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# Chicago's Other Skyscrapers: Grain Elevators and the City, 1838-1957.

> "The designing and construction of grain storage buildings, commonly known as 'elevators,' is now undergoing a change as radical as that which created the modern 'sky-scraper' a few years ago, and for precisely the same reason, that something more durable and efficient is desired."
>
> --Jas. MacDonald, MWSE. "Fireproof Grain Elevator Construction."
> *Journal of the Western Society of Engineers*, Vol. VII, No. 1. January, 1902. 36.

## Introduction

The 1882 Montauk Block was heralded as the beginning of Chicago's skyscraper age but, at 130 feet, it was just the eighth tallest building in the city at the time.[1] (Figure 01) While Dearborn, La Salle, and Michigan Avenue would become the city's "skyscraper districts" over the next century, in the 1880s the Chicago River was the city's true high-rise canyon. Grain elevators that buffered the flow of agricultural wealth from the west into eastbound lake and rail systems, and that rose to more than 140 feet, were the city's tallest buildings through the 1880s. *Inland Architect* stated in 1896 that "the first 'sky-scraper' was a grain elevator," the *Chicago Tribune* noted in 1895 that the city's elevators still 'rival[ed] many of the down-town skyscrapers in height,' and two years later it listed the city's "Great Grain Elevators" alongside high-rises as "the Seven Wonders of the City."[2] They mapped the city's changing infrastructure and the region's changing economic geography, represented evolving practices in building and mechanical engineering, and their concentration and leveraging of the Midwest's agricultural wealth meant that they played a crucial role in the evolution of commodities markets in the city and throughout the world. Chicago's grain elevators—the city's *other* skyscrapers—illustrate as explicitly as its commercial towers the financial, technical, and geographical forces that nourished, buffeted, and sculpted the city.

Figure 01. Chicago's other skyscraper district—the south branch of the Chicago River, ca. 1900, showing the Iowa (left) and Rock Island "A" and "B" at 12th Street and the River. (Library of Congress.)

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As mechanisms for storing, transferring, and exchanging the wealth of roughly one million square miles of agricultural hinterland, these structures have played roles in key studies of Chicago's growth and influence. William Cronon dedicated an entire chapter to these structures' relationship to the Midwest grain trade and the growth of Chicago's speculative market in his 1991 book *Nature's Metropolis*, extending earlier studies by Guy A. Lee in the 1930s. Elevators' relationship to the Chicago River and its evolving importance—and eventual obsolescence—in the city's trade has been noted by Joshua A.T. Salzmann, whose 2018 history of Chicago's waterfront, *Liquid Capital*, expanded Cronon's analysis to show how these structures were used by operators to leverage 'private riverfront property—and information' to skew grain markets to their own fiscal ends.[3] Carl Abbott's work showed how elevators' relationship to the River also influenced the location of rail facilities in Chicago, developing in tandem with the lumber industry a great linear harbor "at the outlet of commerce and adjacent to the center of the business part of Chicago."[4] Elsewhere, Abbott documented elevators' contributions to Chicago's growing sense of civic pride in its early years, making it "The Greatest Primary Grain Port in the World" and thus competitive with global cities such as Odessa, Danzig, and New York. Elevators' contribution to the city's capacity was widely touted by civic boosters, who saw these structures as "advertisements" for the city, visible to arriving ships before any of Chicago's other landmarks. The city's official seal, adopted in 1854, featured a sheaf of grain and a sailing ship, paying tribute to the trade that, as much as any other, transformed Chicago from a frontier town into an economic juggernaut.[5] Histories of the River itself have generally noted elevator construction and operation in passing; Libby Hill's *The Chicago River: A Natural and Unnatural History* documents the waterway's extensive reconfiguration and industrialization, much of which supported the grain trade, and David Solzman's geographically-arranged *The Chicago River: An Illustrated History and Guide to the River and its Waterways* notes the locations of key structures, extant and demolished, along the River's banks.[6] The impact of these alterations and the industrial use of the River in general is documented in Harold Platt's *Shock City*, in which he details the grain trade's interdependence with fuel shipments to the city and the role of railroads, in particular the Illinois Central, in building elevators as part of their infrastructural arsenal of structures and facilities that established their economic defenses against market swings—and competitors—at the overall expense of the River's health and the city's well-being.[7] Elevators themselves have rarely been studied as architectural artifacts, however; while Buffalo's tightly grouped concrete structures have attracted occasional interest for their compelling visual and spatial effects, Chicago's elevators have passed almost entirely unnoticed by architectural historians.[8] Yet an accounting of the city's historic grain handling structures evidence advances in mechanical and structural engineering; their construction and operation chart the city's development and evolution in conjunction with the exploitation of its Midwestern hinterland; and they illustrate key events and developments in the city's tumultuous economic, political, and social history.

## Technology

While not unique to Chicago, the grain elevator was well-suited to the city's status as a place of exchange during the nineteenth and twentieth centuries. Pairing vertical bins with mechanical handling equipment revolutionized

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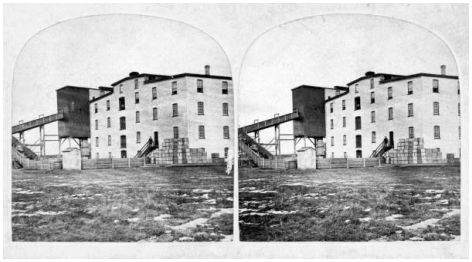
the grain trade, enabling Chicago to store and transfer enormous quantities of wheat, corn, and other agricultural produce. Elevators created their own financial gravity, attracting entrepreneurs who built ever larger and more efficient structures, as well as speculators who recognized the profits that lay within their vast capacity to leverage prices and manipulate markets.[9] Commercial skyscrapers relied on efficiently planned structures, openings for daylight and outside air, and circulatory systems that allowed access to offices and rapid escape in a fire. Grain elevators required only vast volumes and devices to move and sort grain. Their simple formula, however, also brought technical problems related to skyscrapers: how to support a full grain bin's extraordinary weight on Chicago's poor soil, for instance, or how to prevent fire in the flammable grain they stored.

Chicago's agricultural market began with simple, direct exchange. Farmers brought grain to riverfront warehouses in sacks, which were purchased at warehouses or docks and shipped to points east. As William Cronon has pointed out, sacks were labor-intensive and brought risks to sellers. Stacking grain sacks in boats or warehouses relied on "Irish power," and selling them depended on finding a buyer who had available space and labor, as well as immediate prospect of shipment. Warehousing eased these risks, but required additional labor, since grain had to be moved into or out of storage during each transaction.[10] The first storage structure in Chicago to eliminate the need for sacks by relying on gravity to pour free grain into lake boats was built in 1838 by meat-packing entrepreneur George W. Dole and Detroit merchant Oliver Newberry.[11] (Figure 02) Their warehouse, on the River's north bank at Rush Street, still relied on human power to lift sacks to an upper floor with blocks and tackles.[12] From there, sacks were emptied into chutes that delivered grain to eastbound lake ships using the momentum developed by the grain's fall from the upper floors to spread grain throughout ships' holds.[13] John van Osdel, who had worked on the Illinois and Michigan Canal project, engineered this system, the first of several that he worked on. Van Osdel would apply the technical experience gained on elevators to the city's early tall office buildings, including the eight-story Real Estate Exchange Building, the city's tallest commercial block upon its completion in 1873.

Figure 02. Early Grain Warehouse (possibly Newberry and Dole, 1838) with inclined belt for elevating grain.

The Miriam and Ira D. Wallach Division of Art, Prints and Photographs: Photography Collection, The New York Public Library. "Grain elevator, Chicago, Ill." New York Public Library Digital Collections. Accessed July 19, 2019. http://digitalcollections.nypl.org/items/510d47e0-5c8e-a3d9-e040-e00a18064a99



Warehousers sought a more efficient system than this "primitive…ancient" reliance on human labor. In 1842, Buffalo grain merchant Joseph Dart attached metal scoops to a looping rubber belt that were, in turn, connected to horse-powered rotating shafts. By containing this mechanism in an articulated, enclosed arm, Dart could maneuver it into lake boats, lifting grain from ships or wagons to the top of an adjacent storage bin. Dart's process was rapid, clean, and efficient. His "mechanical leg" was adopted in Buffalo and soon took hold in Chicago.

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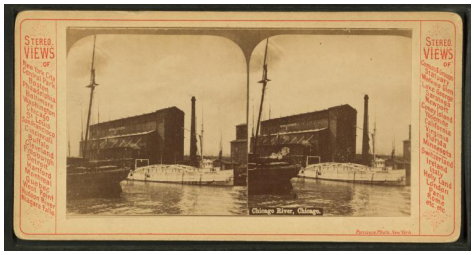
Throughout the 1840s, a horse powering such a leg from the top floor of James Peck's warehouse on the River's south bank was one of the city's "most familiar sights."[14] In 1848, ship captain R. C. Bristol built a grain warehouse on the River's east bank that replaced horse power with steam engines.[15] With a capacity of 100,000 bushels, it was twice as large as the half-dozen other, human-powered warehouses that lined the River's banks by then—and far more efficient.[16]

Van Osdel was just one of Chicago's skyscraper builders to gain early experience with grain warehousers. Edward Burling and Otis Wheelock, two important post-fire builders, began their careers with elevators during the 1850s and fireproofing entrepreneur George H. Johnson designed elevators as part of his broad contracting practice. Some constructors focused exclusively on grain storage, however. New Hampshire native Joseph T. Moulton emigrated to Chicago in 1853, gaining experience in elevator operation and construction by taking work as a laborer in one of the city's riverfront structures. After opening a contracting business with engineer Alexander Miller—who had assisted Van Osdel with the Newberry and Dole elevator—Moulton revolutionized grain elevator construction and design by standardizing construction and incorporating new conveying innovations to provide more efficient operation.[17]

Figure 03. Sturges and Buckingham Elevator "A." Joseph T. Moulton, 1855. The Miriam and Ira D. Wallach Division of Art, Prints and Photographs: Photography Collection, The New York Public Library. "Elevator A. C.M. & St. P.R.R." *The New York Public Library Digital Collections*. 1850 - 1930. http://digitalcollections.nypl.org/items/510d47e1-c0bc-a3d9-e040-e00a18064a99



Moulton's debut as an elevator builder was the massive, 800,000 bushel structure built for banker Solomon Sturges and the Buckingham family, merchants from Ohio in 1855.[18] (Figure 03) With a key location adjacent to the Illinois Central railyards and the River's mouth, Moulton's structure nearly doubled the city's storage capacity. Within two years Moulton built a second structure, fifty percent larger, on an adjacent site.[19] At 130' tall, Sturges and Buckingham's so-called "A' and "B" elevators represented the state of the art in elevator construction. (Figure 04) Grain was shoveled from Illinois Central cars into hoppers next to and below the tracks. From there, conveyer belts fitted with metal scoops carried it to a narrow cupola at the structure's peak, where they discharged grain into two stacked boxes. The first, a "garner," held a thousand bushels. When full, it discharged into a hopper below that weighed the batch and allowed a grader to take a sample for inspection. Depending on the quality, graders could then direct the incoming shipment tw a specific bin below by a rotating chute, ensuring that each bin would contain grain of equal quality.[20] The elevators could then discharge weighed, graded grain into ships through chutes on the wharf side. The Illinois Central elevators symbolized the technical prowess of Chicago's grain market and, visible for miles from the Lake and standing at the mouth of the River, they came to signify the city itself to passengers arriving by ship and beyond. When the future King Edward VII of Great Britain

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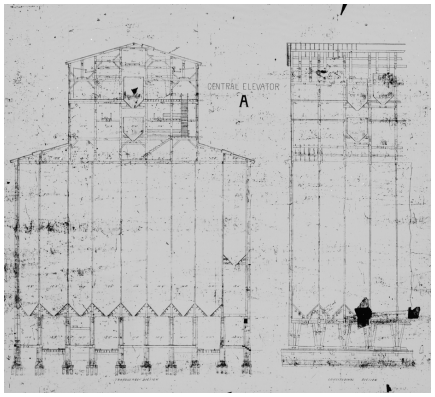
visited Chicago in 1860 he stopped at Elevator "A" and watched, awe-struck, as full trains emptied their grain.[21] Anthony Trollope, on his North American tour in 1861, was also impressed—and horrified—by Sturges and Buckingham's operation:

> "An elevator is as ugly a monster as has been yet produced. In uncouthness of form it outdoes those obsolete old brutes who used to roam about the semi-aqueous world, and live a most uncomfortable life with their great hungering stomachs and huge unsatisfied maws. The elevator itself consists of a big movable trunk—movable as is that of an elephant, but not pliable, and less graceful even than an elephant's. This is attached to a huge granary or barn, but in order to give altitude within the barn for the necessary moving up and down of this trunk—seeing that it cannot be curled gracefully to its purposes as the elephant's is curled—there is an awkward box erected on the roof of the barn, giving some twenty feet of additional height, up into which the elevator can be thrust…the elevator is an amphibious institution, and flourishes only on the banks of navigable waters."[22]

Figure 04. Reconstructed Sturges and Buckingham/Illinois Central Railroad, Grain Elevator "A", South Water Street, Chicago, IL. George A. Moulton & Co., 1872. Sections. Library of Congress Prints and Photographs Division, Call No. HAER ILL,16-CHIG,99B—1. https://cdn.loc.gov/master/pnp/habshaer/il/il0300/il0379/photos/061697pu.tif




Moulton's elevators for Sturges and Buckingham pioneered innovations that set standards for the next fifty years. Steam power ran shafts, pulleys, and belts that filled elevator's cupolas with motion and sound.[23] Belt conveyors were shaped into vees that prevented spillage or into slopes that discharged into bins. Self-contained mechanical legs limited spillage, while belt tightening systems assured constant speed and operation.[24] Grain could be switched into circuits that cleaned, dried, or sifted it if a grader determined that it was inferior quality, while powered shovels, attached to chain drives, reduced the time it took to empty a rail car. Systems that accepted grain from hoppers underneath these cars, or that tilted full cars to discharge their contents to one side sped this process further.[25] These advances largely automated receiving, handling, and storing grain—critical, given Chicago's perpetual labor shortage and the trade's seasonal nature. Loading a 40,000 bushel lake boat took a dozen laborers an entire day in the 1840s; in Moulton's elevators one worker could move this much grain out of rail cars in an hour, and by the 1880s a typical elevator with more powerful steam engines and more sophisticated handling equipment would quadruple this.[26]

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Bins were at the heart of Moulton's system; they formed the bulk of an elevator's structure and bore the tremendous weight of thousands of bushels. They had to be designed for the grain's dead weight and the bursting stresses caused by its fluid pressure. Experiments established that bin walls carried most of a tall grain column's weight through friction, while a bin's floor carried only a shallow pyramid of grain above it.[27] Brick or stone walls could not develop the strength in tension necessary to contain tall columns of grain. Instead Moulton relied on "crib construction," which became the standard in Chicago. Two-inch thick timber planks, ranging in width from four to eight inches, were nailed and spiked together horizontally, with wider planks at the bin's base and narrower ones at its top. These provided increasing strength toward a bins' base, where the outward pressure of grain was greatest, aided by iron tie rods running across or around each bin.[28] (Figure 05) Crib construction was resource-intensive. Such "somber piles of joining" were only economical while lumber flowed through Chicago's in vast quantities. As late as 1902, though, wood remained "the cheapest and most available material in America" and it formed all of Chicago's large nineteenth century elevators.[29] Grain bins' extraordinary loads had to be supported on waterlogged sites adjacent to the River, leading elevator builders to use friction piles, large timbers pounded into the soil until the surrounding mud's pressure provided enough resistance to arrest the pile's movement. Once enough piles had been driven to satisfy an engineer's estimate of the loads above, they would be capped with a large granite or concrete block, atop which the timber bins could be built.[30] This arrangement proved even more effective than the pyramidal and grillage systems developed for Chicago's skyscrapers; engineer Dankmar Adler and builder Henry Ericsson recalled late in their careers that the architectural profession had ignored such a robust foundation system for tall buildings on the city's poor soil just blocks away from their own construction sites.[31] Elevators, Adler noted, bore loads that were not only far higher than those of the city's commercial skyscrapers, they were also constantly shifting, putting unpredictable, dynamic loads onto the unreliable soil below. Yet their pile foundations were "practically incompressible," their structures "sound" and "absolutely reliable."

Figure 05. Demolition of Sturges and Buckingham/Illinois Central Railroad, Grain Elevator "A", South Water Street, Chicago, IL. 1942, showing laid-timber construction of bins. Library of Congress Prints and Photographs Division, Call No. HAER ILL,16-CHIG,99B—6.
https://www.loc.gov/pictures/item/il0379.photos.061702p/

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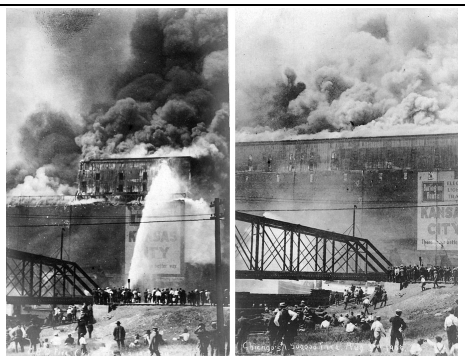
| Figure 06. City Elevator, (South Branch and 12th Place, 1862). Fire on 15 June, 1908. *Chicago Examiner*, 16 June, 1908. 1. |  |

Storing flammable grain in desiccated wooden structures above these sturdy foundations led to conflagrations in Chicago and throughout the country, however. "Once ignited," the four to five million board feet of lumber in an elevator "seldom [left] any salvage."[32] (Figure 06) Elevators in Chicago enjoyed a surprising exception to the city's 1874 fire codes, which banned timber construction in the central city. Influential elevator owners lobbied for a loophole that allowed them to use wood construction provided that their elevators were "externally protected by an envelope of incombustible material."[33] Such external protection did nothing to prevent fires from beginning *inside* elevator structures, of course, where friction from machinery or sparks from passing locomotives could ignite the "strange and mysterious dust forever collecting, growing, feathering on the inside walls, the beams, and rafters, the entire interior structure and mechanism."[34] Chicago was relatively lucky, losing only a few elevators to fire through 1900. But grain dust's explosive nature and an inventory of aging timber structures worried neighbors and angered commercial skyscraper owners, who saw a double standard at work. "It is a shame," wrote one anonymous citizen in 1881, for elevator operators "to ask any such concession, and still a greater shame that men can be found who were elected to protect the interests of the community who will unblushingly ask to have the fire ordinance set aside in such a case as this."[35] Nonetheless, later that year the City Council passed a revised code that allowed only grain elevators and churches to exceed 90' height limits for timber construction in the city's fire district.

By the century's end even the Moulton Company recognized that the timber elevator was an avoidable fire hazard. "The grain elevator of to-day is in a transition period, rapidly passing from a structure constructed entirely of wood to one constructed entirely of steel and other non-combustible materials" read the introduction to their 1902 catalogue.[36] Timber's economics changed as well. Jason Macdonald, another Chicago elevator engineer, noted in the same year that "timber has advanced much in price, and other available materials such as steel and masonry…have been reduced."[37] Steel had been used for elevators since 1866, when the Grand Point Storage Company erected an 88-bin structure on Washington Avenue in Philadelphia, and it was used throughout the 1890s to support cupolas and working houses in Chicago elevators.[38] With a growing native steel industry that took advantage of its position between iron ore in Minnesota and coal in southern Illinois, Chicago rivaled Pittsburgh in steel production. Its downtown skyscrapers were the country's greatest laboratory for steel construction. Elevator builders were, however, more reluctant than their architectural counterparts to adopt the

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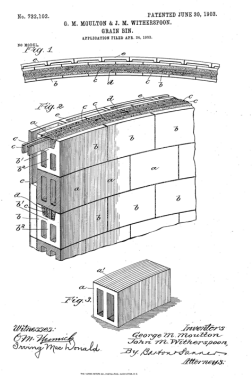
material for grain storage. Owners worried that thin plates of thermally conductive steel would lead to rot-inducing condensation in winter and to dehydrating heat in summer.[39] Brick or hollow clay tile, on the other hand, provided better insulation than steel and required less skilled fabrication, relying more on available local labor. Several companies patented curved, grooved tile shapes that could form monolithic cylinders with integral circular steel reinforcing hoops that proved "exceedingly effective and durable."[40] Minneapolis-based Barnett-Record was a leader in tile bin construction, but George Moulton, heir to his father's elevator construction business, joined with Chicago builder John Witherspoon to patent cylindrical steel-reinforced tile bins in 1903.[41] (Figure 07)

Figure 07. George Moulton and J. M. Witherspoon, U.S. Patent #732,102, "Grain Bin." Issued June 30, 1902.



Neither steel nor reinforced tile proved as well-matched to elevator construction, however, as monolithic, fireproof construction in reinforced concrete. F.H. Peavy built the first concrete test silo in Minneapolis in 1897 followed by million-bushel elevators of reinforced concrete cylinders in West Superior, WI and Duluth, MN.[42] In 1899, E.L. Heidenreich constructed four 53' tall cement storage silos in Chicago for the Illinois Steel Co., and John S. Metcalf designed and built four smaller bins for the Evans Milling Co. in Indianapolis.[43] By 1913, concrete elevators had been built in Buffalo, Minneapolis, Milwaukee, Nashville, and Baltimore and concrete had "almost entirely displaced not only wood, but [also] steel and tile."[44] Concrete had seen slower adoption in commercial skyscraper construction. The 1904 Winton Building by James Gamble Rogers was the first major concrete structure in the Loop, completed just after the pioneering Ingalls Building in Cincinnati (1902-1903).

Steel remained Chicago's preferred material for commercial high rises downtown, but concrete proved itself on the basis of fire and vermin resistance. This performance came with additional construction costs, though, since the formwork for cylindrical silos required skilled carpentry and regional timber prices began rising after 1900. Disarming such formwork and relocating it to pour a fresh layer also took time and labor. But these initial costs were offset by lower maintenance, and better insurance rates.[45] Seeking ways to trim labor and material from their construction, Metcalf recognized that, provided a circular bin remained consistent throughout their heights, short forms could be raised as a bin was poured, allowing a single continuous, slow pour for its entire height. Moving forms, supported on bars cast into the bin walls and lined with galvanized steel to assure a smooth finish, could be jacked up six to twelve inches every few hours, allowing concrete time to cure to a workable strength as

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the forms were raised. Short forms reduced the lumber and skilled carpentry required, while jacking eliminated the time and labor needed to disarm and replace large stationary formwork. Metcalf and his office patented techniques for moving formwork in 1904 and 1905, and concrete costs fell to 10 to 25 per cent below steel by 1911.[46] (Figure 08) "Quite as simple as it is ingenious," according to *Scientific American*, Metcalf's moving forms presaged slip-formed concrete skyscraper cores in the postwar era, where they again enabled greater height and more rapid construction.[47]

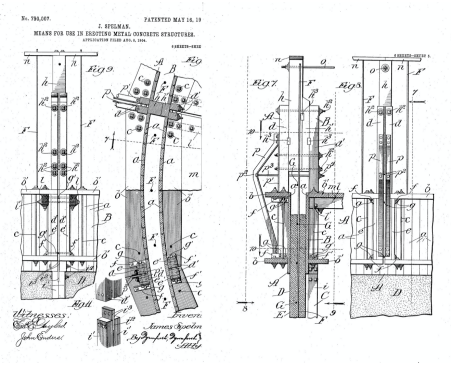

Figure 08. James Spelman, John S. Metcalf Company. U.S. Patent #790,007, "Means for Use in Erecting Metal Concrete Structures." Issued 16 May, 1905.

Figure 09. John S. Metcalf, Elevator for the Santa Fe Railroad, South Branch of the Chicago River at Damen Ave., 1906. Wooden working house (front) and concrete bins (rear). Detroit Publishing Co., Copyright Claimant, and Publisher Detroit Publishing Co. https://www.loc.gov/item/2016815634/.

Metcalf built his first large concrete elevator in Chicago in 1906. The Santa Fe, on the Chicago River at Damen Avenue, consisted of thirty-five reinforced concrete bins, each twenty-three feet in diameter and eighty feet high.[48] (Figure 09) These replaced a timber structure that burned in September, 1905. Metcalf proposed his slip-form method as the fastest way to complete the new elevator in time for the 1906 season. Santa Fe considered steel, but an overheated real estate market that year meant that supplies were limited. Metcalf was commissioned to build the bins in concrete, but—crucially—the Railroad decided to build the workhouse with timber framing, using steel only for its bin's bases and for its fireproof cladding. Throughout, Metcalf employed the latest in fireproofing, including fusible links in the conveying mechanisms that triggered fire doors if drying grain became too hot, and direct hose links to the adjacent River to allow fireboats quick connection if necessary.[49] It was not, by far, the largest elevator in the city, but it served as a large-scale evidence of the new material's cost-effectiveness using slip-forms; the Santa Fe's bins cost just twenty cents per bushel of holding capacity, while the timber-framed workhouse had cost over a dollar per bushel. (Figure 10)

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Figure 10. John S. Metcalf, Elevator for the Santa Fe Railroad, South Branch of the Chicago River at Damen Ave., 1906. Details of concrete construction, from Milo S. Ketchum, C.E., *The Design of Walls, Bins and Grain Elevators.* (2d ed., New York: Engineering News Publishing Company, 1911). 424.

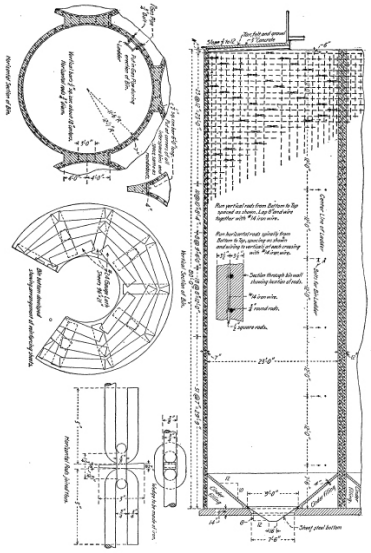
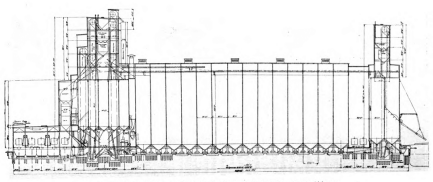


Figure 11. John S. Metcalf and J.M. Witherspoon, Chicago and Northwestern Railway Elevator, Calumet River at 122nd St. 1917. From W. H. Finley, M.W.S.E. "Chicago & Northwestern Railway Co. Terminal Grain Elevator." *Journal of the Society of Western Engineers*, Vol. XXIV, no. 5. May, 1919. 310.



The Chicago and Northwestern elevator, built by Metcalf alongside the Calumet river in 1917, was the ultimate proof of concrete's potential. At 10,000,000 bushels it was by far the "largest single unit grain elevator in the world."[50] (Figure 11) Metcalf's patent partner, J. M. Witherspoon, served as contractor for the structure, which stood along a 1200-foot long wharf on the Calumet River at 122nd Street. A riverside working house composed of twenty-four reinforced concrete bins, each 95 feet tall and topped by a steel-framed cupola that rose another 45 feet, served ships at the wharf. An adjacent complex of 104 concrete bins provided longer term storage next to a covered train yard that accommodated 1250 railroad cars. (Figure 12) Grain moved through the complex on ten miles of conveying belts while boilers produced twenty tons of steam daily to dry incoming grain, monitored by electric thermometers wired to a central control station.[51] The site's riverfront location required more than 18,000 friction piles, while a dedicated on-site plant turned out 1200 cubic yards of concrete per hour to feed climbing formwork. Rotating cement chutes that swiveled to deliver concrete from a tower 100 feet above the construction site. Working twenty hours a day, two shifts of workers built the 104 main bins in just 17 days.[52] The Chicago and Northwestern elevator was the largest built in the Calumet district between the wars. Other grain companies, though, including Norris, Continental, and Rosenbaum, took advantage of the developing port and wharf facilities there, each building one- to two-million bushel elevators in along the Calumet River in the 1930s.

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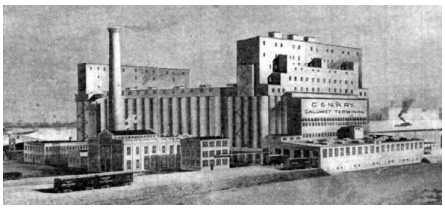

Figure 12. John S. Metcalf and J.M. Witherspoon, Chicago and Northwestern Railway Elevator, Calumet River at 122nd St. 1917. From W. H. Finley, M.W.S.E. "Chicago & Northwestern Railway Co. Terminal Grain Elevator." *Journal of the Society of Western Engineers*, Vol. XXIV, no. 5. May, 1919. 309.

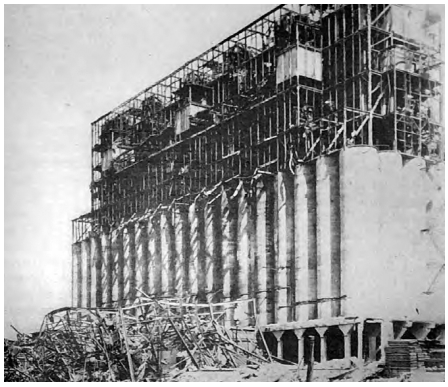

Figure 13. Photograph of the Chicago and Northwestern in the aftermath of the March, 1921 explosion, showing comparative damage to steel track shed (foreground) and concrete grain bins (background). David J. Price, "The Northwestern Elevator Explosion," *Journal of the Society of Western Engineers,* Vol. XXVI, no. 12. Dec., 1921. 408.

Even concrete elevators were not immune to fire, however. In March, 1921, grain dust in the Chicago and Northwestern elevator ignited during a night cleaning shift. The resulting blast was the "most violent explosion of dust that…ever occurred," shattering windows five miles away and felt in Benton Harbor, across Lake Michigan.[53] All six workers cleaning the elevator were killed. Sixteen bins were damaged, but the remaining bins, while shifted off their foundations, survived intact and were repaired and rebuilt. Steel structures that housed conveying equipment and sheltered the train yard, on the other hand, were wrecked and "nearly pushed into the river." (Figure 13) While the explosion led to new recommendations for dust control, bin venting, and lightweight walls that would disperse blast forces, the C&NW explosion was proof of concrete's relative durability compared to timber or steel.[54] Further evidence for its robust fire performance came when the Santa Fe' wooden workhouse burned in 1932. Again, adjacent concrete bins survived, and Metcalf's firm rebuilt the wrecked tower and cupola in concrete.

Elevators' technical development through the twentieth century was incremental rather than revolutionary. A shift in motive power from steam to electricity allowed for cleaner, more efficient and reliable operation, but the most significant improvements after the 1930s were in automation, monitoring, and controls. By the 1950s an elevator required as few as 25 workers to operate.[55] Elevator design, construction, and operation paralleled Chicago's skyscrapers, which adopted concrete in the 1950s and 1960s alongside steel, employed electric and electronic means of control and monitoring that sped workers and residents through their circulatory systems, and adjusted interior environments mechanically to suit their comfort. While architectural technologies such as tube framing and high-strength concrete led to taller commercial and residential structures, the economics of grain storage meant that elevators' physical forms changed little after WWI. They lacked the impetus toward greater height or more efficient structural planning that concentrated real estate markets offered to skyscrapers.

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## Grain Elevators and Chicago's Urban Geography

Like skyscrapers, grain elevators marked key sites in Chicago's geographic evolution. Skyscrapers' locations and heights evidenced explosive rises in land prices, tracking fluctuating demands for space in the Loop. Grain elevators tracked similar urban developments, but they also traced the relationship between Chicago and its broad hinterland. Tied to intersections of rail and shipping lines, elevator construction was based on more than simple land prices. Elevators' siting demonstrated the diffusion of railway and waterway infrastructure from the historic center along the River's main branch to new facilities farther south on the River and the Lake. This reflected the Loop's transformation from a mix of uses to a fully commercial district during the City Beautiful movement, the changing importance of river, canal, lake, and rail transport, and the rise and fall of Chicago's grain operations through the 19th and 20th centuries. Once romanticized as "advertisements" for the city, Chicago's timber elevators came to be seen as obsolete, fire-prone eyesores, while newer concrete structures, located farther from the city's center, were never romanticized as symbols of either the city's technical or economic prowess.

Chicago's first grain shipment—seventy-eight bushels—left by lake boat in 1838, taking advantage improvements made to the harbor at the Chicago River's mouth in 1836 and access to New York and other eastern markets offered by the Erie Canal, which opened in 1821.[56] The city's road network was planked by 1850, making transportation from surrounding farms easier, and Cyrus McCormick began manufacturing his revolutionary reapers from a factory on the north bank that same year, revolutionizing agriculture throughout the Midwest that brought larger crops to the city. The Illinois and Michigan Canal was completed in 1848, bringing grain from western Illinois and expanding the city's economic reach, but it was just the first step in Chicago's ascension beyond its regional grain handling rivals. Until 1848, Chicago had been just one of several Lake Michigan ports that sent grain eastward, each drawing from a hinterland with a fifty-mile radius.[57] Racine, Milwaukee, Port Washington, Sheboygan, and Green Bay all equaled Chicago's grain sales; Kenosha, Wisconsin was the leading grain port on Lake Michigan through the 1840s.[58] Even with the Canal completed, Chicago was at a disadvantage, as Green Bay was more than 200 miles closer to terminal markets at Buffalo. As late as 1850, more grain from the Midwest funneled south, through St. Louis and New Orleans on the Mississippi River, than east via the Great Lakes.[59]

Grain exchange was transformed by railroads over the next decade, however. Chicago's position at Lake Michigan's southern end meant that it was the first city on the west shore to be reached by rail, when The New York Central System arrived in 1852. Railroads soon percolated westward from the city, through the Midwest and Great Plains, bringing corn, wheat, barley, and rye to Chicago's terminals that had to be transferred to east-bound lake boats or railroads. "Everybody has a map of North America," wrote Trollope, reflecting on Chicago's unique location at the inflection point of two trading networks.

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> "A reference to such a map will show the peculiar position of Chicago. It is at the south or head of Lake Michigan, and to it converge railways from Wisconsin, Iowa, Illinois, and Indiana. At Chicago is found the nearest water carriage which can be obtained for the produce of a large portion of these states."[60]

The Chicago and Galena Union Railroad reached west to Elgin in 1850, the Rock Island and Burlington Railroads were the first to extend all the way to the Mississippi, in 1854 and 1856, and the Illinois Central reached Centralia, 270 miles south of Chicago, in 1856. As the nexus between "the markets of this and the Old World," and the hub for railroads that "extend out…like the rays of the sun," Chicago soon surpassed rival port cities to become the Midwest's premiere grain market.[61] The busiest points of this exchange lay along the River on North Water Street, where the Chicago and Galena and the Chicago and Northwestern rail yards ran alongside the main branch. Burling and Miller built a 100,000 bushel elevator here for Scottish *émigré* George Armour and his railroad partners that served as a prototype for rail-to-lake transfer in 1855. (Figure 14) Armour had been a contractor for the Chicago, Burlington, and Quincy Railroad, and with mill owner Wesley Munger he began developing elevators designed specifically to serve the new lines delivering grain from an ever increasing territory. Munger and Armour built adjacent to the C, B, and Q's railyards on the River's main branch and around the more spacious yards at 12th Street and the river, making them the leading elevator developers in the city. They used this wealth to purchase rival's structures during the 1850s before splitting. Armour joined forces with his former rival, George Dole, to form Armour, Dole, & Co, a citywide grain empire that would eventually claim 10,000,000 bushels of storage.[62]

Figure 14. Chicago River scene, ca. 1860 showing Munn & Scott Elevator (1858, left), Munger and Armour Elevator (Burling and Miller, 1855, center), and Neely and Lawrence Elevator (ca. 1848). Library of Congress.

The whole city's elevator capacity was just 1,000,000 bushels in 1854. Construction and expansion could not keep up with the new railroads, and Chicago was soon "bursting with its own produce and smothered in its own fruits."[63] Grain piled up in streets, and other local builders and merchants began to follow Armour's lead, forming business alliances with railroads to construct new warehouses wherever rails intersected the River. Unlike the barges that unloaded thousands of bushels at a time in St. Louis or Buffalo, the 'small but numerous' rail cars of three to four hundred bushel capacity that streamed into Chicago demanded rapid handling so that they could be quickly returned to service. "Every railroad entering the city found elevators, with one side fronting navigable water, the other adjoining their tracks, as necessary a part of their system as the rails, engines, or cars," according

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to city historian Alfred Andreas. "Working efficiency was of no less importance than storage capacity."[64] Such an arrangement was impossible in St. Louis, where the Mississippi River's broad, shallow expanse meant that boats had to be docked on a sloping levee, well out of flood range but remote from warehouses farther inland,.[65] The Chicago River's "absence of current and even stage of water" made it ideal for close-quartered handling, while the surrounding "wide prairie" offered "ample yard-room for cars," avoiding St. Louis' congested urban center.[66] Chicago doubled its elevator capacity between 1854 and the end of the Civil War. The Galena railroad was the first to build a structure dedicated to its own line, also on North Water Street. Sturges and Buckingham's alliance with the Illinois Central inspired entrepreneurs to make deals with the city's other rail networks and to build similarly-scaled elevators wherever rails and river met.

Figure 15. Detail from J.T. Palmatary Map from 1857 showing Sturges and Buckingham Elevators (1855, 1857) at the mouth of the Chicago River and the Galena and Chicago Union Elevator (1854) on the north bank (top).

Palmatary, J. T, Christian Inger, Herline & Hensel, and Braunhold & Sonne. Chicago. Chicago, Braunhold & Sonne, 1857. Map. https://www.loc.gov/item/75693204/.

Congestion along the River's main branch encouraged builders to develop sites farther and farther from downtown. (Figure 15) Alexander Miller and speculator Ira Munn completed a 600,000 bushel elevator in 1866 to handle grain from the Chicago and Northwestern Railway on the North Branch at Kinzie Street.[67] Munn built the city's first two elevators that could hold more than a million bushels in 1863 and 1864 where the river turned, at Halsted and 22nd Street, and Sturges and Buckingham built million-bushel elevators adjacent to the Michigan Southern and Chicago & Rock Island Railroads depot at LaSalle street's southern end. These developments increased the city's capacity from 5,000,000 bushels to 9,000,000, a pace that continued through the decade.[68] Armour, Dole, & Co. went on to build five elevators adjacent to the Chicago, Burlington, and Quincy's railyards between Halsted and Loomis between 1860 and 1867. (Figure 16) The Rock Island line built its own elevators where its yards met the River at what is now Roosevelt Ave. With these, the city began to replicate in compressed urban form the geography of the entire Midwest, with grain from Wisconsin and Minnesota arriving along the North Branch, from western Illinois and Iowa along the South Branch, and from downstate Illinois through the Illinois Central yards along the Lake at the River's mouth.[69] This dispersion saved much of the city's grain trade during the 1871 fire. While the conflagration's trajectory destroyed the commercial district, wind steered it away from the new elevator districts on the south branch, and spared elevators along the north branch.

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Sturges and Buckingham lost the older of their two structures but elevator "B," rebuilt with brick cladding, was spared.[70] Six structures on the main branch burned—including three of Munger and Wheeler's—but nine of the city's largest elevators, including Armour & Dole's and Munn & Scott's were untouched.[71] By the end of 1872, five structures had been rebuilt in place and plans by Armour and Dole for million-bushel expansions on the south branch had been announced.

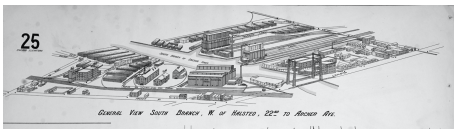


Figure 16. The Armour-Dole complex on the South Branch of the Chicago River at Halsted, as developed by Phillip Armour after 1880. Sanborn Fire Insurance Map from Chicago, Cook County, Illinois. Sanborn Map Company, 1901. Map. https://www.loc.gov/item/sanborn01790_014/.

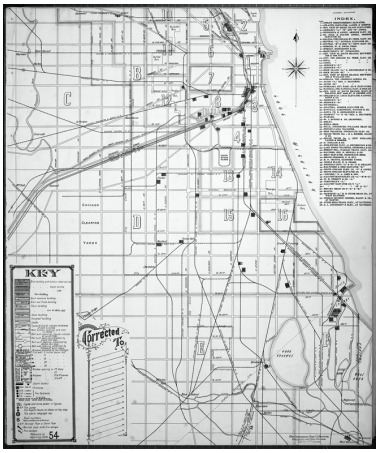


Figure 17. Chicago's major grain elevators in 1901, showing only four remaining on the main branch and concentrations on Goose Island, the South Branch at 12th Street and around Halsted and Damen, and the burgeoning Calumet District. Sanborn Fire Insurance Map from Chicago, Cook County, Illinois. Sanborn Map Company, 1901. Map. https://www.loc.gov/item/sanborn01790_014/.

Beginning in 1874, the main branch's crowded harbor was supplemented and replaced by new facilities along Lake Calumet and the Calumet River, fifteen miles south of the Loop. By century's end, shipping traffic was split between the Chicago and Calumet Rivers as new channels, slips, and docks were built in the burgeoning new industrial district. (Figure 17) As Joshua A. T. Salzmann has shown, the move to Calumet was due in part to the disruptive technology of new, oversized steamships that traversed the Great Lakes more efficiently—and more safely. These larger ships could no longer navigate the tight confines of the Chicago River. Combined with the city's growing desire to redefine its lakefront and to cleanse its drinking water, shipping gradually moved away from the River, while the steel industry's move to the Calumet area after 1900 drew further shipping and rail development away from the city's traditional harbor.[72] This new center in Chicago's grain trade coincided with a movement toward decentralized trade nationwide. Steel rails, developed after 1885, made shipment by rail cheaper than lake boat for the first time, and Chicago's first belt railway was completed in the 1890s, reducing the market for grain transfer and storage. According to *Industrial Chicago,* "grain handling at Chicago…ceased to grow with the increased volume of grain products." The city's elevator capacity peaked in 1900, at 64,000,000 bushels.[73] By 1916, less than a quarter of the grain moving through Chicago was transferred from rails to ships—and what ships were still serving the trade were much larger vessels that could only be accommodated in the new Calumet facilities.[74] By the 1920s, half the grain passing through Chicago was handled south of 63rd Street, either through

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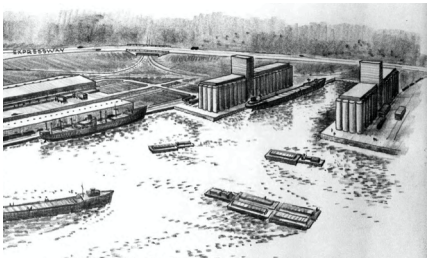
the belt railway system or these new harbor facilities. Elevator construction ceased in the central area as owners sold or demolished aging timber structures there, while the Chicago and Northwestern and other large concrete elevators rose along the Calumet River. The Calumet-Saganashkee Channel linked Lake Calumet to the Sanitary and Ship Canal, twenty miles southwest of the Loop, in 1922, allowing even barge traffic to bypass the Loop. Duluth and Minneapolis surpassed Chicago in storage capacity by 1929, when Chicago's share of the country's grain trade fell to just 17%, the lowest since the railroads' arrival there in the 1850s.[75] The last grain elevators and warehouses along the Chicago River's main branch were abandoned and replaced by developments inspired by the City Beautiful movement and Bennett and Burnham's 1909 Plan of Chicago, including Wacker Drive and the Merchandise Mart.[76]

Figure 18. Illinois Grain and Rice Elevators, Lake Calumet, Chicago, IL. Development rendering, from De Leuw, Cather & Company. *Report On Lake Calumet Harbor Development, Chicago Regional Port District.* Chicago, 1955.



The city expanded Lake Calumet's harbor in the late 1950s in anticipation of the St. Lawrence Seaway's completion, which widened and standardized river locks all the way to Montreal and allowed lake vessels direct access to eastern and transatlantic ports directly from Chicago. Three new elevators were constructed alongside the city's harbor improvements to meet this anticipated demand: Glidden, which produced soybean oil for its paints and varnishes, built a 6.5 million bushel elevator on the Calumet River at 117th Street, while the City constructed twin 6.5 million bushel elevators on the Lake's southwest edge, leasing them to the Illinois Grain Corporation and the Daniel F. Rice Co.[77] (Figure 18) Continental followed suit, announcing another 1.6 million bushel extension to its complex in 1955, while Cargill opened a 100,000 bushel pilot elevator in Michigan City, Indiana and a 3 million bushel addition to its facilities on the Calumet River in 1960.[78] These projects were small, however, compared to a growing elevator network throughout the Midwest. C-G-F constructed a 43-million bushel elevator in Wichita in 1959 that on its own relegated Chicago to just fourth in the country in total grain storage.[79] Within the city, grain fell behind coal and petroleum products in shipping.[80] By 1961, there were just fourteen major grain elevators left operating in the city, with a total capacity of 59,000,000 bushels—well below the city's peak 91 elevators holding 64,000,000 bushels in 1900.[81]

Labor issues plagued the Calumet elevators. A strike in September, 1960 halted shipments for three weeks, during which the Chicago Association of Commerce reported that cargo shipments through the city's port had dropped 10% since 1959. Officials blamed the strikes, but these were just one factor in shipping's decline throughout the city.[82] When the Seaway opened in Spring, 1959, Chicago's facilities proved inadequate. Berths were crowded, fees exorbitant, and local dockworkers inexperienced with the larger ships arriving from points east. Theft and

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organized crime plagued unloading operations, and the six-and-a-half mile journey up the Calumet River to the rejuvenated harbor from the Lake was so full of wharves, elevators, and blind corners that it was called "the worst stretch of waterway from any port in the world."[83] Meanwhile, rails and railyards built to support containerized shipping proved faster and more efficient than Lake or Seaway transportation, and the interstate highway system, coupled with containerization, created more dispersed distribution networks that bypassed transfer points like Chicago altogether. The 1974 oil embargo made shipping even more expensive than rail. Just 5% of Illinois' exports left through Chicago's port that year. The rest were sent by rail or truck to ports on the East coast.[84] These logistical and infrastructural advances encouraged new container ports along the nation's coasts while lake and river ports drifted toward obsolescence; Chicago never mustered funds or enthusiasm to further develop Calumet Harbor or its surrounding infrastructure.[85] In 1979 the *Tribune,* citing intractable political and infrastructural problems, declared that on its twentieth anniversary the Seaway and the Harbor had fallen "far short of its promises."[86] By 1991 Chicago's grain shipments fell to 134,000 tons per year, or just over 5.5 million bushels.[87] The city considered filling in Lake Calumet and converting the area to Chicago's third airport that year, and in 1995, Cargill, Continental, and General Mills all closed their local elevator operations.[88] Deferred maintenance, declining interest from shippers, and the continuing shift away from lake and river shipping toward rail and interstate transport sealed Chicago's fate as a grain hub.

## The Grain Elevator as Financial Instrument: The Board of Trade and "Corner" Attempts, 1848-1900

Like commercial skyscrapers, grain elevators were key elements in some of Chicago's most remarkable financial episodes. They shared with tall office buildings their physical manifestations of location, efficiency, and size, all of which proved to be exploitable by clever speculators. The fiscal instruments that translated elevators' bulk into profit were more complex than those that underlay commercial skyscrapers, and they provided leverage that exposed grain speculators to far greater volatility. The fortunes made and lost by grain speculators dwarfed those of skyscraper owners, as elevator's storage capacities provided much larger stakes than simple monthly leases. If, the commercial skyscraper was truly "a machine for making the *land* pay," as Cass Gilbert (the Minneapolis-based architect of New York's 1913 Woolworth Building said, grain elevators were machines for making Chicago's entire *hinterland* pay, and traders used the fiscal leverage derived from this vast territory to outduel one another.

The financial buccaneering of nineteenth century grain traders emerged as an unintended consequence of attempts to keep the commodities market honest. Prices paid for wheat, corn, or other agricultural products depended on whether those goods were healthy, unadulterated, and vermin-free, but progress toward a robust, reliable, and agreed-upon grain quality system was halting.[89] The Chicago Board of Trade's organization in 1848 and its incorporation as a semi-governmental entity in 1859 codified elevator receipts for grain and established rudimentary standards, but shippers still had to rely upon elevator operators' integrity in grading and on the widespread agreement that receipts would be honored by other traders. Such honest dealing was not universal, however. "A gigantic trade of fifty or sixty million bushels of grain would, of course, breed speculators, and some

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dishonest ones," noted one city booster.[90] Illinois passed warehousing laws in 1851 that required receipts to reflect actual quantities of grain being stored and mandating that only one receipt be issued for each transaction.[91] These rudimentary laws sufficed for the city's local trade, but as railroads brought grain in much greater volumes speculation and corruption grew proportionally. Warehouse receipts were soon traded themselves, and the telegraph's advent in 1848 brought information on grain prices from the east, making it possible to gamble not only on current prices in Chicago, but on fluctuations all over the Eastern Seaboard.[92] Traders took advantage of so-called futures contracts, devised to guarantee farmers during planting months that their crops would be welcomed at country elevators at harvest. These contracts promised prices at monthly dates in the future, which provided opportunities for speculators to profit. If wheat was purchased for August delivery at 60 cents a bushel, for instance, and the price being paid in Chicago rose that month to 63 cents, the farmer bringing the load to a country elevator would receive the lower, guaranteed amount while the trader would receive the extra three cents for taking the risk of a lower price.

Warehouse receipts and futures formed their own, paper markets on the Board. Traders who would never set foot on a farm or in an elevator 'delivered' grain to one another that they would never see or hold but which sat, undisturbed, in one of the city's elevators. Futures also enabled short-selling, or betting on declining grain prices, which, in turn, led to "cornering" attempts—all-in bets on *rising* prices in which a bullish investor would purchase futures contracts from bearish investors trying to short-sell while also hoarding so much actual grain for that delivery date that "bears" could never fulfil their contracts. With supply limited, market prices would rise and short-sellers would be compelled to settle contracts with grain bought at exorbitant prices—often from those engineering the 'corner' themselves. The threat of bankruptcy and even prison meant that corners were effective weapons, since they allowed the most daring traders to acquire whole companies in exchange for discharging exorbitant debts. The spectacular gains and losses that came with these campaigns captivated the general public. Newspapers reported on corner attempts with frantic, large-type headlines, and some of the city's greatest fortunes were made and lost during these episodes.[93]

Such volatility put unavoidable pressures on the Board of Trade. A local fall in prices in 1857, for instance led elevator operators to bulk up their holdings with sawdust and rotten grain, tarnishing Chicago's reputation.[94] Elevator owners consolidated their power into a clique controlled by "about a dozen men" by 1870, giving them the ability to fix prices, lock out smaller operators, and gain them vital leverage over traders and farmers that proved toxic to the grain trade, allowing for enormous insider trading binges that shook the industry. To combat this, a second Warehouse Act passed in Illinois in 1867 designated all elevators in Chicago 'public' because of their importance to the state's economy. As a result, transactions and receipts for all grain in the city had to be posted and subject to inspection by state-sanctioned graders.[95] The 1871 fire, however, revealed that corrupt practices in the elevator trade had continued despite this new legislation. State inspectors visited the city's remaining structures to establish each operators' holdings in Spring, 1872. Operators Munn and Scott came under suspicion when, faced with imminent inspection, they quickly sold their entire business to rival owner Armour for just $10.

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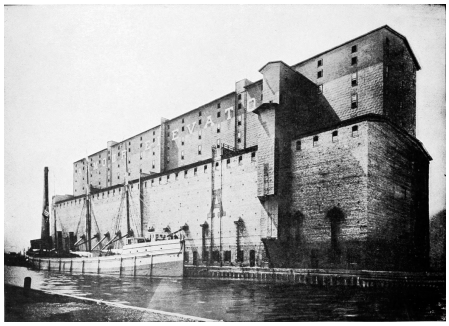
After the sale, Armour reported a 300,000 bushel shortfall. Munn and Scott had failed to cancel settled grain receipts and had built false floors in their elevators to make it appear to inspectors that they held grain that had long since been shipped out. Munn, a former Board of Trade president, fled, and in 1876 his name was immortalized when, in *Munn v. Illinois*, the Supreme Court ruled that the State had a legitimate interest in regulating corporate entities that had such significant impacts on the public welfare.[96]

By 1875, the city's trade in real grain was dwarfed by speculation.[97] While the city's elevators had been "passive tools, buffeted about by cliques who wished to control their storage space," they soon played active roles in the Board of Trade's economic warfare, which escalated in the 1880s and 1890s.[98] In the wake of George Armour's death in 1884, Armour-Dole began negotiations to sell their elevators to the Chicago, Burlington, and Quincy Railroad, but meat-packing titan Philip D. Armour conspired to purchase the lease in the railroad's place, seizing the entire Armour-Dole system. Philip D. Armour was no relation to George but he was a name famous and feared in Chicago on his own. He had made his fortune during the Civil War, parlaying profits from a Gold Rush sluicing business and a Milwaukee dry-goods store into a spectacular bet on falling pork prices in 1865. Realizing that prices would fall as the war ended, he sold futures contracts to deliver pork later in the year for $40 a barrel, "banking," as he would later say, "on Grant and Sherman." After the Confederate surrender, pork prices did, in fact, plunge, and Armour fulfilled his contracts by buying at the lower price and selling at the higher, doubling his investment.[99] Armour realized that he stood to gain further, though, by using the financial leverage from this short sale to break the country's meatpacking companies, flooding the market and sinking operations at deflated prices one city at a time. After vicious takeovers in Cleveland, St. Louis, Cincinnati, and New York, Armour arrived in Chicago in 1867 and centralized his packing operations there, taking advantage of the city's railroad network and developing assembly-line slaughterhouses and refrigerated rail fleet that would make Armour & Co. the largest meat-processing company in the world.[100]

Figure 19. Armour Elevators "A," "B," (George Moulton,1888) Goose Island, Chicago, IL. *Views of Chicago*. (Portland, Me.: L. H. Nelson company, 1910).



Armour's foray into wheat repeated this aggressive approach by betting against traders' enthusiasm for corners. After taking over the Armour-Dole elevators, he used their 10,000,000 bushel capacity to manipulate the Chicago market. In 1882, he hoarded grain to ensure that local prices stayed twenty to thirty cents per bushel higher than other markets in the country, import huge quantities from surrounding cities at reduced costs and allowing his elevators to absorb the extra supply, limiting access to other traders and driving Chicago prices higher.[101]

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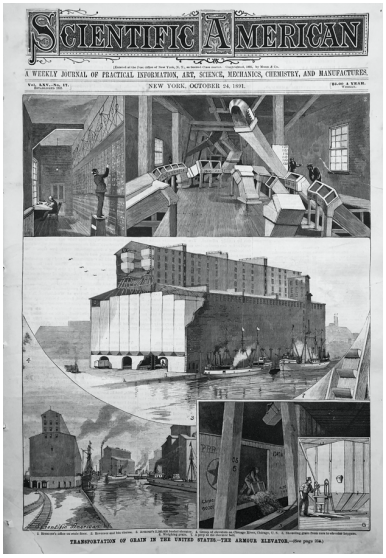
Following this successful strike, Armour built fleets of ships and rail cars as economic fortifications that broadened his supply network, enabling him to short-sell with confidence. In 1887, having sensed a corner attempt by Cincinnati banker E. L. Harper, Armour hired George Moulton to build two mammoth elevators on Goose Island, connected to the Chicago, Milwaukee, and St. Paul Railroad.[102] (Figure 19) This gave him access to wheat from Minnesota, Wisconsin, and the Dakotas to add to his supply from railroads percolating western Illinois, Iowa, Nebraska, and Kansas, and it doubled his territory to over 12,000 miles of track. Construction began stealthily, but in May the *Tribune* ambushed Moulton and Armour and demanded to know what was rising on the massive construction site.[103] The two concocted a story about beating new elevator legislation contemplated by the State, but sensing that their secret was out, Armour paid Moulton to rush construction and the 2,200,000 bushel elevators were finished in just over a month. The grain held by the new elevators broke Harper, "wrecking" his Cincinnati bank and giving "a blow to the grain trade of Chicago from the effects of which it will be long before it recovers."[104] Armour "A" and "B" included more than 8,000,000 board feet of lumber and boasted the first complete electric lighting system in a Chicago elevator. Their machinery was run by a 1,000 horsepower condensing engine connected to 29 separate elevators serving rail sidings and a shipping wharf, all of which could unload more than 100,000 bushels per day—critical speed given the need to accumulate vast quantities to defend against a corner without alerting other traders.[105] (Figure 20)

Figure 20. Armour Elevators "A," "B," (George Moulton,1888) Goose Island, Chicago, IL, *Scientific American*, Oct. 24, 1891. 1. River view of Iowa, Rock Island, and City Elevators in lower left.




Armour furthered his strategy an even larger structure in 1893 during an attempt on May wheat by trader John Cudahy. On March 23, Armour broke ground on the "B Annex," a 3,500,000 bushel elevator in the island's center, connected to "A" and "B" by quarter-mile long belts. "People on the 'Change would like to know," wrote the *Tribune*, suspecting that Armour was once again preparing for battle, "what connection there is between the great deal in May wheat and the big elevator which Armour is erecting on Goose Island."[106] With the Columbian Exposition scheduled to open on May 1, Moulton had already committed his entire labor force elsewhere. Armour was forced to serve as his own contractor, competing with Exposition work by offering carpenters up to

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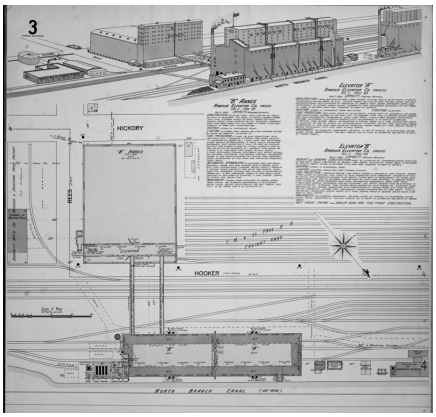
$15 a day (over $400 in current terms).[107] More than 700 workers completed the elevator in time to fulfil the contract—on the very day that the Exposition opened. To save time, workers waited to install equipment to *unload* wheat until after Armour had "checkmated" Cudahy.[108] The Annex had no active rail lines underneath its bins. It sat directly on the ground and relied on the neighboring elevators for loading and unloading, a clear sign that it was intended long-term, clandestine storage rather than for rapid processing. (Figure 21)

Figure 21. Phillip Armour's "Thirty-Day Elevators:" Armour "A" and "B" (George Moulton, 1888) and Armour "B Annex" (Phillip Armour, 1893). Goose Island, Chicago, IL. Sanborn Fire Insurance Map from Chicago, Cook County, Illinois. Sanborn Map Company, 1901. Map. https://www.loc.gov/item/sanborn01790_014/.




Armour expanded his elevator holdings on the River's north branch to include two neighboring elevators: the Minnesota (1891) and the St. Paul (1880). With these he controlled Chicago's entire northwest trade. *Scientific American* used the "A" and "B" elevators on its cover to illustrate the grain transportation network, and they were used to illustrate the city's grain elevators when they were named among the "Seven Wonders of Chicago" by the *Tribune*.[109] But their greatest moment came with the largest and most dramatic corner attempt in Chicago's history, by Joseph Leiter, son of mercantilist Levi Z. Leiter, in 1897. Wheat prices had soared that spring and summer, rising from 56-1/4 cents per bushel in August, 1896 to 90-3/4 cents. Elevator operators had been desperately moving wheat out of their bins to take advantage of the rising prices and Leiter, "known to the public heretofore chiefly as a society man," had waded in, making conspicuous bets on the continued upward trend.[110] Recognizing a speculative bubble—and a naïve mark—Armour short-sold 9,000,000 bushels of December wheat to Leiter at $1.43 a bushel, a figure that made sense for Leiter only if the market continued its astronomical rise or if Armour was unable to fulfill such an enormous contract. In mid-December, with Lake Superior frozen over by ice and elevators standing empty during the winter lull, Leiter seemed ready to bankrupt Armour and to take over the nation's largest grain and meat empires. But the city soon saw a bizarre sight that doomed Leiter's attempt. "Chicagoans have been perplexed by the arrival of steamer after steamer laden to the water's edge with choice wheat," the *Tribune* reported, "in spite of the fact that Chicago has always heretofore shipped wheat and not imported it."[111] These steamers made their way to Goose Island and the South Branch, where Armour, having calculated that he had the necessary capacity but not yet the speed to acquire and hold the necessary wheat, installed new machinery with reversed the belt systems to take wheat *up* from lake ships instead of discharging *into* them. He secretly engaged a fleet of ice breakers to open up Duluth's harbor, freeing millions of bushels to arrive by ship in addition to rail. At the same time, he brokered a deal with Minneapolis' F. H. Peavey to flood the

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Chicago market with Minnesota and Dakota wheat. When Armour's contract came due, he had not only the 9,000,000 bushels owed to Leiter, but an *additional* 9,000,000 bushels that he used to further collapse prices. By the end of December, wheat stood at just 85-1/2 cents.[112] Leiter was forced to buy the 9,000,000 bushels from Armour at $1.43, nearly doubling Armour's investment but losing over $5,000,000 ($150,000,000 in contemporary dollars) in "the most stupendous generalship in connection with the handling of a food product that the eyes of man have ever seen."[113] Armour bought much of the wheat back at the lower market rates, holding it until the effects of the corner wore off and prices recovered.

The Armour/Leiter battle was the greatest—and last—elevator-based corner battle. Armour died in 1901, and few had the resources and daring to continue the fights. Further securities regulations limited opportunities for corners, but elevators continued to serve as barometers of Chicago's grain trade throughout the 20th century. The Depression brought price controls and federal intervention that consolidated the storage industry. Regulators urged that elevators be pooled, separated from the railroads that owned them, and managed to ensure consistent, fair pricing. Dust bowl summers and the Depression saw consolidation into a few giant conglomerates. Smaller companies collapsed, including Rosenbaum, which declared bankruptcy in 1934 and was expelled from the Board of Trade when it emerged that it had manipulated its balance sheets.[114] Minneapolis-based Cargill, which leased and expanded the rebuilt Chicago and Northwestern elevator in 1931, was also expelled from the Board in 1938 for manipulating corn prices.[115] In 1939 elevator operators throughout the Midwest were forced to store more than 250,000,000 bushels at reduced rates, and when the United States entered World War II problems with capacity and movement were exacerbated when the military marshalled rail cars and shipping.[116] The War Production Board embargoed construction materials in 1942, limiting elevator construction, but grain still played an important, if secondary, role in the war effort. Grain alcohol was an important component in new explosives. Processing and manufacturing industries in the city meant that most grain that came into Chicago during wartime stayed in the city, trucked to factories instead of being shipped on to eastern markets. "A war industry is usually pictured in terms of planes, tanks, and shells moving off the assembly line," Charles Wright wrote in the *Chicago Tribune* in 1942. "But modern war has changed the old conception…. [and] has placed the grain elevators on a war footing."[117] Wartime also saw the Sturges and Buckingham's "A" and "B" elevators, at the mouth of the Chicago River, demolished. Standing in the way of the Wacker Drive extension to Lake Shore Drive, the they were disassembled board-by-board in 1942 and their lumber repurposed for the war effort.[118]

## Conclusions

Over 110 grain elevators were built in Chicago between 1838 and 1959. Of these, just a handful remain standing. The most visible are the Santa Fe on the River's south branch at Damen Avenue, where the original 1906 concrete bins and the reconstructed 1932 workhouse, both in reinforced concrete, stand abandoned. (Figure 22) The city's last two major structures, the 1959 Rice and Illinois Grain elevators on Lake Calumet's southwestern shore, are

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still in use but at far reduced capacities. The two-million bushel Garvey/Norris elevator still stands, abandoned, on the Calumet River under the I-90 Chicago Skyway bridge, and the Rialto, built in steel in 1902 and expanded in concrete, remains at 104th and the River. A steel elevator in the Back of the Yards district still stands at 44th and Halsted, as do concrete silos built for the Eckhart Milling operation on West Carroll Street at Ogden Avenue in 1912.[119] Archer-Daniels-Midland bought the Eckhart complex in 1990 but moved its operations to a new plant outside of Chicago in 2017. The property is owned by developer Sterling Bay and there are plans to develop it to take advantage of the neighborhood's rebirth as a residential, corporate, and restaurant district.

Figure 22. John S. Metcalf, Elevator for the Santa Fe Railroad, South Branch of the Chicago River at Damen Ave., 1906, 1932. 2019 Photograph showing working house (left) reconstructed in concrete after fire and original 1906 storage bins (right). (Author)

Physical evidence of these structures is scarce, as their riverfront sites have proven useful for other purposes. Sturges and Buckingham's elevators (later Illinois Central) stood where the Columbus Avenue bridge now crosses the River. Improvements related to that bridge eliminated all traces of Chicago's one-time gateway skyscrapers. There is also no trace of Armour's giant complex on Goose Island and straightening the River's south branch in 1930 removed the ground itself where George Armour's "E" and "F" elevators, along with the Iowa and two other structures once stood. Between Halsted and Ashland, only the riverfront slips that once served the Armour & Dole complex remain. The site is now occupied by the inactive Fisk Street Generating Station, built in 1903 to take advantage of river access to coal from barge traffic. Finally, the 10,000,000 bushel Chicago and Northwestern Elevator at 112nd Street and the Calumet River was abandoned by Cargill and demolished in 2004. Unlike other aspects of Chicago's industrial and economic heritage that have been converted into new urban elements—the Riverwalk, for instance, or Navy Pier—the city's grain infrastructure has never been memorialized by similar developments. The scattered historic sites and the elevators' transitory nature left little opportunity to make their contributions to the city's growth and development visible today.

If constructed evidence of Chicago's grain trade has been lost, however, its importance to the city can be found in the philanthropies that its tremendous profits supported. Buckingham Fountain in Grant Park is the most visible, given in 1927 to the city by Kate Sturges Buckingham, whose grandfather commissioned the two namesake elevators at the River's mouth. Philip Danforth Armour endowed the Armour Institute in Fall, 1893, just weeks after completing "thirty-day" elevators on Goose Island that broke the Cudahy corner.[120] Daniel F. Rice, whose company leased one of the 1959 structures on Lake Calumet, funded a wing of the Art Institute, a pavilion of the Chicago History Museum, and elements of the Adler Planetarium, the Field Museum, the Chicago Botanic Garden, and the Shedd Aquarium.

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The knowledge gained by construction under time, budgetary, and material constraints also transferred to the building community in the city. Moulton's firm went on to become a successful skyscraper contractor, building the New York Life and Fisher Buildings in Chicago (William Le Baron Jenney, 1893; D.H. Burnham & Co., 1896) and the Guaranty Building in Buffalo (Adler and Sullivan, 1893).[121] Jason Macdonald and John S. Metcalf, Chicago's leading grain elevator engineers and builders in the 20th century, helped to introduce concrete construction to Chicago, pioneering the material's use and application in a city with a native, ingrained steel industry. The two firms made Chicago a center for grain elevator engineering, too. Structures throughout North and South America, Europe, and even Soviet Russia were designed in their Chicago offices throughout the early and mid-twentieth century.

Without extant structures, however, Chicago's grain elevator history has remained obscure. While Corbusier's publication of concrete elevators in Montreal and Buffalo in *Vers Une Architecture* made those cities' structures known and appreciated by architects worldwide, Chicago's demolition of its elevators has left them unpublished and unrecognized. City and River histories rarely mention them despite their importance to Chicago's growth and economy.[122] How do we assess the importance or meaning of built work that has vanished, in many cases with barely a photograph or a mention in the local press to attest to its existence? Here, further parallels with skyscraper history are fruitful. It has been common for historians and reporters to refer to high-rises as economic "barometers"—their height or concentration has indicated economic pressures since the real estate booms that first sculpted skylines in the nineteenth century. But skyscrapers evidence much broader influences when their planning, construction, and built fabric are interrogated. Their materials evidence transportation networks and sources, techniques reveal the changing labor costs and political influence, systems and structures illustrate changing or evolving knowledge of building statics, environmental performance, and human comfort. Grain elevators, too, provide tangible if no longer extant evidence for changing techniques and material availabilities. Even more than skyscrapers, however, elevators' locations throughout the city, their timing, their configuration in conjunction with rivers, canals, and railroads, and their roles in the city's financial battles illustrate, in ways that skyscrapers cannot, Chicago's economic and industrial geography. In its gradual migration from the Chicago River's main branch to the yards around 12th Street, the Archer Avenue corridor, Goose Island, and the Calumet district, the city's grain trade evidenced changing allegiances between railroads and operators and barge, lake, and rail traffic's fluctuating importance to the city. The Calumet district elevators' rise and fall shows, for instance, the hopeful but stumbling investment in the St. Lawrence Seaway as insurance for Chicago's relevance as a port, and railroads' economic and political power in the United States. Finally, the personalities involved, the anecdotes of construction in response to financial mischief downtown, and the elevators' status as defensive weapons in the commodities warfare of corner attempts in the late 19th century shows that elevators, like skyscrapers, were not only the *resultants* of economic forces, but also active *implements* in the ebb and flow of fortunes won and lost on the Chicago Board of Trade. Capital flowed through Chicago much as grain did, and what Trollope said of corn might well have applied to the rivers of finance that accompanied them:

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> "And thus rivers of corn are running through these buildings night and day. The secret of all the motion and arrangement consists, of course, in the elevation. The corn is lifted up; and when lifted up can move itself, and arrange itself, and weigh itself, and load itself."[123]

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[2] "Chicago's Elevator System." *Chicago Daily Tribune*, July 14, 1895. 33; "A Great Elevator Architect," *The Inland Architect and News Record,* Vol. XXVIII, no. 3. Oct., 1896. 28; and "Feature of Chicago Which Constitute the Seven Wonders of the City." *Chicago Daily Tribune*, Dec. 5, 1897. 45.
[3] Joshua A. T. Salzmann, *Liquid Capital: Making the Chicago Waterfront.* (Philadelphia, University of Pennsylvania Press, 2018). 46-48.
[4] Carl Abbott, "The Location of Railroad Passenger Depots in Chicago and St. Louis, 1850-1900." *The Railway and Locomotive Historical Society Bulletin*, No. 120. April 1969. 31-47.
[5]Carl Abbott. "Civic Pride in Chicago, 1844-1860." *Journal of the Illinois State Historical Society*, Vol. 63, no. 4. 1970. 399–421.
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[7] Harold Platt, *Shock City: The Environmental Transformation and Reform of Manchester and Chicago.* (Chicago: University of Chicago Press, 2005).
[8] Reyner Banham's tribute to Buffalo's grain elevators, *A Concrete Atlantis* (Cambridge: MIT Press, 1986), is the most complete of these. William Brown's *American Colossus: The Grain Elevator, 1843 to 1943* (New York: Colossal Press, 2015) also focuses on Buffalo.
[9] William Cronon, *Nature's Metropolis: Chicago and the Great West.* (New York: Norton, 1991).
[10] "Moving goods by water almost always meant transferring them several times along the way, from pier to flatboat, from flatboat to levee, from levee to steamboat, from steamboat to sailing craft. Such transfers worked best if shipments were small enough that their weight and bulk did not prevent an individual worker from handling them. Moving grain on and off a ship usually meant negotiating tortuous passageways—across gangways, down stairs, through corridors, into storage bins—and the more complicated the path, the more critical the need to keep down the size of the unit being moved. Beyond these purely physical problems of water-based grain handling, the prevailing apparatus for transferring ownership rights also worked in favor of the sack system. Shippers and their customers wanted to know exactly what they were selling and buying, so it made sense not to break up individual shipments or mix them with others. In all these ways, marketing and transportation systems reflected each other. Sacks and ships seemed an ideal combination." William Cronon, *Nature's Metropolis: Chicago and the Great West.* (New York: Norton, 1991). 108.
[11] "Death of George W. Dole." *Chicago Press and Tribune* Apr. 14, 1860. 1.
[12] "Chicago's Elevator System." *Chicago Daily Tribune*, July 14, 1895. 33.
[13] Even with established rail links east, lake transport remained the least expensive method of shipping bulk goods through the 1890s, in large part due to the expense of replacing relatively soft wrought iron rails. The advent of harder steel rails brought the cost of rail shipping down dramatically. *Industrial Chicago: The Commercial Interests*. (Chicago: Goodspeed Pub. Co., 1891-1896). 291-2, 319-320.
[14] Henry Ericsson, *Sixty Years a Builder: The Autobiography of Henry Ericsson*. (Chicago: A. Kroch & Son, 1942). 187.
[15] "Chicago From 1837 to the Great Fire." *Chicago Daily Tribune*. Feb. 7, 1909, Q2.
[16] E. A. Duddy, "Grain Elevator Storage at the Interior Terminal Markets: Chicago." The Journal of Business of the University of Chicago, Vol. 4, no. 1. Jan., 1931. 4.
[17] Ericsson, *op. cit.*, 227; and "A Great Elevator Architect," *op. cit.,* 28.
[18] For a family/business genealogy of the Buckingham/Sturges enterprise see Rima L. Schultz, *The Businessman's Role In Western Settlement: The Entrepreneurial Frontier, Chicago, 1833 - 1872 (illinois)*, Boston University, Ann Arbor, 1985.

[19] Andreas, *op. cit.,* 374. See, too, "Solomon Sturges Dead." *Chicago Tribune*, Oct. 16, 1864. 4; and Philip Hampson, "Old Elevator, City Landmark, Bows to Time: Played Major Role in Early Trade." *Chicago Daily Tribune,* Dec. 26, 1942. 16.
[20] See Guy A. Lee, *op. cit.,* 20-21. Cronon, *op. cit.*, also includes a description of the weighing and grading of grain in cupolas.
[21]H. Rowsell, *Visit of His Royal Highness the Prince of Wales to The British North American Provinces and United States in The Year 1860.* (Toronto: Roswell, 1861). 340.
[22] Anthony Trollope, *North America*. (Philadelphia; J. B. Lippincott & Co., 1863). 180-181.
[23] Milo S. Ketchum, C.E., The Design of Walls, Bins and Grain Elevators. (2d ed., New York: Engineering News Publishing Company, 1911). 285, 287, 288.
[24] *Ibid*., 283-290.
[25] Jas. MacDonald, MWSE. "Fireproof Grain Elevator Construction." Journal of the Western Society of Engineers, Vol. VII, No. 1. January, 1902. 38. See, too, "The Handling and Storage of Our Huge Grain Crop." *Scientific American,* Vol. 101, no. 24. December 11, 1909. 445.
[26] Guy A. Lee, "The Historical Significance of the Chicago Grain Elevator System." Agricultural History, Vol. 11, No. 1. Jan., 1937. 20-21.
[27] Jas. MacDonald, MWSE. "Fireproof Grain Elevator Construction." Journal of the Western Society of Engineers, Vol. VII, No. 1. January, 1902. 39.
[28] Milo S. Ketchum, C.E., The Design of Walls, Bins and Grain Elevators. (2d ed., New York: Engineering News Publishing Company, 1911. 297-298. See, too, Jas. Macdonald, MWSE, *op. cit.,* 39-40; and John S. Wright, *Chicago: Past, Present, Future. Relations to the Great Interior, and to the Continent.* (Chicago: Horton and Leonard, 1870). 157.
[29] Jas. Macdonald, MWSE, *op. cit.,* 36-37.
[30] G. M. S. Armstrong, ed., Grain Elevator Construction. (Chicago: George M. Moulton & CO., 1902). 6.
[31] Henry Ericsson, *op. cit.*, 231. Adler, cited in *Industrial Chicago: Vol. 1, The Building Interests.* (Chicago: Goodspeed, 1891). 473-474.
[32] Jas. MacDonald, MWSE. "Fireproof Grain Elevator Construction." *Journal of the Western Society of Engineers*, Vol. VII, No. 1. January, 1902. 37, 39.

[33] Francis Adams and Egbert Jamieson, *The Municipal Code of Chicago: Comprising the Laws of Illinois Relating to the City of Chicago, And the Ordinances of the City Council.* (Chicago: Beach, Barnard & co., printers, 1881). 255.
[34] "Unsuspected Dangers of Life in Chicago." *The Chicago Sunday Tribune*, June 2, 1901. 53.
[35] "Observer." "An Outrage." *Chicago Daily Tribune,* Nov. 13, 1881. 9 and Clarence A. Knight, *Supplement to the Municipal Code of the City of Chicago: (from April 18, 1881, to January 1, 1887.) (Published by Authority of the City Council.).* (Chicago: E. B. Myers & company, 1887). 22.
[36] G. M. S. Armstrong, ed., *Grain Elevator Construction.* (Chicago: George M. Moulton & CO., 1902). 3.
[37] Jas. MacDonald, MWSE. "Fireproof Grain Elevator Construction." *Journal of the Western Society of Engineers*, Vol. VII, No. 1. January, 1902. 37.
[38] Milo S. Ketchum, C.E., *The Design of Walls, Bins and Grain Elevators.* (2d ed., New York: Engineering News Publishing Company, 1911). 299.
[39] "Why is it that often little or no thought is given to the permanence of the building material or construction, nor to providing safeguards against fire, rust, rot and the depredations of rats and mice?" *Concrete Grain Tanks*. (Chicago: Portland Cement Assoc., 1918).
[40] MacDonald, *op. cit.*, 40-42.
[41] G. M. Moulton & J. M. Witherspoon, "Grain Bin." U.S. Patent #732,102, issued June 30, 1903.
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[43] R. F. Durham, "Concrete Grain Elevator Construction." *Concrete-Cement Age,* January, 1913. 41.
[44] "Various 'Concrete' Questions: Concrete Grain Elevators." *Concrete Engineering,* January, 1910. 19; and Durham, *op. cit.,* 41.
[45] *Concrete Grain Tanks*. (Chicago: Portland Cement Assoc., 1918).
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[47] R. P. Crawford, "Moving Forms for Concrete Elevators." *Scientific American,* Sept. 1, 1917. 155.
[48] Milo S. Ketchum, C.E., *The Design of Walls, Bins and Grain Elevators.* (2d ed., New York: Engineering News Publishing Company, 1911). 421-422.
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[55]Robert Doherty, "Big, New Grain Elevator on Lake Calumet: Ships and Shipping." *Chicago Daily Tribune*, Jun. 10, 1957. C5.
[56] Alfred Theodore Andreas, *History of Chicago: From the Earliest Period to the Present Time*. (Chicago: A. T. Andreas, 1900). 374.
[57] Duddy, *op. cit.,* 6.
[58] *Industrial Chicago*, *op. cit.*, 318-319.
[59] Cronon, *op. cit.*, 109-110.
[60] Anthony Trollope, *North America.* (Philadelphia, J. B. Lippincott & Co., 1863). 171-172.
[61] Ephraim H. Cummings, "Chicago's Greatness." *Chicago Daily Tribune*, Nov. 29, 1885. 28.
[62] Andreas, *op. cit.*, 374.
[63] Trollope, *op. cit.*, 176.
[64] Alfred Theodore Andreas, *History of Chicago: From the Earliest Period to the Present Time*. (Chicago: A.T. Andreas, 1839-1900). 373-374.
[65] Cronon, *op. cit.*, 112.
[66] John S. Wright, *Chicago: Past, Present, Future. Relations to the Great Interior, and to the Continent.* (Chicago: Horton and Leonard, 1870). 157.
[67] Henry Ericsson, Sixty Years a Builder: The Autobiography of Henry Ericsson. (Chicago: A. Kroch & Son, 1942). 227.
[68] "The Erection of New Elevators." *Chicago Tribune*, Nov. 25, 1861. 4.
[69] Duddy, *op. cit.,* 7.
[70] G. M. S. Armstrong, ed., Grain Elevator Construction. (Chicago: George M. Moulton & CO., 1902). 58.
[71] Andreas, *op. cit.,* 373.
[72] Joshua A. T. Salzmann, *Liquid Capital: Making the Chicago Waterfront.* (Philadelphia; University of Pennsylvania Press, 2017). 92-93.
[73] "The result has been that the railroads have carried forward large amounts of grain, not so much for the foreign trade or for New York, as for the use of the numberless small towns throughout the Eastern States, towns requiring from one or two to a dozen carloads per week for local consumption. This grain is largely shipped direct from where it is raised, in Illinois, Missouri, or Iowa, to the point of consumption, and while the trade is almost entirely in the hands of Chicago grain operators, it does not appear in the footings of the grain trade of the city. This particular trade has been largely increased by the making of special rates by the railroads from points west of Chicago to the East, which are less than the two rates to Chicago and from Chicago to the Eastern consignee. This amounts to an actual discrimination against the city to an amount often sufficient to divert the business around it. To meet this rail competition, all elevator charges and lake freights have been largely reduced, and the lake shipments are still of colossal magnitude, but the grain handling at Chicago has ceased to grow with the increased volume of grain products. Not alone has the trade been affected by rail shipments, but the Lake Superior ports, especially Duluth, are forwarding by lake much of the grain product of the Dakotas and Manitoba." *Industrial Chicago.* (Chicago: Goodspeed Pub. Co., 1891-1896). 319. See also Duddy, *op. cit.,* 10.
[74] "Under the pressure of railroad competition, both the size and speed of lake carriers had become greatly modified. 'The size of vessels which averaged about 700 tons in 1890 increased to an average of 1,200 tons in 1898. The maximum size of steamers reached as high as 7,000 tons.' By 1915, when water competition was restored, the average size of all steam vessels was 1,534 tons, with a maximum carrying capacity of 11,000 long tons. The shift of elevator space from the Chicago to the Calumet River is coincident with this change in size of the bulk freighter. That the shift was accelerated by this same cause is evidenced by the fact that in 1925 the average size of the bulk freighter had increased to 4,835 tons, the average length to 500 feet, and the carrying capacity to 14,000 long tons. It was no longer practicable to maneuver ships of this size into the Chicago River and the smaller boats could not compete. In 1925 but 70 package steamers of 1,000 gross tons and

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upward remained on the Great Lakes." E. A. Duddy, "Grain Elevator Storage at the Interior Terminal Markets: Chicago." *The Journal of Business of the University of Chicago,* Vol. 4, no. 1. Jan., 1931. 13.
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[76] Duddy, *op. cit.,* 14.
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[78] "Grain Storage Expansion Set by Continental." *Chicago Daily Tribune*, Oct. 28, 1955. C11;
[79] Richard Orr, "Wheat Storer Builds to Keep Up With Glut: He Sees Elevator as Thing of Beauty." *Chicago Daily Tribune*, Jun. 17, 1959. B10.
[80] Harold M. Mayer, "Prospects and Problems of the Port of Chicago." *Economic Geography*, Vol. 31, No. 2. Apr., 1955. 108
[81]United States Board of Engineers for Rivers and Harbors. *The Port of Chicago, Illinois*, (part 2, Washington : U.S. Govt. Print. Off., 1961).109; and Duddy, *op. cit.*, 8.
[82] Poulos, Nick. "Chicago Port Cargos Drop 10.2% in Year: Exports Increase Traffic Lead." *Chicago Daily Tribune*, Dec. 29, 1960. B5.
[83] Ronald Koziol and James Strong. "Looting Perils City Docks: Merchants' 2-Year Loss is 30 Million Terror Plagues Waterfront." *Chicago Tribune,* Mar 16, 1969. 1; and "Chicago Not Ready for Port, Say Shippers: Faults to Hinder World Trade." *Chicago Daily Tribune,* Jan 03, 1960. 1-s4.
[84] Ridgely Hunt, "Shipping Stagnates Here." *Chicago Tribune*, July 11, 1974. C9.
[85] Alvin Nagelberg, "Calumet Harbor Lures New Industry: Lack of Streets, Sewers Hinders Rapid Growth." *Chicago Tribune,* Apr. 9, 1972. C1.
[86] James O'Shea, "At 20th Birthday, Seaway Fails Far Short Of Promises." *Chicago Tribune,* Jul. 8, 1979. D1.
[87] William Gruber, "Area Port Waiting for Ship to Come In." *Chicago Tribune*, Feb. 14, 1992. A3.
[88] George Gunset, "Talks Grind on to Keep Big Grain Elevator Working." *Chicago Tribune*, Nov. 2, 1996. 1.
[89] Cronon [PAGE????]
[90] John S. Wright, *Chicago: Past, Present, Future. Relations to the Great Interior, and to the Continent.* (Chicago: Horton and Leonard, 1870). 159.
[91] Andreas, *op. cit.,* 376-7.
[92] Cronon, *op. cit.* 120.
[93] For a business 'genealogy' of the city's major financial figures and their interrelationships through partnerships, alliances, and familial or social relations, see Rima Lunin Schultz. "The Businessman's Role in Western Settlement: The Entrepreneurial Frontier, Chicago, 1833-1872." Ph.D. Dissertation, Boston University, 1985.
[94] Cronon, *op. cit.,* 117 and Andreas, *op. cit.,* 375.
[95] Andreas, *op. cit.,* 376.
[96] In 1872, the Iowa elevator, a small structure on Wolf Point that had survived the 1871 blaze, burned, and it became clear that its operator had failed to cancel receipts as grain was claimed, making it appear that the Iowa contained more than three times the grain it actually held. See "A Final Elevation." Chicago Tribune, Aug. 6, 1872. 5 and William G. Ferris, "The Disgrace of Ira Munn." *Journal of the Illinois State Historical Society*, Vol. 68, No. 3. Jun.,1975. 202-212.
[97] Cronon notes that Chicago's actual grain business in 1875 totaled $200 million, while the futures trade topped $2 billion. Cronon, *op. cit.,* 126.
[98] Guy A. Lee, "The Historical Significance of the Chicago Grain Elevator System." *Agricultural History*, Vol. 11, No. 1. Jan., 1937. 26.
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[111] "How P. D. Armour Got the Wheat Which May Mean A Loss of $1,000,000 to Joseph Leiter." *Chicago Daily Tribune*, Dec. 19, 1897. 25.
[112] "Joseph Leiter is Dead at 63."*Daily Boston Globe*. Apr. 12, 1932. 17.
[113] Armour was relentless in enforcing the contract. Leiter's father covered most of the settlement, and in an almost cruel twist, Armour received the wheat back as part of the settlement; so-called "Leiter wheat" left the city's elevators at depressed prices for months. After attempting to form a milk trust and to purchase the Great Wall of China, Joseph Leiter settled into a career as a coal magnate and thoroughbred horse breeder, but when he died in 1932 his obituaries led with the titanic failure of the 1897 grain deal. "How P. D. Armour Got the Wheat Which May Mean A Loss of $1,000,000 to Joseph Leiter." *Chicago Daily Tribune*, Dec. 19, 1897. 25; and "Joseph Leiter, Financier, Dies at Age of 63." *Chicago Daily Tribune*, Apr. 12, 1932. 1.
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