"Built Mostly of Itself": The Chicago Brick Industry and the Masonry Skyscraper in the Late 19th Century.

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> "The new Chicago is being built mostly of itself. The clay that makes the products used in the loftiest buildings is the clay dug form the mud of the territory embraced by what is called the Chicago district. The sky line that rises above Michigan avenue is simply a pleasingly modified form of clay like that deposited in the made land a few hundred feet to the east. Only the specialized form of facing brick and other costly manufactures are brought from outside the city, and new concerns are springing up to supply this demand." –*Chicago Daily Tribune*, Mar. 10, 1912.[1]

Chicago would come to be known as a city of steel, but well into the 1880s it remained a city of brick. The same soil that would prove to be so problematic in the city's foundations—a thick stratum of wet, compressible clay that was a geological result of its location at the outlet of a sluggish, silt-clogged river—proved to be a generous provider of building material for the city in its post-fire generation. Chicago had built brick buildings since the construction of Fort Dearborn's magazine in 1803, and brick served as a primary or adjunct structural material to commercial buildings built in the aftermath of the 1871 and 1874 fires, backing up such cast iron fronts as the 1872 McCarthy Building by John van Osdel, and supporting the city's tallest buildings, notably the seven story Portland Block by Jenney. Brick was made in fire, and the kiln-burning that made it solid and resilient also made it the most fireproof of all building materials available in the 19th century.

Brick also came with an ancient history, with methods that had literally been handed down for thousands of years, and with a long track record of steady performance.[2] While seen as a traditional, sometimes anti-technological material today, masonry bore no such stigma in the late nineteenth century; in fact, a great deal of important innovation occurred in brick production and engineering during the 1880s and 1890s, and its relatively low price combined with ease of construction ensured that it remained the structural and enclosure material of choice for mid-rise buildings of up to eight or ten stories well into the twentieth century.[3] Brick had largely been proven in its fire-resistive capacities over centuries, but particularly after the disastrous performance of stone, cast iron, and timber in the fires of the 1870s, brick was relied on increasingly in Chicago for its strength against flame; early iron and steel framing employed local clay in brick or terra cotta fireproofing at the behest of insurance companies and, later, city building codes.

Bricklaying in Chicago

Such reliance on masonry in commercial structures, of course, determined several things about these buildings. First and foremost, bricklaying has always been a manual technique, and this was particularly true in the 1880s. Machinery gradually made the process of making bricks more efficient (see below), but on the construction site the weight of bricks themselves relied on the accumulation of thousands—even millions—of parts small enough to be lifted and placed by hand. Terra cotta, a lighter ceramic material, was employed more and more for larger decorative and fireproofing elements, but brick itself relied on simple processes for manufacture; adding hollows or admixtures to reduce weight added time and expense while reducing brick's inherent strength, and thus common brick usually consisted of solid dried or baked clay. The resulting dense, heavy product had to be sized to allow easy placement by a

single mason—not just once, but hundreds of times over the course of a working day. Bricklayers were, as a rule, a strong lot, but there were obvious efficiencies to keeping their repetitive task of lifting, placing, and trowelling within a reasonable range of effort. Thus, since Roman times, individual bricks were necessarily restricted in size to that which could be easily grasped, lifted, and placed, and by the late nineteenth century American bricks had become more or less standardized to 2" x 4" x 8", though these varied in official nomenclature by 1/4" to 3/8", and likewise varied with the thickness of mortar bed used.[4] Masonry buildings were thus, essentially, large structures composed of many small, hand-placed parts, and their design had to incorporate both the grain and texture of the individual brick module and its inherent inaccuracies. Even after the standardization that occurred in the brick industry in the 1880s, *Industrial Chicago* reported the following:

> "Different cities make different bricks; in reality the products of no two brickyards are entirely alike in size, nor, for that matter, all bricks burned in the same kiln. The necessity of acknowledging some standard for purposes of mensuration and calculation is obvious. In these rules the dimensions of a brick are understood to be 2 x 4 x 8 inches. We therefore speak of four-inch walls, meaning the width of one brick; of eight-inch meaning the width of two bricks, and of twelve-inch walls, meaning the length of one and width of another brick, etc., although the actual width of the wall will be more or less in excess of these measures. Every superficial foot of 'one-half brick (or four inch) wall' to be estimated at seven and one-half bricks; of 'one brick (or eight-inch) wall' at fifteen bricks; of 'one and one-half brick (or twelve-inch) wall' at twenty-two and one-half bricks; of 'two-brick (or sixteen-inch) wall' at thirty bricks, etc.—increase the number of bricks by seven and one-half for every additional half brick in thickness of wall."[5]

In its inaugural 1892 issue, the trade journal *Brickbuilder* noted that this fact in itself required understanding and accommodation on the part of the designer:

> "A brick building is necessarily made up of small parts. This is perhaps constructionally the quality which most distinguishes a brick building from buildings of other material. In applying, then, to brick buildings the rule of design referred to at the beginning of this paper, it is obvious, that the small pieces of which the design is constructionally made up must be recognized in the design itself, if the best and most characteristic result its to be produced. Large members made up of small pieces should therefore be avoided; they only call attention unpleasantly to the necessary limitatsion of the material, and make what should be a source of excellence into a shortcoming. The design itself, then, should be made up of small units as the unit of construction itself is small…A similar consideration will suggest that the joints of brickwork should be emphasized rather than disguised. They should be regarded as an element of design to be used, not a defect to be covered up."[6]

Likewise, the job site itself presented standards and practices that necessarily influenced the forms and designs of masonry buildings. Rules of thumb for brick construction suggested that a well-made masonry wall could support roughly ten tons per square foot, or roughly 140 pounds per square inch—but this was entirely dependent on the key phrase 'well-made.'[7] The process of masonry construction contained, inevitably, several key moments where its quality could easily be compromised either by neglect, lack of skill, or attempts to save time or money by contractors. Bricks themselves could be of low quality clay, or have been fired inadequately, both of which could lead to flaking or actual disintegration once in place. Mortar, especially before the widespread availability of locally produced Portland Cement in the late 1890s, was a notorious opportunity for unscrupulous contractors to shortchange their clients in quality of lime or excess of water, either of which could lead to the joints between bricks deteriorating, often within just a few years of construction.[8] Finally, the care with which

each brick was placed presented another conflict between the desired quality and the contractor's time and budget. Architect George Beaumont, in a cautionary essay in *Inland Architect* in 1886, dryly noted that this pressure was industry-wide:

> "A journeyman bricklayer seldom uses his own judgment when at work, beyond gauging the quality of his labor by the standing of his employer. The moment he steps on the scaffold he knows whether good, bad or indifferent work is expected of him. Should he dare, under the watchful eye of some contractors, to lay bricks solid and true in the wall, he would be instantly discharged as a slow, expensive workman; should he in another case lay bricks in the generally accepted manner, he would again be discharged, this time because he was a poor workman. The result is, a great many of our mechanics learn only the worst kind of brickwork and such a thing as a brick groined vault is unknown to them, even by name. Therefore how necessary it is that they should serve an apprenticeship or go through a manual training school creditably, where every kind of brickwork could be taught."[9]

Furthermore, mortar was sensitive to temperature, and its placement during Chicago's cold winters often led to inadequate bonding as water within the mix could freeze; Beaumont further decried the "vile and pernicious practice of covering mortar beds and foundations in winter with manure," but given the alternatives and the probably astonishing quantity of such insulating material available on a typical Chicago street, this technique was probably, on the whole, a useful one.

Finally, the strength in particular of tall masonry walls relied on multiple thicknesses of bricks, bonded together by either iron ties or by bricks laid perpendicular to the wall surface to form monolithic elements. Single widths, or wythes, of brick could support relatively little before their thin proportions led to buckling and collapse, but double-wythe brick walls, properly bonded to one another by header bricks turned perpendicular to the wall faces, provided enough resistance to buckling to be structurally useful.[10] This bonding again relied, however, on care in construction; from an engineering standpoint, typical recommendations included headers to bond the wythes every every third row for tall structures.[11] This required additional time, care, and bricks, and was another area in which pressures on the job site often led to shortcuts (such as adding headers only every sixth row) and thus decreased structural performance. Furthermore, in double-layered masonry walls it was often the case that inner, hidden wythes could be built more quickly, with less attention paid to the visual quality of mortar joints or brick faces. These layers could be built faster than the more exposed, exterior layers, and to save time contractors often allowed these elements to proceed at their own paces; the possibility for providing good bonding courses, or even iron ties in this situation became nearly impossible.

The image of the Chicago bricklayer, under enormous pressure to build quickly and cheaply, hoisting brick after brick in the cold of winter and surrounded by steaming piles of manure-warmed mortar, gives a fairly rich idea of the conditions under which masonry buildings were constructed, and suggests why masonry, for all its advantages, remained a largely un-engineered material well into the twentieth century. It was impossible to precisely calculate the likely bearing strength of a masonry pier or wall given these multiple variables in its strength, and thus masonry design and calculation remained firmly entrenched in conservative, experience-based rule-of-thumb methods. This image also hints at the often appalling, dangerous conditions faced by bricklayers and hod-carriers—general laborers whose primary task was moving bricks and large pots of mortar up scaffolds to supply bricklayers. The emergence of bricklayers' unions alongside the general labor movements of the late nineteenth century also had important effects on Chicago construction, particularly as their demands for higher pay and more humane working conditions led to strikes that occasionally paralyzed the city's construction industry.[12] Depending on one's politics, these unions were either great leaders in demanding a share of the enormous

profits being made by developers and builders in the skyscraper era, or political mobs bent on wresting as large a slice of these profits as possible for not only members, but also the unions' leaders. This uncomfortable relationship between white and blue collars on job sites would be a constant sub-plot to the unfolding development of the skyscraper in Chicago, and would influence the very composition of these buildings alongside other factors in the coming decades.[13] The often vituperative anti-unionism of the *Inland Architect* in its editorial pages is particularly striking. Here, for instance, in George Beaumont's above-cited article, is a typical, almost throwaway remark:

> "Another potent factor allied against the execution of good brickwork, is trades unionism as at present conducted, for it is contrary to human nature to expect an ordinary mechanic to make an effort to improve his handicraft, when a high rate of wages is fixed for him, irrespective of his qualifications, and I say without fear of reliable contradiction, that the abilities of a majority of our bricklayers have been deteriorating this last five years and it is only by the incoming of eastern mechanics to assist the old hands that the excellent brickwork I am about to speak of has been possible."[14]

Brickmaking in Chicago

The almost medieval conditions of bricklaying on the job site were largely matched by those of brick manufacture, but particularly in the 1880s—and particularly in Chicago—this changed significantly. Writing in 1891, manufacturer W. H. Alsip noted that "more has been done during the past twenty-five years than in all the preceding ages" to improve the methods and quality of brickmaking.[15] Indeed, the methods of the early nineteenth century had nearly all evolved from those of centuries before; arguably the quality of bricks produced in 1800 was inferior to those of two-thousand years prior.[16] Inevitably, making bricks required finding large beds of naturally occurring clay, usually eighteen to twenty-four inches beneath topsoil.[17] Gerald Larson has noted that digging for the Illinois and Michigan Canal in 1848 produced immense quantities of useful clay and spurred development of dedicated brickyards.[18] Clay fields had to be tended by turning and spading in the season prior to actual digging; this had the effect of draining excess water and providing relatively solid material. Digging itself was a back-breaking chore, with an estimated sixty-four cubic feet being required for a single thousand bricks. Raw clay was taken to large pits, where fresh water was added back to the clay to achieve a workable consistency and the resulting 'mud' was stirred mechanically until it was uniform. "Mud-wheelers" then took barrows of the mixture to sanded tables, where brickmakers proper rolled out rough quantities of individual bricks and forced them into a mold, slicing off the excess mud with a piano wire.[19] Wet bricks were then dried before being stacked into kilns—either permanent structures or temporary ones made out of wet bricks.[20] This was something of an art form, with a great deal of discussion and secrecy surrounding various companies' kiln sizes and geometries; the intention in all cases was to use the wet bricks to shape an ideally formed furnace, within which a constantly stoked fire would not only dry the clay, but also fire it, rendering it monolithic and water-resistant. This often took place in several stages, the first step being to dry the water out of the bricks, the second, at higher temperature, to chemically cure the clay. In all cases, attention had to be carefully paid over a period of days and weeks to the temperature of the furnace, to the air-tightness of the kiln—the outside layer was often plastered over to ensure this—and to the moisture content of the bricks. Despite the onerous need for careful monitoring, brick-burning was often a social event of major importance. An account of a typical kiln firing appeared in Industrial Chicago in 1892:

> "The 'season' closed in the early fall; October was the usual month. The entire summer's product was set in a single kiln. Then came 'burning time.' This was a hilarious event. It looked forward to with great interest by certain of the community as an occasion when rum, if

ever, was needed to successfully do the job. Everybody then connected with the kiln was happy but the owner of the property; he was commonly overwhelmed with anxiety lest his volunteer help become so utterly drunk as to endanger his kiln by neglect. Such instances were not infrequent."[21]

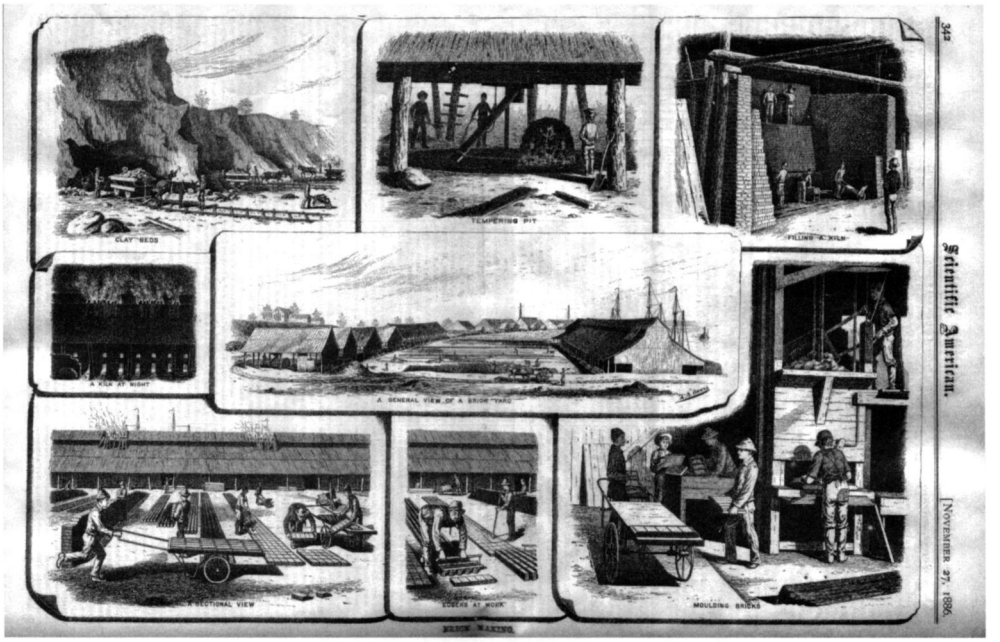

Figure 1. Brickmaking in the mid-1880s, showing clay extraction (upper left), moulding (lower left), and kiln building (upper right). Scientific American, 342 (17 November 1886), 342.

None of this could be directly monitored, relying instead on the intuition of the kiln-builders and the yard foremen. Such methods had existed in some form or another for centuries, though, and progress in manufacturing better bricks, and in doing so more efficiently, came gradually after 1850 (Fig.1). Horse-power was used to mold brick for the first time in 1835, but brickmakers, fearing their jobs were at stake, revolted against a steam-powered brick molder in Philadelphia in 1840. That city remained the center of brick making and innovation through the 1880s, including new kiln dēsigns enabling greater heights and thus greater quantities from a single firing. Molding was gradually automated, first with lever-powered machines designed by brickmaker Erus Bishop, and later by steam with machines that accepted raw ingredients and turned out up to four thousand 'finely shaped' bricks per hour.[22] Drying by gas or steam heat was first employed in Scotland in the 1880s, shortening the time that bricks had to sit before being kiln-fired, and resulted in "tunnel dryers," which took bricks on a moving belt through a long chamber from which they emerged ready for the furnace.[23] This innovation permitted constant drying; as one load of bricks moved through the tunnel, more could be loaded in the front. The temperature throughout the tunnel could likewise be varied, enabling more precise control of the drying process. Fragile clays, for example, could be dried more gradually with cooler temperatures at the front of the tunnel.[24] Improvements in kiln design and fueling also sped the overall process and permitted firing even in cold weather, lengthening the digging and molding 'seasons' considerably. Tunnel kilns emerged in the United States in the 1890s, following the development of the Hoffman kiln in Europe.[25] Finally, changes in molding enabled a superior structural product. The 'stiff-clay' method relied on drier 'mud' being

pressed through an extruder and cut into lengths, rather than simply being pressed into a mold. The result was a denser, heavier brick, inherently stronger in itself, but also one with a defined grain, as clay pressed through the extruder's die inevitably formed striations that gave the brick even greater crushing strength in a given direction. A variant of this process included hydraulic re-pressing bricks after molding, which further densified the resulting bricks and brought greater structural performance (Fig.2).[26] Alongside this enhanced greater strength were aesthetic benefits, in particular a smoother surface from the extruding and pressing processes, and greater uniformity in size due to the stiffer clay's tendency to shrink less during drying. Stiff-clay bricks proved cheaper and faster to manufacture as well, leading to their extensive use during the 1890s.[27]

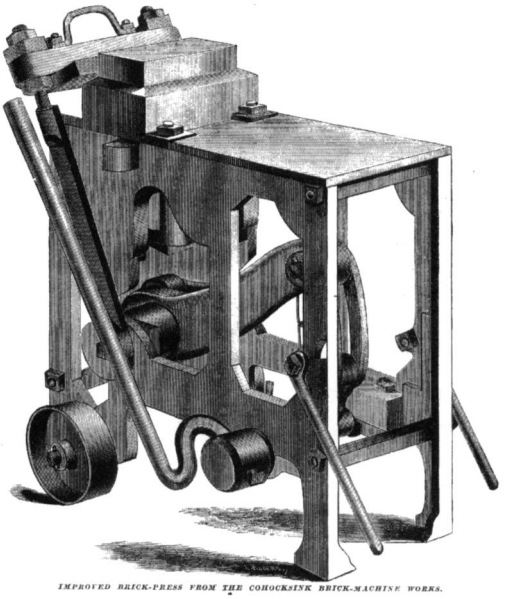

Figure 2. A re-pressing machine designed to densify moulded brick, giving it greater strength and a more finished appearance. Manufacturer and Builder, 6 (February 1874), pp. 31-32.

By 1891, brickmaking could claim some measure of industrial, even scientific progress, and the industry's development placed it squarely in the midst of the intensive progress being made in other building material industries. Investment in land, machinery, and expertise gradually led to consolidation and better-capitalized brick companies. "The day is about past," noted one manufacturer, "when any of us need hesitate to say we are brickmakers, for surely the days of the clod hopper in the brick business are numbered in our large cities."[28] This progress was particularly keen in Chicago, which took over from Philadelphia as the center of American brick-making sometime in the 1880s; the first coal-fired kiln in the country was built by the Grape Creek Coal Company in Chicago in 1889.[29]

"Chicago brick," noted the *Daily Tribune* in 1907, reflecting on a century of masonry construction in the city, "from the rapidity of their manufacture and their durability, when tested by time, weather, and fire, have been the wonders of builders everywhere. It is said that more brick can be made out of Chicago clay in a day than from the clay of any other great city."[30] Brick was among the first construction materials used in Chicago, but brick was also an early industry in the city; the first brickyard was

established by Tyler Blodget and Henry Lampman on the north bank of the River between Dearborn and Clark streets. Blodget built the first brick house in the city directly across the River from his yards. The slow-moving river left ample deposits of clay along its banks and at its mouth, and by 1839 brickmaking was one of the young settlement's major industries, with four active yards set up along the River and four bricklayers offering their services. By 1850 these numbers had tripled.[31] The nature of the clay and the booming construction industry inevitably led the city's brickmakers to produce mostly common brick, which was renowned for its durability but which had a relatively crude finish—"rough, crooked, and fairly durable" was a common description.[32] Face brick was typically imported from St. Louis, where similar clay deposits had also attracted brickmakers, or Philadelphia.

Reconstruction after the 1871 fire led to a large influx of brickmakers from other parts of the country, occasionally bringing expertise in developing methods, but more typically focused on the potential profit that the building climate in Chicago offered. A decade after the fire, the city's brick-making concerns numbered over 200.[33] Many of these firms lasted only a few years, indicative of their speculative nature, and despite some efforts to form associations the industry remained extraordinarily competitive, with buy-outs and bankruptcies being common throughout the boom years of the 1880s. The first stiff-clay machine was imported to Chicago from Philadelphia in 1881 by Purington & Kimbell, and the introduction of automation and large machinery intensified the already heated climate amongst brickmakers; those companies large enough to afford these cost- and labor-saving devices were able to undercut smaller, less capitalized firms.[34] As those firms lost market share or went under, consolidation inevitably followed and by 1891 about 40% of the city's 540,000,000 bricks were produced by only six yards, with the remainder produced by over fifty smaller, likely struggling manufacturers.[35] That year, Purington & Kimbell produced nearly twice as many as their nearest competitor.

Automation was rapid; by 1891 most of Chicago's bricks were mechanically produced by the stiff-clay method, but this came with a price. Angry about low wages and the loss of jobs that came with the new machinery, brickmakers and layers throughout the city staged an epic series of strikes from 1882 to 1884 that severely impacted building construction as supplies dried up and prices climbed accordingly from around $7.50 per thousand to nearly $11.[36] The strikes were ultimately broken, but the lingering threat of labor unrest in the masonry industries cast a long-standing shadow over the material. To use brick in Chicago was, henceforth, to gamble with the possibility of a strike, and the sense that masonry was something of a necessary evil for this reason pervades much editorial comment of the day.[37] The rising lumber trade deprived the brickmaking industry of its traditional fuel source by the late 1880s, and further capital investment was required for more sophisticated furnaces, first using crude oil from Ohio (Purington & Kimbell led the way here, too), and eventually relying on natural gas piped from Indiana wells.[38]

The advent of stiff-clay and hydraulic pressed brick in the early 1880s was a key factor in the initial burst of tall building construction in Chicago.[39] The drier mix and greater density of these bricks provided far greater strength, which created piers and walls that could carry more floors; this simple recipe extended the reach of masonry construction well beyond the six or seven floors that had represented the practical limits of masonry construction in the post-fire years. St. Louis led the development of hydraulic pressing techniques, and the St. Louis Hydraulic Pressed Brick Company boasted the most sophisticated machinery in the West, as reported by *Inland Architect* in 1883:

> "When the clay leaves the charger, which works automatically and carries enough to make ten brick at a time, it passes into the moulding machine, where it undergoes a pressure of from 300 to 800 tons, depending on the moisture in and quality of the clay. Ten bricks are made at each revolution of the machine, which has a speed of eight revolutions per minute. All power is

> furnished by hydraulic pumps, driven by an engine of sixty-horse power, which runs two machines. A gauge shows just what pressure is being used, and the machine is under the complete control of the engineer, who can stop it in any position and at any instant....Fifteen men are required at each machine, and the brick are drawn by carts directly from the machine to the kilns, which are an invention of Mr. W. N. Graves, the superintendent..."[40]

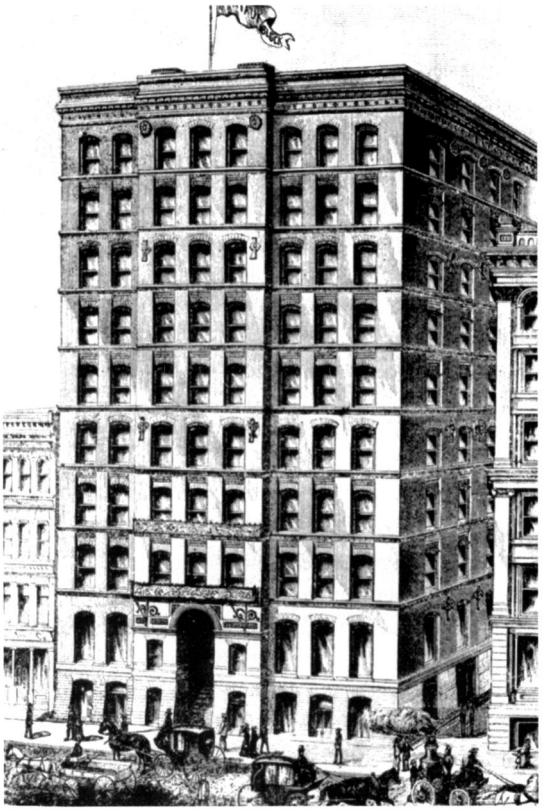

Figure 3. The greater strength of pressed brick allowed taller structures in the 1880s. At ten stories, the Montauk Block (Burnham & Root, 1882) demonstrated the potential for the material to reach record heights in Chicago. One Hundred and Twenty-Five Photographic Views of Chicago. (Chicago: Rand-McNally, 1902).

St. Louis' product was expensive—after a price cut in 1885 from $35.00 to $27.00 per thousand it was still nearly four times the average rate for Chicago common brick—but its structural properties and finish were highly sought after, and it became the material of choice for early skyscrapers in Chicago, including the Grannis Block, the First National Bank, and the Montauk (Figs.3-7).[41] The high prices paid for pressed brick spurred development in Chicago, however, where the Chicago Anderson Pressed Brick Company was the first to market hydraulic pressed brick as early as 1882. Despite a fire in 1883 that destroyed entirely their works, the company soon became the leading local supplier of the stronger material, and following the use of its stock in the well-regarded Calumet Club of 1884 pressed brick grew 'from a fashion...into a permanent style' among builders and architects.[42] There was, in the late

1880s, clearly enough work for both companies, as major buildings of those years featured pressed brick from both Chicago Anderson and St. Louis. While these two dominated the trade, other pressed-brick companies grew in the region as well, including Hinchliff & Owen, who supplied the millions of brick needed to construct the town and factories of Pullman, and the La Salle Pressed Brick Company at La Salle, IL, at the end of the Illinois & Michigan canal and thus uniquely suited to supply both Chicago and St. Louis.[43] Purington and Kimbell, too, expanded their operations to Galesburg, IL to serve the two cities. As the possibilities inherent in this newly engineered material became apparent, pressed brick became the material of choice in tall buildings for load-bearing piers and walls and, eventually, for finish masonry work in general. "For nine years," noted *Industrial Chicago*, "pressed brick worked its way gradually into popularity, and then came the Montauk…with a hundred other massive monuments to its utility."[44] By 1890, the use of pressed brick for tall buildings had largely eclipsed that of common brick.

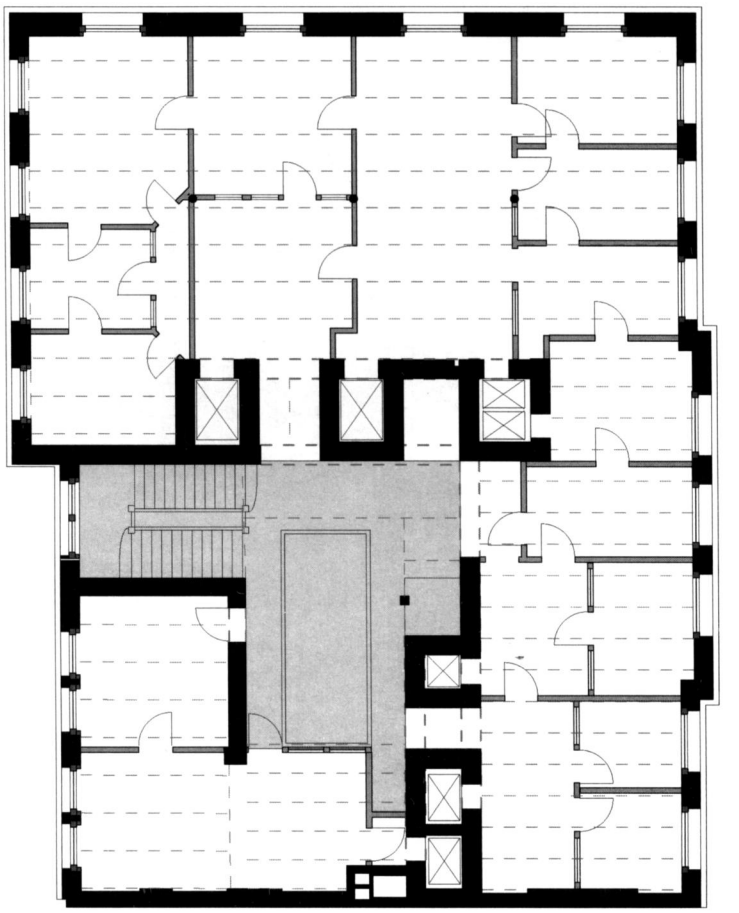

Figure 4. Montauk Block, plan, showing extent of load-bearing pressed brick walls. Drawing by the author based on Burnham and Root drawings, Reel 26, frames 50-74, Burnham Library–University of Illinois Project to Microfilm Architectural Documentation Records, 1950-1952.

Brick's gradual improvement in Chicago is an early example of technology and design chasing one another toward greater efficiencies. This pattern would be repeated in more celebrated instances—iron,

steel, terracotta, and glass, for example—but brick was the first building material to find in Chicago's economic climate and physical geography a fertile ground for innovation and improvement. The jump in height that occurred in skyscrapers of the mid-1880s cannot be fully explained without understanding the new engineering capabilities of pressed brick, and understanding the economic and industrial contexts of this event demonstrates that technical developments influenced and shaped architectural design in Chicago commercial architecture even before the advent of the iron frame.

Figure 5. The Monadnock Block (Burnham and Root, 1891) was the greatest statement of pressed brick's structural potential, rising 215 feet. Contemporary postcard, photographer unknown, from author's collection.

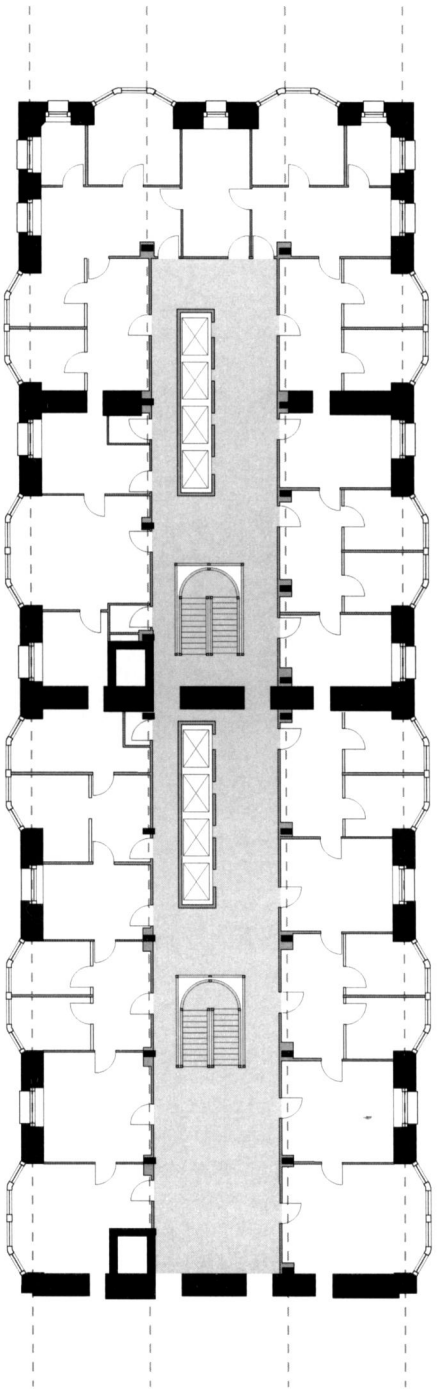

Figure 6. While revealing the structural potential for pressed brick, the Monadnock's planning revealed the planning problems inherent in the masonry skyscraper's planning. Drawing by the author based on floor plan in Prominent Buildings Erected by the George A. Fuller Company (New York: George A. Fuller Co., 1893).

Figure 7. While brick as a structural material was superseded by steel for Chicago's skyscrapers, it remained an important fireproofing material. The Williams Block (Holabird and Roche, 1897) offered a particularly articulate set of masonry jackets around its steel frame.

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References:

1 'Chicago Acquired Title 'Clay City.'' *Chicago Daily Tribune* (10 March 1912), K7.

2 Brick's history has generated an exceptional quantity of scholarly literature. Most immediate for the America's is Karl Gurcke, *Bricks and Brickmaking: A Handbook for Historical Archaeology* (Moscow, Idaho, 1987). A broader reference is James Campbell, *Brick: A World History* (2003), while Cecil Elliott, *Technics and Architecture* (Cambridge, MA, 1992) offers a cogent overview of manufacturing techniques. Specific information on pressed brick is covered in Susan Begley Broeksmit and Anne T. Sullivan, 'Dry-Press Brick: A Nineteenth-Century Innovation in Building Technology', *APT Bulletin*, 37 (2006), pp. 45-52. American brick industry and architecture during the late 19th century was well covered by the journal *Brickbuilder*, and a partial account of the region's industry by D. V. Purington, 'Brick Manufacture Near Chicago,' *Transactions of the American Society of Civil Engineers*, 18, (1888), pp. 291-296.

3 "Load-supporting walls.—Load supporting walls, built of solid masonry, and carrying all of the wall-, floor-, and roof-loads which come upon them without the use of steel or iron members, constitute the ordinary practice in buildings of moderate height, whether of fireproof or non-fireproof construction. Eight or ten stories is about a maxium height for load-supporting walls, so that in higher structures, which are here being considered in particular, it is a rare exception under modern methods to rely entirely on masonry piers." Joseph Kendall Freitag, B.S., C.E., *Architectural Engineering. With Especial Reference to High Building Construction, Including Many Examples of Prominent Office Buildings*. (Second Ed., New York, 1904), p. 145.

4 "In 1889 the National Brickmakers' association considered the question of adopting a standard size for brick, and in December of that year a name for each class of brick was suggested. The standard size of good, hard, common bricks, was placed at 8-1/4 x 4 x 2-1/4 inches, and of pressed or front bricks at 8-3/8 x 4-1/8 x 2-3/8 inches. The nomenclature, as suggested in September, 1889 by the editor of the *Brickbuilder*, does not appear to be considered in convention, but it may be said to have been adopted by the manufacturers. *Industrial Chicago* (Chicago, 1891), Chapter XII, 'Brick and Terra Cotta' p. 379. This chapter, prepared for a promotional book celebrating the city's manufacturing and construction achievements in the run-up to the 1892-3 Columbian Exposition, is the fullest single account of the city's brick, terra cotta, and stone industries.

5 *Industrial Chicago*, p. 517. See, too, Gurcke, *Bricks and Brickmaking*, pp. 115-120 for a definitive overview of historical brick sizes in America.

6 'A Few Neglected Considerations with Regard to Brick Architecture', *The Brickbuilder*. 1 (January, 1892), pp. 3-5.

7 George Beaumont, 'Brickwork', *The Inland Architect and Builder*, 7 (May, 1886), p. 61.

8 "The first thing an ordinary Chicago contractor desires in preparing mortar, is rapidity, or rather cheapness, os he orders his mixer to place in the box a certain amount of lump lime, turns on the hose, and while his eye is cast over the busy groups of men at work on the building, he yells to this bespattered knight, 'screen that sand,' until sufficient water has run for slacking purposes. Very probably this gentleman is not acquainted with the chemical properties of the material he battles with, so lets the water run until through with what he is doingk, and then suddenly notices that the lime is completely submerged; nothing daunted, he seizes his hoe, stirs up the mixture into a paste very often no thicker than restaurant cream, and dashes into it an unknown quantity of loamy sand, the whole is then attacked by three or four pair of strong arms with shovels, and thrown on the ground ready for the hod carrier, who comes along and turns it over gently, filling his hod to the utmost capacity, and passes on to the scaffold where rests the mortar board ready to receive his load. Occasionally one sees a bricklayer who has the moral courage to ask that the mortar be better tempered, but he must be very careful or he is likely to get 'fired' for being too conscientious.
"What is the result of all this hurry? Ask the owner of a four-year old building, who has just paid

a considerable portion of its rental for labor and material in raking out the crumbling mortar joints and refilling them with a similar kind of mortar; if he does not know, permit me to enlighten him; it is because the mortar was made as I have just described, and if used in winter, the defect is only aggravated." George Beaumont, 'Brickwork', *The Inland Architect and Builder*. p. 62. Chicago had extensive deposits of limestone, which had proven disastrously incapable of weathering the region's freeze-thaw cycles but which provided cheap, easily mined lime for mortar.

9 George Beaumont, 'Brickwork', *The Inland Architect and Builder. p. 62.*

10 Donald Friedman, *Historical Building Construction*. (2nd ed., New York, 2010), pp. 25 provides a succinct overview of double-wythe construction and structural performance. Such walls should be distinguished from cavity walls, which employed a clear separation between wythes to provide a waterproofing break.

11 "The present system of bonding [brick] is done for convenience and cheapness; if it were repeated oftener the men could not do overhandwork so rapidly, and would have to back up the walls more frequently, thus preventing their standing on the inside face instead of on the scaffold, which is the proper place. On first coming to this city, I was amazed to see thick walls carried up with headers at every sixth course. Nothing less than a row of headers every third course should be allowed, and in first class work an alternate course of headers and stretchers only. This latter mode is called English bond, and is the strongest that can be used; being the most expensive it is, therefore, seldom adopted." George Beaumont, 'Brickwork', *The Inland Architect and Builder*. 62.

12 Bricklayers joined stonemasons to form Chicago's first trade union. See Gerald R. Larson, 'Fire, Earth, and Wind: Technical Sources of the Chicago Skyscraper. Part II', *Inland Architect*, January/February, 27 (Jan.-Feb., 1983), p. 31. Strikes by stonemasons and bricklayers in 1896 and 1899 were particularly effective, the latter tying up work on the new Postoffice for several months.

13 Joseph Siry has argued that the switch from labor-placed brick to manufacturer-installed terra cotta may have been in part due to architects and owners wanting to avoid the complications inherent in working with heavily unionized bricklayers and brickmakers. Joseph Siry, 'Adler and Sullivan's Guaranty Building in Buffalo', *The Journal of the Society of Architectural Historians* 55 (March, 1996), pp. 6-37.

14 George Beaumont, 'Brickwork', *The Inland Architect and Builder*. p. 62.

15 *Industrial Chicago*, p. 387.

16 Gurcke, *Bricks and Brickmaking*, pp. 84-85, notes that many early 19th century patents for brick-making machines reiterated processes or techniques that had been in place since the 17th century, and that popular opinion held that early machine made bricks were inferior to hand-made ones.

17 The following description is largely taken from S. K. Fletcher, 'Nomenclature in Brickmaking', *Building Age*, 13 (July, 1891), p. 169.

18 Gerald Larson, 'Fire, Earth, and Wind: Technical Sources of the Chicago Skyscraper. Part II', *Inland Architect*.

19 S. K. Fletcher, 'Nomenclature in Brickmaking', *Building Age*.

20 These systems were both referred to as "kilns" in regional literature (see, for instance, Purington, 'Brick Manufacture Near Chicago', *Transactions of the American Society of Civil Engineers*), though more specialized terms were used by experts to distinguish between permanent kilns into which green bricks were placed and "scove" or "field" kilns in which the structure was itself composed of green bricks. A further distinction was sometimes made between these and a "clamp," which also referred to the arrangement of bricks needed to ensure proper airflow. Gurcke, *Bricks and Brickmaking* pp. 29.

21 *Industrial Chicago*, pp. 386.

22 *Industrial Chicago*, pp. 372-3, 386-7. See, too, Cecil Elliott, *Technics and Architecture*, and Gurcke, *Bricks and Brickmaking* for overviews of developments in brick pressing and firing during the late 19th century in America.

23 D. V. Purington, 'Brick Manufacture Near Chicago', *Transactions of the American Society of Civil Engineers*, described eleven tunnels 94 feet long at the Purington-Kimbell brickyards outside of Chicago. By using mechanical exhaust and an efficient system of rail cars, these tunnels could dry up to 50,000 brick in 24 hours.

24 Gurcke, *Bricks and Brickmaking*, pp. 26.

25 Elliott, *Technics and Architecture*, p. 44.

26 Broeksmit and Sullivan note that both "re-pressed" and "dry-pressed" brick were referred to as simply "pressed brick" in American literature. Broeksmit and Anne T. Sullivan, 'Dry-Press Brick: A Nineteenth-Century Innovation in Building Technology', *APT Bulletin*, p. 46.

27 "What are the advantages of this [stiff clay process] over the hand- or mud-machine process?....The greatest excellence of the stiff-clay bricks is secured by the way in which it is forced through the forming die and in its being cut off at the end. The advantages of these bricks are: First, they are smoother and more uniform in size. The smoothness results from their being forced through a smoothly polished die. They are more uniform in size because, having but little water in them, they do not shrink as badly as soft-mud bricks do in drying. This smoothness and uniformity enable the mason to make a smoother and more perfect wall. Second, they are stronger in resisting a crushing strain, and are very much stronger in resisting the tendency to crack by the settling of the foundations of heavy buildings." *Industrial Chicago*, p. 388

28 *Industrial Chicago*, 391.

29 *Industrial Chicago*, 374-5

30 'Greatest of All in Building', *Chicago Daily Tribune* (Mar. 4, 1907), p. 20.

31 *Industrial Chicago*, p. 363.

32 George Beaumont, 'Brickwork', *The Inland Architect and Builder.* p. 61.

33 *Industrial Chicago*, p. 366.

34 "The writer can in no better way show what a revolution these machines [for working stiff clay] have worked in some parts of our country than by reciting the history of their advent and growth in the city of Chicago, where, up to ten years ago, we were plodding along contentedly, on temporary yards, doing our work with horses and mules, and employing a man for every thousand of bricks we made on the soft mud machines. Our yards were equal to our wants, for we were blissfully ignorant of any better way. In an evil hour our friends of the firm of Purington & Kimbell came to Philadelphia (just about ten years ago now) and imported a stiff-clay machine and erected it in Chicago. We called it a hurdy-gurdy, a sausage machine...but it went right ahead, attending to its business and making good bricks....One after another of us selected large sites for yards and quietly ordered stiff-clay machines...now in the city of Chicago a veritable revolution has occurred, and the vast majority of the five hundred millions of bricks made for that market is made by this once despised method." W. H. Alsip quoted in *Industrial Chicago*, pp. 387-88.

35 'Brick Manufacturers Combine', *Chicago Daily Tribune* (5 June 1890), 3; and *Industrial Chicago*, p. 378.

36 'The Chicago Brick and Lumber Market', *Engineering News and American Contract Journal*, (20 May 1882), pp. 162-3.

37 The reliably anti-union *Inland Architect* reported on the end of one of the 1882-1884 strikes in characteristic fashion: "The strike of the bricklayers' union is at the present writing in active operation, with little hope of immediate change. A more ill-advised strike than this it is impossible to conceive, coming as it does before the building season has fairly opened, and at a time when at the best capitalists are hesitating about investing, and on the heels of a season of depression in business circles. So much for the advisability of the strike. It is its purposes that are of the more vital importance. Always a turbulent class, the bricklayers of Chicago have massed themselves, and feeling they have power, endeavor to completely subjugate the contractor, and through him the owner, to the wishes of their union. They make the rate of wages; they state the number of men and

of apprentices each contractor may employ; and, in fact, to all intents and purposes, the bricklayers' union fully controls a building until the last brick is laid....If the union had, instead of saying that every man, no matter how inferior his capabilities as a mechanic might be, should receive four dollars a day, made an equitable scale of prices, a strike would have been avoided. But instead, the ignorant heads that run the union...have prevented those who have families to support and are willing to work from earning their daily bread, and have allowed several weeks of the best of building weather to go by, spending the time in useless dispute and attempts to perpetrate a wrong. Fortunately, the city is filling with non-union masons from the surrounding cities and from Canada...." Editorial, *The Inland Architect and Builder*, 1 (April, 1883), p. 32.

38 'Petroleum Fuel', *Chicago Daily Tribune* (15 May 1890), p. 3. See also *Industrial Chicago*, pp. 393-4.

39 Eventually any brick made by either extrusion or hydraulic pressing was known as 'pressed brick.' See William Roberts, quoted in *Industrial Chicago*, pp. 375-376.

40 'Hydraulic Pressed Brick', *The Inland Architect and Builder*, 1 (July, 1883), p. 85.

41 "Pressed brick has become the prevailing material for facing all classes of structures, and from one firm the business has extended until six or eight firms are supplying pressed brick from as many different localities, ranging form St. Louis, Mo., to Zanesville, O., and a considerable market for Philadelphia and Trenton brick is found. IN this line the prices have ranged high, thirty-five dollars being the prices for two of the best brands and it is noticeable that the Chicago agent for the manufacturers of one of these, the ST. Louis Hydraulic Pressed Brick Company, has dropped the price of their best brand to twenty-seven dollars. This is the most noticeable change that has occurred in the past month, and shows that the demand for low prices is going to rule even among the best and most sought for materials." 'Synopsis of Building News', *The Inland Architect and Builder*, 5 (Feb., 1885), p. 14.

42 "The contract for 400,000 of this company's special Brown Obsidian pressed brick for the office building for the Central Safety Deposit Company, illustrated in this number, calls for some special mention in regard to pressed brick work in general, and the product of this company in particular. When the Chicago Anderson pressed brick company first commenced the production of pressed brick, very little of this material was known to Chicago, but the fronts of a few fine residences attracted attention to pressed brick as an elegant and substantial substitute for stone and common brick. The building of the Calumet Club building from Chicago Anderson brick, marking the commencement of a period of pressed brick building, which, from a fashion, grew into a permanent style. If this transition from stone to brick building had depended upon the regular pressed brick alone, the ornamental quality of stone would have again brought that material into popular favor, but the special designs in molded brick exhibited in the Calumet Club building demonstrated that there was a much more beautiful and tractable material which would lend itself to an infinite variety of architectural styles with but little additional cost to the builder. Then followed a general adoption of these bricks, not only in Chicago, but throughout the West—the immense works of the Chicago Anderson Company being taxed to their utmost to supply brick that, beautiful in color, firm in texture, for geometrical accuracy and equality of shade, have never been equaled, while the molded brick produced presented such a variety in design that the public soon spoke of this company as the representatives of the pressed brick in the West." 'Chicago Anderson Pressed Brick', *The Inland Architect and Builder*, 7 (June, 1886), p. 84.

43 'Trade Notes', *The Brickbuilder*, 3 (March, 1893), p. 48.

44 *Industrial Chicago*, p. 372.