

Engineering the Metropolis: William Sellers, Joseph M. Wilson, and Industrial Philadelphia

VISITORS TO THE Centennial Exhibition of 1876 in Philadelphia could not help but take away from the experience images of a city being transformed by engineers and manufacturers who were working to industrialize both the local region and the larger North American continent.* Machines and manufactured products were at the center of the attractions and ceremonies—far more so than at any previous world's fair. The built environment of the fairgrounds itself reflected important innovations in machine building, civil engineering, and materials science that were developed collaboratively on the shop floors of Philadelphia factories and in the laboratories and halls of the region's technical and educational institutions. Constructed of standardized iron parts and designed in the shape of immense foundries or train sheds, the main exhibition halls showed off the productive systems and industrial aesthetics of local designers. Beyond the fairgrounds in Fairmount Park, the same engineers and industrialists who had planned the exhibition were molding a new urban ecology, with new types and arrangements of buildings and land uses. This article traces the careers of two of Philadelphia's leading engineers, William Sellers (1824–1905) and Joseph M. Wilson (1838–1903), examining how they worked—often in collaboration—to build an industrial metropolis according to their visions of a systematically organized world. Following an exploration of their involvement in the Centennial, the professional lives of Sellers and Wilson are considered first in the broader context of American

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industrialization and finally as windows onto the physical transformation of the late nineteenth-century city.

It is no accident that the main attractions at the Centennial Exhibition were machines. The fair illustrates a broader pattern in which engineers and metalworking manufacturers, together with their merchant and political allies, formed networks of businesses and institutions to guide economic and urban development in the late nineteenth century.¹ In 1870, mechanical engineer William Sellers convinced his colleagues in the Franklin Institute for the Promotion of the Mechanic Arts, the nation's leading learned society of applied science and center for technology transfer, to lobby city, state, and federal officials for a national celebration in Philadelphia.² The Fairmount Park Commission, of which Sellers was a charter member, donated the land for the fairgrounds, while the Centennial Board of Finance brought the fair to fruition without the aid of federal funding.³ The Board of Finance was dominated by leaders of the Franklin Institute and the University of Pennsylvania, including Sellers, Baldwin Locomotive Works partner Matthew Baird, Penn provost Charles Stillé, merchant John Welsh, and Board of Trade president Frederick Fraley.⁴ Sellers took leave from the board to attend to the affairs of his three businesses during the depression of 1873, but he and his firms continued to shape the fair.

Sellers and his colleague Joseph Miller Wilson, chief engineer of the

¹ Such collaborative infrastructure development by engineers, manufacturers, and institutions (including government) is the subject of Thomas Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore, 1984), which has sparked a wave of scholarship on the social organization of technology. Neighborhood development activities of Philadelphia manufacturers, particularly John B. Stetson's hat company and the Disston family's Keystone Saw Works, are highlighted in Philip Scranton and Walter Licht, *Work Sights: Industrial Philadelphia, 1890-1950* (Philadelphia, 1986), and Harry C. Silcox, *A Place to Live and Work: The Henry Disston Saw Works and the Tacony Community of Philadelphia* (University Park, Pa., 1994). Urban, ecological, and planning histories that trace broader patterns in the development of industrial North America and its cities include William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York, 1991); Robert Lewis, *Manufacturing Montreal: The Making of an Industrial Landscape, 1850-1930* (Baltimore, 2000); and John L. Larson, *Internal Improvement: National Public Works and the Promise of Popular Government in the Early United States* (Chapel Hill, 2001).

² J. Thomas Scharf and Thompson Westcott, *History of Philadelphia, 1609-1884* (3 vols., Philadelphia, 1884), 2264.

³ Fairmount Park Commission, *Annual Report, 1899*, 5, Fairmount Park Commission, Annual Reports, record group 149.3, Philadelphia City Archives (hereafter, PCA).

⁴ "Meeting of the Executive Committee of the U.S. Centennial Commission, August 1872," Centennial Collection, box 1, folder 4, Historical Society of Pennsylvania (hereafter, HSP).

Pennsylvania Railroad, tackled the central engineering challenges of the Centennial. Amidst the cash shortage of the depression, cost considerations constrained the design and construction of the Main Building and Machinery Hall, the fair's principal facilities. Wilson, working first with architect John McArthur, Jr., and later with civil engineer Henry Pettit, proposed to construct the two halls out of uniform, mass-produced iron parts in such a manner that the buildings could be dismantled and their materials "readily disposed of in the market after the exhibition [was] over."⁵ Sellers's Edge Moor Iron Company, an innovator in the standardization and mass production of iron and steel building materials, furnished the columns and trusses that made up the wrought iron skeletons of Wilson's and Pettit's designs. His machine tool works, William Sellers and Company, supplied the shafting to transmit power from the great Corliss engine to all the exhibits in Machinery Hall, a space larger than any factory yet built. Anticipating the modern pattern of the equipment lease, Sellers and Company submitted a reduced bid in return for ownership of—and the opportunity to resell—the shafting at the close of the fair.⁶ While creating business for Sellers's companies, these creative technical schemes also reduced the cost of the exhibition and enabled the rapid prefabrication and erection of Machinery Hall and the adjacent Main Building, which was at the time the world's largest building.⁷

Although commerce and financial markets suffered during the depression, a building boom in anticipation of the fair provided a much-needed spark for the local construction trades. Wilson's primary employer and Sellers's most important customer, the Pennsylvania Railroad, developed the rail spurs, bridges, and terminals that brought building materials, exhibits,

⁵ John McArthur, Jr., and Joseph M. Wilson, *Revised Design in Competition for Proposed Centennial Exhibition Building, for Exposition of Industry of all Nations* (Philadelphia, 1873), 17; Henry Pettit and Joseph M. Wilson, *Specifications for the Construction, Erection, and Finishing of the Main Exhibition Building on Lansdowne Plateau, Fairmount Park* (Philadelphia, 1874); both in Documentary Record of the Centennial Exhibition, v.3b, Buildings, HSP.

⁶ William Sellers and Co. [Justus C. Schwacke] to John S. Albert, chief of the Bureau of Machinery, Dec. 10, 1875; William Sellers and Co. [H. C. Francis] to John S. Albert, Jan. 7, 1876; William Sellers and Co. [H. C. Francis], "Proposal for Shafting" (n.d.), all in record group 230.29, Centennial Commission, Bureau of Machinery, Construction Papers, Proposals folder, PCA.

⁷ Joseph Wilson and Henry Pettit to Thomas Cochran, chair of the Committee on Grounds, Aug. 28, 1874, record group 231.11, Centennial Board of Finance, Committee on Grounds, Plans and Buildings, Correspondence and Papers, folder 1, PCA; George E. Thomas, "Design for the Main Exhibition Building, Philadelphia Centennial Exhibition," in James O'Gorman et al., *Drawing Towards Building: Philadelphia Architectural Graphics, 1732–1986* (Philadelphia, 1986), 140–42.

and people to the fair. In 1876, visitors traveling from the rapidly expanding areas to the west arrived in Philadelphia at a new railroad station designed by Wilson at the intersection of 32d and Market Streets, which became a major node in the Centennial city. Across from the station sat Frank Furness's Centennial Bank, where visitors left their valuables for safekeeping, while new hotels offered lodgings nearby. Rail passengers traveling directly to Fairmount Park disembarked at Wilson's new station along Elm (later Parkside) Avenue, across the street from Machinery Hall. Wilson also designed viaducts to span the railroad tracks that separated the park from West Philadelphia to the south, framing scenic views of the fairgrounds for visitors arriving on foot and facilitating real estate development in the city's Mantua and Parkside neighborhoods (figs. 1 and 2).

In the fall of 1876, Joseph Wilson authored a commemorative volume on the mechanical "masterpieces" exhibited that summer, recounting in detail

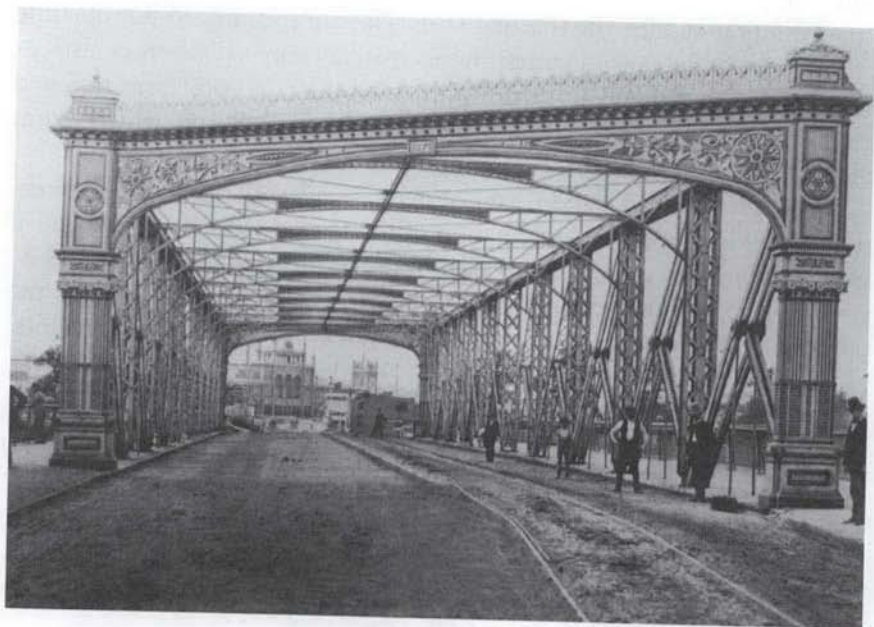


Fig. 1. Bridge over the Pennsylvania Railroad tracks at 41st Street, framing a view of the Main Building of the Centennial, Philadelphia, c. 1875. The Wilson Brothers & Co., *A Catalogue of Work Executed* (Philadelphia, [1885]), 32H. Collection of George E. Thomas.

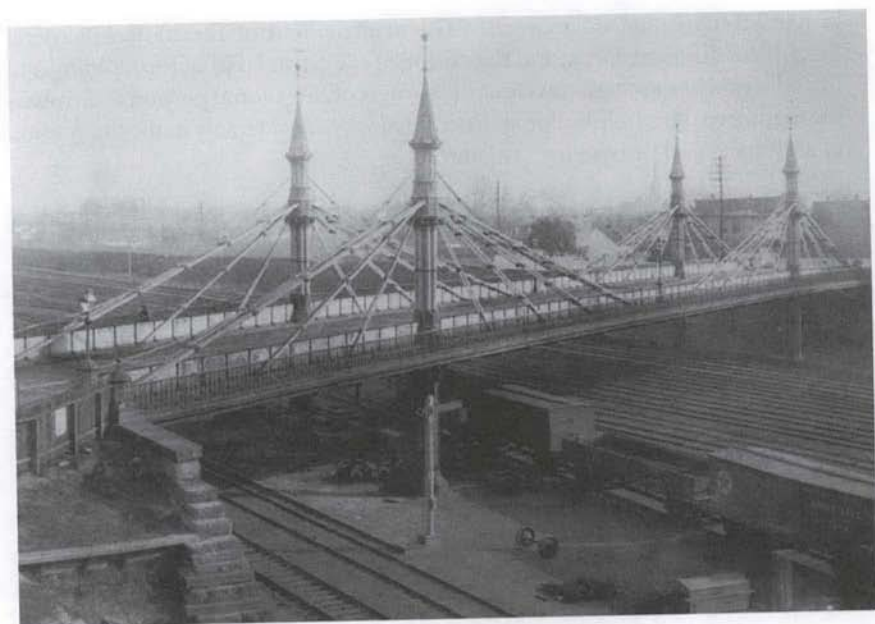


Fig. 2. Bridge over the Pennsylvania Railroad tracks at 40th Street, Philadelphia, c. 1875. The Wilson Brothers & Co., *A Catalogue of Work Executed* (Philadelphia, [1885]), 32G. Collection of George E. Thomas.

the principal technical innovations manifested in the exhibits of Machinery Hall. The new machines particularly impressed him with their "greater simplicity, perfection and solidity of construction . . . better adaptation of form to the materials employed; . . . adaptation of machines to more universal use, allowing several operations to be performed on the same piece of material without dismounting it; construction of portable machinery."⁸ Wilson's exhibit halls reflected these same goals. He described the Main Building in terms of its practical engineering objectives:

There are no projections, no recesses—all such accessories to architectural effect being rigidly excluded on the score of economy, and every foot covered by the building has been made fully available for the purposes of the Exhibition . . . The amounts of material used had to be kept strictly to the requirements for

⁸ Joseph M. Wilson, *History, Mechanics, Science*, vol. 3 of *The Masterpieces of the Centennial International Exhibition* (3 vols., Philadelphia, 1876–78), 17.

proper strength and no more . . . The arrangement of the roofs in varying heights for different spans, and the raising of the central part of the building and introduction of four high towers at the corners of this central portion as a crowning feature to the whole building, have aided very considerably in the production of a pleasing and satisfactory structure.⁹

As temporary buildings with standardized, reusable parts, using volumes of space rather than ornament to create their architectural effects, Wilson's exhibition halls were remarkable for their "simplicity . . . and solidity of construction," "adaptation of form to the materials employed," and design for "more universal use."¹⁰

In his reflections on the machines exhibited at the Centennial, Wilson paid closest attention to the tools central to American industrialization. The Corliss engine, the most visited attraction at the fair, offered dramatic evidence of innovations in power generation. Baldwin's locomotives represented the immense motive power that helped railroads span the continent, forging the physical and communication links critical to the nation's economic growth. Wilson expressed a preoccupation with computing large amounts of information in his discussion of Philadelphia machine maker George B. Grant's "Difference Engine . . . designed for the construction of large Mathematical Tables . . . and built for the University of Pennsylvania."¹¹ Among the machines that furnished America's factories, Wilson lavished his highest praise on William Sellers and Company's exhibit of thirty-three massive tools; an international committee of judges agreed, rating this display as "probably without a parallel in the past history of international exhibitions."¹² Wilson focused in particular upon Sellers's universal "patent self-acting planing-machine," which he hailed as an example of the best qualities of American mechanical engineering: "original methods of design, taking the problem presented to them with certain

⁹ Ibid., cxx-cxxii.

¹⁰ Ibid., 17. Engineering historian Carl Condit has seen in Joseph Wilson's work the makings of a modern architecture: "Although Wilson's primary concern was functional, with emphasis on the validity of pure empirical form, he anticipated three cardinal doctrines of modern architectural theory—simplicity, volume rather than mass, and free-flowing space." Carl W. Condit, *American Building Art: The Nineteenth Century* (New York, 1960), 218.

¹¹ Wilson, *History, Mechanics, Science*, 28.

¹² United States Centennial Commission, *International Exhibition, 1876* (11 vols., Washington, D.C., 1880-84) [vols. 3-8, *Reports and Awards*, ed. Francis A. Walker (Washington, D.C., 1880)], 7:14-18.

given conditions, . . . and working the whole out from a new basis, without any blind adherence to old-established forms or precedents."¹³

In their manufacturing and design pursuits, William Sellers, Joseph Wilson, and their colleagues followed these same principles of machine design to mold new systems of factory production, building construction, and metropolitan growth.¹⁴ The Centennial Exhibition itself was a city-building enterprise intended to position Philadelphia among the leading manufacturing centers of the nation and the world. In the international realm one nation certainly took note. The stark contrast between the German exhibits of plaster curios and military cannons and the great turbines and tools shown by American and British companies was a source of profound humiliation to German engineers and political leaders, who subsequently embarked on "a furious program of modernization."¹⁵ For Philadelphians, the organization of the fair and the machines and manufactured products that filled its main halls not only brought investment, new customers, and publicity but also confirmed the central role of the city's engineers in the broader process of American industrialization.

A dozen years before the Centennial, Joseph Wilson would have been found working along the northern edge of the Mason-Dixon line, striving to ensure the Pennsylvania Railroad's swift and secure movement of troops and supplies for the Union Army. In Philadelphia, meanwhile, William Sellers and his employees were engaged in tests on their shop floor, aimed at developing a uniform system of screw and bolt threads to facilitate the

¹³ Wilson, *History, Mechanics, Science*, 23.

¹⁴ John K. Brown and Philip Scranton make important distinctions between systems of mass production and the machine *building* processes that characterized Philadelphia's specialty metalworkers. The links between civil and mechanical engineers in the region were facilitated in part by their common design and production processes. Brown, *The Baldwin Locomotive Works, 1831-1915* (Baltimore, 1995); Brown, "When Machines Became Gray and Drawings Black and White: William Sellers and the Rationalization of Mechanical Engineering," *Journal of the Society for Industrial Archeology* 25 (1999), 29-54; Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865-1925* (Princeton, N.J., 1997); see also Thomas Heinrich, *Ships for the Seven Seas: Philadelphia Shipbuilding in the Age of Industrial Capitalism* (Baltimore, 1997). In his survey of nineteenth-century European and North American civil engineering practice, *Building the Nineteenth Century* (Cambridge, Mass., 1996), Tom Peters argues that engineers developed a distinctive "building culture" that formed the foundations of modern architectural and urban design.

¹⁵ Michael J. Lewis, "Modernism Without Program," in *American Architectural Masterpieces* (New York, 1992), xix.

construction and maintenance of everything from small machines to locomotives and iron bridges. Reading a paper on the topic at the monthly meeting of the Franklin Institute in April 1864, Sellers noted that "no organized attempt has as yet been made to establish any system." "The importance of the [engineering] works now in progress," he asserted, "admonish[es] us that so radical a defect should be allowed to exist no longer."¹⁶ The Institute, of which he was president at the time (1864–1867), appointed a committee to test his system of screw threads in the shop of William Bement, a competing tool builder. With the subsequent endorsement of the committee and the Institute, the United States government adopted the system in 1868, followed by the Pennsylvania Railroad—the "Standard Railroad" of the nation—the next year, the Master [Railroad] Car Builders' Association in 1872, and the International Congress for the standardization of screw threads at Zurich in 1898.¹⁷

Mechanical standardization boosted productive efficiency in sectors as distinct as engine making and bridge building. Not only did it alter the work of mechanics and laborers, it also transformed manufacturers' relationships with their customers by providing unprecedented access to replacement parts. Although decades passed before Sellers's system became widespread among American manufacturers, the standardization movement launched from the shop floor of William Sellers and Company and the halls of the Franklin Institute addressed what Philadelphia engineers viewed as the greatest challenges of their age. From the seemingly minute question of screw threads to the regularization of track width for railroads or the prefabrication of buildings, the economic and ecological growth and integration of North America depended, in their eyes, upon the capacity of machines, technological systems, and people to work together. Through the interlocking pursuits of their businesses and institutions, William Sellers and Joseph Wilson developed tools and systems that fueled profound technological, economic, social, and ecological transformations in the latter half of the nineteenth century. Their careers offer windows onto the world of an engineering-industrialist elite with roots in Europe,

¹⁶ "Proceedings of the Stated Monthly Meeting, April 21, 1864," *Journal of the Franklin Institute* 77 (May 1864), 344 (emphasis added).

¹⁷ Joseph Wickham Roe, *English and American Tool Builders: The Men Who Created Machine Tools* (New Haven, 1916), 249; Bruce Sinclair, "At the Turn of a Screw: William Sellers, the Franklin Institute, and a Standard American Thread," *Technology and Culture* 10 (1969), 20–34.

strong commitments to applied science, and firms that expanded their businesses along the lines of the railroads that physically integrated North America and its economy.

William Sellers's family had engaged in science and engineering for over a century before the Civil War. His paternal grandfather, John Sellers, was appointed by the American Philosophical Society to observe the transit of Venus (the passing of the planet between the earth and the sun) in 1761, while his maternal grandfather, William Poole, traveled from England to Philadelphia to observe the same astronomical event and subsequently settled in the region.¹⁸ William Sellers's extended family included early nineteenth-century innovators in the production of fire engines, fire hoses, and paper-making machines.¹⁹ William attended a school run by his parents in Upper Darby, Pennsylvania, until the age of fourteen, when he was apprenticed in the machine shop of his uncle, J. Morton Poole, outside of Wilmington, Delaware. After seven years, he left to take charge of the Providence, Rhode Island, workshop of Fairbanks, Bancroft and Company, where he supervised the young George Corliss.²⁰ Sellers returned to Philadelphia two years later, in 1848, to establish his own machine tool works.

Over the next half century, William Sellers built a reputation as a world leader in the design and production of machine tools, with over ninety patents in his name. England's most prominent machine designer, Joseph Whitworth, called him "the greatest mechanical engineer in the world."²¹ Sellers pursued his business interests and related research through his involvement in technical, professional, and business organizations, including the Engineers' Club of Philadelphia, the American Philosophical Society, the American Society of Mechanical Engineers, the National Academy of Sciences, the Société d'Encouragement pour l'Industrie Nationale, and, most importantly, the Franklin Institute. Investing heavily in research on

¹⁸ Alexander Outerbridge, Jr., and Coleman Sellers, Jr., "William Sellers," *Journal of the Franklin Institute* 154 (1905), 365-66.

¹⁹ Accounts of these individuals and their businesses are found in Eugene S. Ferguson, ed., *Early Engineering Reminiscences (1815-1840) of George Escot Sellers* (Washington, D.C., 1965).

²⁰ Monte A. Calvert, *The Mechanical Engineer in America, 1830-1910: Professional Cultures in Conflict* (Baltimore, 1967), 9-11.

²¹ Quoted in Outerbridge and Sellers, "William Sellers," 381.

its shop floor, William Sellers and Company pioneered in the design, manufacture, and promotion of hydraulic pressure equipment and revolutionized the millwork systems that transmitted power to the machines running factories across the nation.²² The firm's treatise and company catalogue on shafting was widely circulated internationally and went through numerous printings, particularly in the decades following the Centennial. Engineers and manufacturers from around the world visited the plant, which served as a magnet for Northern European immigrants highly skilled in metalworking.²³ In their perpetual search for new business and labor, Sellers and his colleagues organized the exhibition in large part because they appreciated the possibilities of marketing.

As the home of the Pennsylvania and Reading Railroads, Philadelphia sat at the center of the nation's largest transportation and communications network and enjoyed unparalleled access to anthracite coal, the nineteenth century's richest natural source of energy. It was a metropolis whose reach extended—principally along the rails and parallel telegraph lines—throughout the industrial heartland of the United States in the Northeast and Midwest and into the frontier regions of the West.²⁴ Sellers, who sat on the board of the Reading as well as the Philadelphia, Wilmington and

²² William Sellers and Co., *A Treatise on Machine Tools* (Philadelphia, 1873); William Sellers and Co., *A Treatise on Improved Turn-Tables for Railways, and for General Service: Pivot Bridges, Transfer Tables, etc.* (Philadelphia, 1885); William Sellers and Co., *Illustrated Catalogue and General Description of Improved Machine Tools* (Philadelphia, 1895); William Sellers and Co., *Metal-Working Machine Tools for Railway and Machine-Shop Equipment* (Philadelphia, 1900); Louis C. Hunter and Lynwood Bryant, *A History of Industrial Power in the United States, 1780–1930*, vol. 3, *The Transmission of Power* (Cambridge, Mass., 1991), 155 n. "Through an extensive series of experiments the Sellers firm determined what strength and consequently what weight and proportions were required for each millwork item. Using special machine tools and gauges and a carefully systematized organization of production, the firm turned out immense numbers of interchangeable parts at costs and prices below those of the common sort of millwork." Louis C. Hunter, *A History of Industrial Power in the United States, 1780–1930*, vol. 1, *Waterpower in the Century of the Steam Engine* (Charlottesville, 1979), 476; reprint of two lectures given by William Sellers at the Stevens Institute of Technology, *Journal of the Franklin Institute* 94 (1872), 233–43, 307–19. For a detailed discussion of the organization of machine design and production at William Sellers and Company, see Brown, "When Machines Became Gray and Drawings Black and White."

²³ William Sellers and Co., *Shafting* (Philadelphia, 1887, 1895, 1896, 1901); William Sellers and Company visitor's register (1861–1947), accession 1466, item 2, Soda House, Hagley Museum and Library; Howell John Harris, *Bloodless Victories: The Rise and Fall of the Open Shop in the Philadelphia Metal Trades, 1890–1940* (New York, 2000), 25, 43.

²⁴ As a major coal port, the center of vast rail networks, and a leader in a host of diverse manufactures, Philadelphia enjoyed close, metropolitan economic and ecological relationships to the anthracite, iron, and oil regions of Pennsylvania, the industrializing markets further west, as well as the cotton belt of the

Baltimore Railroad, took advantage of the railroads' physical and business connections to develop a customer base made up largely of heavy manufacturers and transportation and power companies. William Sellers and Company furnished locomotive turntables, shafting, and large tools to railroad workshops across the continent, including the main shops of the Pennsylvania Railroad at Altoona, Pennsylvania, where Joseph Wilson designed and supervised construction of the buildings. The largest manufacturer in Philadelphia, the Baldwin Locomotive Works, was located adjacent to Sellers's six-acre plant in Bush Hill, the city's main machine building district, and was a major purchaser of steam injectors and metalworking tools from its neighbor. Another Bush Hill metalworker, the United States Mint, commissioned custom-built medal presses from Sellers, while the U.S. Navy ordered specialty tools, including a 500,000-pound lathe. Sellers and Company made large cranes to order for customers including Baldwin (fig. 3), the Carnegie Steel Company, Merrick and Towne's Southwark Foundry, the Philadelphia Traction Company, and the Niagara Falls Power Company.²⁵

In 1868, Sellers and Company accepted stock as payment for a steam hammer and other tools built for the William Butcher Steel Works in the Nicetown section of Philadelphia. Four years later, William Sellers became the president of Butcher Steel and reorganized it as the Midvale Steel Works. He transformed the company into a "scientific" steel maker, hiring Yale University-trained chemist Charles Brinley to direct laboratory research, explore metallurgical practices in foundries throughout the United States, and apply his findings to the chemical standardization of iron and steel production.²⁶ Midvale furnished locomotive tires, piston and connecting rods, rails, and other steel forgings for the railroads, and it soon became the largest supplier of ordnance to the United States military. Beginning in 1880, Sellers sponsored Midvale foreman Frederick Winslow Taylor's earliest time-and-motion studies, which were based on earlier experiments at William Sellers and Company and led to the development of

South. Diane Lindstrom, *Economic Development in the Philadelphia Region, 1810-1850* (New York, 1978).

²⁵ William's second cousin and business partner Coleman Sellers was a member of the prestigious Niagara Falls Commission.

²⁶ "Journal of Activities and Memos from the Superintendents," Aug. 1876-June 1887, and notebook of Charles A. Brinley, 1873-1883, Midvale Steel Collection (misc. items box), Franklin Institute.

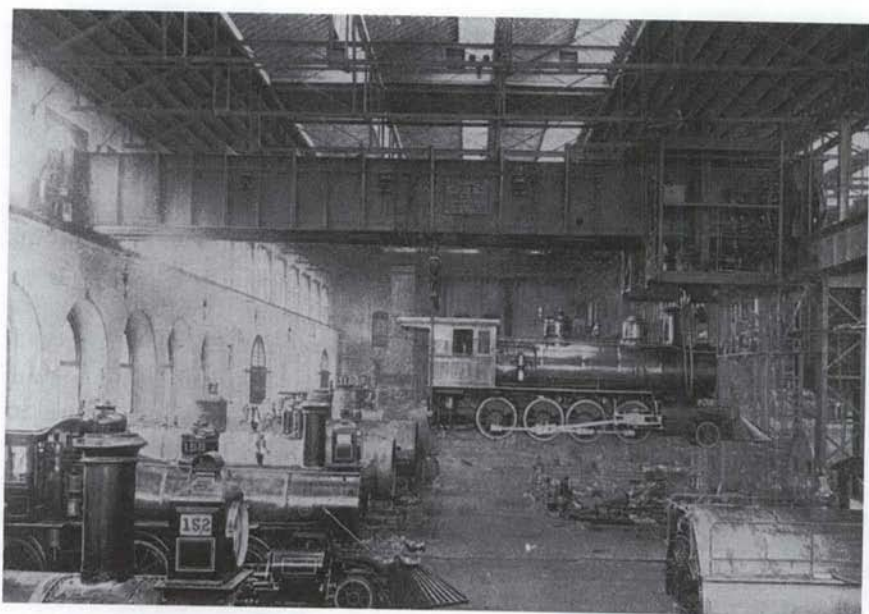


Fig. 3. Baldwin Locomotive Works erecting shop with William Sellers and Company crane, Philadelphia, c. 1885. William Sellers and Company, *Illustrated Catalogue and General Description of Improved Machine Tools* (Philadelphia, 1895), 335. University of Pennsylvania Library.

scientific management.²⁷

Sellers's third company, Edge Moor Iron, was established in 1868 outside Wilmington to address still other challenges of American industrialization:

The introduction of iron and steel into the construction of such engineering works as bridges, roofs, buildings, etc., has necessitated the establishment of manufactories devoted exclusively to this comparatively new industry, and in which the designs of engineers can be constructed in an accurate and inexpensive manner.²⁸

²⁷ Midvale Steel Company, *Fiftieth Anniversary, 1867-1917* (Philadelphia, n.d. [c.1917]), 12; Robert Kanigel, *The One Best Way: Frederick Winslow Taylor and the Enigma of Efficiency* (New York, 1997), 158-59.

²⁸ William Sellers and Co., *A Treatise on Machine Tools* (Philadelphia, 1877), 263.

At Edge Moor, Sellers furthered the standardization of building systems, particularly for the bridges, depots, and company towns along the lines of expanding railroads. Like other construction materials manufacturers, the firm soon added a department for the design and manufacture of bridges, becoming the Edge Moor Iron and Bridge Company. Beyond its countless railroad bridges, Edge Moor collaborated with Trenton's Roebling wire company to produce the structural steel for the Brooklyn Bridge. From Philadelphia's City Hall to the market hall in Demerara in British Guyana (designed by Joseph Wilson), Edge Moor Iron supplied prefabricated metal construction materials and heating and ventilation systems to build an industrial world. Furnishing the superstructure, mass-produced and specialty castings, and precise machine tools to build and drive factories, transportation and power systems, and large buildings, William Sellers's three firms operated as their own disaggregated, though coordinated, system of research, design, and production.

The private consulting firm founded by Joseph Wilson and his brothers in 1876 addressed a similar series of challenges. Merging civil engineering, architecture, and planning, "The Wilson Brothers and Company" (hereafter, the Wilson Brothers) constituted a new sort of integrated professional service provider. Its international practice developed new technological systems for central cities, suburbs, small towns, and the frontier. While William Sellers focused on the mechanics of industrialization, the Wilson Brothers applied the engineering sciences to large infrastructure and building systems.

Joseph Wilson and his brothers John (1837–1896) and Henry (1844–1910) were the fifth generation in a family of engineers going back to the seventeenth century in Scotland.²⁹ Their father, William Hasell Wilson (1811–1902), spent most of his career as an engineer for the Pennsylvania Railroad.³⁰ Following his graduation from Rensselaer Polytechnic Institute (RPI) in 1858, Joseph Wilson studied chemistry for two years at the University of Pennsylvania under Fredrick Genth (who was fired from his teaching job in 1888 for spending too much time consulting for private

²⁹ George E. Thomas, *Drexel University: An Architectural History of the Main Building, 1891–1991* (Philadelphia, 1991), 8.

³⁰ William Hasell Wilson, *Reminiscences of William Hasell Wilson, 1811–1902* (Philadelphia, 1937), 53–55.

metal manufacturers).³¹ In Genth's laboratories, he became intimately acquainted with the chemical and physical properties of iron. For the next sixteen years, Joseph worked for the Pennsylvania Railroad, designing bridges, depots, workshops, and stations. John Wilson graduated from RPI in 1856 and spent the next three years working as a topographer in Honduras for the Inter-Oceanic Railway. From 1859 until 1876, he too was employed as an engineer with the Pennsylvania Railroad and its subsidiary lines. Henry Wilson likewise went to work for the "Standard Railroad" upon his graduation from college in 1864.

Working for the railroad, particularly during the Civil War, entailed much more than ensuring the swift and safe movement of trains across the landscape by maintaining solid bridges and depots and efficient work crews. The Pennsylvania Railroad and its subsidiary lines stretched across the entire North American continent, and the war years exposed a generation of engineers and architects—including William LeBaron Jenney, Frank Furness, and Fredrick Law Olmsted—to a world in which machines altered landscapes and human life with unprecedented speed and consequences.³² In the post-war decades, the railroad's directors and affiliated financiers and industrialists developed vast tracts of suburban and frontier lands. Railroad engineers performed topographic surveys and land planning, architectural design, materials analysis, and technological systems development as ordinary parts of their job. The Wilson Brothers organized its consulting practice in 1876 to serve the same range of challenges:

Recognizing the changes that had taken place in the business of the country, and believing that the time had arrived for combining the professions of engineering and architecture in such a manner that corporations and individuals could avail themselves of the best professional advice without having to maintain an expensive staff, we associated ourselves together and offered our services to the public.³³

The partnership included two architects, Frederick Godfrey Thorn (c. 1837–1911) and Henry Macomb (1845–1933), both of whom had trained in the office of John McArthur, Jr., designing military hospitals

³¹ Jesse Y. Burk, secretary, to trustees, June 4, 1888, General Administration 1820–1930, box 22, Towne no.1 folder—1888, University of Pennsylvania Archives (hereafter, UPenn).

³² Michael J. Lewis, *Frank Furness: Architecture and the Violent Mind* (New York, 2001).

³³ The Wilson Brothers & Co, *A Catalogue of Work Executed* (Philadelphia, [1885]), 3.

during the Civil War.³⁴ Upon his graduation from the University of Pennsylvania with a degree in engineering and coursework in architecture, William Sellers's nephew, Horace Wells Sellers, joined the Wilson Brothers as a draftsman.

The firm's international practice extended from Canada to North Carolina, throughout the rapidly industrializing Midwest, to western states and territories such as Colorado, Arizona, Texas, and Oregon, and abroad to Panama, Mexico, Cuba, and Australia. The office's professional services were equally wide-ranging, including:

Designs with complete drawings and specifications prepared for all kinds of public buildings and institutions, railroad stations, stores, factories, schools, churches, dwellings and all other branches of architectural work. Also for bridges, water works, sewerage systems, steam and electrical plants and miscellaneous engineering work including surveys for railroads, etc. Materials inspected and construction supervised. Expert examinations and reports made on railroads, electrical, steam heating and sewerage plants or other investment properties.³⁵

The Wilson Brothers' practice was structured in large part around the empire of the three brothers' former employer, the Pennsylvania Railroad, and its numerous subsidiary and affiliated lines, manufacturers, and financiers. Their father's position as director of the railroad's Department of Real Estate, a post he held from 1874 to 1884, presumably aided the new firm's growth in profound, if not corrupt, ways. In Philadelphia, the firm designed office and factory buildings for the Baldwin Locomotive Works, the Railroad's principal supplier of motive power. The Wilson Brothers consulted on the design of rail spurs and loading facilities that connected all the major plants of Bush Hill to the rail lines leading to their customers.³⁶ In addition, Baldwin's directors commissioned the office to design their homes in the city, the suburbs along the Main Line of the Pennsylvania, and at the New Jersey shore. Anthony Drexel, the railroad's principal financier and a leading developer of suburbs along its commuter lines, was

³⁴ Sandra Tatman and Roger Moss, *A Biographical Dictionary of Philadelphia Architects, 1700-1930* (Boston, 1985), 788, 868-70; George E. Thomas, "Wilson Brothers (1876-1902)," in O'Gorman et al., *Drawing Toward Building*, 140.

³⁵ *Architectural Work of the Wilson Brothers & Co.*, ([published as vol. 1], Philadelphia, 1897), 3.

³⁶ E. C. Quarles, *History of the Pennsylvania Avenue Subway and Tunnel* (Philadelphia, 1899).

another of the Wilson Brothers' most active clients, commissioning designs for residential, bank, office, and institutional projects.

The Wilson Brothers focused on building *systems*. Its engineers and architects designed and supervised construction of rapid transit lines in New York and entire company towns in Illinois and Pennsylvania, "adapting the plot to the topographical features of the site, so as to provide for the contingencies of drainage, water supply, lighting, etc." In 1884, Frederick Thorn was replaced in the partnership by civil and hydrological engineer Charles G. Darrach, who organized a branch of the firm for "special reports on the commercial value of water-works already built, or proposed, in which capitalists may be thinking of investing." The office's 1885 *Catalogue of Work Executed* boasted that Darrach "had been for some ten years principal assistant engineer of the Philadelphia Water Department, a service which includes eight distinct systems of water-works of different types, and which, so far as the variety of work and experience goes, is not equaled by any other city in the world excepting London."³⁷ Because of its members' range of architectural and engineering expertise, the firm was a logical choice for clients developing power plants, laboratory buildings, and entire cities and towns' transit and utility systems.

Like William Sellers, the principals in the Wilson Brothers firm marketed and expanded their business while conducting and following research in applied science through networks of professional and learned societies. The partners' affiliations included the American Society of Civil Engineers, the American Institute of Architects, the Engineers Club of Philadelphia, the American Institute of Mining Engineers, the American Philosophical Society, the Historical Society of Pennsylvania, and the Philadelphia Art Club.³⁸ Joseph Wilson served as president of the Franklin Institute (1887-93) and contributed regularly to technical journals. The Wilson Brothers, like other innovative firms, published promotional catalogues that combined advertisement with original engineering treatises. The 1885 catalogue includes discourses on architectural theory and technical questions including a long section on strength specifications for iron bridges—a logical specialty for consultants working for railroads around the world. The firm designed the vast building for the Franklin Institute's

³⁷ *Catalogue of Work Executed*, 30.

³⁸ *Ibid.*, 1-2.

Electrical Exhibition of 1886, the first such fair in the United States, where engineers conducted cutting-edge experiments on site. Like the Centennial halls, this facility at 32d and Market Streets was built in the form of a train station with reusable parts.

The Wilson Brothers firm explained its integration of architectural and engineering services as a rational, *systematic* response to a rapidly changing world, where new materials, systems, and types of buildings had altered the process of design:

We are frequently called upon by architects standing high in their profession, and otherwise entirely competent to carry it on successfully, to furnish them with plans and calculations for roofs, girders, etc., and to figure out for them matters involving construction, which, if not properly cared for, would cause the best designs and the finest decorations to prove utter failures . . . So intimately is the constructive skill of the engineer united with the decorative and artistic taste of the architect, that we are at a loss to understand how the two professions can be successfully practised separately.³⁹

The firm employed all varieties of architectural style, from Gothic Revival to Richardsonian Romanesque to neoclassical, depending on the client and the context of the building. Recognizing that style and aesthetics helped buildings communicate their purposes, the Wilson Brothers differed from many turn-of-the-century historicist and later modernist architects by eschewing stylistic dogma.⁴⁰ In its 1885 catalogue, the firm asserted that an architect "should not allow precedent to fetter his reason or prevent him from properly adapting his work to local conditions and special wants."⁴¹ Stylistic details had their uses, but the Wilson Brothers were more concerned with developing ecological and construction systems that addressed the needs and goals of an industrializing society.

Through this work of system building, William Sellers and the Wilson Brothers most radically transformed the urban environment of their own city. Visitors to Philadelphia in 1876 could scarcely have failed to recognize that industrialization was reshaping the metropolis. Before the profession-

³⁹ Ibid., 46.

⁴⁰ For a discussion of turn-of-the-century historicism and early modern American architecture, see George E. Thomas, *William L. Price: Arts and Crafts to Modern Design* (New York, 2000).

⁴¹ *Catalogue of Work Executed*, 42-43.

alization of city planning, engineers provided the technical expertise in large-scale urban development. The formation of Fairmount Park in 1867, encompassing the Schuylkill and Wissahickon watersheds, was arguably Philadelphia's most important planning initiative of the nineteenth century. By protecting the city's water supply from upstream pollution, creating the world's largest urban recreational space (conceived as a restorative and reforming influence for the "masses"), and providing attractive sites for new middle-class neighborhoods on the borders of the park, the commissioners of Fairmount Park facilitated the city's rapid growth. William Sellers was among the civic leaders, including John Welsh and senior municipal engineer and former Pennsylvania Railroad chief engineer Strickland Kneass, who initiated the development of the park. Sellers sat on the Fairmount Park Commission's committees on Land Purchases and Damages, Plans and Improvements, Finance, and Superintendence and Police.⁴² Thirty years later, Joseph Wilson furthered this work, serving as the principal consultant on the Philadelphia Commission on the Extension and Improvement of the Water Supply.⁴³ In addition, the Wilson Brothers' designs for railroad and streetcar lines, bridges, and gas and electric power systems addressed many of the infrastructure needs of the growing metropolis.

Looking south and east from Fairmount Park in 1876, smokestacks dominated the skyline, railroad lines cut across the city's rectilinear grid of streets, and factories and warehouses clustered along the rivers and rails. Most neighborhoods were in turn oriented around these places of work in an urban ecology that was distinctively industrial.⁴⁴ On the Main Line and other routes of the Pennsylvania and the Reading, the railroads, their directors, financiers, and architects and engineers were developing elite and upper-middle-class suburbs that accelerated the dispersion and segregation of the region's population.

Downtown, at Broad and Market Streets, a mile west of the city's colo-

⁴² Fairmount Park Commission, *Annual Report, 1868*, 1, Fairmount Park Commission Annual Reports, record group 149.3, PCA.

⁴³ Philadelphia Commission on the Extension and Improvement of the Water Supply, *Report to the Honorable Samuel H. Ashbridge, Mayor* (Philadelphia, 1899).

⁴⁴ The Philadelphia Social History Project remains the classic quantitative study of this urban ecology. Theodore Hershberg, ed., *Philadelphia: Work, Space, Family, and Group Experience in the Nineteenth Century* (New York, 1981); Stephanie W. Greenberg, "The Relationship between Work and Residence in an Industrializing City: Philadelphia, 1880," in *The Divided Metropolis: Social and Spatial Dimensions of Philadelphia, 1800-1975*, ed. William W. Cutler III and Howard Gillette, Jr. (Westport, Conn., 1980), 141-68.

nial center around Independence Hall, a new City Hall was rising and a new central business district was growing up around it. Designed by the office of John McArthur to be the tallest building in the world and adorned with Alexander Milne Calder's myriad sculptures telling the story of Philadelphia's founding and growth, City Hall was intended to be the visual and symbolic center of the new city. Historians have seen the building, with its high cost, ornate exterior design, and lavish contracts for bricks, stone, and labor, as a monument to the corruption of a powerful Republican political machine. When it opened on New Years' Eve 1900, though not yet finished, City Hall had cost upwards of \$24 million, most of which went to contracting firms, quarries, and brick works owned by local political bosses. The building also illustrates the multiple, sometimes contradictory roles played by engineers and industrialists who publicly preached political reform but also gained large public contracts.⁴⁵ Despite William Sellers's membership in the anti-machine Committee of 100 and the Citizens' Committee of 95 for Good City Government, the Edge Moor Bridge Works was among the principal suppliers of iron beams and settings for the interior metal frame of City Hall's office blocks and tower.⁴⁶

Joseph Wilson served as an unpaid member of publicly appointed technical committees guiding the construction of City Hall, but his firm was also awarded contracts for specialized services to the project. In 1876, Wilson, architect Addison Hutton, and Department of Public Works engineer George Watson were appointed to a "Committee of Experts" to examine and report on the structure and materials of the building, which they oversaw for the next decade.⁴⁷ The committee ordered extensive scientific tests on the marble, bricks, and steel furnished by a long list of quarries and manufacturers, which were carried out by the United States Ordnance Department at the Watertown Arsenal in Massachusetts.⁴⁸ The Wilson

⁴⁵ Commissioners for the Erection of the Public Buildings, "A Complete Statement of all their Financial Transactions," [1901], record group 160.18, PCA; Howard Gillette, "Philadelphia's City Hall: Monument to a New Political Machine," *Pennsylvania Magazine of History and Biography* 97 (1973), 233-49.

⁴⁶ Minutes of the Commissioners for the Erection of the Public Buildings, III (1895), record group 160.1; Expenditures Journal (1872-1901), record group 160.12; City Hall Drawings and Plans (1871-1901), record group 160.20; all PCA.

⁴⁷ Minutes of the Commissioners for the Erection of the Public Buildings, I (1876), record group 160.1, PCA.

⁴⁸ "Mechanical Tests of Building Material, Made August, 1882, and November, 1883" (Philadelphia, 1884), record group 160.22, PCA.

Brothers designed an expandable and movable steel crane that lowered iron beams and blocks of the granite base and marble walls into place and was adjusted to reach new areas as the building went up (fig. 4). Serving on the Committee on the Metal Work of the Tower, as well, Wilson pushed for the radically new use of aluminum plating rather than copper, which was typically employed in construction, in order to give the tower its original metallic shine and to avoid corrosion as the building and its cast-iron sculptures weathered over time.⁴⁹

New passenger terminals of the Pennsylvania and Reading Railroads designed by the Wilson Brothers would soon provide the focal points for circulation in the professional office district around City Hall and the strip of department stores along Market Street to the east.⁵⁰ The Pennsylvania's Broad Street Station and the office towers of the downtown heralded the development of a new type of building—the skyscraper. In West Philadelphia, new campuses for the University of Pennsylvania and the Drexel Institute, designed in large part by William Sellers and the Wilson Brothers, were small urban systems in their own right and they reflected these men's intention of molding new generations of professionals and skilled operatives. Engineers were obviously not the only Philadelphians working to guide urbanization—they both competed and collaborated with mercantile and financial interests, real estate developers, and the “contractor bosses” and “utility monopolists” of the local Republican machine—but their machines and technological systems shaped much of the city's growth.⁵¹

Joseph Wilson's intimate understanding of the properties of metals prepared him to solve the challenges of designing tall buildings in innovative and explicitly practical ways. Across 15th Street from City Hall, at the head house of Broad Street Station, the Wilson Brothers designed what may have been the world's first skyscraper—defined in engineering terms as a tall building with exterior masonry walls supported by an iron frame (fig. 5). In his comments on an 1897 paper on “Steel Skeleton Construction in

⁴⁹ Minutes of the Committee on the Metal Work of the Tower (1889–1900), record group 160.9; Francis Schumann, “Monograph on the Design and Construction of City Hall Tower” (Philadelphia, 1898), record group 160.27; both PCA.

⁵⁰ Jeffrey P. Roberts, “Railroads and the Downtown: Philadelphia, 1830–1900,” in Cutler and Gillette, *Divided Metropolis*, 27–55.

⁵¹ The contractor bosses and utility monopolists are discussed in Peter McCaffery, *When Bosses Ruled Philadelphia: The Emergence of the Republican Machine, 1867–1933* (University Park, Pa., 1993).

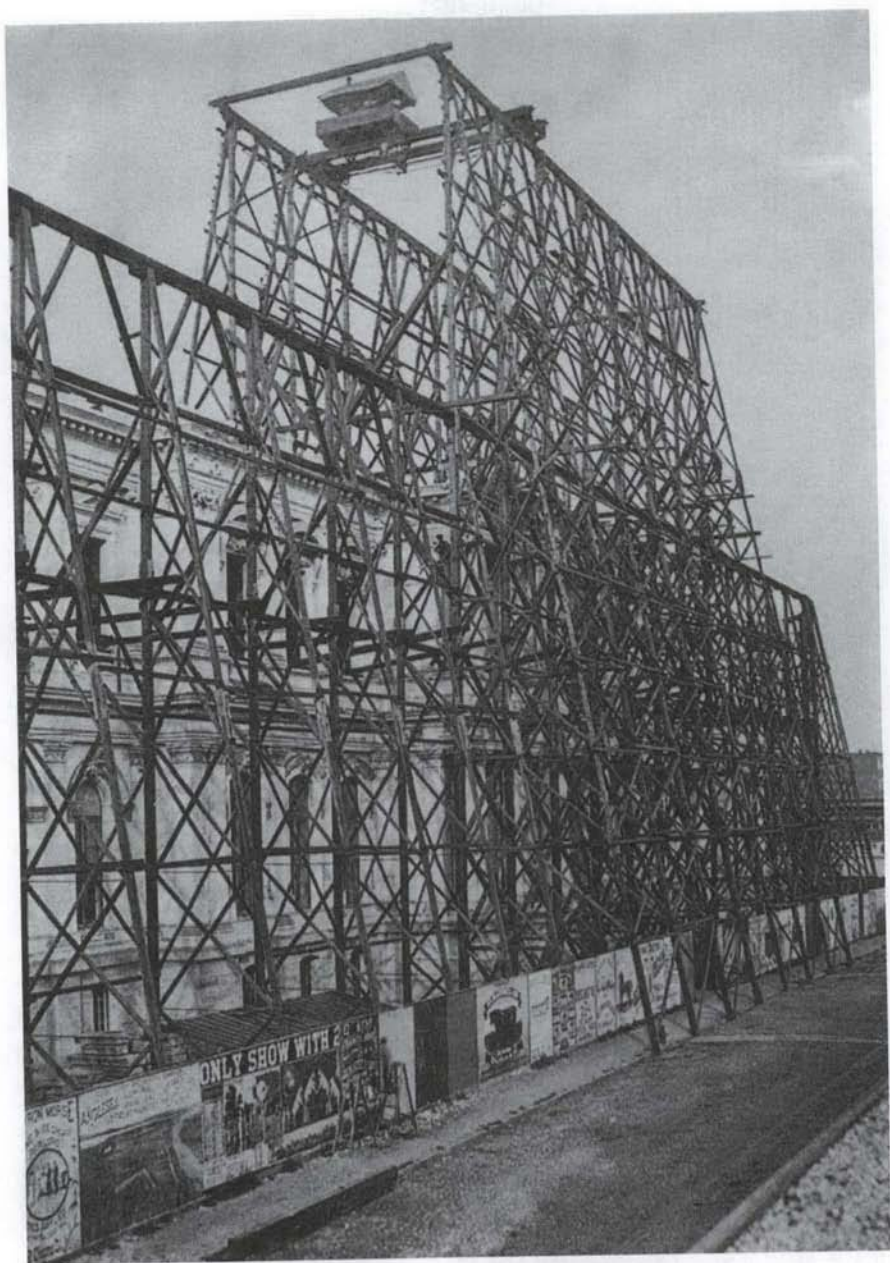


Fig. 4. Trestle work used in constructing the new City Hall, Philadelphia, c. 1880. The Wilson Brothers & Co., *A Catalogue of Work Executed* (Philadelphia, [1885]), 32E. Collection of George E. Thomas.



Fig. 5. Broad Street Station, Philadelphia, c. 1882. *Architectural Work of the Wilson Brothers & Co.*, vol. 1 (Philadelphia, 1897), not paginated. Collection of George E. Thomas.

Chicago" published by the British Institution of Civil Engineers, Wilson remarked upon the origins of skyscraper technology:

[T]he method of steel skeleton construction had been a natural growth from the substitution of iron and steel for wood, and the demand for higher buildings which the new material rendered it possible to build . . . [A]s long ago as 1873 he [Wilson] had suggested for temporary buildings of the Centennial Exhibition thin walls of brick as an outside covering, stiffened inside with timber framing, by which the roof was also to be carried . . . In 1880–81 he had used, in the construction of the Broad Street Station, Philadelphia, wrought-iron columns from the ground floor upwards, encased in masonry carrying a second floor, then extending to the third floor and carrying plate-girders, on which was built the upper part of the rear exterior wall of the building. The structure was subdivided into a series of parallelepipeds, wrought- and cast-iron columns being placed at the intersections on a similar system to that now adopted for skeleton buildings; and the interior walls and floors were carried on girders between the columns, the building being a type of the more perfect skeleton structures which came afterwards.⁵²

For Wilson, skeletal construction was neither a matter of regional aesthetic style, as historians of modern architecture have claimed, nor of technical showmanship, although the firm did stress in its 1885 catalogue that the Pennsylvania Railroad station's "iron work is all exposed to view, and decorated in colors."⁵³ Like the exposed I-beams, ironwork sprocket motifs on the stair railing, and iron framed skylights of Frank Furness and George Hewitt's Pennsylvania Academy of the Fine Arts two blocks away, the metal structure of the head house was a central element of its aesthetics. For the station's train shed, Wilson proposed a tall Gothic arch, "by virtue of its ability to withstand wind loads and its great height, which he theorized could dissipate the corrosive effects of the smoke and steam of coal-burning engines."⁵⁴ While art and aesthetics mattered to Wilson and his partners, it

⁵² Summary of Joseph Wilson's discussion of Edward Clapp Shankland, "Steel Skeleton Construction in Chicago," *Minutes of Proceedings of the Institution of Civil Engineers* 128 (London, 1897), 54–55.

⁵³ *Catalogue of Work Executed*, 49. See, for example, Sigfried Giedion, *Space, Time and Architecture: The Growth of a New Tradition* (Cambridge, Mass., 1949); Carroll L. V. Meeks, *The Railroad Station: An Architectural History* (New Haven, 1956); Leland Roth, *A Concise History of American Architecture* (New York, 1979); William H. Pierson and William H. Jordy, *American Buildings and Their Architects* (4 vols. to date, New York, 1970–). For a contemporary critique of the historical study of late nineteenth- and early twentieth-century architecture, see Thomas, *William L. Price*, 1–29.

⁵⁴ Thomas, "Design for the Main Exhibition Building," 140.

was the practical engineering demands of particular projects such as Broad Street Station that drove their innovations in architecture, including the skyscraper building system that subsequently transformed American cities.

Wilson crafted a similarly innovative solution to the peculiar structural challenges of the Drexel Building (1887–89), at a site across from Independence Hall at 5th and Chestnut Streets in what was then the city's financial district. Rather than demolishing the two-year-old, single-story bank designed and built by the Wilson Brothers, Anthony J. Drexel, Philadelphia's leading financier and J. P. Morgan's partner, asked the firm to design an office tower, part of which would rest on top of the bank. When the aptly named Independence Bank next door refused to sell, Drexel chose to build around it, creating a ten-story building with an H-shaped plan. The Wilson Brothers designed a six-and-a-half-story iron frame on top of the earlier Drexel Bank, with four-story trusses forming an A-frame on which portions of the fifth through eighth floors were hung by rods, distributing weight to the walls of the 1885 building. The same framing system was used in the new wing of the building, on the opposite side of the Independence Bank, to create a large volume for the trading floor and gallery levels of the Philadelphia Stock Exchange (fig. 6). The building's interior wall partitions were made of hollow terra-cotta blocks, and "The skeleton construction sustained the floors and division walls independently in each storey, thus allowing any arrangement of rooms and fireproof partitions, without reference to their disposition in the other storeys."⁵⁵ As a machine for office work, Drexel's office tower embodied the systematic goals of mechanical engineering that Joseph Wilson had applauded at the Centennial: "adaptation of machines to more universal use, allowing several operations to be performed on the same piece of material without dismounting it; construction of portable machinery."⁵⁶

Another Wilson Brothers skyscraper that responded to the new ecology and working life of the downtown was the Professional Building on Chestnut Street near 18th (fig. 7). Built in 1896 to house medical offices, with a pharmacy on the ground floor, it represented an early consolidation of a traditional district of professional offices into one high-rise building with

⁵⁵ Discussion of Shankland, 55.

⁵⁶ Wilson, *History, Mechanics, Science*, 17.

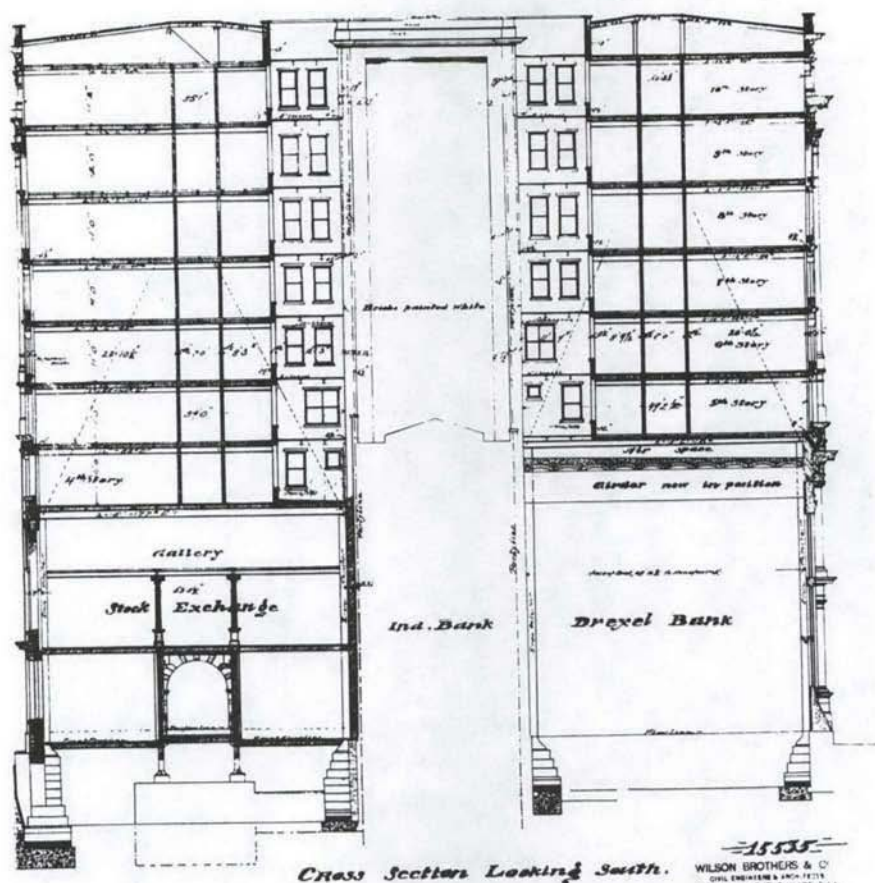
*Drexel Office Building.**Scale: Eight feet to one inch.*

Fig. 6. Wilson Brothers and Company (drawing 15535), cross section of the Drexel Building looking south, Philadelphia, c. 1887, Architectural Plans and Drawings Collection, Drexel Building folder, National Park Service, Independence National Historical Park.

shared services. (Later tall buildings in central Philadelphia created similar patterns of agglomeration among architectural firms and social service agencies.) Through the Drexel and Professional Buildings, as well as other office towers, the Wilson Brothers were at the forefront of accommodating

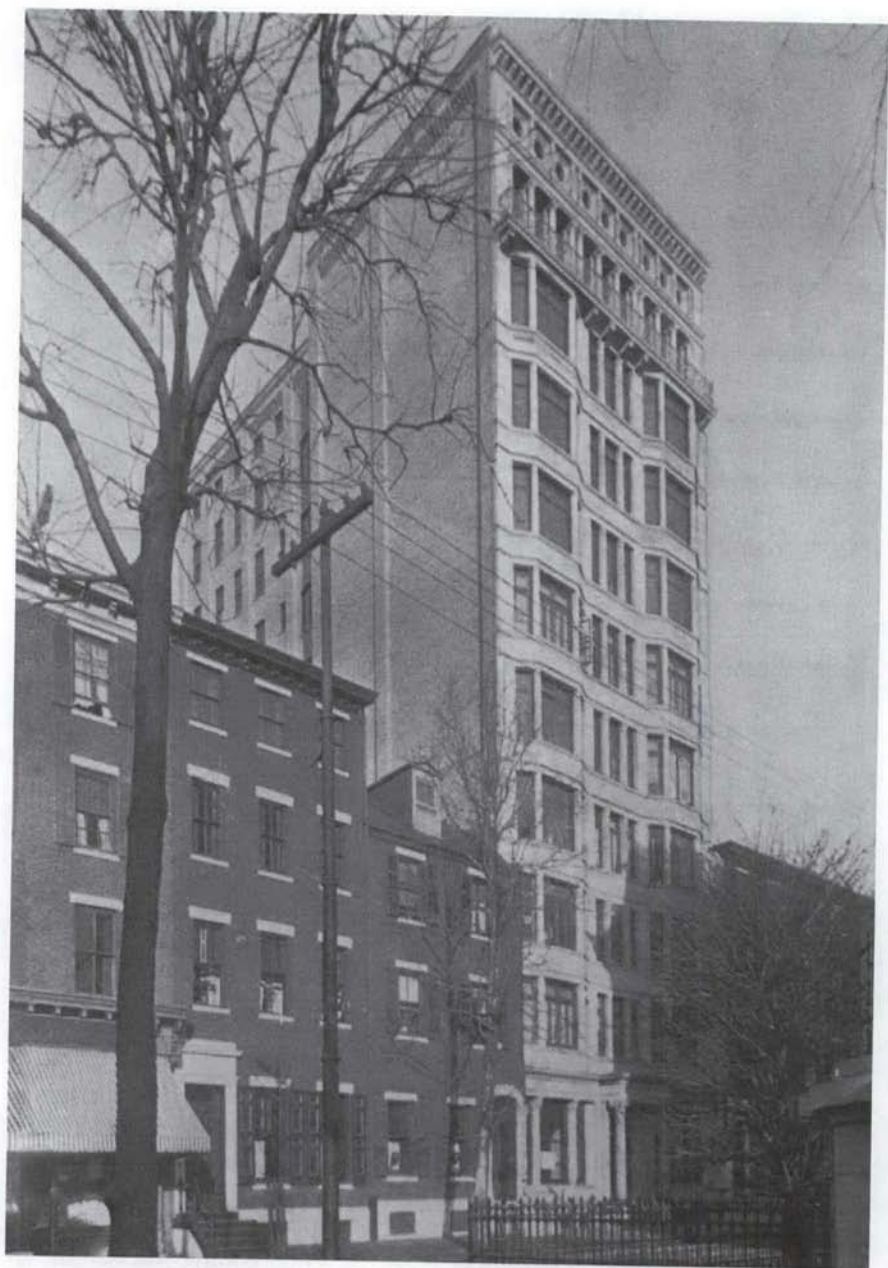


Fig. 7. Professional Building, Philadelphia, c. 1896. *Architectural Work of the Wilson Brothers & Co.*, vol. 1 (Philadelphia, 1897), not paginated. Collection of George E. Thomas.

and shaping emerging patterns of white-collar work.⁵⁷ The firm moved its own offices into the Drexel Building in September 1888.⁵⁸

The following year, Anthony Drexel called upon Joseph Wilson to explore a different set of problems facing the future of the industrial city. The banker sent his engineer and architect to Europe to tour the technical academies of England and Germany, where he gathered curricular and programmatic information for the new Drexel Institute of Art, Science, and Industry. Upon his return, Wilson published a book-length series of articles on technical education in the *Journal of the Franklin Institute*, which served as the foundation of Drexel's early curriculum. In 1891 the Wilson Brothers designed the Main Building of the new university at 32d and Chestnut Streets, complete with lecture halls, laboratories, and a grand entrance hall lit by a vast skylight.⁵⁹ As the leading engineer on Drexel's board of directors, Joseph Wilson continued to shape the school's curriculum.

Just two blocks southwest of the new Drexel Institute, the University of Pennsylvania had been led by a group of engineers and industrialists since 1868, when the new provost, Charles Stillé, appointed William Sellers to its board of trustees. In addition to his early efforts to revitalize the Department of Mines, Arts, and Manufactures, Sellers oversaw Penn's removal from the old city center to a tract purchased from the city in West Philadelphia and developed in 1870–72. Chosen to guide the design of the campus because of his "large experience in the erection of public buildings," Sellers worked closely with Franklin Institute-trained architecture professor Thomas Richards on plans for the College Hall.⁶⁰ From the grading of the site and layout of the building to the replacement of shoddy iron columns and the rebuilding of chimneys, Sellers followed every aspect of the project in minute detail.⁶¹ George Thomas has suggested that Sellers

⁵⁷ For a detailed study of the development of white-collar work, including discussion of skyscraper office environments, see Olivier Zunz, *Making America Corporate, 1870–1920* (Chicago, 1990), esp. 103–24.

⁵⁸ *Philadelphia Builder and Decorator* 7, no. 2 (Oct. 1888), 8.

⁵⁹ Thomas, *Drexel University*, *Journal of the Franklin Institute* 129, no. 2 (Feb. 1890), continued monthly until 130, no. 4 (Oct., 1890).

⁶⁰ Charles J. Stillé to Thomas W. Richards, Feb. 28, 1870, Thomas Richards Papers, UPenn.

⁶¹ General Administration Papers, 1820–1930, box 15, 1869–1873, Archives General—1870–1872, New Building folder; Minute Book of the Building Committee for the Erection of the New Building, 1870–1872; William Sellers to Thomas W. Richards, March 30, 1870, Jan. 26, March 17 and 25, and Oct. 28, 1871, Richards Papers; all UPenn.

was responsible for the extensive (and relatively new) use of iron in the building, including cast iron columns in the main entrance hall, treads and balusters on the stairs, cast iron piers framing the windows of the central corridor, and large brackets that "reduce the span of ceiling timbers in the large classrooms."⁶² Sellers's intense involvement in the development of College Hall and the university's academic programs reflected his approach to engineering the future of the city. Speaking at the inauguration of the new building, Franklin Institute president (1870-74) Coleman Sellers articulated a vision shared by his second cousin in his assertion that Penn was "a mechanism, the object of which is to shape, to mold, minds into usefulness."⁶³

Together with Franklin Institute colleagues Frederick Fraley, Eliot Cresson, John Henry Towne, J. Vaughan Merrick, and Fairman Rogers, William Sellers led the boards of Stillé and his successor, William Pepper, in promoting and redefining technical education at Penn's Towne School of Engineering. They used the university as a laboratory for innovative research in the applied sciences, collaborating with the faculty to explore problems encountered in their consulting practices and on the shop floors of their factories. Professor Edgar Marburg, who had begun his career at the Edge Moor Iron Company, furthered Sellers's work by "overseeing technical committees on the standard specifications for iron and steel and on concrete and reinforced concrete" at both Penn and the Franklin Institute. In 1898, Marburg further institutionalized this mission by co-founding the American section of the International Association for Testing Materials (later the American Society for Testing Materials).⁶⁴

Towne was the engineering school of choice for the sons of Philadelphia industrialists, offering students unparalleled hands-on experience with machines in the laboratories and power station designed by the Wilson Brothers in 1889-91.⁶⁵ Sellers and former Franklin Institute president (1867-69) J. Vaughan Merrick headed the building committee for the complex,

⁶² George E. Thomas and David B. Brownlee, *Building America's First University: An Historical and Architectural Guide to the University of Pennsylvania* (Philadelphia, 2000), 59.

⁶³ Coleman Sellers's address in University of Pennsylvania, "Proceedings at the Public Inauguration of the Building Erected for the Departments of Arts and Sciences, October 11, 1872," Richards Papers, UPenn.

⁶⁴ Thomas, *William L. Price*, 121; Thomas and Brownlee, *Building America's First University*, 213-14.

⁶⁵ An explosion caused by a student experiment destroyed the classroom and laboratory building in 1906.

determining at the outset that:

the Station should be arranged so that it might form a prominent means of educating the students in Engineering, both Mechanical and Electrical . . . Accordingly the boilers and machinery were so diversified in type, that comparisons and tests could be conducted on a large scale . . .⁶⁶

Edge Moor Iron built and installed two Galloway boilers, of which it was the sole U.S. manufacturer, as well as steam supply, drip, and bleeder pipes, blow-off wells, and additional apparatus to carry heat to the surrounding buildings.⁶⁷ Sellers and Merrick not only made certain that the plant heated and lit all of the university's existing facilities but built it to accommodate future construction on the expanding campus.⁶⁸

Situated at the prominent corner of 34th and Spruce Streets, the heat and light plant took the form of a machine shop, while the adjacent engineering school building resembled a factory office block (fig. 8).⁶⁹ Sellers and Merrick determined that by locating the plant in the heart of the campus rather than along the nearby railroad tracks, the greater efficiency of transmitting steam to university buildings at close range would more than offset the cost of hauling coal over a greater distance. The prospect of building an industrial facility alongside College Hall and the library designed by Frank Furness did not appear to factor into this decision.⁷⁰ The power plant's smokestack towered over the campus, announcing the university's industrial purpose on the city's skyline.

As they worked to industrialize the North American continent, Philadelphia engineers and manufacturers collaborated to mold a new urban

⁶⁶ J. Vaughan Merrick and William Sellers to the Board of Trustees of the University of Pennsylvania, Dec. 28, 1893, Miscellaneous Contracts, UPenn; Announcement of mortgage bond, General Administration Collection (1830-1920), box 23, 1891—Buildings and Grounds folder, UPenn.

⁶⁷ Contracts between the trustees of the University of Pennsylvania and Edge Moor Iron Co., Sept. 12, 1892, Miscellaneous Contracts, UPenn.; Richard Wood, acting treasurer, University of Pennsylvania, to Edge Moor Iron Co. [William H. Connell, treasurer], Dec. 12, 1892, and Wilson Brothers and Co. to Richard Wood, March 29, 1893, Contracts box, Light and Heat folder no. 2, UPenn.

⁶⁸ J. Vaughan Merrick to Wilson Brothers and Co., May 15, 1889, Pepper Collection, UPenn.; Wilson Brothers and Co. [Charles Darrach] to J. Vaughan Merrick, Aug. 15, 1891, Collection of the Office of the Treasurer, Heat and Light Plant folder, UPenn.

⁶⁹ Thomas and Brownlee, *Building America's First University*, 73.

⁷⁰ J. Vaughan Merrick and William Sellers to the trustees of the University of Pennsylvania, March 25, 1891, General Administration Collection (1830-1920), box 23, 1891—Buildings and Grounds folder, UPenn.



Fig. 8. University of Pennsylvania Heat and Light Plant, c. 1892. University of Pennsylvania Archives.

environment that reflected their systematic visions of the city and its growth. The machines and technological systems pioneered by William Sellers and Joseph Wilson and applied to the construction of railroads, bridges, and buildings by their firms served to integrate the continent's diverse economy and transform its ecology. Together with their colleagues, Sellers and Wilson developed institutional networks to promote their business and social concerns, using technical education to shape the future of engineering and industry, and organizing events such as the Centennial and Electrical exhibitions to promote their city and foster new phases of industrialization. In their mechanical, architectural, and civic endeavors, they were *engineering* the metropolis.

At the close of the Centennial Exhibition in November 1876, a group of men, including Baldwin Locomotive Works partner Charles T. Parry, publisher Charles Lippincott, Strickland Kneass, and Henry Pettit, formed the International Exhibition Company. They purchased the Main Building from the Board of Finance and negotiated with the Fairmount Park Commission to keep it on Lansdowne Plateau. Noting that the fair had

served "to create a demand for many works of industry and fine art which had heretofore not found a market in this country," the company announced its intention "to continue the good effects derived from the Centennial, by affording unusually favorable facilities to manufacturers and producers to bring their wares to the further notice of the public."⁷¹ Its circular depicted a map of the shipping facilities on Philadelphia's two rivers, inviting industrialists and merchants to a global marketplace.

The International Exhibition Company kept the largest building in the world open for five years, maintaining several popular exhibits from the fair, installing the world's largest roller-skating rink, and hosting concerts, theatrical events, and holiday celebrations, most notably on Independence Day. In the spring of 1881, the company advertised the sale of the Main Building, "either as a whole or in parts," which it stressed was "so constructed that the columns and trusses can be easily taken down and erected at another site." Oil company director J. L. Mitchell purchased and agreed to dismantle the entire structure, presumably to furnish mass-produced iron parts for the building boom going on around his headquarters at Bradford in northwestern Pennsylvania, the "oil capital of the world."⁷² Whatever their ultimate destination and use, Edge Moor Iron's standardized columns and trusses had not only built the Centennial halls, they remained part of technological and building systems that served and shaped the broader industrialization of North America.

University of Pennsylvania

DOMENIC VITIELLO

⁷¹ The company allowed manufacturers to exhibit their wares at no charge, taking a 5 percent commission on products ordered and 10 percent on goods sold on site. International Exhibition Company, *Official Bulletin of the International Exhibition* (Philadelphia, 1877), 4, Centennial Collection, Philadelphia Permanent Exhibition, HSP.

⁷² International Exhibition Company, *Catalogue for the Sale of the Building of the International Exhibition Company* (Philadelphia, 1881), 7, Centennial Collection, Philadelphia Permanent Exhibition, HSP; "Under the Hammer: Selling Centennial Relics," *Philadelphia Evening Bulletin*, Oct. 13, 1881, 1; Ernest C. Miller, ed., *This Was Early Oil: Contemporary Accounts of the Growing Petroleum Industry, 1848-1885* (Harrisburg, 1968), 53.

