic and Journal of the Useful Arts and Sciences. November 1835.*

27 George Woodward, *Woodward's Country Homes* (New York: Geo. E. & F. W. Woodward, 1865), p. 154.

28 George Woodward, "Balloon Frames - No. II," *The Country Gentleman* 14 (Dec. 15, 1859) p. 387.See also Woodward, "Balloon Frames - 5th Article," *Country Gentleman* 16/20 (August 23, 1860), p. 180. "Corrosion of nails in permanent work is considered desirable and adds much to the force required to draw a nail. We have sometimes recommended the use of green timber or studding to produce this very effect."

29 ibid, p. 387.

30 James O'Gorman, *Drawing Toward Building: Philadelphia Architectural Graphics, 1732 - 1986* (Philadelphia: University of Pennsylvania Press, 1986).

31 Smith, *The Modern Architect*, p. iv.

32 Michael Tomlan, "Introduction." Reissue of 1887 and 1888 republication of *George & Charles Palliser's Model Homes* (1878) and *American Cottage Homes* (1878). For Robert Shoppell, see Cooperative Building Plan Association. *How to Build, Furnish, and Decorate* (New York: Robert Shoppell, 1883); *Shoppell's Modern Houses* journal starting January 1886; and Garvin, "Mail-Order House Plans and American Victorian Architecture."

33 David Brett, "Drawing and the Ideology of Industrialization," *Design Issues* 3/2 (1986): 59 - 72.

34 Margaret Purser, "Ex Occidente Lux? An Archaeology of later capitalism in the Nineteenth Century West," in Mark Leone and Parker Potter, *Historical Archaeologies of Capitalism* (New York: Plenum Press, 1999), p. 124.

35 Joseph Rykwert, *The First Moderns: the Architects of the Eighteenth Century* (Cambridge, Mass.: MIT Press, 1980), p. 19.

36 Pierre Macherey, *The Object of Literature* (Cambridge, U.K.: Cambridge University Press, 1995), p. 15.

37 Woodward, "Balloon Frames - III," *Country Gentleman* 15 (April 5, 1860), p. 226.

38 Thomas Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm, 1870-1970* (New York: Viking, 1989), p. 4.