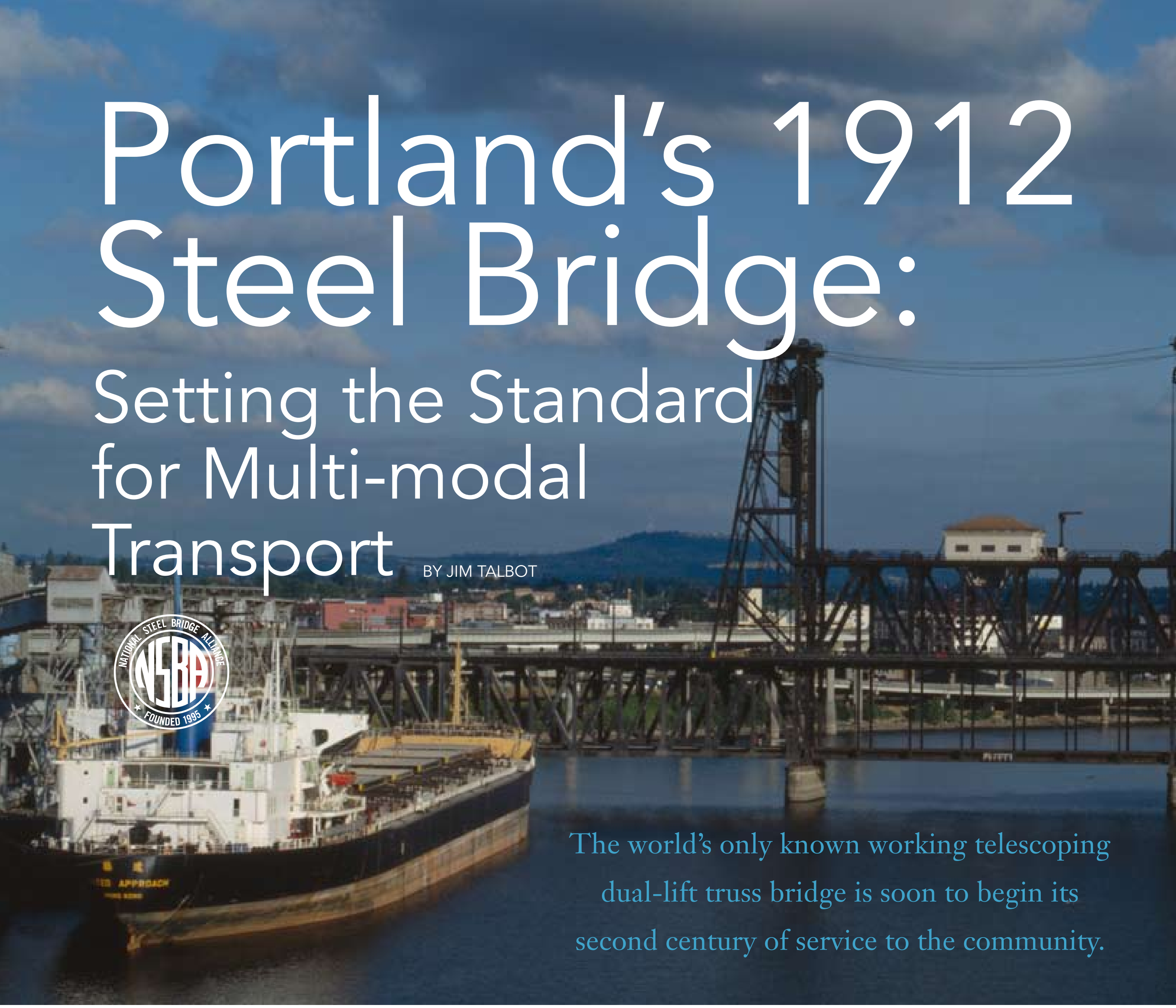
Portland's 1912 Steel Bridge:

Setting the Standard for Multi-modal Transport

BY JIM TALBOT



The world's only known working telescoping dual-lift truss bridge is soon to begin its second century of service to the community.

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IN THE MID-19TH CENTURY, the Columbia and Willamette Rivers carried major seagoing traffic to and from the inland port city of Portland, Ore. As Portland grew to be a major shipping port for wheat, lumber, and other commodities, these two major rivers running through the city presented major obstacles to local travel.

By 1853, ferry service began across the Willamette River, but not until 1887 did the first Morrison timber bridge with a wrought-iron swing span cross the Willamette. It was followed a year later by the original Steel Bridge, a double-deck swing-span railroad bridge. Its name derived from the fact that in 1888 steel represented an unusual bridge-building material. The additional bridges that followed contributed greatly to the growth of Portland, which by 1900 had grown to 90,000 inhabitants.

A Replacement Steel Bridge

Early in the 20th century, the Oregon Railway and Navigation Company, which today is the Union Pacific, and the Southern Railroad made plans to replace the original Steel Bridge. Although the intent was to carry only passenger and freight trains, the city insisted

Jet Lowe, from the Library of Congress HAER

The Steel Bridge, Portland, Ore.

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SPANNING 100 YEARS

Our nation's rich past was built on immovable determination and innovation that found a highly visible expression in the construction of steel bridges. The Steel Centurions series offers a testament to notable accomplishments of prior generations and celebrates the durability and strength of steel by showcasing bridges more than 100 years old that are still in service today.

on an upper deck for road and pedestrian traffic. The new bridge, being essentially on the same site and of the same material, took on the Steel Bridge name. It opened for trains nearly a century ago, on July 21, 1912, and less than a month later for vehicles and pedestrians.

The 1912 Steel Bridge is the second oldest vertical-lift bridge in North America and is the only known working telescoping dual-lift truss bridge in the world. The lower deck retracts neatly into the upper deck girders, permitting vehicles to continue crossing the upper deck undisturbed.

The bridge continues today as the epitome of multi-modal transport. The upper deck has two light-rail tracks bracketed by one lane for automotive traffic and a 6-ft-wide pedestrian lane on each side. The lower deck carries two railroad tracks and has an 8-ft cantilevered pedestrian/bicycle lane on its southern side. The average daily traffic in 2000 was 23,100 vehicles (including numerous buses), 200 light-rail trains, 40 freight and Amtrak trains, and 500 bicycles. Adding the lower-deck walkway in 2001 sharply increased bicycle traffic; by 2005 it had grown to more than 2,100 daily, many bound for the Eastbank Esplanade on one end of the bridge or Portland's downtown Waterfront Park on the other.

Design and Construction

Prolific civil engineer John Alexander Low Waddell, along with his mechanical engineer John Lyle Harrington, designed the $1.7 million 1912 replacement as a through-truss, double-deck, double-lift steel bridge. The lower deck served to carry passenger and freight trains and the upper deck horse-drawn carriages, automobiles, and electric trolley cars. The firm of Waddell & Harrington designed more than two dozen vertical lift bridges while their partnership existed between 1907 and 1914, and Waddell went on to design many more lift bridges over the course of his lifetime.

Harrington contributed the bridge's ingenious lift mechanisms. Small components included equalizers that distribute weight among the ropes and the guides that keep the spans in alignment as they move. The telescoping vertical members and the system of ropes, sheaves and counterweights are examples of larger novel contributions. Harrington claimed that with proper maintenance, such as renewal of decks and cables, occasional painting, and daily lubrication, his bridges would be "permanent." Now, as the structure completes its first century of service, his claim sounds much less far-fetched than it must have in the bridge's earlier days.

Constructing the Steel Bridge took two years. The Union Bridge Construction Co. of Kansas City, Mo., built the piers and Robert Wakefield of Portland erected the trusses, towers, and lift span. The design included a wrought-iron woven lattice railing for the top deck as its only decorative embellishment.

The record-setting loads of counterweights and lift-spans demanded innovative engineering to erect. Elaborate travelers, falsework and ramps facilitated erection of the lift towers and mechanisms. Massive posts and lower chords, each measuring a yard or more in width and depth, help the century-old structure continue to safely carry its multi-modal transports.

Double Lift Raises

The lift span of the bridge extends 211 ft. The lower lift span consists of vertical steel members while the upper one has both vertical and diagonal members. Two secondary steel through-Pratt truss spans on either side of the lift span, about

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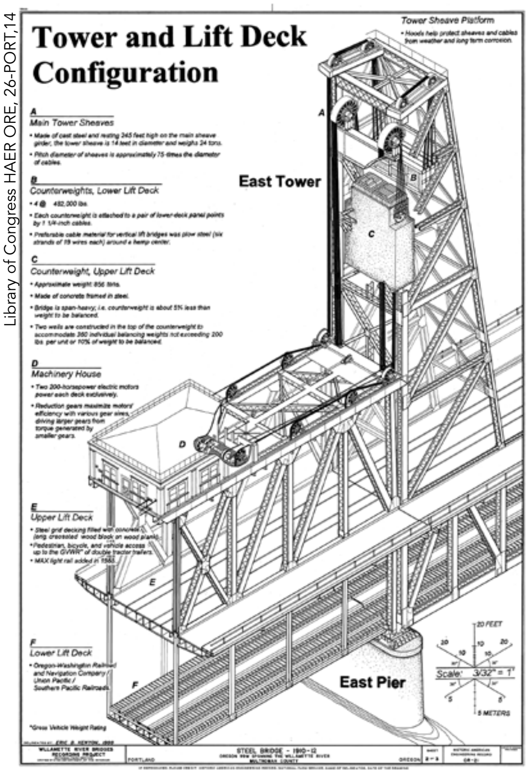

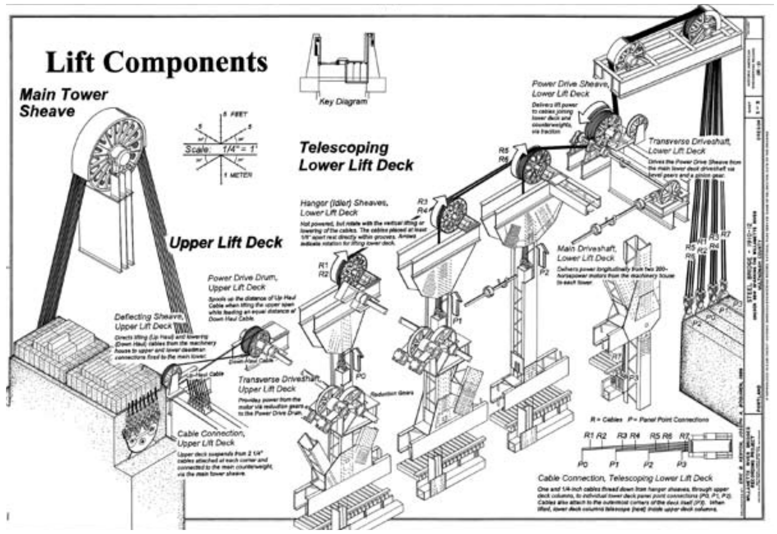

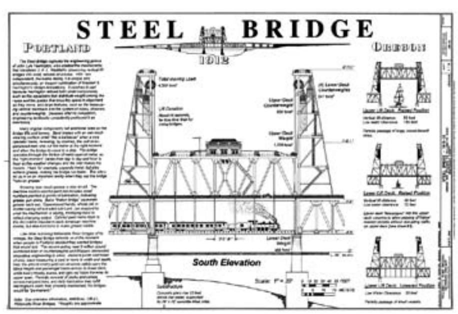

These highly detailed, annotated illustrations of the mechanical and structural systems from Portland's Steel Bridge, the only working double-deck, double-lift span in the world, can be found at www.steelbridges.org/PortlandCenturion.

290 and 300-ft long, complete the river crossing. The typical top deck width runs to 74.5-ft (62.5 ft for the roadway plus two 6-ft sidewalks). The sidewalks flare out at the towers, taking the maximum width to 77 ft.

This Steel Bridge is believed to be the world's only double-deck bridge with independent lifts. The operator can raise the lower deck 72 ft; the lower lift truss smoothly "telescopes" into the upper lift truss. The operator also can raise both decks, providing 163 ft of vertical clearance above the water. Two counterweights serve the upper deck, and eight the lower, totaling about 4,500 tons.

The machinery house sits above the upper-deck lift span with the operator's room suspended below it, allowing the operator to view both the river traffic and the upper deck. The operator can raise the lower deck 45 ft in about 10 seconds, and the upper deck at a rate of 1-ft per second. As in other early American machine rooms, colorful paint patterns added decoration and function. Small painted numbers indicated points of lubrication. Oilers charged with wiping excess extruded lubricant from metal-on-metal movements would soon learn to determine optimum lubricant amounts.

With experience, operators learned just when to cut the motor, allowing lift sections to coast to a stop and avoiding the need to apply band brakes. The exact instant to cut motors changes with the weather and grease applications during the day. The band brakes have an oak block wearing surface, exuding a barbecue-like smell when applied—as during operator training.

The lower deck offers relatively low clearance above the water: 1 ft at high water and obviously no clearance at flood water. Major floods threatened the lower deck in 1948, 1964 and 1996. The 1948 flood submerged the lower deck in 5 ft of water. During the 1964 and 1996 floods, water touched the lower deck.

Lower deck raisings have continued to diminish through the years. In 1914, operators raised the lower deck 20,339 times for river craft. Lower deck annual raisings declined to 10,687 and

The Steel Bridge, Portland's century-old mechanical marvel.

3,000 in 1943 and 1988 respectively. Now it's the practice to keep the lower deck up when no train crossings are scheduled.

Later Developments

Originally, as noted earlier, the upper roadway deck included rails for the city's first electric trolley cars. With the decline in streetcar use, the rails were removed in mid-century. In 1950 the Steel Bridge became a significant portion of a new U.S. 99W highway. In 1986 rails returned when a $10 million rehabilitation project added the cross-river portion of Metropolitan Area Express (MAX) light rail system, which is part of TriMet, the public transit agency for the Portland metropolitan area.

In 2001, another project installed a 220-ft-long, 8-ft-wide cantilevered walkway on the south side of the bridge's lower deck, raising to three the number of publicly accessible walkways across the bridge, including the two narrow sidewalks on the upper deck. Oregon DOT closed the upper deck in the summer of 2008 for maintenance and to allow a junction to be built at the west end for the MAX Green Line.

Union Pacific owns the bridge, which is the most complete and complex transportation link in the city, and leases the upper deck to the Oregon DOT, which subleases to TriMet. The City of Portland takes responsibility for the approaches. Today, as it turns 100, the black, towering Steel Bridge dominating the skyline at Willamette River mile 12.1 is the most well-known among Portland's world-class collection of bridges. MSC

A City of Steel Bridges

The bridges of Portland, Ore., number 14, or 17 if you count the railroad–only crossings. Twelve vehicular bridges are concentrated on the Willamette River between St. John's and Oregon City, and two interstate bridges cross the Columbia River into the state of Washington. These are supplemented with three important railroad structures.

Portland's bridges have contributed greatly to its growth. The city population, according to the 2010 census, now numbers about 580,000, and about 2.6 million people live in the Portland metropolitan area. The citizenry originally concentrated downtown on the Willamette's west bank. New bridges encouraged migration to the east bank, which is now home to 80% of the population.

The PDX Bridge Festival each summer sponsors an annual, citywide cultural arts festival that celebrates the Willamette River Bridges. This organization considers the bridges "central to regional identity, tying the geography and cultures of Portland into a vibrant whole."

Other cities may have more bridges (New York City boasts 75), but Portland's represent a varied catalog of bridge types, some unduplicated anywhere. Included are the world's only telescoping double-deck, double-lift bridge (discussed here), plus the world's oldest vertical lift bridge and the longest tied-arch bridge. The significant vehicular bridges are shown in the map on the right, including dates of completion and bridge type.