**Introduction**

The Holland Tunnel is one of two highway tunnels under the Hudson River between northern New Jersey and Manhattan Island in New York City (the Lincoln Tunnel is the other), and it was the first constructed. The one tunnel is actually composed of two connected parallel tubes, which are about 35 feet apart under the river but divert even farther as they rise to street level so that the entrances and exits at each end are separated by about two blocks to reduce traffic congestion. The north tube, with two lanes of westbound traffic, is 8,558 feet long from portal to portal. The south tube, with two lanes of eastbound traffic, is 8,371 feet long from portal to portal. Each tube is 29.5 feet in external diameter. The two tubes are commonly referred to as a singular facility, as they often will be in this history, in recognition of their physical connection and unified function.

When the Holland Tunnel opened in 1927, it was the longest and largest vehicular tunnel in the world, and the first with a ventilation system specifically designed to accommodate motor-vehicular traffic. Created in response to extensive research which determined the amount of carbon monoxide produced by motor vehicles, the safe limits of human exposure to this deadly gas, and the most cost-efficient method of providing fresh air and exhausting polluted air, the Holland Tunnel's ventilation system became the model for, or informed the design of, virtually every vehicular tunnel built thereafter.

The Holland Tunnel's unprecedented length, size, and ventilation system are enough to make it historically significant as a great achievement in civil and mechanical engineering. The role it has played from the day it opened to the present as a vital link in the transportation system of the New York metropolitan area also makes it a historical landmark of continuing importance. It proved the viability of vehicular tunnels as alternatives to the ferry-and-barge-based transportation systems of the Port of New York. As the automobile came of age and automobile registrations experienced explosive growth in New York and New Jersey, the tunnel met the need for an alternative to railroad-based transportation. In fact, the tunnel's
very existence created a new need for “superhighways” in New York and New Jersey to handle the traffic that it generated—highways that were the first of their kind.

From 1904, when the first New York City subway line opened, to the early 1920s, most people relied on the subway, streetcars, and their own feet to get about in Manhattan. In the first decade of the twentieth century, the upper class used horse-drawn carriages or, like their upper-middle-class counterparts, occasionally used horse-drawn cabs. Horses also provided the motive power for commercial wagons, by which almost all freight moved throughout the city. The trade-off for dependence on the horse was the near-constant sight and smell of horse manure and urine on city streets, and the not-infrequent dead horse lying temporarily untended on the cobblestones. Gradually, however, the problematic presence of horses was supplanted by the also unpleasant sight, smell, and noise of motor vehicles.

In 1901, New York became the first state to require registration of motor vehicles, with New Jersey following in 1903. But it was not until 1921 that all states required annual registration of new vehicles, and reporting practices varied considerably among states. It is difficult, therefore, to know exactly how many motor vehicles were registered before 1921, much less how many existed (not all owners in the early years followed registration laws), but statistics available from the United States Federal Highway Administration (FHWA) provide a reasonable overview of trends. According to FHWA data, during the first two decades of the twentieth century, New York consistently led all states in the number of motor-vehicle registrations, and New Jersey was near the top of the list.\(^1\)

In 1905, the year that the first gasoline-powered buses in the United States began operating on Fifth Avenue in New York, there were 77,800 motor-vehicle registrations in the United States.\(^2\) Approximately 98 percent were private automobiles, and the rest were trucks. In New York State, there were 9,230 total motor-vehicle registrations in that year (including 160 trucks), and in New Jersey there were 3,640 (70 trucks).\(^3\)

In January 1906, Henry Ford introduced his Model N at the Association of Licensed Automobile Manufacturers Automobile Show in Madison Square Garden, one of fifty-six different models displayed.\(^4\) This car marked a watershed advance in automobile development, due to its simplicity of design, practicality, and above all, low cost. The estimated price announced at the show was $300, quite a contrast to the majority of the cars displayed, priced in the thousands of dollars. Although the price soon doubled to $600, the Model N was still a relatively inexpensive car.\(^5\)
By the end of 1907, gasoline-powered taxis virtually replaced horse-drawn cabs in the Battery area of Lower Manhattan. There were 143,200 total new motor-vehicle registrations in the United States that year, including 2,900 trucks. In New York State, there were 11,750 registrations, including 240 trucks, and in New Jersey, there were 4,550 registrations, including 100 trucks. In 1907, annual registration figures reflected only new registrations and not the total number of vehicles already registered and in use.

According to the best estimates compiled by the Automobile Directories Company of New York City, there were approximately 230,000 motor vehicles registered and in use in the United States, as of September 1, 1917. Counting cumulative registrations from 1901 to 1907, New York led all states, with approximately 47,000 total automobile registrations, and New Jersey was second, with approximately 32,000. (From this point forward, only the number of vehicles newly registered each year will be reported.)

A year later, Henry Ford introduced the Model T passenger vehicle, which was soon to become nearly ubiquitous throughout the country. It was the archetype of the mass-produced, affordable, easy-to-maintain, middle-class car. As sales increased and production efficiency improved during the model’s production from 1908 to 1927 (the year the Holland Tunnel opened), the company actually lowered the sales price from $850 to below $300.

In January 1912, self-starters were introduced in a number of passenger vehicles during Phase I of the Twelfth National Automobile Show in Manhattan’s Madison Square Garden, and a large number of models had electric lights, replacing the troublesome kerosene lamps of earlier models. These improvements marked an important advance in the practicality and usefulness of automobiles. The greatest leap forward in design, however, appeared during Phase II of the show, which brought in large crowds to inspect the wide variety of trucks then being manufactured. In previous years, commercial vehicles had been relegated to the basement or secondary viewing areas of the show, while “pleasure cars,” as passenger automobiles were still called, dominated the prime floor space. Now trucks received greater attention, and two weeks were devoted solely to commercial vehicles after the passenger-vehicle phase of the show ended. Harry S. Houpt, one of the show organizers, said, “Businessmen have seen with their own eyes that the truck has passed out of the experimental stage, and is a vital factor in their transportation systems.”

Among the interested spectators on January 11 was William F. “Buffalo Bill” Cody, the frontier icon whose Wild West Show had so often filled the
same arena. The New York Times reporter who interviewed the great showman found that Cody always “had a great love of horse flesh, but he admits that the motor propelled vehicle has an advantage over the equine drawn wagon nowadays.”

The following month, the Motor Vehicle Dealers’ Association held its second annual, week-long automobile show in the Twenty-third Regiment Armory in Brooklyn. This exhibition featured an appearance by Joan Newton Cuneo, “America’s premier woman motorist,” and offered “special attractions” for women.

Less than a month later, on April 13, 1912, the Motor Truck Club sponsored its second annual parade in Manhattan, showcasing five hundred trucks representing fifty-three different manufacturers. The line of trucks stretched nearly two miles along the parade route, which ran from the Battery to 125th Street. According to the New York Times, the parade was “a revelation to the public of the giant strides which are taking place in the evolution of power transportation vehicles.” Many of the manufacturers represented in the parade were local, such as the Hewitt Motor Company, a New York City-based builder of highly engineered motor trucks.

Hewitt was one of many manufacturers whose products contributed to a total U.S. vehicular registration of 944,000 in 1912 (including 42,404 trucks). New York had more registrations than any other state, with 107,260 (including 4,720 trucks), and New Jersey had 35,410 (including 1,540 trucks).

By the end of 1916, the year Congress passed the Federal Aid Road Act, thus greatly facilitating the construction of highways across the United States, there were more than 3.6 million motor-vehicle registrations in the country. This amounted to one vehicle for every three persons living in the United States, an increase of more than 283 percent from 1912, with a remarkable 489 percent growth in truck registration. New York’s vehicle registrations nearly doubled from 1912 to 1916, with 314,222 registrations in 1916. But even this rate of growth pales in comparison to the 644 percent rise in truck registrations from 1912 to 1916. New Jersey’s registrations grew to 109,414 (a 209 percent increase from 1912), while its percentage increase in truck registrations outpaced even that of New York, at approximately 816 percent.

In 1917, the United States’ entry into World War I greatly increased the demand for trucks due to the need to transport war material in this country and abroad. Ford introduced the Model T one-ton truck chassis that year, its first chassis built specifically for trucks. New York City discontinued its
last horse-drawn streetcar line in 1917, but horse-drawn wagons were still widely used by the trucking industry.

There were 5,118,525 motor-vehicle registrations in the United States in 1917, with 391,057 of those being trucks. New York again led the nation in number of motor vehicles registered in 1917, with 406,016 (55,402 trucks), while New Jersey also showed impressive growth in registrations, with 141,918 (22,300 trucks).13

In 1920, the year that construction began on the Holland Tunnel, motor-vehicle registrations had increased almost 81 percent over 1917 to more than 9 million, and truck registrations had increased by 183 percent to 1.1 million. New York had 676,205 total registrations that year (an increase of almost 67 percent), including 125,401 trucks (a 126 percent increase), while New Jersey had 227,737 total registrations (an increase of 60 percent), including 50,400 trucks (an increase of 126 percent).

Before the Holland Tunnel opened, there was no road or highway to carry the ever-increasing vehicular traffic between the nation’s largest city and New Jersey. Ferries owned and operated by railroad corporations carried almost all passenger automobiles, trucks, and horse-drawn vehicles that crossed the Hudson River into or out of Manhattan. Ferry service was often less than serviceable, however, and was frequently delayed or stopped altogether due to fog or ice in the river or to labor strikes, which were common in the turbulent early decades of the twentieth century.

For daily commuters or railroad passengers, there were options available. The Hudson and Manhattan Railroad began transporting people under the river to Manhattan subway stations at midtown in 1908 and to a downtown station in 1909. Farther uptown, the Pennsylvania Railroad completed a passenger-train tunnel under the river into Pennsylvania Terminal (Penn Station) in 1910. But there were no options for motor vehicles or horse-drawn wagons. Even on days of normal operation, they might have to stand idle for hours in long lines stretching miles through the streets of Jersey City, waiting to board one of the overtaxed ferryboats. In Lower Manhattan, the situation was similar for vehicles headed west to New Jersey, with near-constant traffic gridlock.

Despite rapid growth in the motor-trucking industry during the early years of the twentieth century, the majority of bulk freight from New Jersey destined for delivery to the boroughs of New York City, including almost all the city’s food and fuel, was transported across the river or through the harbor by small, self-propelled cargo boats, called “lighters”; in barges pushed by towboats; or in towboat-propelled “car floats” carrying railcars
Introduction

filled with freight. Lighters, barges, and car floats also carried freight to railroad-owned terminals in New York City for transshipment to other parts of the Northeast or to the docks along Lower Manhattan’s west side, where virtually all the oceangoing ships using the Port of New York loaded their cargo. Although many of the watercraft making up this system, particularly the towboats, were independently owned and operated, the railroad corporations dominated the shipping business of the port.

Like the ferries, this system was vulnerable to the vagaries of weather and labor unrest. Its inadequacies created a problem not just for the greater New York area but for the entire country. In the years immediately preceding and following World War I, approximately 50 percent of the nation’s foreign trade passed through the Port of New York.  

During the severe winter of 1917–1918, the Hudson River was so covered and clogged with ice that fuel and food could not be brought into the city in sufficient quantities to meet the needs of the population. The heating and hunger crisis that ensued, along with the backup of vital war materials destined for Europe in the Port of New York, exposed with dramatic clarity the existing railroad-controlled transportation system’s fatal flaws. The need for an alternative was so apparent that opposition to a highway across the Hudson River began to break apart in 1918 as rapidly as did the ice jams in the river as warmer weather returned. But would that highway be brought across the river by a bridge going over or a tunnel going under?

As early as 1906, state commissions existed in New Jersey and New York charged with the responsibility of determining how best to answer that question. In the first six years of their existence, the commissions primarily concerned themselves with developing plans for a rail, wagon, and pedestrian bridge. In this they followed the precedent established by private-venture planners, who, as early as 1868, had sought charters at the state or federal level for construction of a bridge, a structure that initially seemed easier (and less costly) to construct than a tunnel.

In 1913, the state commissions resolved to build a tunnel first. Engineering studies had revealed that a tunnel was the most feasible and cost-effective option for a link from northern New Jersey to Lower Manhattan, the commercial heart of New York City. A bridge located farther upstream, or additional tunnels, could come later. Questions remained, however, regarding the best type of tunnel and the optimal method of construction.

By 1913, tunnel engineers had already accumulated considerable experience in building rail and utility tunnels under rivers in two ways. They could dig through the bed of the river, using compressed air chambers to
keep the water out until the tunnel was finished, or they could assemble the tunnel sections on shore and then sink them into a preexcavated trench. Each method had advantages and disadvantages. There were also options for the material used to construct the tunnels. Cast iron was the most tried and true, but steel and concrete had their advocates, as well.

What tunnel engineers had not yet figured out was the best method of ventilating a vehicular tunnel. There were a few, relatively short tunnels used by motor vehicles in Europe, but these had been built for use by horse-drawn wagons. As vehicular traffic in them grew, it became increasingly evident that the European tunnels were limited in the amount of traffic they could accommodate without risking human health. Some experts were certain that a vehicular tunnel long enough to reach from New Jersey to New York could not be properly ventilated by any method. Perhaps, they proposed, freight rail tunnels for trains pulled by electric locomotives or tunnels for unmanned carts pulled by cables would be a better and safer option. Even so, the state commissions were committed to constructing a vehicular tunnel. But should such a tunnel be a single-tube design or a multiple tube? And how many lanes of traffic should it accommodate?

These technical questions were largely the purview of the state commissions’ staff engineers and consulting engineers, who, in application of the Progressive-era ideal of objective problem-solving, sought to overcome the physical barrier of the river through the application of scientific study. Years of research followed as they attempted to address these questions, while the commissioners worked to secure the legislative authorization necessary to fund construction. Before detailed design studies could begin, the state commissions had to overcome the political barriers that separated the two states and separated Democratic and Republican politicians within each state.

Not until 1920 were questions regarding type, method of construction, configuration, and funding source resolved and construction begun. Once started, the project took more years, cost more money, and sacrificed more lives than anyone could have imagined.

In *The Road and Car in American Life* (1971), John B. Rae cites road building, including “adjuncts such as bridges and tunnels,” as “economic activity on a massive scale that has been created directly by the automobile and that has been paid for largely by the automobile as well. Apart from the economic effects, the motor vehicle has also been responsible for some spectacular achievements in civil engineering that would not have been undertaken without the demand created by automobile travel.” Rae’s partial
list of U.S. projects includes San Francisco’s Golden Gate and Bay Bridges, the Lincoln and Holland Tunnels, the bridges between New Jersey and New York, and the Mackinac Bridge. What he does not note is that the Holland Tunnel was the first of these to be built. It was, therefore, a seminal work in the history of urban transportation.

The history that follows tells how a vitally important link in the regional transportation system of the New York metropolitan area came to be, as it describes an unprecedented achievement in the fields of civil and mechanical engineering. It is also a tale of great human drama, with heroes and villains, that illustrates how great things are accomplished, and at what price.