HISTORIC AMERICAN ENGINEERING RECORD

ST. CHARLES AIR LINE BRIDGE

HAER No. IL-157

Location:	Spanning S. Branch of Chicago River, N. of 16th St., Chicago, Cook County, Illinois.
USGS Quadrangle:	Englewood, Illinois (7.5-minute series).
UTM Coordinates:	16/447370/4634315
Dates of Construction:	1917-1919; relocated 1930.
Designer:	Strauss Bascule Bridge Co. (Chicago).
Fabricator:	American Bridge Co. (Gary, Indiana).
Builders (original):	Foundation Co. (Chicago), substructure; Ferro-Construction Co. (Chicago), superstructure.
Builders (relocation):	E. J. Albrecht Co., substructure; Strobel Steel Construction Co. (Chicago), superstructure.
Present Owner:	Canadian National Railway (Montréal, Quebec).
Present Use:	Railroad bridge.
Significance:	Like all Strauss heel-trunnion bascule bridges, the St. Charles Air Line Bridge rotates vertically, lifting to clear the river it spans. This particular bridge is unique, however, in that its design anticipated a one-time horizontal movement — to a new, straighter channel of the Chicago River. Its original 260'-0" leaf exceeded the previous world record by 30'-0", but was shortened by 40'-0" during the move. The bridge represents Strauss' first use of air-buffered pistons on the operating struts. It is also significant for the railroad it carries, an unusual "gentlemen's agreement" between four of Chicago's earliest railroads.
Historian:	Justin M. Spivey, January 2001.
Project Description:	The Chicago Bridges Recording Project was sponsored during the summer of 1999 by HABS/HAER under the general direction of E.

Blaine Cliver, Chief; the City of Chicago, Richard M. Daley, Mayor; the Chicago Department of Transportation, Thomas R. Walker, Commissioner, and S. L. Kaderbek, Chief Engineer, Bureau of Bridges and Transit. The field work, measured drawings, historical reports, and photographs were prepared under the direction of Eric N. DeLony, Chief of HAER.

CHRONOLOGY

1849	St. Charles Branch Railroad chartered.
1853	St. Charles Branch Railroad changes name to Chicago, St. Charles & Mississippi Airline Railroad.
1854	Galena & Chicago Union Railroad (G&CU) acquires rights to charter of Chicago, St. Charles & Mississippi Airline Railroad.
1856	Illinois Central Railroad (IC) forms St. Charles Air Line Railroad (SCAL) partnership with G&CU and other railroads, constructs wooden swing bridge across South Branch of Chicago River.
1882	Central Bridge Co. builds new 295'-0"-long iron swing bridge for SCAL.
1898	SCAL elevates tracks, adjusting swing bridge to new grade.
14 Mar. 1912	U.S. Army Corps of Engineers orders removal of SCAL swing bridge.
23 Mar. 1914	City council passes Union Station ordinance, obliging railroads to cooperate in future straightening of South Branch of Chicago River.
Oct. 1917	Foundation work for new SCAL bridge begins.
Oct. 1918	Erection of new SCAL bridge superstructure begins.
Aug. 1919	Construction of new SCAL bridge complete.
8 Jul. 1926	Chicago City Council passes river straightening ordinance.
Aug. 1928	Excavation of new river channel commences.
1929-1930	SCAL bridge moved to new location across new channel.
31 Jul. 1931	Affiliated track elevation work complete.
Jul. 1999	Canadian National Railway acquires IC.

Introduction

The St. Charles Air Line Bridge has spanned two different waterways, or more accurately, two incarnations of the South Branch of the Chicago River. When completed in 1919, the world's longest bascule bridge provided a 200'-0"-wide clear channel for boats navigating what, despite dredging and dock walls, still resembled a meandering prairie stream in its geometry. The St. Charles Air Line Railroad (SCAL) emerged from a nineteenth-century tangle of tracks and streets on one side of the river, crossed the bridge, and disappeared into a similar knot on the other side. Between 1928 and 1930, this location underwent radical change when the city of Chicago transformed part of the South Branch into a straight channel of uniform cross-section. Meanwhile, the city required many railroad companies to build grade-separated street crossings, which indirectly resulted in the untangling of complex rail junctions as well. The straightened river, flowing directly south, and the railroad, rebuilt on a east-west alignment, paralleled the city's street grid. The SCAL bridge, relocated to span the new channel, became a valve between two perpendicular conduits, opening and closing to regulate flows of commerce on river and rails.

The SCAL bridge also spanned two modes of transportation regulation in Chicago. Its initial construction occurred during a period of bridge replacements intended to remove man-made obstructions from Chicago's rivers. With the River and Harbor Act of 1899, the U.S. War Department could require cities and railroads alike to remove swing bridges with obstructive mid-channel piers. Removal orders reached a peak during the first decade of the twentieth century. The record length of the SCAL's bascule bridge, completed in 1919, was motivated primarily by federal requirements for a clear river channel. Built-in provisions for future relocation, however, were a response to local authority. Since the mid-nineteenth century, the city of Chicago had proficiently used its own regulatory power to rationalize transportation systems, particularly railroads. In straightening the South Branch of the Chicago River, the city surpassed the War Department in removing obstructions. Carefully crafted municipal ordinances not only organized the clutter of railroad yards and terminals south of the Loop, but also opened land for the southward growth of downtown Chicago.[1] Relocation of the SCAL bridge in 1930 demonstrates the city's power over the landscape.

The St. Charles Air Line Railroad

The SCAL is less than a mile long and crosses only one waterway, the South Branch of the Chicago River, at its western end. Nonetheless, as railroad historian Fred Ash began his description of the line, the SCAL "may be Chicago's most interesting and least known railroad." Despite its importance to rail traffic in Chicago, it has neither rolling stock nor yard facilities. Foremost among its apparent contradictions, "it is not even a corporation."[2] From its inception in

---

[1] This land remains empty, as the anticipated growth has yet to occur.

[2] Fred Ash, "The Airline across Chicago," *Green Diamond* 43 (Nov. 1996): 4.

1855, the SCAL existed as a "gentlemen's agreement" between four connecting railroads: the Chicago, Burlington & Quincy (CB&Q); the Galena & Chicago Union (G&CU); the Illinois Central (IC); and the Michigan Central (MC). The Chicago & North Western Railway (C&NW) acquired the G&CU in 1864 and assumed its share in the SCAL partnership. As part of the agreement, each of the partners paid equal shares of the construction and operating costs. Because the IC's personnel usually performed construction and maintenance work, it has often been incorrectly credited with ownership.

Although the SCAL follows part of the intended route of a similarly named line, the St. Charles Branch Railroad, the two are not directly related. Chartered in 1849, the St. Charles Branch Railroad would have run from the shore of Lake Michigan to the Mississippi River and competed with Chicago's only other railroad then in existence, the G&CU. But while the G&CU was already running trains, the St. Charles remained a paper railroad throughout its short existence. The St. Charles did little work except to survey its route and change its name to the more imposing Chicago, St. Charles & Mississippi Airline Railroad in 1853. The G&CU eliminated its would-be competitor by purchasing the rights to the St. Charles' charter on 10 April 1854.[3] Although the latter corporation ceased to exist, two disconnected portions of its route were eventually built by others: along Sixteenth Street from Lake Michigan to the Chicago River, and from the town of Elgin to the Mississippi.

The Sixteenth Street route had shown increased promise when construction began on Chicago's second railroad, the IC. Federal legislation specified a north-south route from Cairo to Dunleith (across the Mississippi from Dubuque), with a branch to Chicago, and provided the nation's first railroad land grant in 1850. A state charter reiterated this route and incorporated the IC the following year.[4] The need for a South Branch crossing at Sixteenth Street was created, albeit indirectly, by fiat of the Chicago City Council. Roswell B. Mason, chief engineer of the IC, wanted to build a terminal adjacent to the G&CU's to facilitate transfers between the two lines.[5] The city had other ideas, however. An ordinance granting the IC permission to lay tracks in the city, passed on 14 June 1852, was perhaps the first to require a railroad to make heavy expenditures on the city's behalf. Not only did it specify that the railroad enter along the shore of Lake Michigan, but the route also happened to be under water north of Twelfth Street (since renamed Roosevelt Road). The embankment thus required would serve the double purpose of carrying the IC's tracks and protecting Chicago's central business district from storm damage. According to railroad historian James E. Vance, Jr., the MC, which shared the IC's tracks into Chicago, "saw [this] as an outright holdup by the city to make a corporation provide what the

---

[3] Ash, "The Airline," 8-9.

[4] John F. Stover, "Illinois Central Railroad," in Robert L. Frey, ed., *Encyclopedia of American Business History and Biography: Railroads in the Nineteenth Century* (New York: Facts on File, 1988), 193.

[5] William K. Ackerman, *Early Illinois Railroads*, Fergus Historical Series, No. 23 (Chicago: Fergus Printing Co., 1884), 41-42; James E. Vance, Jr., *The North American Railroad: Its Origin, Evolution, and Geography* (Baltimore: Johns Hopkins Univ. Press, 1995), 140.

municipality should have supplied."[6] Another consequence was that these two railroads were separated by the Chicago River from the G&CU's terminal, which was after 1852 shared by the CB&Q.

The means of connecting these four railroads was not the St. Charles Branch Railroad's charter, but a clause in the 1852 city ordinance. In compensation for denying the IC its preferred terminal site, the city granted permission for a connecting line along Twelfth Street. Given that the CB&Q's tracks west of the river were more in line with Sixteenth Street, Mason recognized that as the better location for a bridge across the South Branch of the Chicago River. With less than one mile of track, he could connect the shared IC-MC tracks on the east bank with the G&CU on the west bank, via the CB&Q. On 27 August 1855, Mason secured the city's permission to build in the block between Fifteenth and Sixteenth streets, rather than in the middle of Twelfth Street. With all four railroads sharing the cost, construction proceeded quickly. The link opened to traffic on 30 March 1856, and though it "had no aspirations of serving the town of St. Charles," was called the SCAL.[7]

Crossing the South Branch

The SCAL's original configuration, one track crossing streets and other railroads at grade, sufficed for mid-nineteenth-century traffic. "It must be noted," wrote Ash, "that according to the business practices of the period, there was almost no interchange of freight."[8] Instead, the CB&Q moved out of the G&CU's crowded Wells Street Station and into the terminal shared by the IC and MC, becoming the heaviest user of the SCAL in its early years. Other railroads entered Chicago in the following decades, with some using the SCAL bridge and others adding to the complicated grade crossings at either end. By 1881, the bridge had become the limiting factor in the SCAL's capacity. Although the line had been double-tracked in 1869, the bridge remained a single-track wooden swing span, which according to contemporary accounts "was open for boat traffic far more than it was closed."[9] Railroads responded by finding terminals elsewhere. Following the 1880 reconstruction of Union Station on the west bank, the CB&Q became a tenant there and stopped running passenger trains on the SCAL. Union Station housed a number of other railroads entering Chicago from the west, all of which would rather have passengers find their own way across the river than vie for space on the SCAL's crowded bridge.[10]

Perhaps in response to the CB&Q's move, the SCAL partners contracted with the Central Bridge Company to build a new double-track span in 1882. This 295'-0"-long steel swing bridge was unusually long for Chicago in the 1880s because it crossed the South Branch at an extreme

---

[6] Vance, *The North American Railroad,* 140.

[7] Ash, "The Airline," 11-12.

[8] Ash, "The Airline," 11.

[9] Ash, "The Airline," 13-17.

[10] Vance, *The North American Railroad,* 142-43.

skew. Although the SCAL ran east-west as it does now, the river followed a different course then, flowing roughly northeast toward Lake Michigan. Even with two tracks, the bridge's capacity was still limited by its frequent openings and complicated approaches. Growing interchange traffic between Chicago railroads warranted other crossings of the South Branch. Most important to the SCAL bridge's later history was a swing bridge near Taylor Street, constructed by the Chicago & Great Western Railroad circa 1885.[11] This span was located six blocks north of the SCAL's, crossed the river on a similarly extreme skew, and provided a more direct westward connection from Chicago's central business district. Ironically, an eastern railroad, the Baltimore & Ohio Railroad's Chicago Terminal route (B&OCT), began using the bridge near Taylor Street in 1890. In order to reach the new Grand Central Station on the east bank, B&OCT trains ran over what Vance called "a very circuitous access line."[12] Rather than enter the already complicated junction at the SCAL's eastern end, the B&OCT crossed the river twice and skirted the SCAL considerably to the west.

Track Elevation

It seemed that the railroads would rather work around the SCAL's problems than construct the expensive grade separations necessary to solve them. Their reluctance continued into the 1890s, when Chicago officials began to clamor for the removal of railroads from city streets. While track elevation did impose a large financial burden, railroads willingly removed street crossings on long stretches of main line to provide faster and safer operation. The first ordinance, in May 1892, accepted the IC's voluntary offer to elevate its tracks through the Hyde Park neighborhood, speeding service to the World's Columbian Exposition. The regulatory climate changed in February 1893, however, when the City Council passed an ordinance requiring track elevation city-wide within six years. Although this proved to be unenforceable, it provided the basis for dozens of later ordinances authorizing voluntary track elevation on a line-by-line basis.[13] Grade separation proceeded most slowly in terminal areas, however, where railroads were hesitant to spend money on changes that would not make a large difference in operating speed.

Nowhere was the lack of progress more evident than the complex junctions at either end of the SCAL. Because these occurred in areas crossed by few city streets, a municipal response was slow in coming. The western junction, in fact, was not substantially altered until the late

---

[11] George M. Campbell, "A Historical Sketch of the Baltimore & Ohio Chicago Terminal Railroad Company and Its Predecessor Companies," paper presented at the Chicago Chapter of Railway & Locomotive Historical Society (11 Apr. 1947), 1, Reference Collection, Chicago Historical Society, Chicago, Ill. This bridge was also known by the names of its other tenants, the Chicago Terminal Transfer Railroad and the Wisconsin Central Railroad.

[12] Vance, *The North American Railroad,* 142-43.

[13] "Track Elevation in Chicago," *Engineering Record* 59, No. 22 (29 May 1909): 679-80; "Track Elevation in Chicago," *Railroad Gazette* 30, No. 2 (14 Jan. 1898): 21.

1920s. According to Ash, the railroads largely ignored consulting engineer E. I. Corthell's 1891 recommendations for improvement, and the issue languished. The eastern end showed greater promise, with the SCAL partners hiring another consultant, John F. Wallace, for a track elevation study in 1894. Wallace's plan earned the approval of city officials, but stalled when other railroads refused to cooperate.[14] When the city finally took action in 1896, it was because the eastern junction had become an impediment to eliminating street crossings elsewhere. Because railroad tracks crossed in three different directions near the intersection of Sixteenth and Clark streets, not including a streetcar line on Clark Street itself, any alteration would have far-reaching effects. An article in *Railway Review* identified thirteen different railroad companies present in what was "easily the worst crossing in existence, and a most difficult one to rearrange with a view of the separation of the grades." The railroads were reluctant to do anything until the city forced the issue by mandating that all trains stop before crossing the streetcar tracks. The move was ostensibly for safety's sake, but as *Railway Review* acerbically reported, "The result had the effect desired by the city authorities and the engineers of the roads concerned are now engaged upon a plan."[15]

After considerable discussion, the railroads arrived at the plan that was codified in a city ordinance on 17 May 1897. It stipulated that tracks running from southwest to northeast, belonging to the Atchison, Topeka & Santa Fe Railway among other lines, would be depressed below city streets. The SCAL's east-west tracks would be elevated along their entire length, crossing above city streets from the IC interchange to the South Branch bridge. Tracks in the third direction, heading north-south to serve LaSalle Street Station, would also be elevated to the same level. While these tracks would still cross the SCAL's, the total number of intersecting tracks was drastically reduced, and no track would cross Clark Street at grade.[16] Work began in April 1898, under the supervision of James Dun, the Santa Fe's chief engineer. Trade journals published lengthy articles describing the project, which took four months to complete.[17] The SCAL bridge over the South Branch of the Chicago River, which was immediately adjacent to the project, had to be raised about six feet in conjunction with the track elevation work. But because the junction at its western end remained at ground level, the bridge also had to accommodate a descending grade. Instead of re-working the floor system, the unusual solution was to insert wedge-shaped castings between truss and turntable, so that the entire span tilted by

---

[14] Ash, "The Airline," 18-21.

[15] "Track Elevation in Chicago," *Railway Review* 36, No. 2 (11 Jan. 1896): 17.

[16] "Track Elevation in Chicago," *Railway Age and Northwestern Railroader* 23, No. 22 (28 May 1897): 440-41.

[17] "Track Elevation and Depression at the 16th St. Crossing, Chicago," *Engineering News and American Railway Journal* 40, No. 2 (14 July 1898): 22-23; "Track Elevation in Chicago," *Railway Age and Northwestern Railroader* 26, No. 4 (29 July 1898): 534-36; G. W. Vaughn, "Joint Track Elevation and Depression at Sixteenth and Clark Streets, Chicago," *Journal of the Western Society of Engineers* 3, No. 6 (Dec. 1898): 1362-75.

about 0.5 degrees.[18] The track elevation work smoothed operations on the SCAL, including the swing bridge, which did not have to open so often because of its increased height.

A New Bridge, a New River

While the bridge's vertical clearance had been improved, its horizontal clearances soon became deficient in light of changing standards for river navigation. There were certainly worse obstructions on the South Branch in 1898, but these were eliminated over the following decade. A double-leaf Scherzer bascule replaced the B&OCT's bridge near Taylor Street in 1901. In conjunction with increasing the river's flow to supply the Sanitary and Ship Canal, the Sanitary District of Chicago constructed double-leaf bascule bridges at Harrison, Polk, Taylor, and Eighteenth streets during the first decade of the twentieth century.[19] Except for the Twelfth Street bridge, every obstruction identified by an 1897 Army Corps of Engineers survey had been eliminated from that part of the South Branch.[20] In 1911, the Twelfth Street and SCAL bridges stood out as the last remaining center-pier swing bridges north of Eighteenth Street. Representatives from industries dependent on river trade turned to their usual federal allies, the Army Corps and its parent agency, the U.S. War Department, with demands for the bridges' removal.

The Army Corps' role in Chicago River navigation had increased throughout the nineteenth century. Although the Army began improving the Chicago River in 1833, when soldiers at Fort Dearborn first attempted to straighten the river where it entered Lake Michigan, it did not use federal appropriations for improvements beyond the river's mouth until 1896.[21] During this time the agency did exert some control over the river, although one annual report hints that the Chicago District had trouble enforcing a "mandate" regarding the city's Canal Street Bridge and laws against dumping in the river.[22] Toward the century's end, however, declining river trade highlighted the Chicago River's problems. The district engineer's recommendations against swing bridges with mid-channel piers appear to have effectively

---

[18] H. W. Parkhurst, "Track Elevation of the St. Charles Air Line," *Journal of the Western Society of Engineers* 3, No. 6 (Dec. 1898): 1358-60.

[19] Joan E. Draper, *Chicago Bridges* (Chicago: Schumacher and Bowman, Inc., 1984), 37. W. W. Wilson, "Types of Movable Bridges,"*Journal of the Western Society of Engineers* 19, No. 6 (June 1914): 564.

[20] See G. A. M. Liljencrantz, "Obstructive Bridges and Docks in the Chicago River," *Journal of the Western Society of Engineers* 3, No. 3 (June 1898): 1058.

[21] Congress first asked the Chicago District engineer to report on potential river improvements in 1892, and began to provide funding with the River and Harbor Act of 1894; see U.S. Army, Corps of Engineers, *Annual Report of the Chief of Engineers to the Secretary of War for the Year 1897* (Washington, D.C.: U.S. Government Printing Office, 1898), 2:2794. This money was not used until 1896, however; see ibid., *Annual Report ... for the Year 1901* (Washington, D.C.: U.S. Government Printing Office, 1902), 1:529.

[22] U.S. Army, Corps of Engineers, *Annual Report ... for the Year 1893* (Washington, D.C.: U.S. Government Printing Office, 1894), 4:2799.

prevented their construction after 1890.[23] The River and Harbor Act of 1899 gave the Secretary of War authority to order bridges removed, and imposed his approval as a necessary step in constructing bridges over navigable waterways.[24] As amended by Congress in 1906, the process of replacing an obstructive bridge began with a petition from shipping interests, triggering a public hearing, the usual outcome of which was an order for the bridge's removal. Often the bridge's owner conferred with local Army Corps officials on the design of a replacement span. Once the design met his requirements, the Secretary of War granted a permit for construction, which had to begin within one year and be complete in three.[25]

These rules would have been followed with the Twelfth Street and SCAL bridges, had the city of Chicago not intervened. It might seem surprising that a municipality could derail a federal process, but Chicago had developed plans to straighten the South Branch, promising an improvement beyond what the Army Corps' limited funding could provide. While city officials worked out plans to relocate the river, the federal government obliged them by granting the bridges a lengthy stay of execution. Although the Secretary of War had originally ordered the Twelfth Street bridge's removal by the end of 1912, this deadline was extended twice, to the end of 1918.[26] The SCAL bridge evidently received similar extensions. When World War I made it obvious that river straightening might not occur for a decade or so, the city encouraged the design of bridges that not only met federal requirements for the existing river, but also could be moved to span the proposed new channel.

River Straightening and City Development

As can be imagined, straightening the river had far-reaching consequences for the SCAL and other railroads whose property abutted the old channel. Although it would certainly improve navigation, moving the South Branch was — perhaps more importantly — a means to accomplish other municipal goals including a consolidation of railroad facilities and southward expansion of the central business district. A complete discussion of these issues is beyond the scope of this report, but their impact on the SCAL and its bridge is considerable enough to warrant a quick summary.

Debate over the future of Chicago's railroad terminals swelled in the wake of the World's Columbian Exposition in 1893. Although the Exposition is most well-known for generating interest in urban planning nationwide, it also had the more practical consequence of calling

---

[23] U.S. Army, Corps of Engineers, *Annual Report ... for the Year 1900* (Washington, D.C.: U.S. Government Printing Office, 1901), 5:3869.

[24] "An Act Making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," 3 Mar. 1899, *Statutes at Large* 30 (1899), 1121 et seq.

[25] "An Act To regulate the construction of bridges over navigable waters," 23 Mar. 1906, *Statutes at Large* 34 (1906), 86.

[26] Hugh E. Young, "Problems Encountered in the Design of 12th Street Bridge," *Engineering World* 15, No. 1 (1 July 1919): 17.

attention to Chicago's disorganized transportation facilities. The unprecedented number of people arriving from around the country at six different stations, all trying to get to the Exposition grounds in Jackson Park, revealed the shortcomings of a system built by the uncoordinated efforts of private enterprise. In his exhaustive 1943 dissertation on the city's railroad network, geographer and Chicago regional planner Harold M. Mayer explained the rationale behind half a century's worth of proposals for consolidating railroad facilities. Passenger and freight terminals were clustered around the central business district and along the Chicago River's branches, an artifact of the city's early history, when industrial activity and rail-water transfers were concentrated at the center. In the twentieth century, many Chicagoans came to perceive that downtown land occupied by railroads was wasted on unnecessary duplication of facilities, and could be put to better use.[27] In addition to the official Chicago Plan published in 1909, numerous architects, engineers, and railroad executives put forth alternate proposals. While these plans disagreed on the number and location of consolidated facilities, they shared the common goal of opening up more downtown land for development.

The large block of railroad-owned land south of Twelfth Street, with its inscrutable jumble of tracks and structures, was a popular target for criticism. Given that the central business district was constrained by water on its other three sides, southward movement of the city's core was a fundamental assumption of most terminal consolidation plans.[28] This idea earned the stamp of officialdom in Daniel H. Burnham and Edward H. Bennett's 1909 *Plan of Chicago,* which observed that because of a bend in the South Branch, only four streets continued southward from the Loop. With their characteristic geometric rationality, the two architects proposed straightening the river and adding north-south thoroughfares west of Clark Street.[29] The straightened river consequently appeared in the alternate proposals as well, making it seem inevitable that the SCAL bridge would have to be moved.

Because the terminal consolidation plans depended upon the cooperation and financial resources of railroad companies, they were prone to disruption by one or more railroads acting independently. Such a challenge came in May 1913, when the three railroads using Union Station incorporated a not-for-profit holding company to construct new, separate passenger and freight terminals.[30] In response, the City Council established a Committee on Railway

---

[27] Harold M. Mayer, "The Railway Pattern of Metropolitan Chicago" (Ph.D. diss., Univ. of Chicago, 1943), 128-31.

[28] One plan had a western emphasis instead; see Allen B. and Irving K. Pond, "Proposal for the Reorganization of the Railway Terminals Of Chicago," in City Club of Chicago, *The Railway Terminal Problem of Chicago: A Series of Addresses before the City Club, June Third to Tenth, 1913, Dealing with the Proposed Re-Organization of the Railway Terminals of Chicago, Including All Terminal Proposals Now before the City Council Committee on Railway Terminals* (Chicago: Univ. of Chicago Press, 1913), 41-54, Municipal Reference Collection, Chicago Public Library, Chicago, Ill. (hereinafter cited as MRC).

[29] Daniel H. Burnham and Edward H. Bennett, *Plan of Chicago, Prepared under the Direction of the Commercial Club During the Years 1906, 1907, and 1908* (Chicago: Commercial Club of Chicago, 1909).

[30] "Relocating of Chicago Railway Terminals," *Railway Age Gazette* 54, No. 22 (30 May 1913): 1187.

Terminals, which in turn hired John F. Wallace as its engineering consultant. Wallace interpreted his task as bringing the Union Station Company's plans into alignment with the general goals of the Chicago Plan. His compromise solution was to agree that the passenger station should be rebuilt at Canal and Adams streets, as this would form a railroad center with the C&NW's recently completed (1911) terminal at Canal and Madison. The company's proposed freight terminal, however, should be moved further south, with depressed rather than elevated approaches.[31] Frustrated by Wallace's complicity with the railroads, prominent Chicagoans formed the Citizens' Terminal Plan Committee and hired a well-known city planner, Bion J. Arnold, as their consultant.[32] In contrast to Wallace's pragmatism, Arnold made the forward-looking suggestion that Union Station be located at Twelfth and Canal instead. Doing so would preserve the Chicago Plan Commission's vision of three consolidated terminals south of Twelfth Street, in preparation for long-term expansion of the central business district in that direction.[33] Furthermore, he objected to the freight terminal because it would present an obstacle to westward development.

Because of Arnold's involvement, Union Station negotiations soon began to involve the SCAL. Although the city let the Union Station Company build a new passenger station on the Adams Street site, the authorizing ordinance omitted the freight terminal and demanded a number of concessions which Arnold had suggested in his dissenting report. Most important among these was "an agreement to co-operate with the other railroads affected, and with the city, in straightening the south branch of the Chicago River."[34] When the City Council passed the Union Station ordinance on 23 March 1914, it was written so as to be invalid unless the railroads agreed its terms. Because the CB&Q was a partner in both the Union Station Company and the SCAL, the ordinance indirectly obliged the other SCAL partners to move the bridge if and when the river was straightened. A similar ordinance, passed on 19 February 1915, affected the B&OCT and its bridge near Taylor Street.[35] Both ordinances bound the railroads to cooperate for a period of fifteen years. The Railway Terminal Commission, appointed by the City Council to study the impacts of the Union Station ordinance, submitted a report the following month. In addition to suggestions for terminal consolidation, the report also included plans for re-allocating

---

[31] "Wallace Report on Chicago Railroad Terminals," *Engineering Record* 68, No. 18 (1 Nov. 1913): 486-87.

[32] "Comprehensive Investigation of the Chicago Terminal Situation," *Engineering Record* 68, No. 9 (30 Aug. 1913): 226.

[33] "Future Development of Chicago Terminals," *Railway Age Gazette* 55, No. 23 (5 Dec. 1913): 1079.

[34] "Mr. Arnold's Report on Chicago Terminals," *Railway and Engineering Review* 53, No. 47 (22 Nov. 1913): 1091.

[35] Citizens Committee on River Straightening, *River Straightening* (Chicago: 1925), 3, MRC; cf. City of Chicago, City Council, *Proceedings* (1914-15), 3693-94.

railroad property after moving the river.[36] Because of America's escalating involvement in World War I, however, all plans were temporarily shelved.

Selecting a Designer

The needs of wartime shipping made the War Department all the more insistent that the South Branch be cleared of obstructions. With the new channel on hold, this meant that the Twelfth Street and SCAL bridges over the old channel would still have to be replaced. Both the city and the railroad faced the daunting prospect of constructing a bridge not only movable in the traditional sense, but also capable of being moved to a different site. While the SCAL's decision process is less well documented, the city's Engineer of Bridge Design, Hugh E. Young, described his experiences with the Twelfth Street Bridge in an article for *Engineering World.* He first considered the city's usual double-leaf bascule design, but it would be too expensive to demolish and rebuild counterweight pits for the new channel. Cable-driven vertical-lift spans were an increasingly popular movable bridge technology, but Young dismissed them as unreliable. He went so far as to order plans for a patented direct-lift bridge using levers rather than cables, but "various civic organizations" objected to its appearance. His final choice was a single bascule leaf with its counterweight pit on the west side of the old channel, which could be reversed within the same pit to become the eastern half of a double-leaf bridge over the new channel.[37] The IC's engineers may have considered many of the same options before arriving at a similar plan for the SCAL bridge. They decided to build a single bascule leaf on the west side of the old channel, which would be widened to 200'-0" in accordance with War Department orders. The bridge would be located where it could be swung around to span the new channel, also 200'-0" wide. Given the difficulty of designing a double-leaf bridge rigid enough to carry railroad traffic, however, the single leaf would be long enough to span either channel, old or new. To accomplish this feat, it would have to be 260'-0" long, which was 30'-0" more than the longest bascule leaf then in existence.

To design this record-breaking span, the IC turned to the engineers of the previous record holder, the Strauss Bascule Bridge Company. (Ironically, Strauss also designed the ill-fated direct-lift version of the Twelfth Street Bridge.) Strauss' patented bascule bridge designs had made rapid increases in length over the previous decade and a half. His first such bridge, for the Wheeling & Lake Erie Railroad (W&LE) at Cleveland in 1904, measured 150'-0" from trunnion to tip of leaf. A bridge for the C&NW at Kinzie Street in Chicago, completed in 1908, was 20'-0" longer and represented an important second step in Strauss' development of the heel-trunnion

---

[36] City of Chicago, Railway Terminal Commission, *Preliminary Report, Chicago Railway Terminal Commission: Submitted to the City Council Committee on Railway Terminals, March 29, 1915* (Chicago: Chicago Railway Terminal Commission, 1915), MRC.

[37] Young, "Problems Encountered," 24 et passim.

type.[38] As will be explained below, this type overcame certain limitations of Strauss' earlier designs to allow further increases in length. The C&NW may have used its positive experiences with Strauss bridges to influence the other SCAL partners. By far the most convincing proof of Strauss' capabilities, however, was the B&OCT's 230'-0" heel-trunnion span over the Calumet River. As *Engineering Record* reported in December 1913,

> It is notable not only for its dimensions but for the fact that since its completion last February the superstructure has been left standing open with the main trusses in a nearly vertical position without endangering its safety or stability and without prejudice to its future operations.[39]

The B&OCT bridge's survival of this unexpected predicament, caused by a delay in removing a nearby swing bridge, demonstrated the stability of a long Strauss bascule leaf when fully open. This feature would be essential to erecting the SCAL bridge in an upright position (avoiding interference with river traffic), and also to the proposed relocation, which would involve rotating the entire superstructure, locked in an upright position, through a horizontal angle of 160 degrees. Although the span was never moved in this way, it is important to keep in mind that design proceeded on the assumption that it would be. So far as the author could determine, the 260'-0" single-leaf record was never surpassed, although Strauss did design a 336'-0" double-leaf span at Sault Ste. Marie for the Canadian Pacific Railway, completed in 1913.[40]

"Chiefly a Human Dynamo"

Biographies of Joseph Baermann Strauss focus on his five-foot height, as if a need to compensate for it motivated his mechanical ingenuity, ceaseless invention, and political acumen. On the fiftieth anniversary of San Francisco's Golden Gate Bridge, one publication directly linked his ineligibility for the University of Cincinnati football team to his desire "to build the biggest thing of its kind that a man could build."[41] But Strauss' success stems from his keen understanding of the kinematics of complex moving structures. About 150 patents, from window sashes to prison doors, and amusement rides to airplanes, attest to his obsession with movement and balance. Some of Strauss' patents cover the use of concrete in structures and vehicles,

---

[38] See Justin M. Spivey, "Chicago & North Western Railway, Kinzie Street Bridge," HAER No. IL-142, Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior.

[39] "Largest Bascule Bridge," *Engineering Record* 68, No. 25 (20 Dec. 1913): 697.

[40] Joseph B. Strauss, "Bascule Bridges," in *Proceedings of the Second Pan American Scientific Congress*, ed. Glen L. Swiggett (Washington, D.C.: U.S. Government Printing Office, 1917), 6:315.

[41] Dixie W. Golden, "A Man and His Bridge," in *A Golden Gate Jubilee, 1937-1987* (Cincinnati: College of Engineering, Univ. of Cincinnati, 1987), 3, quoted in Henry Petroski, *Engineers of Dreams: Great Bridge Builders and the Spanning of America* (New York: Alfred A. Knopf, 1995), 274.

showing a facility with that material as well. These two interests came together in Strauss' work with bascule bridges, which started in Chicago and spread throughout the world.[42]

Born in Cincinnati on 7 January 1870, Joseph B. Strauss belonged to a talented family of musicians and artists. "In spite of his natural artistic and literary learnings," wrote one biographer, "Mr. Strauss early showed a strong bent for mechanics and the sciences."[43] Although this flattering quote appeared in a company brochure, there could be some truth to the author's assertion that Strauss' youth was spent observing mechanics and engineers at work. Strauss proceeded through public schools to the University of Cincinnati, where he took part in student activities both technical and literary. His years as Class President indicate an ego suited to politics; as Class Poet, a confidence in written and verbal expression. After presenting a thesis on bridging the Bering Strait, he received a civil engineering degree in 1892. These were the makings of the Golden Gate Bridge's Chief Engineer, a role which Strauss played as more of a promoter than a designer.[44]

Strauss' years between Cincinnati and San Francisco are of greater concern to this report. After graduating from college, he worked for two years with the New Jersey Bridge & Iron Company in Trenton, then returned to teach for one year at his alma mater. He must have arrived in Chicago with his new bride, college sweetheart May Van, around 1895. Employment at Lassig Bridge & Iron Works, then at the Chicago Sanitary District, led to work on movable bridges at Ralph Modjeski's engineering firm in 1899. According to engineering historian Henry Petroski, Strauss left because his ideas about concrete counterweights and trunnion bearings gained little acceptance there.[45]

Petroski implied that Strauss went directly to independent practice in 1902, but the Western Society of Engineers' member directories tell a different story. Strauss became a member of the society on 8 December 1899, and is listed as "Bridge Engineer, Monadnock Block" in its 1900 and 1901 directories. If he was then with Modjeski's firm, it seems odd that his employer's name was not mentioned. The next year, the listing changes to "Chief Engineer, Hall Bascule Bridge Co., 97 Washington St."[46] Departure from this firm, not Modjeski's, must

---

[42] For example, a list of Strauss bridges under construction in June 1925 shows projects in the U.S., Canada, Egypt, and Japan. See A. B. Reeve, "The Story of Strauss Bridges," typescript (Chicago: Strauss Bascule Bridge Co., n.d.), 29, private collection of Eric N. DeLony.

[43] Reeve, "The Story of Strauss Bridges," 17.

[44] See Petroski, *Engineers of Dreams*, 272-85, for more about Strauss' work on the Golden Gate Bridge.

[45] Petroski, *Engineers of Dreams*, 275. Petroski evidently agreed with Strauss' critics, calling his overhead-counterweight Fourth Street Bridge (San Francisco, 1916) "nondescript if not downright ugly"; see ibid., 273.

[46] Western Society of Engineers, *Fifteenth List, Western Society of Engineers: Constitution, By-Laws, List of Officers and Members, June 1900* (Chicago: 1900), 33; ibid., *Sixteenth List ... August 1901* (Chicago: 1901), 32; ibid., *Seventeenth List ... July 1902* (Chicago: 1902), 40. "Hall" might be a misspelling of Rall Bascule Bridge Co., which held the patent for a rolling-lift design that receives some attention in Strauss' histories of bascule bridge design; see Strauss, "Bascule Bridges," 6:309-10; ibid., "The Bascule Bridge in Chicago," in John H. Jones and Fred

be the basis for the 1902 date in Petroski's book, which also appears in Strauss company brochures. Strauss is listed as "Consulting Engineer, Opera House Block" in the 1903, 1904, and 1905 directories; the next year's issue contains the first mention of Strauss Bascule & Concrete Bridge Company (incorporated 1904). According to one company brochure, Strauss subsequently dropped "Concrete" from the name to reflect a focus on bascule spans. This occurred in 1910 or 1911.[47] By that time, Strauss' bascule bridge designs had earned six U.S. patents and attention in the national engineering press.

Strauss' engineering firm achieved financial success with a strong belief in intellectual property, reinforced by patents and defended by patent-infringement suits. Although bridge engineers had sought exclusive rights to their designs as early as 1841, when Squire Whipple was granted U.S. Patent No. 2,064 for "Construction of Iron-Truss Bridges," Strauss took it to new extremes. A Strauss Bascule Bridge Company brochure produced circa 1925 devoted three pages to the subject of patents, including a portrait of Donald M. Carter, the company's patent attorney.[48] Strauss' most well-known patent-infringement lawsuits were against the city of Chicago in 1913 and against Seattle in 1921. Strauss claimed that both cities had constructed bascule bridges with trunnion supports similar to his U.S. Patent No. 995,813, without paying royalties for using the design. The courts decided against Chicago, and Seattle settled out of court.[49] As the defensive tone of Strauss' brochure might indicate, the lawsuits earned him criticism from some fellow engineers, while others would have agreed with his desire to recoup the expense of a long-term effort to improve the bascule bridge.

The engineering profession's debate over proprietary designs neither began nor ended with Strauss' bascule bridges. As early as 1902, discussions in the American Society of Civil Engineers' *Transactions* pitted pro-patent engineers against those who felt that the existence of proprietary designs "lowers the dignity of the profession."[50] Citing the medical profession's ethical restriction on patenting medical instruments, opponents claimed that engineering patents impeded progress toward public good. Another important point of dispute was whether engineers made unfair gains by charging royalties for proprietary designs. A powerful counter-argument, in the words of engineer S. Whinery, was that engineers "must have some assurance that, after they have spent large sums for the development and introduction of the invention, they

---

A. Britten, ed., *A Half-Century of Chicago Building* (Chicago: 1910), 92.

[47] Reeve, "The Story of Strauss Bridges," 18. "Strauss Bascule Bridge Co." first appears in Western Society of Engineers, *Twenty-Eighth List ... 1911* (Chicago: 1911), 57.

[48] Reeve, "The Story of Strauss Bridges," 54-56.

[49] "Chicago Settles with Strauss for Infringing Bridge Patent," *Engineering News-Record* 85, No. 24 (9 Dec. 1920): 1158; "Eight Years of Litigation over Seattle Bascule Bridges,"*Engineering News-Record* 103 (19 Dec. 1929): 968.

[50] James Owen, discussion following Archibald R. Eldridge, "Is It Unprofessional for an Engineer to Be a Patentee?," *Transactions of the American Society of Civil Engineers* 48 (1902): 325.

will be able to prevent competitors from robbing them of the reward."[51] Undoubtedly, Strauss' continual improvement of the bascule bridge was financed by the dozens of clients who chose to pay for his proprietary design. As stated in Strauss' brochure, clients chose patented designs in an open market, therefore "the only hope for a patented product lies in its ability to do things at less cost or to do them better."[52]

Evolution of Strauss' Heel-Trunnion Design

The SCAL bridge's record-setting length, as noted above, was made possible by Strauss' heel-trunnion bascule bridge design. Before describing the process of development, however, a basic identification of design issues is necessary. A bascule bridge is defined by a movable span, or leaf, rotating about a horizontal axis. Usually the work of rotation is made easier by balancing the leaf with a counterweight on the other side of the axis. The axis can be either stationary, where the leaf rotates about a fixed trunnion, or moving, where the leaf rocks or rolls along a track. Almost all of Strauss' bascule bridges have fixed trunnions, where the structure's weight is always delivered to the foundation at the same point. Strauss was granted a patent for an electromagnet-driven rolling bascule bridge in 1908, but no such spans were ever constructed.[53] For the most part, Strauss recognized and avoided the troublesome situation of a rolling leaf imposing a moving load on its foundation. Another major variable in bascule bridge design is the connection between the leaf and its counterweight. If rigidly attached, the counterweight must descend while the leaf ascends, requiring a pit below the roadway level. To reduce the pit's depth, the counterweight arm can be made shorter, but then the counterweight must be proportionately heavier. This is because balance is dictated by not only weight, but also the distance at which the weight is located from the axis of rotation. As an alternative to rigid attachment, the counterweight could be connected to the leaf by mechanical links and kept above the roadway level. Without the restrictions of a pit, the counterweight could be made any size, a significant improvement because concrete is significantly less expensive — but significantly less dense — than steel or pig iron.

The idea of a separate counterweight did not originate with Strauss, but he did make significant advances in the design of mechanical links. In essays on the history of bascule bridges, Strauss and his contemporaries listed numerous means of ensuring that the counterweight balanced the leaf throughout its range of motion. These included weights rolling down sinusoidally curved tracks, suspended from ropes wound around spiral drums, or divided into segments and dropped in sequence.[54] Strauss' early schemes were no less inventive. In

---

[51] S. Whinery, discussion following Eldridge, "Is It Unprofessional?," 323.

[52] Reeve, "The Story of Strauss Bridges," 55.

[53] Joseph B. Strauss, "Bascule Bridge," U.S. Patent No. 894,239, 28 July 1908.

[54] H. S. Prichard et al., "Lift Bridges — a Discussion,"*Proceedings of the Engineers' Society of Western Pennsylvania* 25, No. 1 (Feb. 1909): 20 et seq.; Strauss, "Bascule Bridges," 6:304 et seq.

1901, he patented a bascule bridge with counterweights that descended in the river as the span opened, so their downward pull was reduced by buoyant force.[55] This impractical design was never built, but he soon hit upon the parallel-link concept that made him famous. Strauss freely acknowledged a basic similarity between his bascule designs and nineteenth-century Dutch bridges, both of which included a parallelogram-shaped configuration of links.[56] He claimed originality, however, in configuring the movable truss and the trunnion supports so that the counterweight could occupy most of the span's width and yet pass beneath the trunnions during rotation. This arrangement permitted a large (i.e., concrete) counterweight with a minimum of pit excavation. Although Strauss' infringement suits were based on a 1911 patent, this same feature also appears in a patent issued eight years earlier.

As with many design patents, the text of U.S. Patent No. 738,954 makes vague claims with the hope of protecting the widest possible range of designs. The drawings, of bascule leaves with counterweights below deck, do not even show the classic Strauss parallelogram of counterweight links. The configuration is more accurately described as a quadrilateral that collapses into a triangle when the bridge is fully open.[57] Even so, the links force the counterweight to remain vertical, using the full effect of its weight to balance the leaf in any position. By the time that Strauss had constructed the W&LE bridge in Cleveland, he had adopted the parallel arrangement of links to support an overhead counterweight. Demonstrating the flexibility of his patent's claims, Strauss implied that it protected the W&LE bridge. "Although thus first applied in the overhead type of bridge in 1904," he wrote, "the pin-connected concrete counterweight was originally proposed by the writer for the underneath counterweight type of bascule in 1901 in a series of plans ... later embodied in patent application No. 738,954."[58] The Kinzie Street Bridge's design can also be considered as a descendant of this patent, even though the trunnion sits above the leaf rather than below it. Strauss applied for a patent to protect the overhead-trunnion version of his design in March 1908, but it was not issued until August 1915.[59] By that time, the Strauss bascule bridge had evolved once more to the heel-trunnion type.

Another patent applied for in March 1908 embodies the essential features of the heel-trunnion design. Its distinguishing feature is the separation of leaf and counterweight loads to opposite sides of the supporting tower.[60] This concept is illustrated in Figure 1, which shows the SCAL bridge in three positions: closed, open halfway, and at its maximum inclination of 83 degrees to the horizontal. In earlier Strauss bridges, the leaf supported the counterweight

---

[55] Joseph B. Strauss, "Bridge," U.S. Patent No. 668,232, 19 Feb. 1901.

[56] Strauss, "Bascule Bridges," 6:305, 314.

[57] Joseph B. Strauss, "Bridge," U.S. Patent No. 738,954, 15 Sep. 1903.

[58] Strauss, "Bascule Bridges," 6:313.

[59] Joseph B. Strauss, "Bascule Bridge," U.S. Patent No. 1,150,643, 17 Aug. 1915.

[60] Joseph B. Strauss, "Bridge," U.S. Patent No. 974,538, 1 Nov. 1910.

directly, and practically all of the bridge's weight passed through the main trunnions. It would have been difficult to fabricate trunnions, or members to support them, for longer spans. To solve this problem, Strauss rearranged the characteristic parallelogram so that the counterweight no longer formed one side. In the heel trunnion design, a rocking truss, essentially a large lever with the tower as its fulcrum, allows the counterweight to descend on one side of the tower while the leaf ascends on the other. Strauss also moved the leaf out in front of the tower, with the end of its lower chord pivoting on a main trunnion which sat directly on the foundation. In the analogy of a tapping foot, the trunnion occurs at the heel, so this new form was called a heel-trunnion bascule bridge. This helped to remedy a deficiency shared by the W&LE and Kinzie Street bridges: their leaf and tower trusses did not lie in the same plane.[61] Because the leaf truss had to pass through the tower in earlier designs, it was offset from the tower trusses on either side, subjecting the trunnions to a high shearing force. Because its main trunnions are concentrically loaded, however, the heel-trunnion design is not as adversely affected by the pounding of passing trains. The live-load pedestal required on earlier bridges could therefore be eliminated.[62] More importantly, the heel-trunnion bascule bridge required main trunnions proportionately smaller than its predecessors, allowing great increases in span length over the following decade. As stated in the patent, "This construction is particularly adapted for large and massive structures."[63]

[61] Strauss, "Bascule Bridges," 6:314.

[62] This feature appeared in the Kinzie Street Bridge; cf. claim 15 in Strauss, "Bascule Bridge," U.S. Patent No. 1,150,643.

[63] Strauss, "Bridge," U.S. Patent No. 974,538.

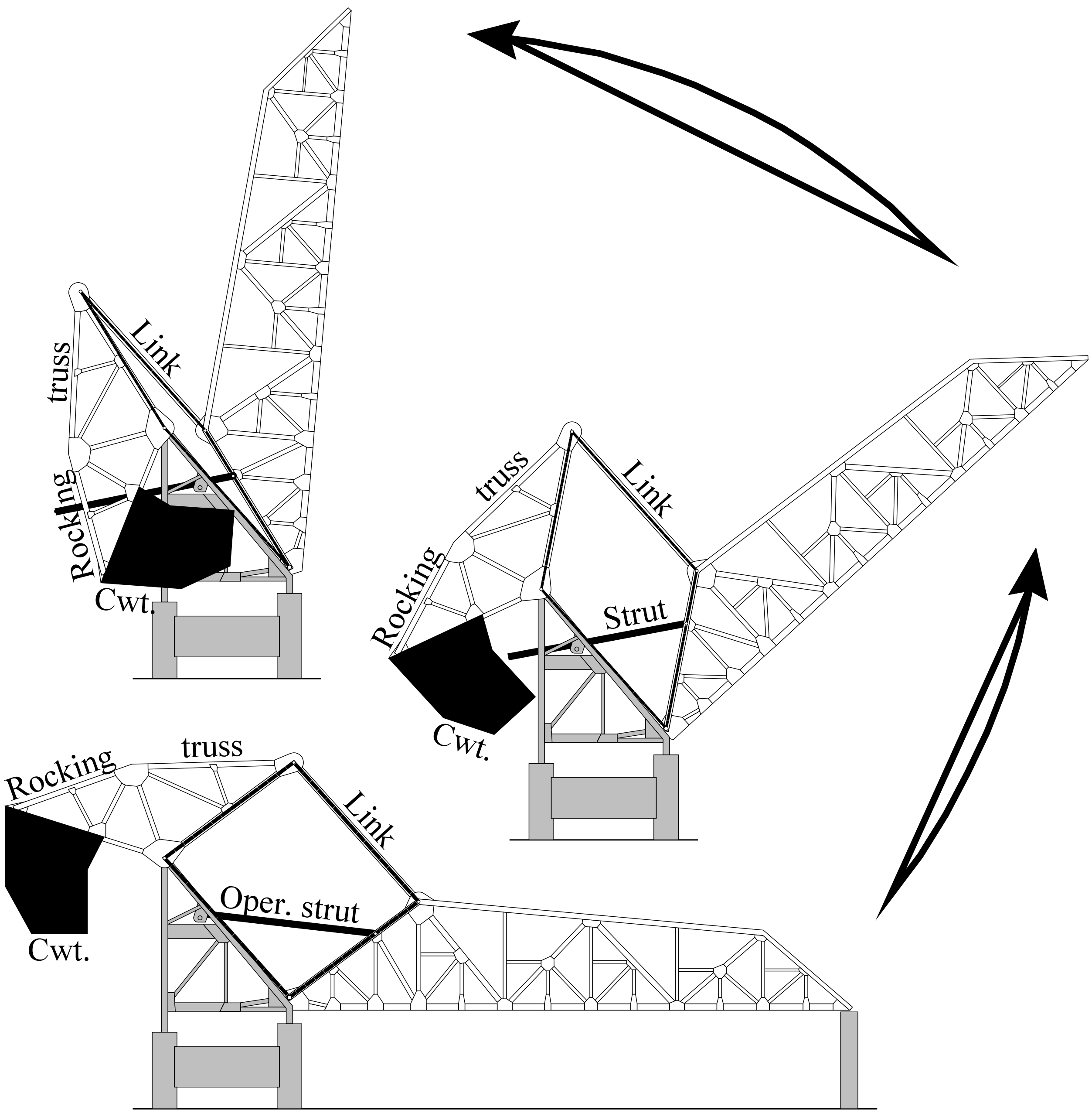

Figure 1. Schematic of SCAL bridge in 1919 (not to scale), with stationary parts in grey tone. Sketch by author.

Strauss made several changes to the heel-trunnion design between his patent in 1908 and the SCAL bridge constructed roughly a decade later. Most remarkable among these is the introduction of two wing-style counterweights swinging downward on either side of the tower, rather than a single massive block swinging between its legs. The change was a trade-off. In the patented configuration, all three trusses — leaf, tower, and rocking truss — lie in the same vertical plane, with the single block counterweight between them. The counterweight trunnions are loaded concentrically and the same benefits accrue as described above for the main trunnions.[64] Unfortunately, space inside the tower's clearance envelope is limited, so the counterweight can only be so heavy. In order to balance longer spans, the counterweight must be heavier, with a center of gravity further from the trunnion, or both. The wing counterweights answer this need, but introduce two undesirable features. First, the rocking truss must be spaced further apart than the tower trusses, requiring a heavy girder to support the cantilevered counterweight trunnions. On the SCAL bridge, the leaf and tower trusses are 32'-4" apart, the rocking trusses are 42'-4" apart, and the girder supporting the counterweight trunnions is an impressive 14'-0" deep.[65] Strauss subsequently applied for a patent on the wing-type counterweight, which was not granted until 1926. His patent drawings show four wings, one on either side of each tower leg, which permitted a return to co-planar trusses.[66] A second negative consequence of wing counterweights is that they might be so large as to swing below the deck level, requiring shallow pits on either side of the abutment. As a compensating advantage, however, wing counterweights do not obstruct the roadway. This feature found use on the C&NW's bridge at Deering Station in Chicago, which is relatively short at 186'-0", but has wing counterweights. In this case, the span was erected in the open position on the same alignment as an old swing bridge, where a single block counterweight would have obstructed rail traffic.[67]

Strauss made other improvements to the heel-trunnion bascule's operating mechanism during the decade leading up to the SCAL bridge. His writings do not mention where the heel-trunnion design was first implemented, but other sources seem to point toward a 160'-0" span for the Northern Pacific Railway over the west channel of the Duwamish River at Seattle. This and other early heel-trunnion bridges had machinery on the moving leaf that engaged operating struts attached to the tower. Conventional wisdom held that machinery should be kept in a fixed orientation, so Strauss later reversed this arrangement.[68] Another improvement was the addition of air-buffered pistons to slow the span toward the end of its movement. Originally these were installed only at the tip of the leaf, where they were compressed against the abutment to keep the bridge from slamming shut. Strauss always asserted, however, that "in practice the balancing of

---

[64] Philip L. Kaufman, "The 'Heel Trunnion' Bascule Bridge," *Engineering News* 67, No. 18 (2 May 1912): 833.

[65] "Longest Single-Leaf Bascule Bridge: Chicago River," *Engineering News-Record* 83, No. 22 (25 Dec. 1919): 1058-59.

[66] Joseph B. Strauss, "Bridge," U.S. Patent No. 1,583,705, 4 May 1926.

[67] O. F. Dalstrom, "The 186 Foot Bascule Bridge of the C. & N. W. Ry., over the North Branch of the Chicago River at Deering," *Journal of the Western Society of Engineers* 22, No. 7 (Sep. 1917): 461.

[68] "Bascule Bridges," *Engineer* (London) 115 (28 Mar. 1913): 341; Kaufman, "The 'Heel Trunnion' Bascule Bridge," 830.

the bridge is such as to render these cylinders precautionary only."[69] The SCAL bridge was the first to have air-buffered pistons mounted on its operating struts as well. As the span reached its fully open position, the pistons hit against a bumper on the tower and prevented a sharp impact.[70] Like their counterparts at the tip of the leaf, these were considered to be a precaution. Ideally, the counterweight balanced the leaf so precisely that operating machinery moved the span by simply overcoming friction in the trunnions. This was not true in actual operation, where the machinery worked against unbalanced forces such as wind or the weight of water, dirt, or snow that might have accumulated on the span. On previous Strauss bascule bridges, the leaf was held open against these unbalanced loads by brakes acting on the motors and drive train. (Most, if not all, Strauss bridges are held closed by latches or wedges at the tip of the leaf.) Braking the drive train was not particularly safe, and risked burning out the motors. For the heel-trunnion design, Strauss devised brakes that acted on the operating struts; this invention was protected by a 1917 patent.[71] The buffers and brakes appearing on the SCAL bridge constitute a set of safety devices that define the mature Strauss heel-trunnion design.

The St. Charles Air Line Bridge of 1919

The SCAL's record-breaking bridge received extensive coverage in the engineering press, with detailed descriptions, drawings, and photographs of workers dwarfed by various parts of the structure. Dimensions in the following description have been culled entirely from these secondary sources. Because of a policy against releasing plans of active structures, the bridge's current owner, the Canadian National Railway (CN), declined to provide the author with copies of the original drawings.[72]

Because the original substructure was demolished after the SCAL bridge was relocated, it warrants only a brief description here. The Foundation Company began construction of the substructure in October 1917. Headquartered in New York, with plants in Pittsburgh, Chicago, and elsewhere, the company was familiar with the demands of large railroad structures. Most relevant to the SCAL bridge was the Foundation Company's experience as the contractor on the B&OCT's Strauss bascule bridge over the Calumet.[73] Similar to the B&OCT bridge, the original SCAL bridge had cylindrical reinforced concrete pier foundations, extending down to bedrock. The tower legs were supported by four 11'-6"-diameter piers, arranged in a rectangle 58'-0" by 32'-4" on center and tied together by reinforced concrete walls. Because of the heel-trunnion configuration, the two front piers carry entire weight of the leaf, with the two rear piers carrying

---

[69] Kaufman, "The 'Heel Trunnion' Bascule Bridge," 832.

[70] "Big Bascule Bridge over the Chicago River," *Railway Review* 65, No. 20 (15 Nov. 1919): 715.

[71] Strauss, "Bascule Bridges," 6:315; cf. "Bridge," U.S. Patent No. 1,211,640, 9 Jan. 1917, which also shows a helicopter blade propelling the span up and down.

[72] Gail Dever, Director of Research Services for Canadian National Railway, e-mail to author, 15 July 1999.

[73] "Piers for Drawbridge over Calumet River," *Engineering Record* 67, No. 8 (22 Feb. 1913): 208.

the counterweight load. Given that bedrock occurred only 30'-0" below the river's surface at this location, sheet piling could not be driven to form a cofferdam in which to excavate the front piers. Instead, a timber crib was floated in from elsewhere, used as a cofferdam, and left as pier protection. At the east end of the span, the Foundation Company constructed two 8'-0"-diameter piers, joined by a concrete wall, in an excavation on the river bank. These smaller piers carry the weight of passing trains but no dead load, even when the leaf is latched closed, because the leaf's weight is balanced by the counterweight.[74] All of the foundations were completed in August 1918.

Two months later, the Ferro-Construction Company, also of Chicago, began erecting the superstructure. American Bridge Company fabricated the 1,544 tons of structural steel at its plant in nearby Gary, Indiana. It was then considered normal to build a Strauss bascule leaf in its open position to avoid interfering with river traffic. Ferro-Construction used this procedure for the SCAL bridge, but altered the certain details on account of the leaf's extreme length. They began with the unprecedented step of constructing timber falsework to serve as a gantry crane. This took the form of an inverted "U" straddling the tower foundation, 118'-0" high at the front of the tower and 168'-0" at the rear. Capable of carrying the bridge's heaviest members, the gantry was used to erect the tower and heel end of the span. Above this point, members were handled with an A-frame derrick mounted on the span itself. As an article in *Railway Age* described the process, "The span in its vertical position may be considered as forming an enormous elevator shaft in which the erection equipment is comparable with the elevator."[75] In other words, the derrick legs were braced against the inside surfaces of the already completed part of the leaf truss. As erection proceeded upward, the gantry falsework was dismantled to clear the way.

Meanwhile, the rear of each rocking truss was surrounded by forms to pour the concrete wing counterweights. Heavy timber cribbing in the counterweight pit beneath each form helped support the wet concrete inside, which was significantly heavier than it would be after curing.[76] Each wing measured about 60'-0" wide, 37'-0" high, and 5'-7" thick in this position (width and height being reversed in the closed position). In addition to the truss members projecting into the counterweight, reinforcing rods and mesh were added to prevent cracking. Strauss also specified dozens of small cubical pockets in the counterweight, which could be filled with concrete cubes to fine-tune each 885-ton wing when complete.[77] Ferro-Construction finished its work in August 1919, leaving the bridge open until machinery could be installed and tested. Needless to say, the towering leaf, a subdivided Warren truss more than 260'-0" from trunnion to tip, invited

---

[74] "World's Longest Bascule Span Erected at Chicago," *Railway Age* 67, No. 24 (12 Dec. 1919): 1136.

[75] "World's Longest Bascule Span," 1137.

[76] A photograph in the collection of Charles Stats shows the falsework in place; see Ash, "The Airline," 24. Note that Ash's caption mistakenly cites the Detroit Bridge Company as the erection contractor.

[77] The pockets allowed an adjustment up to 7 percent of the total weight; see "World's Longest Bascule Span," 1134.

comparisons to a skyscraper. Chicago's *Fort Dearborn Magazine* even published a composite photograph with the completed bridge superimposed next to a twenty-story building.[78]

Another feature emphasized in contemporary publications were the massive main and counterweight trunnions, the latter being "the largest yet built." The 46"-diameter main trunnions each consist of a 23"-diameter forged steel pin, to which the members are attached, within a cast steel sleeve. Between trunnion and bearing are 1-1/2"-thick phosphor bronze bushings, described in one engineering textbook as "finished to turn within the bearings, as well as around the trunnions ... depending on the lubrication of the surfaces."[79] Lubricated by grease injected through numerous grease cups and distributed by grooves on the bushing, the two possible surfaces of rotation reduced the likelihood of the trunnions sticking. The counterweight trunnions, each a 13-1/2"-diameter pin within a 25"-diameter sleeve, are of similar construction. This type of pin-in-sleeve trunnion was the subject of a patent application filed in December 1921.[80] It is unclear why Strauss waited so long after the SCAL bridge's completion to protect this crucial feature of his invention.

By far the most remarkable aspect of the SCAL bridge was the possibility that it might be moved within a decade. The Union Station ordinance had secured the railroads' cooperation in straightening the Chicago River for fifteen years, or until 1929. Not wanting this period to expire without action, the city dusted off its plans as World War I came to a close. The Railway Terminal Commission submitted another report in 1921, reinitiating the pursuit of a simpler, more rational transportation network.

The St. Charles Air Line Bridge of 1930

The excavation of the new Chicago River channel seems like a simple task when compared to the legal wrangling necessary to make it happen. The myriad committees established to discuss consolidation of railroad terminals soon buried that issue under dozens of alternative schemes. Perhaps frustrated by the lack of progress, city officials decided to make river straightening a separate item that could be implemented right away. On 7 June 1924, the U.S. Congress agreed that the old channel could be abandoned as a navigable waterway when the new channel was completed.[81] With this assurance, the City Council passed an ordinance on 8 July 1926 to specify detailed procedures for condemning railroad property, straightening the river, and re-allocating property afterward. All property transfers had to be approved by the

---

[78] "New Bridge Higher than Skyscraper," *Fort Dearborn Magazine* 1, No. 3.

[79] Otis E. Hovey, *Movable Bridges,* 2 vols. (New York: John Wiley & Sons, 1926), 2:74-75.

[80] Joseph B. Strauss, "Rotating Connection for Bascule Bridges," U.S. Patent No. 1,604,498, 26 Oct. 1926.

[81] *City of Chicago* v. *New York Central Railroad Company* et al., Circuit Court of Cook County (1928), 5, MRC.

Illinois Commerce Commission, a process which lasted until March 1928.[82] Actual construction work did not begin for another four months, but then proceeded quickly. The SCAL bridge was moved to its new location by late 1930, and connecting tracks reached their final configuration in mid-1931. This section of the report describes the process of moving the bridge to the new channel and affiliated grade separation work.

Although the city initiated the river straightening project, the War Department had significant influence over its design because of the navigable waterway issue. One important consequence of federal involvement was a reduction in the number of separate crossings of the new channel. Whereas the B&OCT previously crossed the South Branch near Taylor Street, about three-quarters of a mile north of the SCAL bridge, the War Department insisted that the two railroads build adjacent bridges over the new channel.[83] This helped to advance the city's goals in four ways. First, it consolidated two railroads onto one alignment along Sixteenth Street, reducing the number of separate street crossings. West of the river, the new alignment could be elevated to eliminate an at-grade crossing of tracks serving Union Station. The new alignment would also make it easier for the B&OCT to join other railroads in a consolidated terminal south of the Loop and abandon Grand Central Station. Finally, the two railroads could use each other's bridges during construction, reducing the number of temporary structures necessary to maintain traffic. The city therefore embraced the War Department's requirement by including it in the river straightening ordinance.

One condition of the War Department's approval resulted in a curious situation, whereby CSX Transportation is currently responsible for operating the SCAL bridge, which it does not own. The permit for the B&OCT bridge over the South Branch required "that the said bridge, and the Illinois Central bridge ... adjacent thereto, shall be operated as a unit in order that they may be raised and lowered simultaneously."[84] The railroads constructed a single operator's house between the two bridges for this purpose, to be staffed by B&OCT employees. In a 1962 merger, the Chessie System (now CSX) acquired the B&O, the Chicago Terminal division, and the responsibility for operating both bridges over the South Branch. After a freighter destroyed the B&OCT's Calumet River bridge in the 1980s, CSX abandoned the line, removed the tracks, and locked its South Branch span in an upright position. Nonetheless, a lone CSX operator remains to fulfill the company's obligation to operate the SCAL bridge.

Chicago's 1926 river straightening ordinance specified a construction sequence for the two bridges. The B&OCT would first construct a new bridge at Sixteenth Street, for which it would be reimbursed up to $1 million by the city. (The railroad selected a Strauss heel-trunnion

---

[82] Edward J. Noonan, *The Railway Passenger Terminal Situation at Chicago* (Chicago: City Council Committee on Railway Terminals, 1931), 7-8, MRC.

[83] Citizens Committee on River Straightening, *River Straightening,* 13. This does not constitute a four-track bridge for the SCAL, as implied in Ash, "The Airline," 26.

[84] U.S. Engineer Office, Chicago, Ill., "Approval of Location and Plans of Bridge for Baltimore and Ohio Chicago Terminal Railroad Company of Chicago, Illinois," 8 Oct. 1926, permit files, Ninth District, U.S. Coast Guard, Cleveland, Ohio.

design with a single massive counterweight.[85]) The B&OCT was obligated to allow the four SCAL partners to operate over its new bridge "until twelve months after the old channel [was] abandoned and superseded."[86] This was accomplished by running B&OCT trains over the north track and providing a temporary connection so that SCAL trains could use the south track. At this stage, the SCAL was also using its own bridge to cross the old channel. The Great Lakes Dredge & Dock Company began excavating the new channel in August 1928.[87] Once the new channel was opened to navigation in mid-1929, the SCAL switched to a temporary trestle across the old channel, freeing up its bridge for relocation.[88] Although Strauss' original design anticipated moving the bridge, the ordinance recognized that the SCAL could also scrap it and build a new one. The city agreed to reimburse the SCAL up to $425,000 for relocating or replacing its bridge, although the city would have received scrap value in the latter case.[89] With both bridges in place over the new channel, the old channel was filled in preparation for laying permanent tracks on the east approach.

The decision to elevate tracks over Canal Street on the west approach added a few more steps to the construction sequence. This was complicated further by the fact that the SCAL officially ended at the west end of the bridge, after which point the tracks were owned jointly by the C&NW and the CB&Q. While the IC assumed responsibility for moving the SCAL bridge, it could take no part in constructing the new west approach. This work was supervised by the CB&Q, no doubt in close coordination with the IC. Because Canal Street already crossed the tracks on an elevated viaduct, the B&OCT and SCAL approaches would have to be elevated to a third level above the street.[90] The B&OCT bridge over the new channel was therefore constructed at a temporary lower level to connect with the existing approach tracks. After SCAL trains began using the B&OCT bridge in mid-1929, the SCAL bridge was relocated to the new channel, at a height compatible with its new west approach. When this was complete in late 1930, B&OCT trains were temporarily re-routed to the SCAL bridge. As a final step, the B&OCT raised its bridge and completed its own separate elevated approach.[91] The total cost of

---

[85] See Frances Alexander and John Nicolay, "Baltimore and Ohio Railroad, Chicago Terminal Railroad, South Branch of the Chicago River Bridge," HAER No. IL-67.

[86] Straightening ordinance, Article VI, Section 22, reprinted in City of Chicago, City Council, Committee on Railway Terminals and Citizens Committee on River Straightening, *Straightening the Chicago River* (Chicago: J. T. Igoe Co., 1930), 75, MRC.

[87] Chicago Department of Public Works, *Ceremonies Inaugurating the Work of Straightening the South Branch of Chicago River* (Chicago: Fred J. Ringley Co., 1928), MRC.

[88] C. H. Mottier, "A Complex Bridge-Moving Job," *Railway Age* 90, No. 9 (28 Feb. 1931): 446.

[89] Straightening ordinance, Article VI, Section 27, reprinted in Committee on Railway Terminals et al., *Straightening the Chicago River,* 80.

[90] "Three-Level Grade Separation at Chicago," *Engineering News-Record* 106, No. 18 (30 Apr. 1931): 731.

[91] Mottier, "A Complex Bridge-Moving Job," 446.

the grade separation work, completed on 31 July 1931, was more than $4 million and borne entirely by the railroads.[92]

The process of moving the SCAL bridge merits its own detailed description. The IC's engineers chose to relocate the Strauss bascule span, but decided against the original plan of rotating the tower 160 degrees on the east bank of the new channel. If dismantled and re-erected on the west bank, the SCAL bridge would open in the same direction as the B&OCT span, facilitating joint operation. Also, its original 260'-0" length had been determined by a skew crossing of the old channel. The SCAL intersected the new 200'-0" channel at a right angle, meaning that 40'-0" could be removed from the leaf and not re-erected, as shown in Figure 2. Of the five bidders on the project, only the Strobel Steel Construction Company of Chicago proposed dismantling and moving the bridge in small pieces. Other firms offered more expensive schemes of floating pieces as large as the whole tower on barges, so Strobel won the contract. The E. J. Albrecht Company received a separate contract for new substructure.[93]

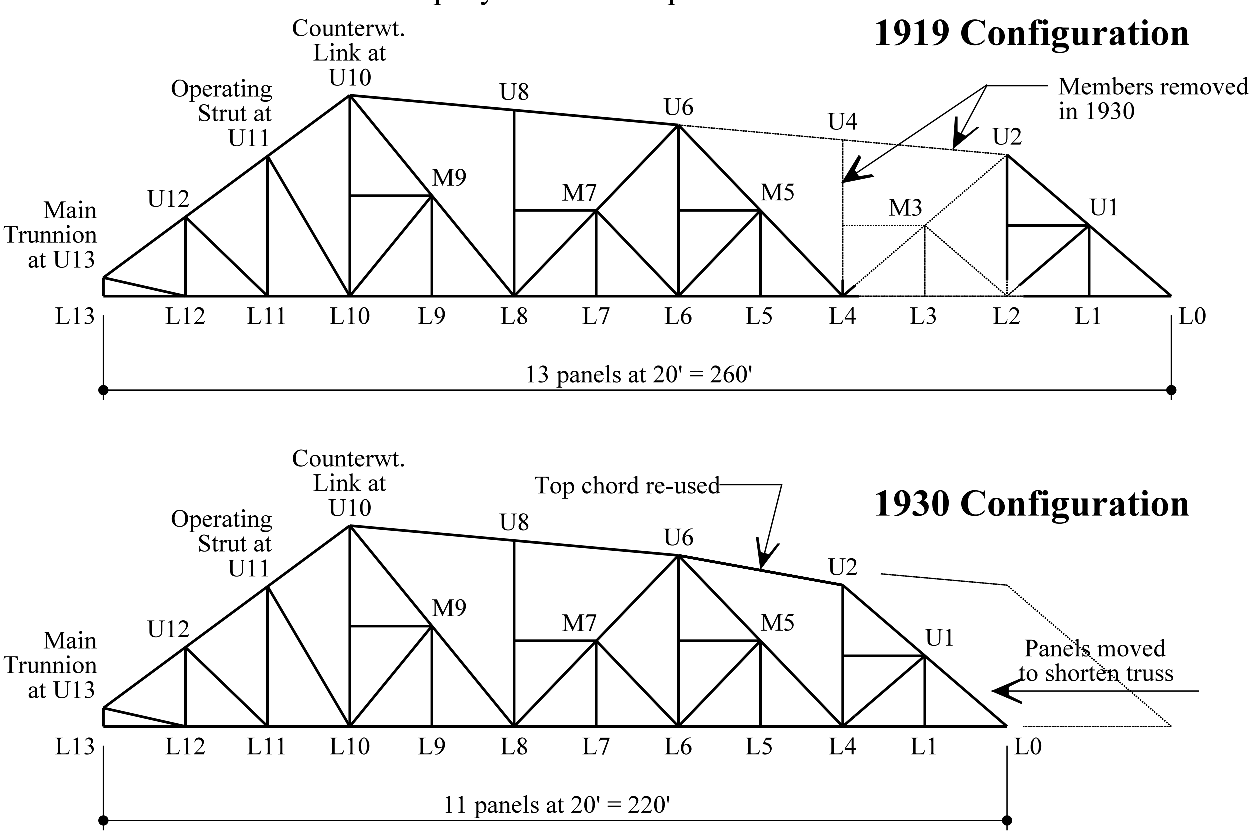

Figure 2. Reconfiguration of SCAL bridge for new location (not to scale). Sketch by author.

---

[92] "Busiest Railway Crossing Is No More," *Railway Age* 91, No. 7 (15 Aug. 1931): 241.

[93] "Joint Separation of Railroad Grades at W. 15th Pl. And Stewart Ave., Chicago — II," *Engineering and Contracting* 69, No. 10 (Oct. 1930): 731; Mottier, "A Complex Bridge-Moving Job," 447.

The process of dismantling and re-erection took about seven months, and proceeded with few difficulties. Rather than reverse the elevator-shaft-like erection scheme, Strobel used a derrick riding outside the truss on its upper chords. An article in *Railway Age* described the process, including an interesting incident caused by one 16"-diameter pin that would not budge from its sleeve. The pin, and the gusset plates connected to it, were taken to the IC's shops, where a 700-ton press was needed to remove it.[94] It was not economical to move the concrete counterweights, so they were broken up and discarded. To balance the shorter leaf, Strobel cast new counterweights during re-erection. These were not only lighter, but also had a center of gravity closer to the trunnions. It is unclear whether Strauss or the IC's engineering department designed the new counterweights, however. Strobel re-erected the bridge in less than three months, without using falsework.[95] This improvement over Ferro-Construction's original erection performance can certainly be attributed to better equipment, in addition to the smaller amount of material handled. The SCAL bridge was finished in late 1930, with B&OCT trains running over one track from April to July 1931.[96]

Conclusion

Straightening the South Branch of the Chicago River accomplished all but one of its goals during the twentieth century, the exception being dramatic southward growth of the central business district. There has been little demand for the new land created on the east bank, even though it has been cleared of all but the most essential railroad facilities. Commuter service terminating south of the Loop has since been consolidated into LaSalle Street Station. The SCAL now carries through traffic exclusively, having removed spur tracks as industry disappeared from along its right-of-way. After the IC abandoned its lake-front freight terminal, the SCAL's northbound ramps to the IC main line were no longer needed. In 1968, it was replaced by a new southbound leg allowing more direct movements without reversing in the Twelfth Street yard. Amtrak passenger trains serving eastern cities now use this route to and from Union Station.[97] Looking upriver from an Amtrak coach crossing the bridge, the visitor might be surprised to see an expanse of brush-covered land with the Sears Tower in the background. As of this writing, the commercial growth anticipated by city officials has yet to occur.

New medium-density residential development is appearing in the area, however. And while it may serve as a landmark to some, the railroad is at odds with the city's vision for the neighborhood. The SCAL's elevated tracks are seen as an obstacle to development, which is spreading south from Dearborn Park (around the old Dearborn Station) and north from

---

[94] Mottier, "A Complex Bridge-Moving Job," 447.

[95] "Joint Separation of Railroad Grades — II," 371; Mottier, "A Complex Bridge-Moving Job," 447.

[96] "Busiest Railway Crossing Is No More," 251.

[97] Ash, "The Airline," 26.

Chinatown. During the administration of Mayor Richard M. Daley, the city began asking the IC to remove the line. This came to a head in February 1999, when the city filed an objection to the CN-IC merger before the Surface Transportation Board, but withdrew it in exchange for the IC's "understanding" of the SCAL's fate. The railroad is studying a new 12-mile bypass, with no specified completion date, to carry traffic around the city center and replace the SCAL link.[98]

The future looks bleak for the SCAL and B&OCT bridges, which will probably be scrapped if the line is removed. Contemporary criticism of their aesthetics will probably work against their survival. During the early twentieth century, their towering raised leaves and complex counterweight links might have evoked feelings of wonder and awe. Now that Chicago's role as a financial center has surpassed its industrial prowess, however, the bridges' imposing masses of flat-black steel look out of place against the shiny skyscraper core. To some modern observers, Strauss bascule bridges even resemble "giant cockroaches." (The SCAL bridge, with its wing-shaped counterweights, is perhaps more deserving of the remark.) Between aesthetic objections, safety concerns, and the high value of recycled steel, there will be reason enough to scrap the two spans. When that occurs, no physical evidence will remain of what was once the world's longest bascule bridge.

SOURCES CONSULTED

Published

Ackerman, William K. *Early Illinois Railroads.* Fergus Historical Series, No. 23. Chicago: Fergus Printing Co., 1884.

Ash, Fred. "The Airline across Chicago." *Green Diamond* 43 (Nov. 1996): 4-28.

"Bascule Bridges." *Engineer* (London) 115 (28 Mar. 1913): 340-43.

"Big Bascule Bridge over the Chicago River." *Railway Review* 65, No. 20 (15 Nov. 1919): 713-17.

Burnham, Daniel H., and Edward H. Bennett. *Plan of Chicago, Prepared under the Direction of the Commercial Club During the Years 1906, 1907, and 1908.* Chicago: Commercial Club of Chicago, 1909.

"Busiest Railway Crossing Is No More." *Railway Age* 91, No. 7 (15 Aug. 1931): 241-51.

Chicago Department of Public Works. *Ceremonies Inaugurating the Work of Straightening the South Branch of Chicago River.* Chicago: Fred J. Ringley Co., 1928. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

---

[98] "CN, IC Rebut Opponents to Their Merger Plan," *Danville Flyer* 31, No. 1 (Jan. 1999): 3-4; "IC May Get New Chicago Entrance," *Trains* (June 1999).

"Chicago Settles with Strauss for Infringing Bridge Patent." *Engineering News-Record* 85, No. 24 (9 Dec. 1920): 1158.

Christine, W. T. "Bascule Bridge, Largest of Its Type, Built over the Chicago River." *Engineering World* 16, No. 1 (1 Jan. 1920): 11-14.

Citizens Committee on River Straightening. *River Straightening.* Chicago, 1925. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

City Club of Chicago. *The Railway Terminal Problem of Chicago: A Series of Addresses before the City Club, June Third to Tenth, 1913, Dealing with the Proposed Re-Organization of the Railway Terminals of Chicago, Including All Terminal Proposals Now before the City Council Committee on Railway Terminals.* Chicago: Univ. of Chicago Press, 1913. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

City of Chicago. City Council. Committee on Railway Terminals, and Citizens Committee on River Straightening. *Straightening the Chicago River.* Chicago: J. T. Igoe Co., 1930. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

City of Chicago. City Council. *Proceedings.* Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

City of Chicago. Railway Terminal Commission. *Preliminary Report, Chicago Railway Terminal Commission: Submitted to the City Council Committee on Railway Terminals, March 29, 1915.* Chicago: Chicago Railway Terminal Commission, 1915. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

City of Chicago v. *New York Central Railroad Company* et al. Circuit Court of Cook County, 1928. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

"CN, IC Rebut Opponents to Their Merger Plan." *Danville Flyer* 31, No. 1 (Jan. 1999): 3-4.

"Comprehensive Investigation of the Chicago Terminal Situation." *Engineering Record* 68, No. 9 (30 Aug. 1913): 226.

Dalstrom, O. F. "The 186 Foot Bascule Bridge of the C. & N. W. Ry., over the North Branch of the Chicago River at Deering." *Journal of the Western Society of Engineers* 22, No. 7 (Sep. 1917): 453-78.

Draper, Joan E. *Chicago Bridges.* Chicago: Schumacher and Bowman, Inc., 1984.

"Eight Years of Litigation over Seattle Bascule Bridges." *Engineering News-Record* 103 (19 Dec. 1929): 968-69.

Eldridge, Archibald R. "Is It Unprofessional for an Engineer to Be a Patentee?" *Transactions of the American Society of Civil Engineers* 48 (1902): 314-26.

Frey, Robert L., ed. *Encyclopedia of American Business History and Biography: Railroads in the Nineteenth Century.* New York: Facts on File, 1988.

"Future Development of Chicago Terminals." *Railway Age Gazette* 55, No. 23 (5 Dec. 1913): 1078-81.

Hovey, Otis E. *Movable Bridges.* 2 vols. New York: John Wiley & Sons, 1926.

"IC May Get New Chicago Entrance." *Trains* (June 1999).

"Joint Separation of Railroad Grades at W. 15th Pl. And Stewart Ave., Chicago — II." *Engineering and Contracting* 69, No. 10 (Oct. 1930): 366-71.

Kaufman, Philip L. "The 'Heel Trunnion' Bascule Bridge." *Engineering News* 67, No. 18 (2 May 1912): 830-33.

"Largest Bascule Bridge." *Engineering Record* 68, No. 25 (20 Dec. 1913): 697.

Liljencrantz, G. A. M. "Obstructive Bridges and Docks in the Chicago River." *Journal of the Western Society of Engineers* 3, No. 3 (June 1898): 1056-97.

"Longest Single-Leaf Bascule Bridge: Chicago River." *Engineering News-Record* 83, No. 22 (25 Dec. 1919): 1056-60.

Mottier, C. H. "A Complex Bridge-Moving Job." *Railway Age* 90, No. 9 (28 Feb. 1931): 445-47.

"Mr. Arnold's Report on Chicago Terminals." *Railway and Engineering Review* 53, No. 47 (22 Nov. 1913): 1087-91.

"New Bridge Higher Than Skyscraper." *Fort Dearborn Magazine* 1, No. 3.

"The New 260 Ft. Span Single Leaf Bascule Bridge of the Illinois Central R. R." *Engineering and Contracting* 52, No. 26 (24 Dec. 1919): 717-19.

Noonan, Edward J. *The Railway Passenger Terminal Situation at Chicago.* Chicago: City Council Committee on Railway Terminals, 1931. Municipal Reference Collection, Chicago Public Library, Chicago, Ill.

Parkhurst, H. W. "Track Elevation of the St. Charles Air Line." *Journal of the Western Society of Engineers* 3, No. 6 (Dec. 1898): 1352-61.

Petroski, Henry. *Engineers of Dreams: Great Bridge Builders and the Spanning of America.* New York: Alfred A. Knopf, 1995.

"Piers for Drawbridge over Calumet River." *Engineering Record* 67, No. 8 (22 Feb. 1913): 208.

Prichard, H. S., et al. "Lift Bridges — a Discussion." *Proceedings of the Engineers' Society of Western Pennsylvania* 25, No. 1 (Feb. 1909): 11-75.

"Relocating of Chicago Railway Terminals." *Railway Age Gazette* 54, No. 22 (30 May 1913): 1184-87.

Statutes at Large.

Strauss, Joseph B. "Bascule Bridge." U.S. Patent No. 894,239. 28 July 1908.

______. "Bascule Bridge." U.S. Patent No. 1,150,643. 17 Aug. 1915.

______. "Bascule Bridges." In *Proceedings of the Second Pan American Scientific Congress,* edited by Glen L. Swiggett, 6:304-23. Washington, D.C.: U.S. Government Printing Office, 1917.

______. "The Bascule Bridge in Chicago." In *A Half Century of Chicago Building,* edited by John H. Jones and Fred A. Britten. Chicago: 1910.

______. "Bridge." U.S. Patent No. 668,232. 19 Feb. 1901.

______. "Bridge." U.S. Patent No. 738,954. 15 Sep. 1903.

______. "Bridge." U.S. Patent No. 974,538. 1 Nov. 1910.

______. "Bridge." U.S. Patent No. 1,211,640. 9 Jan. 1917.

______. "Bridge." U.S. Patent No. 1,583,705. 4 May 1926.

______. "Rotating Connection for Bascule Bridges." U.S. Patent No. 1,604,498. 26 Oct. 1926.

"Three-Level Grade Separation at Chicago." *Engineering News-Record* 106, No. 18 (30 Apr. 1931): 731-34.

"Track Elevation and Depression at the 16th St. Crossing, Chicago." *Engineering News and American Railway Journal* 40, No. 2 (14 July 1898): 22-23.

"Track Elevation in Chicago." *Engineering Record* 59, No. 22 (29 May 1909): 679-82.

"Track Elevation in Chicago." *Railroad Gazette* 30, No. 2 (14 Jan. 1898): 21-22.

"Track Elevation in Chicago." *Railway Age and Northwestern Railroader* 23, No. 22 (28 May 1897): 440-43.

"Track Elevation in Chicago." *Railway Age and Northwestern Railroader* 26, No. 4 (29 July 1898): 534-36.

"Track Elevation in Chicago." *Railway Review* 36, No. 2 (11 Jan. 1896): 17.

U.S. Army. Corps of Engineers. *Annual Report of the Chief of Engineers to the Secretary of War for the Year....* Washington, D.C.: U.S. Government Printing Office, 1876-1906.

Vance, James E., Jr. *The North American Railroad: Its Origin, Evolution, and Geography.* Baltimore: Johns Hopkins Univ. Press, 1995.

Vaughn, G. W. "Joint Track Elevation and Depression at Sixteenth and Clark Streets, Chicago." *Journal of the Western Society of Engineers* 3, No. 6 (Dec. 1898): 1362-75.

"Wallace Report on Chicago Railroad Terminals." *Engineering Record* 68, No. 18 (1 Nov. 1913): 486-87.

Western Society of Engineers. *Constitution, By-Laws, List of Officers and Members....* Chicago: Western Society of Engineers, 1900 et seq.

Wilson, W. W. "Types of Movable Bridges." *Journal of the Western Society of Engineers* 19, No. 6 (June 1914): 549-89.

"World's Longest Bascule Span Erected at Chicago." *Railway Age* 67, No. 24 (12 Dec. 1919): 1133-37.

Young, Hugh E. "Problems Encountered in the Design of 12th Street Bridge." *Engineering World* 15, No. 1 (1 July 1919): 17-26.

Unpublished

Campbell, George M. "A Historical Sketch of the Baltimore & Ohio Chicago Terminal Railroad Company and Its Predecessor Companies." Paper presented at the Chicago Chapter of Railway & Locomotive Historical Society, 11 Apr. 1947. Reference Collection, Chicago Historical Society, Chicago, Ill.

Dever, Gail, Director of Research Services for Canadian National Railway. E-mail to author, 15 July 1999.

Mayer, Harold M. "The Railway Pattern of Metropolitan Chicago." Ph.D. diss., Univ. of Chicago, 1943.

Reeve, A. B. "The Story of Strauss Bridges." Typescript, Chicago: Strauss Bascule Bridge Co., n.d. Private collection of Eric N. DeLony.

"St. Charles Air Line Bridge over Proposed New Channel, South Branch of Chicago River near 16th Street." Drawing No. 3952 (May 1926). Permit files, Ninth District, U.S. Coast Guard, Cleveland, Ohio.

"St. Charles Air Line Bridge over Proposed New Channel, South Branch of Chicago River near 16th Street." Drawing No. 3953 (June 1926). Permit files, Ninth District, U.S. Coast Guard, Cleveland, Ohio.

Alexander, Frances, and John Nicolay. "Baltimore & Ohio Railroad, Chicago Terminal Railroad, South Branch of the Chicago River Bridge." HAER No. IL-67. Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior.

U.S. Engineer Office, Chicago, Ill. "Approval of Location and Plans of Bridge for Baltimore and Ohio Chicago Terminal Railroad Company of Chicago, Illinois." Drawing, 8 Oct. 1926. Permit files, Ninth District, U.S. Coast Guard, Cleveland, Ohio.

APPENDIX: Builder's Plates

Two builder's plates are located on the east end post of the north truss:

STRAUSS TRUNNION BASCULE BRIDGE
PATENTED
BUILT 1917 FOR
ST. CHARLES AIR LINE
FABRICATED BY
AMERICAN BRIDGE CO.

ERECTED BY
THE FERRO CONSTRUCTION CO.
CHICAGO