

A CONCISE HISTORY
OF
THE HUDSON AND MANHATTAN RAILROAD

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August 19, 1971

New Harrison station
opened in 1937

Exie also
had plans
for new
station

H+M plans for
Exie link-up
need develop to

More on Speedwalk +
why removed

INTRODUCTION

PATH passengers over the years have been asking penetrating questions about the pioneering rail rapid transit system they ride. The Hudson and Manhattan Railroad, which the Port Authority Trans-Hudson (PATH) Corporation agreed to operate, improve, and maintain beginning on September 1, 1962, was a railroad rich in history. Two years before Custer's last stand, the first uptown tunnel of the Hudson and Manhattan (H&M) Railroad was under way in 1874--the first tunnel of its kind to traverse beneath the rocky river bed of the Hudson. Lives were lost, tunneling methods were replaced, capital investments collapsed, and work on the tunnel was abandoned and resumed often before it was finished three decades later. When it was opened to the public on February 25, 1908, The New York Times claimed that the obstacles which had been overcome made the tunnels a greater engineering feat than the Panama Canal. This is perhaps difficult for the modern commuter to appreciate--living in an age of moon exploration--63 years hence.

Some of the perennial questions asked by PATH passengers about their "sub-aqueous" rail system, as it was regularly called years ago, include the following: Why are there numerous tight curves in the tunnels, especially at the New York approach to the uptown tunnels? How come 19th Street Station lies dormant? Why were there separate train platforms at Hudson Terminal for out-going and in-going passengers? What methods of construction were used in building the tunnels? Is it true that there were special H&M cars for women passengers only? Why did the Hudson and Manhattan Railroad go bankrupt? A concise history of the old railroad reveals the answers.

NEW YORK AND NEW JERSEY PRIOR TO 1874

New York City was gradually expanding uptown by the early part of the 19th Century, there being few other places to expand considering Manhattan's enclosing water boundaries. New areas of industry and commerce were opening up on the West Side, north of Canal Street. Principally to serve the commercial needs of these new areas, ferry routes were established between them and the national railroads that terminated on the banks of the Hudson in New Jersey. With the establishment of ferry service between New York City and New Jersey, bankers and laborers alike had the option to move across the river, living in New Jersey's suburban comfort. So it is fair to say that by 1850 conditions of population and commercial growth created a need for transportation across the Hudson River which would finally result in building a rail system under the river itself.

It was by no means coincidental that most of the great national railroads serving New Jersey terminated their service directly opposite downtown Manhattan on the New Jersey shore. For an unusual feature of the New Jersey shoreline is a rocky ridge extending down river from Nyack to just north of Hoboken. This ridge is referred to as the Palisades. It was the sheer unevenness and hardness of the Palisades that drove the railroads to terminate most of their New Jersey service at facilities in the Hoboken-Jersey City area, facing lower New York City.

The railroads acquired large grants of land on the Jersey Shore, building large terminal and yard facilities. With one exception, all these railroads were required to ferry their passengers and freight across the Hudson. The singular exception was the New York and Hudson River Railroad, which entered Manhattan from the north at Spuyten Duyvil.

A mile in width and 40 to 60 feet deep, the Hudson River constituted a formidable barrier to the people of New Jersey and New York. Before the opening of the Hudson and Manhattan system, about the only way to cross the Hudson was to board large steam ferryboats owned by the Pennsylvania Railroad, the New Jersey Central, and other railroads. Although they were at first rather simple crafts, increasingly efficient ferryboats were introduced to meet growing commuter demands. By the turn of the century, boats had been designed which could move in both forward and reverse directions, and load and unload from either end. In addition, long dock-like bridges, hinged at the shore with the ferry-end resting on floating pontoons, helped speed cargo and passenger flow.

These newer ferryboats had steel hulls, overhanging decks, and a double carriageway for vehicles in the middle. Some had an upper deck with large cabins. They were often driven by not one, but seven propellers--located at the bow and stern. In contrast, the older boats, prominent prior to 1874, were steam driven side paddle-wheels. On the other hand, the newest boats in service by about 1905--three years before the opening of the H&M system--were 206 feet long, with a top speed of 12 knots, and a passenger capacity of 500 sitting, and twice as many standing.

Even so, the average ferry crossing between New Jersey and New York City one-way took 32 minutes, while passengers were to make the same journey aboard the Hudson and Manhattan trains in just three minutes. In 1908 that saving of time made the H&M system an immediate big hit with daily commuters.

COLONEL DEWITT HASKINS BEGINS TUNNELS IN 1874

For many years no means of crossing the Hudson River existed south of Albany (145 miles up-stream) other than by ferry boat. Continuous land transportation between New England and states to the south and west was therefore necessarily interrupted by ferryboat service. This situation prevailed until 1889, when the Poughkeepsie bridge was built--crossing the Hudson 75 miles north of the mouth of the river. Still the desire for some means of crossing the river at New York City besides using ferryboats, persisted. The idea of building a mile wide bridge--given present day engineering knowledge--was considered far flung indeed.

The construction of a tunnel was considered to be the only reasonable way to unite New Jersey and New York City, and when Colonel DeWitt Clinton Haskins moved to Manhattan from California about 1873, he decided he would build one. Haskins, an English born civil engineer, was well known for his excellent work out West with the Union Pacific Railway. When he saw the need for underwater tunnels, he worried about what construction methods he would use until finally he developed and patented his very own.

If the on-again off-again history of the tunnels under Haskins direction is to be understood, a brief explanation of the construction methods Haskins used must be given. Let's let Haskins himself explain his invention. His patent of February 3, 1874, reads:

"Be it known that I, DeWitt Clinton Haskins, of Valejo Solano County, California, have invented a new and useful improvement in the art of tunneling. Three features constitute the leading characteristics of my invention. First, the use of compressed air acting directly upon the excavation walls to prevent leakage or caving. Second, the use of temporary flexible plugs to stop leaks.

Lastly, the partial refilling with earth of the completed tunnel to diminish the area of the surface exposed to the action of the compressed air."

In other words, compressed air would be pumped into the tunnel as it was being built, thus holding up the ceiling and keeping water from coming into the tunnel. In this way, any loose material or seepage encountered in the roof or tunnel walls would be prevented from caving in upon the workman by compressed air; dangerous debris would be held up against the ceiling like flies.

If this description of Haskins' tunneling methods strikes the reader as dubious, he may take comfort from the fact that Scientific American also predicted Haskins' failure, terming it "inevitable." In its issue of December 12, 1874, the journal acknowledged that while the air compressing apparatus was useful in conjunction with other tunneling methods, 50lbs of air pressure alone was insufficient pressure to prevent falling debris and cave ins. The clumsy, costly caissons, shields and other appliances, it wrote, were heretofore thought necessary, but Haskins discards them. Haskins patent is, indeed, "a new wrinkle in the science of engineering."

As hinted earlier, people were talking up the idea of bridging over or tunneling under the Hudson River as early as the 1850's. But it wasn't until May 22, 1873, that Haskins converted talk into action by incorporating this long range enterprise under the name of the Hudson Tunnel Railroad Company. It began with a stock authorization of \$7 million dollars. Another company was begun under the laws of the State of New Jersey on May 26, of that same year. DeWitt Haskins, founder and originator of the under water tunnels which would later mature into the H&M system, was named company president. The express

purpose of the enterprise was daring and difficult: to tunnel under the Hudson in such a way that New York City would have a connecting transportation link with railroads terminating near Jersey City.

The following year, on May 19, 1874, the two companies were consolidated as the Hudson Tunnel Railroad Company, with capital stock authorized to \$10 million--an increase totaling \$3 million dollars. With this, the company began the preliminary work of digging a shaft at the foot of 15th Street ^{in Jersey City.} But exactly where would the tunnel connecting to this shaft terminate? At or near Washington Square, New York City, if all had gone according to plan. Part of the tunnel would then have gone under private property, and part would have extended under public streets. Haskins had envisaged steam locomotives of the Delaware, Lackawanna, and Western Railroad as well as the Erie Railroad operating through his tunnels into New York. The 15th Street site, (where the first shaft was dropped in Jersey City) ^{terminals} was located conveniently between these ^{of these} two railroad ^{terminals}. But this coordinated plan excluded the powerful Pennsylvania Railroad and other important lines, and this cost him their legal harrassment during the early stages of tunnel construction.

The New York Sun wrote in mid-1874 that Haskins "is confident of success, that there is no stock for sale, and that members of the company have plenty of money to complete the work, and are willing to pay all costs and expenses." This formidable optimism would be challenged early on.

The Jersey City shaft had been dug only 20 feet when the Lackawanna Railroad took the Hudson Tunnel Railroad Company to court. The Lackawanna argued that it was unfair to exclude its trains from Haskins' underwater rail system. Haskins' countered that the Lackawanna train terminals were located too far away from his tunnels to make a convenient rail link between them practical. But the Lackawanna Railroad was granted a court injunction against

the Hudson Railroad--halting tunnel construction. Because of this injunction and other legal bickering, almost five years lapsed until in 1879 Haskins was permitted to resume his enterprise.

When work resumed, the shaft was dug to a depth of 60 feet, and a tunnel heading toward the river was begun. The original tunnel plan was to build a ^{single} tunnel 26 feet wide and 24 feet high, large enough to accommodate a double-track rail system. This original tunnel plan was altered in 1879, however, in favor of a plan calling for two tunnels to be built--(instead of just one double-track tunnel). Each of the two tunnels ^{was} ~~were~~ to measure 18 feet high by 16 feet wide. With the adoption of this plan approved by the company, Haskins' compressed air tunneling methods were started--the diggings taken from inside the tunnel being lifted to the surface and dumped at sea. Finally, work was progressing without interruption.

But not for long. A year later a severe leak flooded the tunnel and cost the lives of 20 men. On July 21, 1880, Peter Woodland, of Jersey City, was working at the heading with several other "sand hogs," as the workmen were affectionately called. Woodland was apparently the first to discover the intrushing water. In a moment of great heroism, he ran to the door of the airlock, yelling to his fellow workers to run for their lives. After eight workmen passed through the airlock door, he saw that unless the door was quickly closed from the inside, all the escaping men would drown. Therefore, in order to preserve the lives of the escaping men who had a better chance of surviving, Woodland closed the door of the airlock. The intrushing water drowned him and the others unable to pass. A memorial commemorating Woodland's courageous deed stands over his grave today in New York Bay Cemetery, in Jersey City.

At the time of the tragedy, the tunnels had progressed 280 feet in the north tube and 15 feet in the south tube. Six months elapsed before the 20 bodies were recovered during the installation of a new pneumatic caisson.

The tragedy sent shock waves throughout the tunneling enterprise, and on March 30, 1881, a new company calling itself the Hudson Tunnel Railway Company was organized. (The name of the former company was the Hudson Tunnel Railroad Company). Undaunted, Haskins returned to the business of boring beneath the Hudson.

This newly structured company carried out several major steps in the tunneling operation. First, it sunk a shaft on the New York side of the river at the foot of Morton Street. Secondly, it extended the north tunnel on the New Jersey side 1,542 feet, and the south tunnel was extended 570 feet. In addition, iron plates were fitted into place and bolted, and 1900 feet of brick lining was erected inside north tunnel "A". The alert passenger may notice this brick lining on PATH's westbound uptown service.

Financial and engineering problems ~~did not go away~~ ^{persisted} between the years 1881 and 1889, and tunnel construction was interrupted several times during this period. Even so, Haskins would not give up. He went to his native England in 1889 and floated bonds there to the tune of over \$2 million dollars. The English contracting firm of S.S. Pearson & Son had agreed to back him. When he came home, there was renewed hope that his dream of an underwater rail system would materialize. Unfortunately, in 1890 another threatening "blow-out" occurred in the tunnels. As a result of this latest blow-out, tunnel contractors apparently abandoned Haskins' compressed air methods--introducing instead the use of the tunnel shield. The tunneling then continued without further accidents.

Although the shield method of tunneling was working out well, the Hudson Tunnel Railway Company was to suffer a final economic relapse from which it would not recover. What triggered this final relapse? It is not exactly known. Presumably, the costs of changing tunneling methods and therefore equipment, coupled with continuous legal pressure against the tunnel company by unfriendly railroads, contributed heavily to breaking the financial back of the company. It was a dark day for Haskins in 1892--to be sure--when his contractors secured a lien against the tunnel company for \$20,000.

A total of 4,076 feet of construction was completed in the north tunnel, 160 feet from the New York shaft, and 3,916 feet from the New Jersey shaft. In addition, 570 feet of the south tunnel was completed by the Hudson River Railway Company. With a ~~lien~~ pending in court against his company, all work on the rail system was stopped in 1892. No action was taken for 10 full years beneath the bed of the Hudson River. Fatigued by years of frustration, DeWitt Haskins gave up.

WILLIAM G. MCADOO RESUMES TUNNELS IN 1902

It was left to a young Georgia born lawyer, who moved to New York City in 1892, to somehow resurrect the dead tunnels. His name was William Gibbs McAdoo. McAdoo was no newcomer to railroading. While practicing law in Chatanooga, Tennessee, he became a trustee of the Knoxville Street Railroad. There were plans to electrify the Knoxville horsecar line, and through McAdoo's persuasive skills, he secured the large loans needed to complete this modernization in 1890. He had also helped supervise this changeover in motive power, having been a daily commuter of the Knoxville line himself. It is an odd footnote in history that when McAdoo moved to New York City, he reportedly did so to further his legal career rather than get further involved

with rail operations. But like so many men, chance had different designs on the course of McAdoo's life.

As it happened, McAdoo became a business associate of John R. Dos Passos, a leading corporate lawyer, and the recently appointed president of the bankrupt Hudson Tunnel Railway Company. A foreclosure against his company had been ordered by the Supreme Court of New York on February 28, 1898, and a law firm, which represented the bondholders, purchased all the company properties. Dos Passos put McAdoo in contact with Charles M. Jacobs and J. Vipond Davies, chief engineer and deputy engineer respectively of the abandoned tunnels, for McAdoo had expressed a deep interest in reviving the underwater system.

Apparently McAdoo's experience with the Knoxville Street Railroad convinced him that running electric rather than steam trains through the tunnels offered the best solution in terms of speed and comfort to the late 19th Century commuter.

What were the transportation conditions faced by the New York area commuter around the dawn of the 20th Century? According to the 1900 Census, there were about 3.5 million people living in the five boroughs of New York City, the largest borough constituted by Manhattan island with its 1.9 million residents. The growth of Manhattan had been successively stimulated by improvements in transportation facilities. First, elevated railways were built between 1870 and 1880, and extended at various intervals. Secondly, surface tramways were electrified in the years 1895 to 1903. In addition, there was considerable improvement in the speed and capacity of the elevated, due to change in motive power from steam to electricity in 1902 and 1903. No doubt McAdoo was particularly influenced by this impending local development, as he began to favor electricity for the Hudson tunnels as well. Finally,

check 1900 Census

the city's first subway--the IRT Broadway ^{which extended north} ~~Limited~~ to 145th Street--was opened in 1904, ushering in a new era in underground transportation for this region. As described earlier, ferryboat service across the Hudson to Hoboken and Jersey City was perhaps sluggish, but getting sophisticated.

Improvements in local transportation facilities were also largely responsible for ~~diverting~~ ^{facilitating the move of} great numbers of people to ~~the boroughs of~~ Brooklyn and Queens, across the East River. The opening of the Brooklyn Bridge in 1883 had encouraged this pattern: the Brooklyn elevated trains entered Manhattan riding over the bridge since 1898, as did the electric tramways beginning in that same year. Similarly, the Williamsburg Bridge, opened in 1903, also carried both the elevated and electric tramways.

About one million people were living within a 20-mile radius of New York City on the west side of the Hudson, the census of 1900 reports. Hudson Railway Company Chief Engineer Jacobs said that insufficient transit facilities accounted for the comparatively slower growth of the cities and towns of New Jersey's suburban area. In a paper delivered at the Institute of Civil Engineers in London in 1910, he observed that although suburban New Jersey was not politically part of New York City, "these municipalities are essentially part of the same community. They are influenced by the same natural forces which have caused a concentration of population around this great port."

Jacobs also noted that since the New Jersey suburbs sat outside of the jurisdiction of various New York commissions designed to investigate and improve metropolitan area transit facilities, these commissions were in effect powerless to assume responsibility for transportation between New Jersey and New York City. Hence it was incumbent upon private enterprise to create adequate

transportation and in some way unite the people of both states.

Enter William Gibbs McAdoo . . .

McAdoo was convinced that essentially Colonel Haskins' idea of uniting the people by rail lines running beneath the Hudson River was a good idea. Evidently, McAdoo had dreamed up a similar plan before he knew of the existence of the abandoned tunnels. But was this dream workable? Yes. After inspecting the pumped out tunnels, Jacobs and Davies advised McAdoo that the basic tunnel structure and tunneling equipment was ^{sound,} ~~o'kay~~. ~~Together~~ they estimated that it would cost about \$4 million dollars to complete the tunnels which Haskins started in 1874. McAdoo said that he would undertake to complete the operation. He would raise the needed capital by forming several different tunnel companies--both New York and New Jersey based--with plans for the eventual consolidation of these smaller companies into one large company.

McAdoo's first step in acquiring the tunnels was to enter into negotiations in 1901 with the Bondholders Reorganization Committee, headed by a Mr. F.B. Jennings, of the law firm of Stetson, Jennings, and Russell. The bondholders of the bankrupt company agreed to let McAdoo take over and try to complete the system.

In accordance with his earlier thinking, McAdoo formed three tunnel companies in the year 1902: (1) The New York and Jersey Railroad; (2) The Hoboken and Manhattan Railroad; and (3) The Hudson and Manhattan Railway. What these early companies accomplished in the four years of their existence was ~~pretty~~ amazing.

The New York and Jersey Railroad ^{obtained} ~~got~~ a franchise giving the Company New York rights to build an underground line extending from Morton Street--up Sixth Avenue--to 33rd Street. This is the present route of PATH's uptown

New York service. On that same day, December 22, 1904, the company also obtained from New York City's Board of Rapid Transit Commissions, the option to construct tunnels from 9th Street crosstown to Fourth Avenue--an option never utilized. William G. McAdoo was the president of the New York and Jersey Railroad, and Walter G. Oakman, president of the Guaranty Trust Company, was designated its vice-president. (This was the first company and it formed in 1902.)

The Hoboken and Manhattan Railroad, organized under the laws of New Jersey, was responsible for building a tunnel from Hoboken to platforms underneath the Pennsylvania Railroad's Exchange Place terminal, in Jersey City.

Finally, the Hudson and Manhattan Railway, a New Jersey-based company chartered on September 19, 1902, was responsible for building tunnel connections from Exchange Place, Jersey City, to a point in downtown Manhattan.

To fully understand the development of these and succeeding tunnel companies, it is first necessary to follow the progression of McAdoo's thinking about the rail system he and his talented engineers were putting together. Curiously enough, some evidence suggests that he initially explored the idea of returning to Haskins' very first plan, which entailed the construction of a single tunnel--through which narrow gauge trains would travel on a double-track. If McAdoo did reconsider this design, it didn't hold his confidence for long. In terms solely of tunnel size, the construction he finally authorized closely resembled Haskins' revised tunnel plan of 1879: a plan calling for two parallel single-track east and westbound tunnels spanning the Hudson. On the other hand, McAdoo was to make highly innovative changes and additions in the design of this underwater rail system between the years 1902 and 1909 that would constitute a radical departure from Haskins' formulations.

Two of McAdoo's most important decisions came early on. First, he

Why didn't Hoskins choose electric powered cars?
Because of heavier weight of electric
would have involved reinforced
tunnel construction?
Despite border Underground - electric
cars - electric still primitive

steam was in its Golden Era
(1st PRR tunnel O.K. for electric)
Tied also PRR tunnel
engineer

decided to use electric powered trains instead of steam driven trains. In fairness to Haskins, this decision took wise advantage of the latest advances in railroad technology unavailable to his earlier enterprise. Evidently, the go ahead was first given by McAdoo for tunnels accommodating single unit electric tramcars. But after re-examining the severe week day rush hour experienced by metropolitan ferry service, a new decision was made in favor of multiple unit electric trains. Multiple unit electric trains offered a promising remedy to reducing the rush hour commuter squeeze: they ran at comparatively higher speeds and thereby enlarged rail service capabilities. Generally speaking, these cars ran in such a way that they could be pulled or, conversely, they could operate on their own power--independently of each other. They would help get more people across the Hudson River faster.

A major reason for the sharp curves in PATH's uptown tunnels to this day is directly related to the implementation of a multiple unit system. Easier gradients, it seems, were desirable for multiple unit trains, as were wide curves. But by the time McAdoo decided to use these trains, a good portion of westbound tunnel "A" had already been built. So this westbound tunnel, at least, was not perfectly suited to the trains it would carry. Presumably, if the character of the rolling stock had been known from the start, such sharp curves and sometimes steep gradients would have been largely avoided.

McAdoo's second most important decision was to authorize the building of a second pair of tunnels to carry passengers between downtown Manhattan and Jersey City, New Jersey. "No tunnels under the Hudson River would be satisfactory," McAdoo said, "unless a system was provided by which people could be landed into the downtown district of New York City as well as the uptown district." With this pledge, an expanded tunnel network was planned. New tunnels would extend parallel to the river from Hoboken to Exchange Place, in Jersey City, on the

New Jersey shore. From Exchange Place twin tunnels would go under the Hudson, terminating at Cortlandt and Fulton Streets in New York City. Of course, this construction was in addition to the uptown line connecting Hoboken with New York's Sixth Avenue and 19th Street area. The uptown line would eventually continue up Sixth Avenue to a Hudson and Manhattan station located at 33rd Street.

The westbound and eastbound tunnels of the twin uptown tunnels were designated tunnel "A" and tunnel "B", respectively. The westbound and eastbound tunnels of the downtown service were designated tunnel "E" and tunnel "F". For purposes of clarity, it is convenient to adopt these designations in some of our descriptions of the system.

McAdoo was a keen innovator. He was by no means being impulsive when he decided to build the downtown tunnels. His New York and New Jersey Railroad had apparently commissioned a study of commuter traffic between New York City and New Jersey around 1903. The study revealed that a total of 90 million passengers a year rode ferryboats across the Hudson, with an annual traffic increase of 5 per cent. Of this total volume of passengers, 75 per cent crossed the Hudson at points one-half to one-mile south of the original uptown tunnels. Thus it was only after utilizing surprisingly sophisticated methods of passenger ^{market} research that McAdoo authorized a new pair of downtown tunnels to be built approximately one mile south of the uptown tunnels. ~~Sheerly~~ ^{In} terms of capturing an ever expanding commuter market, building the downtown tunnels made good business sense.

A crosstown extension of the New York uptown service was also on the drawing boards about this time which would run off the eastern corner of the 9th Street Station near Sixth Avenue and proceed under 9th Street to a terminal on Fourth Avenue at Astor Place. Among other advantages, this extension would have permitted connections between the H&M system and the (old) municipal city subway (now the lower portion of the Lexington Avenue line), but the plan was never implemented.

(Nonetheless, this does help clarify the motivations behind the New York and Jersey Railroad's acquisition of tunneling rights from 9th Street to Fourth Avenue, as previously mentioned.) No doubt the crosstown Fourth Avenue plan was dropped in view of the ambitious underground construction of the New York City subway system in subsequent years, reducing somewhat the need for this expensive extension. In sharp contrast to the downtown tunnels, the New York crosstown extension began to look like a bad investment.

McAdoo continued to follow through with his idea of developing various tunnel companies. On March 20, 1903, he developed the fourth such company, the Hudson and Manhattan Railroad--a name retained by McAdoo's large consolidating company formed in 1906, when the four smaller companies merged as one. This earlier and distinct New York company was granted a perpetual franchise under the Hudson River from the state boundary line of New York to an area bounded by Greenwich and Cortlandt Streets (in uptown) and Church and Fulton Streets, in downtown Manhattan. This franchise was granted by the Rapid Transit Board in November of 1903, and it helped speed the way for the later acquisition of the Hudson Terminal site.

How did McAdoo raise the needed capital for what had been a defunct business enterprise? At least four factors were responsible. Perhaps most important was the fact that Haskins' original idea to build an underwater rail system looked like a big money making opportunity. The problem was to assemble a competent team of managers and engineers to complete it. Secondly, by 1900 the revolution in rail transportation was literally transforming the character of a nation formerly wedded to horse drawn vehicles on land, and steam driven vehicles on sea. If rail lines could now be built through rocky riverbeds like the Hudson's, then the realization of this feat looked like a worthwhile and exciting chapter

in the application of advanced railroad technology. For example, the conversion in motive power from steam to multiple unit electrically powered trains naturally enhanced McAdoo's proposals, increasing the dispatch and comfort of underground transportation. Many investors said the ferrys ^(ie) would be left behind, and ~~they~~ ^{they were} ~~were~~ eventually right.

Thirdly, McAdoo himself was a very persuasive businessman, and his legal training was seen by investors as a big plus. It was probably a foregone conclusion that legal battles would have to be fought in an undertaking of this scope. Besides, he had already made a good name for himself as a railroad executive in Knoxville. In a word, he looked like the man for the job. Lastly, once McAdoo decided to try and restore the tunnels, he proceeded to make important business contacts which would help accomplish his ends. It was probably not entirely by accident that he made the acquaintance of John R. Dos Passos, who arranged his first meeting with Messrs. Jacobs and Davies. It was after conversations with these three men that his plans really gained momentum. In addition, Walter C. Oakman, ^{the} ~~a~~ financier ^(ie) who was appointed vice-president of the New York and Jersey Railroad, introduced McAdoo to managers of the conservative and wealthy investment firm of Harvey Fisk & Sons, in the autumn of 1905. After a thorough investigation of McAdoo's credentials and proposals, this firm decided to back McAdoo's enterprise. Clearly, McAdoo was a man of acute ability, inspiring the confidence of those he met.

He knew how to reward those who put their confidence in him, too. On December 6, 1906, the four companies connected with the construction of McAdoo's rail system were consolidated according to plan. The New York and Jersey, Hoboken and Manhattan, Hudson and Manhattan Railway, and Hudson and Manhattan Railroad companies became the Hudson and Manhattan Railroad Company, Incorporated, with McAdoo as president. In addition, a group of diverse

Who was pling Frok? Any relative
of Wilbur Frok?

Did Charles Jacobs actually
work on construction of London
Underground?

financial interests came together that same year ^{in an enterprise} and were called the Hudson Companies. The Hudson Companies constituted a subsidiary holding company, which managed real estate properties connected with the tunneling. ~~The~~ ^{C.} Financier Walter Oakman went from vice-president of the dissolved New York and Jersey Railroad to president of the Hudson Companies. McAdoo also made ~~the~~ investor Wilbur C. Fisk the new vice-president of the Hudson and Manhattan Railroad. Fisk also had a seat on the Board of Directors of the ^{Hudson} ~~Company~~. By 1907, men no less in stature than J.P. Morgan himself, in conjunction with The First National Bank, and other first rate security holders, had put their financial faith in the tunnels beneath the Hudson. The Hudson Companies alone was said to have had ^{assets} as high as \$16 million dollars when it was formed.

CHARLES M. JACOBS DIRECTS COMPLETION OF OLD UPTOWN TUNNELS

The story of how the Hudson River tunnels were dug is the story of men and machines advancing new techniques in engineering. As will become increasingly clear, McAdoo did not know how to build tunnels, but he did know how to marshall men and money together and rally them on against slim odds to complete a great task.

The man who knew something about how to build tunnels was Charles M. Jacobs. Jacobs was an English born civil engineer, familiar with the methods used in building the London Underground--the world's first subway system, built in 1863. In addition, he had had broad experience in tunnel and bridge construction on both continents, and was regularly commissioned by major American railroads. He was ^eminently qualified to tackle the job of completing the abandoned uptown tunnels, but the hardships of that enterprise would place great demands on his ingenuity. So difficult was the task at hand that no tunnel construction had ever been done anywhere that would anticipate

the problems which Jacobs would encounter. The London Underground, for example, had been bored effortlessly through the soft clay of the Thames River, in contrast to the stubborn sediments of gneiss and mica schist awaiting Jacobs' efforts, not to mention silt and hard rock.

Given his creative independence of mind, however, Jacobs would masterfully and systematically overcome these engineering problems. Indeed, by the time the first H&M train had crossed under the Hudson in 1908, Jacobs had--figuratively speaking--written the textbook on the methods of underwater tunneling. Little wonder, then, that the Pennsylvania Railroad enlisted Jacobs as their supervising engineer when the Pennsy followed McAdoo's lead around 1904, and decided to build their own underground tunnels. Quite possibly, Jacobs was the only engineer at that time who knew from experience how to safely bore beneath the riverbed of the Hudson. To learn the details of how he did this, it is helpful to return to his London paper of 1910, an authoritative source from which the bulk of our description of tunneling methods is drawn.

Jacobs^s/involvement with the tunnels began when he was commissioned to analyze their condition in a preliminary report submitted to the ~~B~~ondholders of the bankrupt tunnel enterprise in 1895. In this report, he concluded that two central problems had to be solved before the tunnels could be continued. First, there was a good chance that the tunnel might collapse unless a more effective means of structural support from within the tunnel were adopted. He suggested that this weakness in the tunnel's metal lining could be remedied by erecting an internal lining of reinforced concrete. The second major problem was that about 135 feet from where the tunneling work had stopped, a reef of hard rock extended 750 feet on the line of the tunnel. If this reef could not be penetrated, the fate of the tunnels would be sealed. But according to Jacobs^s/analyses, the reef probably could be penetrated if an

apron were added to the front of the shield, thereby providing needed protection to the men performing the drilling. Although his report was encouraging, it remained for McAdoo's New York and Jersey Railroad to get the shields going in early 1902.

When McAdoo took over, the tunnels had been inactive for 10 years. On Jacobs' recommendation, several of the older methods of construction were discarded or updated. For example, while Haskins had used mules to cart material out of the tunnels, McAdoo ordered cars pulled by cable. Kerosene ^{lamps} ~~laterns~~ were replaced by electric lights, thanks to Edison's recent invention of 1879. On the other hand, the old shield introduced into ^{westbound} Tunnel "A" by Haskins' contractors in 1890 was retained. The principal reason it was retained was that here only ten feet of river silt rested above the tunnel roof. If attempts were made to replace the old shield with a newer shield, there would be considerable risk of aggravating a serious blow out.

Generally, however, the shields Jacobs used in boring the tunnels were built to one design. With few exceptions, the outside diameter was 17 feet, and the length was 11 feet, five inches. The way the shields worked is quite interesting. Each shield was advanced by sixteen eight-inch hydraulic pumps, which were located in engine rooms well outside the tunnels themselves. Above the transverse girder of a shield there were three platforms. These platforms were powered by hydraulic jacks in such a way that the platforms could be advanced ahead of the cutting edge of the shield. Thus the platforms served as a protective cover for the workmen drilling rock at the tunnel heading.

*use
illustrations*

The method of excavation was simple in principle but dangerous in practice. We learn from Jacobs that when the doors of the compartment of the shield are opened, the shield is pushed forward into the mud about two

feet. The material which is displaced by this two foot advance enters the shield's compartments. The workers inside the airlock then remove this displaced material. When the inside of the shield is cleared, a number of arc shaped sections of the cast iron lining are taken forward and bolted. Each individual section forms a continuous connection with the previous lining construction, forming a giant ring equal in width to the length of each push forward of the shield. Therefore, the tunnels were completed in roughly two foot segments. Of course, this process was retarded considerably during the blasting and drilling through rock, which was sometimes necessary. At such times, heavy debris had to be cleared from in front of the shield before it could be shoved ahead, and this took more time. In addition, if men working in the air compression chamber of the shield were adversely affected by the varying levels of pressure, a decompression chamber stood off shore at which they could receive treatment for the "bends" in reduced pressure. Reportedly, the weight of one shield, complete with hydraulic machinery, was 61 tons.

use
illustrations

When Jacobs was told to resume the job of completing the uptown, tunnels in February of 1902, it was to westbound tunnel "A" that he first returned, the system's northernmost tunnel under the Hudson. Three difficult problems were confronted in tunnel "A". The first problem occurred on November 29th when, after 136 feet of tunnel ^{were} ~~was~~ constructed, the cutting edge of the shield could advance no further--blocked by a hard rocky reef. Jacobs had worried about this reef in his preliminary analysis of 1895, and he followed his own suggestions for possible remedy. He stopped construction for 47 days in order to modify the shield, attaching to it a protective steel apron suitable for blasting. The apron extended five feet in front of the shield's cutting edge. As it turned out, this

modification worked well: the workers were protected from any sudden inflow of silt while the reef was successfully blasted away.

The modifications on the shield being completed, men and machines pushed on. By February of 1903, one year after construction was resumed, the shield stood partly in rock and partly in silt. Normally, when the shield was not up against rock, the shield was forced ahead by its 16 hydraulic pumps without any men working in front of the shield's cutting edge. In such instances, when the shield advanced two feet onward, excavated material was forced into the shield chamber through open doors in the diaphragm. The second difficulty was precisely this: the shield had somehow gotten stuck; it wouldn't budge even though the maximum 3,000 lbs per square inch of pressure was applied. The shield was at a standstill. Again, it was decided to blast. Special precautions were taken during this blasting because it was probable that it would upset the riverbed and cause a bad "blow". Seeing this, a series of ingenious measures were taken to avoid accidents. Six hundred cubic yards of clay was placed into two or more scows, and these scows were positioned in readiness over the point of the underwater blasting. Should a blowout occur during blasting, the clay would be dumped from the scows. This would stop the escaping air from leaking out of the tunnel through the exposed riverbed, as well as the intruding water.

The clay laden scows were life-savers during the scheduled blast, for indeed blowouts did occur--not just one, but two! The clay was dumped over the blowouts. Thus, the intruding water which was forced into the tunnel through leaks in the tunnel lining became plugged by the clay. In less than 12 hours, workmen applying compressed air techniques pumped the water which had flooded part of the tunnel back out. Overcoming the shield standstill problem, as in this case, was characteristic of the successful way Jacobs and his staff proceeded to solve tunneling problems as they arose beneath the Hudson. No doubt

laborers and engineers alike worked in close concert to accomplish these victories. By the time tunnel "A" was completed, nine minor blowouts--in addition to these two blows--would occur with no reported loss of life. One threatening underwater crisis after another would be overcome.

Perhaps the third problem to arise for Jacobs was his most puzzling. The shield had progressed through rock to a point where the troubling reef would be penetrated altogether, if the next few feet of rock could be blasted. But just here an enormous rock formation towered 16 feet above the bottom of the cutting edge of the shield, requiring that a delicate blast be executed. Equally troubling, the river silt at this junction was of a semi-fluid texture. So roughly half of the cutting edge of the shield was in rock, and half in watery silt.

To reinforce the silt, five barges of clay were dumped, making the silt in theory easier to remove. But the theory failed. Instead of solidifying the silt, the silt and clay together crept through the shield doors. The leaking was so profuse that mining devices ordinarily used to impede the inflow of silt proved ineffective. To solve this compound problem, it was decided to bake the muddy clay and watery silt by directly applying the hot flame of kerosene blow torches. These torches caused the hardening of the exposed clay, blocking the flow of oozing and slipping silt into the tunnel. Now workers could remove the clay with greater ease and control. The rock formation was blasted away. According to Jacobs, this was the first time that soft material had been solidified by means of fire during under water tunnel construction. Workmen applying the torches performed this task under an air pressure of 38 lbs per square inch, which is 18 lbs in excess of normal room air pressure.

Seven days after boring the towering rock formation at the end of the reef, the reef gave way to sand which made the digging easier. The shield

shoved ahead smoothly. An additional distance of 740 feet--all of it sand composition--was conquered. The "holing through" of tunnel "A" would soon be realized--30 full years after Haskins started it. Two shields, one from the New York and one from the New Jersey tunnel approach, were now working toward each other in tunnel "A". They finally met on March 11, 1907, and in so doing achieved the first unitary and continuous public transportation corridor under the Hudson River. The final sections of the tunnel were bolted into place. William Gibbs McAdoo was the first person to walk through the completed tunnel, followed by Walter ^{C.?} Oakman, and Jacobs. Five hundred and five days had passed since Jacobs began the construction of tunnel "A", picking up where Haskins left off. Jacobs was responsible for actively supervising the building of 1,625 feet of the 5,700 foot tunnel, progressing at the average rate of 3.2 feet per day during this period. ^{was reluctant when he} When McAdoo saw that the tunnel headings joined perfectly--without a bit of variation in height or direction, (he was extremely pleased.)

Unlike westbound tunnel "A", eastbound tunnel "B" of the uptown system was rapidly constructed with no serious delays. Jacobs decided to abandon the 570 feet of tunnel "B" begun by Haskins' company. He analyzed the old tunnel and discovered that there was an insufficient distance between the ends of the tunnels at the 15th Street Jersey City shaft, and the first switch enlargement. The engineering requirement stated that there had to be enough distance between the tunnels to separate them so that one could be carried above the other without excessive gradients. For this reason, it was necessary to abandon the original tunnel "B", and rebuild the first 500 feet of new tunnel "B" adjoining the 15th Street shaft. Work proceeded by erecting a shield in the same shield chamber that was used for the abandoned tunnel. The old shield was in this case laid to rest in favor of a new shield

use
illustration

which could be safely introduced, a substitution not feasible in tunnel "A". The new shield was driven westward toward the tunnel shore, using the more agreeable, slightly ascending gradient. Old south tunnel "B" remains deserted near the 15th Street shaft to this very day. ✓

Jacobs and his crew learned a great deal about the peculiar problems of tunneling under the Hudson River, gained from their experiences with tunnel "A". Happily, this new knowledge could be ~~cashed out~~ ^{utilized} in building tunnel "B", speeded by the application of tested techniques. Basically, the same tunneling mistakes were not repeated. For example, Jacobs saw that at times the shield could not be controlled as well as other times through the silt. To stabilize control over the shield's direction, he determined that it would be helpful to keep the shield door partially closed in such a way that only five per cent of the silt excavated by the advancing shield would enter the door. Conforming to this operational procedure made the shield a more managable tool. Very rapid progress was made as a result of this and other mechanical adjustments: in one 24 hour period workmen completed 62 feet of construction, and during another week workers reported that they finished 346 feet of construction in tunnel "B". Both of these accomplishments set new building records for the company. X

Unfortunately, tunnel "B", like its predecessor, cost human lives. Muck and silt, rushing in through an open shield door which had been ordered shut, smothered a worker to death. Against instructions to the contrary, the door was opened by a night superintendent. The superintendent reasoned that the shield would advance more swiftly if material could come in through the door, like in the old days. Later that night, a man, a shield, and the tunnel headway itself were buried in silt. The body was recovered during the nine days of hard labor which followed the accident, during which time

ingenius-but cumbersome-drudging techniques were used to clear the heading.

Tunneling resumed on November 23 and continued until April 1, 1904, when work was suspended, pending approval by city authorities to : (a) extend the New York approach to 33rd Street; and (b) to obtain a right-of-way for the New Jersey approach across the property of the Delaware, Lackawanna and Western Railroad Company. The idea here was to halt the expensive work of building tunnel "B" until coordinated work could be pushed concurrently on the shore approaches. Basic approval was granted to both requests, and construction inside tunnel "B" was resumed after five months had elapsed, on August 24, 1904.

It took a little less than two years to complete tunnel "B". The first ring had been attached on September 22, 1903, and the bulkhead at Morton Street, New York City, was holed through on August 25, 1905. Deducting the time lost during suspended construction, the tunnel was bored in 502 days--a brilliant contrast to the 30 years it took, all told, to complete neighboring westbound tunnel "A". The length of tunnel "B" is about 5,206 feet, and construction progressed at the average rate of 9.3 feet per day--a daily rate almost three times greater than its predecessor.

THE DOWNTOWN TUNNELS AND SIXTH AVENUE LINE

The downtown tunnels of the Hudson and Manhattan rail system were begun in March, 1905. A shaft was dug on the New Jersey side of the river, near Exchange Place terminal, and in about four years this shaft would become part of the completed downtown segment of the system. The Fulton Street westbound tunnel "E" and the Cortlandt Street eastbound tunnel "F" were constructed simultaneously, the former begun on February 6, and the latter begun on February 26 of the year 1906.

Jacobs tells us that both tunnels were built under "very similar" conditions. If so, let us look upon the type of building conditions he encountered in tunnel "E" as characteristic of the kinds of problems he faced in the construction of both downtown tunnels.

After the first ring of tunnel "E" was fastened, the shield worked eastward against a silt base, progressing well at the average rate of about 12 feet per day. Even so, Jacobs notes that rock formations were encountered for at least 2,000 feet during the boring, and this slowed things down. To accelerate the rate of building, Jacobs decided to begin a shield from the New York side, boring westward--and in this way meet the eastward shield which was lodged in a rocky reef. In implementing this bi-lateral boring method, Jacobs found it necessary to install a large compressor plant in the ends of both tunnel approaches--running off-shore from Church Street, in lower Manhattan. This additional compression equipment aided two teams of workers, each advancing shields, in completing tunnel "E" on May 20, 1909. Similarly, tunnel "F" was bored a few months earlier on March 9.

But tunnel "E" had its harrowing difficulties before workmen could complete it. On November 20, 1908, for example, a fissure was encountered in the riverbed rock, causing a bad blowout. The tunnel flooded at once. This blowout was compounded by the fact that clay ^{could not} ~~needed to~~ be dumped from river barges to seal out the flooding waters, (and clay could not be dumped.) Transatlantic steamship traffic crossing over the damaged section of tunnel "E" in the river channel above, made dumping there frightfully dangerous. The solution would be to plug the blowout through other means, probably working from inside the tunnel. Construction was delayed for almost a month during this occurrence until the tunnel could be pumped, cleared, and advanced.

This was apparently the first time that shipping traffic in the Hudson River channel had seriously curtailed construction maneuvers vital to the underwater tunnels.

The Sixth Avenue line of the Hudson and Manhattan system presented construction problems through untamed New York City turf beginning at Morton Street, and tunneling up Greenwich to Sixth Avenue and 33rd Street. This segment of the tunneling accounted for about two miles of a rapid rail system that would eventually total 13.9 miles, providing underground transportation between Newark, New Jersey, and 33rd Street, New York City, at its two most distant points.

Basically, two methods of construction were used in building the Sixth Avenue line: (1) the shield method and (2) the cut and cover method.

The shield method, used successfully under the Hudson River, was implemented in excavation beginning at the old Morton Street shaft, driving inland to a terminal point at Sixth Avenue and 12th Street. The cut and cover method, in contrast, involved digging from street level in such a way that a ditch is cut out and then land-fill is dropped to cover connective rings which are already bolted into place inside the ditch. Curiously enough, plans originally called for the cut and cover method to be used throughout construction of the Sixth Avenue line. The city altered these plans, however, by stipulating that the tunnel be dug to a depth deep enough to allow future city subways to pass above the H&M tunnel. This provision prevented cut and cover techniques ~~(just here because cut and cover construction could not dig tunnels~~ ^{due} to the greater depth now required. New York City did approve, and cut and cover construction was used, north of Twelfth Street-- on condition that Sixth Avenue ^{vehicular} lanes to 33rd Street would not have to be closed.

Why are the curves so tight on the New York tunnel approach to Sixth Avenue up Morton, Greenwich, and Christopher Streets? Again, when the Rapid Transit Board issued uptown extension rights to the Hudson and Manhattan Railroad, it imposed the additional condition that all uptown tunneling had to be done directly under these streets themselves. This was a strict requirement not ideally suited to rail engineering. Conforming to this requirement entailed driving a shield around a very sharp curve from Morton to Greenwich Street. In addition, the narrow right of way granted the H&M directly under these streets left little leeway. Hence, this particular left-hand curve up Greenwich Street had to be built at an extreme radius of 150 feet. Likewise the right-hand curve off Greenwich Street to Christopher Street required that a curve be built there to 169 foot radial specifications. To assure maximum comfort to its passengers, PATH trains ^{today} regularly negotiate these tight uptown turns at ~~drastically~~ reduced speeds.

Great care was exercised in driving the shields in a generally northward direction to Sixth Avenue from the Morton Street approach. There was some anxiety that the underground digging might cause a noticeable settlement of the street level properties--but as it turned out there was no property damage. "The ^{tenants} ~~tenants~~ of these (Greenwich Village) houses were not aware of the proximity of the tunnel until the shield had passed their buildings", Jacobs later boasted.

The tunneling obstructions and complications while using cut and cover methods between Twelfth and 33rd Streets on Sixth Avenue were severe.

Grand Central Proposal

Whose proposal in 1910 - 3 McAdoo's
Adopted by H M
Needs more investigation
in re: Grand Central tie-in

A twin tunnel design was adopted for the 33rd Street service, with each tunnel set side by side in reinforced concrete. A concrete wall was constructed to separate trackage, however, so that air would be forced ahead of either north or southbound trains, maintaining and simplifying adequate levels of tunnel ventilation.

Sixth Avenue was an obstacle course in the early 1900's, (above and below street level.) Above ground at street level, a double-track tramway ran along the surface, directly over which a double-track elevated rail service operated. Under the streets, a large city sewer, municipal gas pipes, and water pipes crowded the tunneling enterprise. The terrain was basically a composition of sand and rock. It was feared that if a sudden flow of material entered the diaphragm of the advancing shield, this might well result in an equally sudden settlement of the structure supporting the Sixth Avenue elevated above street level. To guard against this, the large columns supporting the Sixth Avenue el were reinforced with steel girders. This idea proved sound, as no structural damage to the elevated occurred.

In addition to stations at both Christopher and 9th Streets, three H&M stations were soon constructed on Sixth Avenue: Fourteenth Street, Nineteenth Street, and Twenty-Third Street. These stations were of similar design. About four months after the first H&M service between Hoboken and 19th Street was inaugurated, on June 15, 1908, uptown New York service was extended from 19th Street Station to 23rd Street. This extension opened using ^{only} the east track ~~only~~ for both uptown and downtown trains. There were also three double-track stations planned, one at 28th Street which was built, and two more which were never built at 38th Street ^{& Sixth Ave} and 42nd Street and 5th Avenue. (The reason that stations were never built at 38th and 42nd Streets, was due to a proposal)

What was cost of
Grand Central proposal?
When was proposal
abandoned?

(adopted by 1910. This ^(A) proposal ^{adopted in 1910} would have extended H&M service up Sixth Avenue to 38th Street, across town to a terminal at 42nd Street and Fifth Avenue, and finally into Grand Central Station (opened in 1913). This proposal was later rejected because of its great cost, and because ^{the expansion of} New York City subway routes ~~expanding~~ in succeeding years cast serious doubt on its profitability. || ? Is this true

Even so, construction ^{ion} was carried out up Sixth Avenue from 28th Street to 33rd Street Station, the only triple-track uptown station. Originally, 33rd Street Station was planned as an off-street rather than an underground terminal. To accomodate this, land was purchased at 33rd Street where the Gimbel Brothers Department Store now stands. For many years the Hudson and Manhattan Railroad owned and leased this land to Gimbels. At any rate, it was decided to build 33rd Street Station underground because this would be better suited to the proposed cross town Grand Central Station extension McAdoo then had in mind. Trains between 28th Street and 33rd Street Stations began serving the public on November 10, 1910, operating on both eastbound and westbound tracks.

The stations at 14th, 19th, and 23rd Streets were constructed in reinforced concrete by cut and cover methods. In general, they consisted of a series of groined arches, supported by a partition wall between the tracks. A row of cast iron columns was erected on each station platform, as well as at the side walls. Each of these stations had two platforms for the ingress and egress of passengers. On the other hand, the Christopher and Ninth Street stations were designed with simply one platform each. The entrances to the Sixth Avenue stations either went through adjoining street shops or connected to stairs leading to the elevated railway stations above. When H&M station entrances passed through adjoining street shops, fashionable show windows were

built facing passenger passageways displaying the latest consumer wares.

TUNNELING BETWEEN JERSEY CITY AND HOBOKEN

Since H&M service from the uptown tunnels of the Sixth Avenue line would extend northward to Hoboken and southward to Jersey City, this required the installation of six large switches. These switches were called "caissons." They were designed so that they could be sealed inside protective concrete structures, and were sunk in a triangular pattern on the New Jersey approach in such a way that the eastern-most caisson--caisson I--faced Morton Street, New York City.

Each caisson was also designed to accomodate two switches, one on an upper and one on a lower level.

Caisson I, made of concrete and reinforced steel, had a net weight of 12 million pounds, and was sunk 84 feet below the surface of the ground. By enclosing the switches in concrete rather than structural steel, the cost and duration of caisson construction was decreased, without ~~decreasing~~ ^{diminishing} safety.

Why were two-story caissons instead of single level switches adopted? "If these junctions had been constructed with the tracks on the same level, Jacobs advised, "then dangerous crossings would have existed." Therefore, in order to avoid dangerous crossings, the tunnels for trains moving in opposite directions, e.g., tunnels "A" and "B", were placed one above the other. In contrast, the standard formula was to place tracks side by side.

Another interesting feature about the H&M caissons was that they were pneumatic. Pneumatic caissons provided at least two advantages over the other caissons. First, they permitted construction to be carried out concurrently with, and in advance of, the shields. Secondly, they permitted added flexibility so that a caisson could be planted in the ground regardless of the material encountered in excavation.

With the advantages of pneumatic caissons, it was possible to sink Caisson I in just two-and-a-half months. In driving the tunnels toward Caisson I westward, away from the Hudson River, the lower tunnel, tunnel "B", was kept slightly ahead of tunnel "A". Sandstone, sand, gravel, and boulders were typical of material encountered, especially with lower tunnel "A". In digging tunnel "B" connections toward caisson I, on the other hand, the excavated material consisted of less rock, more gravel and boulders, "and a great deal of ashes and rubbish," according to Jacobs.

Anecdotes of a quite unusual nature accompanied the installation of the caissons. At one point the tunnels passed through a mass of waste material from a gas plant which gave off a disagreeable odor. The result was that a number of men were overcome, and had to be bodily removed from the tunnel before they could recover their senses. In a disrelated incident, Jersey City authorities decided to build a new sewer line directly over caisson I which extended to an outlet in the nearby Hudson River. But a crisis developed when river water backed up into the sewer line trench and poured into caisson I, before the caisson could be sealed. Finally, Jacobs resorted to the use of pneumatic air pressure to discharge the river water from inside the caisson, making connections between caisson I and the tunnels entering it possible.

The first two H&M stations to be built in New Jersey were Hoboken Station, and a station under the Pennsylvania Railroad's Exchange Place terminal, in Jersey City. Hoboken Station was opened on February 25, 1908. It was designed as a three-track ^{stub} ~~steel~~ end terminal, ^{adjoining} ~~butressing~~ the terminal station of the Delaware, Lackawanna, and Western Railroad. Hoboken Station was also located below the terminal of the old Public Service Corporation Street Railway. This pivotal location put Hoboken near some vital links in New Jersey's transportation network. Separate platforms were designed at Hoboken for the ingress and egress

of passengers--in order to reduce passenger conflict between arriving and departing trains. A central departure platform was situated between two main tracks, with arrival platforms on the outer sides of these tracks. In this way, trains discharged passengers from one side and received passengers on the other--a pioneering station design in its day.

Ninety-two feet below the Pennsylvania Railroad's trains at Exchange Place Station, the Hudson and Manhattan Railroad constructed a twin platform terminal through which two separate tunnels were adjoined, each of a 23 foot, six inch span. At the westward end of the terminal, each tunnel branched into two tunnels, providing the necessary quartet of connections to the uptown and Summit Avenue tunnels. Furthermore, a group of four lifts, each nine feet, three inches square, took passengers up to the Pennsylvania trains. In addition, two somewhat larger lifts carried passengers out of the Pennsylvania train platform area to street level. In rushing, silt and water threatened the construction of the four lifts leading into the railroad station from the H&M terminal below it. Difficulties arose when water began leaking into the elevator shafts being installed. The force of the water dislodged the steel piling beams which support^{ed} the concrete walls of the shaft. To overcome this ominous predicament, an air tight concrete floor was built into the shaft. It remained, then, to set up air locks and air pressure equipment. When this equipment was activated, water was pumped out of the shafts and construction on the lifts was resumed without difficulty. 7/19/09, ~~7~~

Exchange Place opened on August 2, 1909 and fast became the nucleus of rail travel into and out of Jersey City--with Jersey City's heaviest passenger volume. Not only Pennsylvania Railroad and Hudson and Manhattan trains, but street car and pedestrian traffic, too, frequently terminated at Exchange Place terminal.

PRESIDENT THEODORE ROOSEVELT SENDS SIGNAL OPENING THE H&M SYSTEM

When it opened on February 25, 1908, the Hudson and Manhattan system began train service to the public between 19th Street Station, New York City, and Hoboken Station, in New Jersey. Since New York's uptown 33rd Street Station, Jersey City's Exchange Place terminal, and a downtown New York terminal--called Hudson Terminal--would all be in service by 1910, the H&M was opening a rail rapid transit system in 1908 of increasing importance to New Jersey and New York commuters. Aware of both its transportation and engineering achievements, the commuting public literally went wild with enthusiasm when the first underwater rail rapid transit system into New York opened. To recapture the excitement of this gala event, a page one New York Times account of it published on the following day enhances our historical perspective.

This opening marks the realization of a dream which has occupied the minds of engineers for nearly half a century, the Times reported. "It is conceded to be one of the greatest engineering feats that has ever been accomplished, greater perhaps than the Panama Canal will be when completed, considering the obstacles which had to be overcome."

The Times tells us precisely what happened when President Theodore Roosevelt, sitting at his desk in the White House, sent a signal to New York City activating the very first train to officially roll under the waters of the Hudson:

The hour for starting the official train had been set for 3:30 P.M. A great crowd gathered about the 19th Street Station long before that hour. Fifty policemen held them in check. Mr. McAdoo personally received most of the distinguished guests and ushered them into

the first car of the train. A few minutes before the scheduled hour for starting, the following message was flashed to President Roosevelt from a telegraph instrument on the 19th Street Station train platform:

The first official train of the Hudson & Manhattan Railway Company under the Hudson awaits your signal and your pleasure. W.G. McAdoo.

While this message was being ticked-off, the (electric) current was ~~shot~~ off. But the cars stayed lighted. Each car in the system is equipped with storage batteries, so that in case motive power is cut off the cars will not be in darkness.

Everyone in the cars knew that the message had been sent to President Roosevelt and they waited for his answer. In a few minutes it came. There was a sudden flare of lights as the current started up additional bulbs—then a subdued hum of the air pumps as fresh air was sucked down into the ventilating shafts.

Chief Motorman Winkley, who had been assigned the first run through the tunnel, was at his post. One by one the heavy steel doors of the train closed with a snap. The crowd on the station's platform cheered and waved their hands. There was a great slight tremor as the power was turned on, and the official train pulled slowly out of the station southward bound toward Morton Street, where the tunnel turns for its dip beneath the river.

A crowd of over 10,000 people awaited the arrival of the first H&M train at Hoboken, on the western Hudson shore. The train rolled into Hoboken station at exactly 3:51 P.M., ten minutes to the minute after departing 19th Street Station, in New York City. This short travel time constituted an immense improvement over the ferry service, since ferry boats customarily crossed the Hudson at an average travel time of 32 minutes one-way. In point of fact, this official train journey took much longer than the average H&M travel time of three minutes one-way, which would be achieved between New York City and New Jersey aboard Hudson Terminal service. The crowd at Hoboken was amazed to learn that H&M trains would run on three-minute headways during weekday rush hours, with a reduction to five minute headways scheduled for the off-rush hour periods.

A mighty shout went up from the crowds when the train pulled up to the platform. William G. McAdoo, followed by the governors of New York and New Jersey, Governor [?] Hughes and Governor [?] Fort respectively, emerged from the front car and proceeded with other officials out of the station. Ecstatic crowds greeted the official entourage, waving and pointing. Thousands gathered in the square outside the station, and people perched themselves on roof tops and leaned out of the windows of neighboring buildings, hoping to catch a glimpse of the official party.

The governors of both states, the mayors of Jersey City and Hoboken, railroad financiers and a host of lesser public officials presented their inaugural speeches on the square before the people. Everyone congratulated McAdoo on his success, and praised the Hudson and Manhattan Company for its Promethean achievement in rail engineering. Although the speeches could not be heard ^{by many} there being no public address systems in those days — the crowds applauded each speaker unfailingly. Everyone seemed eager to help herald this historic occasion.

In a telegram sent that day ~~from~~^{by} President Roosevelt and read ~~publically~~ by McAdoo at the Hoboken ceremonies, the President made the observation that "the successful completion (of the tunnels) represents moving New Jersey bodily three miles nearer to New York in point of time, and immensely increasing the ease of access from one state to the other."

Thus, at the cost of a five cent fare, commuters in 1908 could traverse under the Hudson River to either shore via the H&M trains. The McAdoo companies employed no less than 6,500 men and women, and the uptown and downtown tunnels together would have a maximum daily capacity of 500,000 passengers. The total cost of building the entire system was projected at \$70 million in 1908 dollars. This figure represents an enormous investment in contrast to the \$9 million dollar purchase price McAdoo paid when he acquired the abandoned tunnels back in 1902.

Later in the evening on opening day, McAdoo hosted a celebration dinner at Sherry's, one of New York City's finest restaurants. The guests of honor were Governor Fort and Governor Hughes, both of whom continued into the early morning hours to praise Mr. McAdoo for his incredible achievement.

Source
of data

HUDSON TERMINAL

When it opened on July 19, 1909, Hudson Terminal was the most modern rail terminal in New York City and the world's largest office building. It was designed after an Italian Renaissance style, and was without a doubt the showcase station of the H & M line — the only downtown New York terminal serving the system.

The basement floor of the five track terminal was 56 feet below the earth's surface and 38 feet below the ground water level. The depth of the bottom floor suggested to Jacobs the necessity of enclosing a giant wall around Hudson Terminal which would be impervious to moisture, and of sufficient strength to withstand the pressure from the surrounding water and soil. Hence, to reduce the peril of constructing a building on a weak foundation, Jacobs proceeded to enclose the terminal by a continuous concrete wall. This wall extended from the earth's surface to the rock far below, forming a dam. Excavation began on the Church Street site between Fulton and Cortlandt Streets, on December 27, 1906.

The ground for the site was formally river frontage which had been filled in. Therefore, when excavation was begun down to water level, there was a considerable amount of water seepage through the soil. This seepage confirmed the requirement for a huge coffer dam to embrace the building. This dam was built in monolithic sections which were sunk from the surface in the form of pneumatic caissons. The walls of the dam were built to eight foot thick specifications, and ^{each} ~~earth~~ section was normally 30 feet long.

Admittedly, the high cost of land in the Hudson Terminal area of downtown Manhattan was a major factor in the decision to build the twin towers over the basement of Hudson Terminal. It was desirable to obtain as great a return from the land as possible. Erecting two 275 foot,

twenty-two story buildings, containing 4,000 offices and serving over 10,000 workers at 30 and 50 Church Street was what McAdoo had in mind. Twenty-four thousand tons of steel, 39 elevators, and 27 acres of floor space comprised this station located in the heaviest passenger congestion zone in New York City, south of City Hall. It was the world's largest building in terms of floor space. The erection of steel began on January 10, 1907, and the girders were in place by December 23 of that same year. The offices over Hudson Terminal, which were capped ⁱⁿ on one tower with an exclusive restaurant offering a breathtaking view of the harbor area, were opened before the terminal itself opened on May 1, 1908.

The terminal was opened to the public when Miss Harriet McAdoo, Mr. McAdoo's daughter, stepped up to a small stage in the mezzanine of the terminal before a crowd of over 2,000 invited guests and pressed a button sending power into the tracks of the new downtown tunnels.

First, all lights in Hudson Terminal were turned off and the people stood in darkness. Then, at the direction of Charles M. Jacobs, Miss McAdoo activated the third rail and relighted every light by pressing the button about 10:30 AM on July 19, 1909. Pandemonium broke out both inside the terminal and out — so happy were the crowds to be witnessing the opening of the most modern terminal around.

Hudson Terminal was an engineering wonder not only architectually, but in terms of passenger comfort. When it opened, it accomodated numerous concessions, ranging from a meat market to a movie theatre. It had six platforms, including a separate platform for baggage. In addition, plush powder rooms for the ladies provided free hairpins and face powder to deter fly away hair, and shiny noses. A bar of soap plus towel entailed a five cent charge, however. To help the passenger get on the right train, illuminated exterior train destination indicators were installed

on the train platforms. A man popular with the ladies, McAdoo initiated a special system at Hudson Terminal whereby a wife could leave packages purchased earlier in the day for her husband to carry home at the end of his work day.

With its majestic twin towers and full complement of passenger convenience features, it is hardly surprising that the opening of Hudson Terminal generated so much enthusiasm. Now commuters could move easily between downtown Manhattan through ^{the} new underwater tunnels, taking trains across the river to Exchange Place, Jersey City. In less than ~~just~~ one month beginning August 2, 1909, passengers would be able to ride the Hoboken-Hudson Terminal service, or ~~the~~ Exchange Place-33rd Street service, to uptown New York City. \$

President William Howard Taft sent a special telegram from the White House which was read at a giant outdoor celebration on the other side of the Hudson, at Jersey City's City Hall. When the first official train began to roll out of the terminal for Jersey City, cheers echoed by a chorus of church bells and boat whistles pervaded both sides of the shore.

With trains taking only three minutes to cross the Hudson River from downtown Manhattan to Exchange Place, the press was jubilant about Hudson Terminal, acclaiming the downtown tunnels for saving passengers upwards of three million minutes a day in commuting time.

Few people in 1909 knew of the idea McAdoo had to construct a pedestrian passengeway from his newest terminal to an IRT station located downtown on Broadway. But this idea was never served, and later the city subway lines either passed close by Hudson Terminal, or terminated there. For example, the Sixth Avenue elevated station at Cortlandt Street connected with the corridors of the third floor of Hudson Terminal, (which also faced

Cortlandt.) In fact, the architects of the terminal, Clinton and Russell Associates, decided to construct a pedestrian bridge between the third floors of each tower. This pedestrian bridge crossed over Dey Street and provided easier access between both office buildings, and between commuter systems.

Besides Clinton and Russell Associates, who worked mainly on the terminal, McAdoo enjoined the efforts of his best engineers in completing the downtown segment of his rail system. Along with Jacobs and Davis, L.B. Stillwell, consulting electrical engineer; Hugh Hazelton, electrical engineer; and John Van Vleck, a mechanical engineer, performed important supervisory duties essential to the tunnel network.

The 50 Church Street building was demolished in 1969 to make way for the Northeast Plaza Building of the World Trade Center. Thirty Church Street was demolished in 1971 to accommodate the Southeast Plaza Building of the World Trade Center ~~and~~ and the main entrance to the World Trade Center Plaza. The last train to leave Hudson Terminal was the 9:57 PM train bound for Newark on July 2, 1971. All Hudson Terminal service was permanently transferred to the new World Trade Center terminal on July 6, marking the opening of New York City's first ~~and only~~ air-conditioned subway terminal.

Hudson Terminal, the world's largest office building, was destined to give way to the World Trade Center, the world's tallest building. Both buildings had twin towers. The basements of both buildings served the same underwater rail system joining the shores of two neighboring states.

PASSENGER CONVENIENCE FEATURES

The Hudson and Manhattan Railroad may ^{have its origins in last quarter} ~~date back to the first~~ ^{e/ 19th} years of this century, but there is no denying that this was a rail system that instituted many advanced ideas, especially in terms of passenger comfort. A brief look at some of the passenger convenience features it offered holds several surprises.

In addition to ~~the~~ those features at Hudson Terminal already described, there were token booths on wheels at Hudson Terminal known as the "flying squadrons". The advantage of the flying squadrons was that they could be positioned where needed inside a station by station porters. The upshot of these contraptions was that each booth housed a pretty girl who sold train fares — which in those days took the form not of tokens, but cardboard tickets. Reportedly, Mr. McAdoo hired only women as ticket agents because he believed they were friendlier to the public than men, and more efficient at handling change. Every so often though, a dapper young man would try to become better acquainted with one of the gals, and a male, "ticket chopper" would diplomatically — but firmly — urge such a young man to move on. Predictably, ticket booths on wheels could sometimes prove unwieldy. For example, at the Hudson Terminal opening a sizable crowd at Cortlandt Street was trying to get a glimpse of the inside of the terminal. The crowd started to push against one such flying squadron near the Cortlandt Street entrance, and in so doing inadvertently sent it speeding aimlessly on wheels across the mezzanine. The shrieking young voice of the female ticket agent panicking from inside the booth alerted the police, who let her out of the booth, and finally calmed her down.

It so happened that soon after the rail system opened, a New York Women's Organization suggested the idea of a special train car for lady passengers only. Although the IRT declined the suggestion, McAdoo decided to give it a try. Hence, on March 21, 1909, the H&M introduced a special "ladies only" car located at the end of each train. A specially dressed male guard stood in this car wearing a fancy red cap — a color matching the H&M signs which advertised this unique car. Originally, it was thought that the presence of the guard on the car would allay female fears of molestation. But, in fact, the chance for the ladies on this car to meet eligible young men-while en route-was so slim that insufficient numbers of women rode on it. Consequently, on July 1, a few months after it began, the "ladies only" car was dropped from regular service. Local newspapers had fun joking about the special car describing it as "the old maids retreat." Oddly enough, the "ladies only" car idea was revived in the fifties. On July 10, 1958, the H&M railroad re-installed the cars. But the cars proved too impractical even then, tending to produce dissension among the passengers, so it was taken off the tracks around 1960 for the last time.

In addition, on March 14, 1910, a three car train was placed in service with automatic station indicators inside. These station indicators announced the next train terminal en route via illuminated signs which passengers could read from their seats. If the results of the performance tests on the signs had proven them effective, they would have been installed in additional cars. But results of tests on the signs did not warrant further expenditures for their use, and thus they were gradually phased out.

As ^{noted} ~~hinted~~ earlier, a baggage service was introduced in 1910, although apparently it was used very briefly and exclusively on Hudson Terminal runs. Station baggage was placed onto baggage wagons which worked in such a way that the wagons could be rolled directly onto two specially built "3-2 baggage cars," with baggage still in [^]tact. Basically, these cars were built in the same conventional way as passenger equipment — except that the sides of baggage cars had curtains which rolled to the ceiling. These special cars, designed by ^{the firm of} J.G. Brill, were used only a short while on the downtown service: baggage was removed from cars at Hudson Terminal and raised to the mezzanine via special elevators. Incidentally, baggage cars were never used at 33rd Street Station due to Morton Street tunnel clearance problems, and objections voiced by the Pennsylvania Railroad, which was building its own Trans-Hudson underwater tunnel.

Another passenger feature McAdoo advanced was the idea of building into some of his stations — Hoboken and Hudson Terminal are two examples — separate train platforms for the ingress and egress of passengers. Providing separate platforms in this way, resulted in somewhat smoother traffic flow of passengers, since passengers entered cars by one platform, and departed by another. This feature was thought to be a helpful safety measure during rush hours at Hudson Terminal, particularly. For example, on one night in August of 1921, upwards of 20,000 New Yorkers jammed H&M trains in Hudson Terminal to get across the river to Jersey City. There, at a site known as Boyle's 30 Acres, the "battle of the century" raged at ring side — as the first million dollar boxing gate in history witnessed ^{Jack} Dempsey ^{knockout} ^{George} Carpentier. The intense flow of daily passengers at Hudson Terminal regularly reached 85,000 commuters during weekday rush hour periods. /?

AN ASSESSMENT OF McADOO'S MANAGEMENT PHILOSOPHY

As many observers of the contemporary business world have pointed out, there are virtually no large American corporations today where one man alone is encouraged to make almost all the important decisions. (Living in the age of the expert, information is usually gathered in groups of men, and decisions are frequently made by groups of men.) But this was not generally the case in the pre-World War I business community to which McAdoo belonged. ✓

In McAdoo's day, great business leaders were not merely corporate presidents, they were "captains of industry," a term reserved for men possessing brilliant managerial ability or financial wizardry. In contrast to today's more sophisticated and aloof approach to management, a skillful corporate president in McAdoo's era was expected to project his unique personality onto his company. He was expected to instill in his employees—at all levels—his own unique qualities of mind so that they would both fear and revere his leadership. In keeping with the expectations of his day, McAdoo would clearly and directly put the impress of his personality on the Hudson and Manhattan Company he headed. He carried himself dashing but forcefully amongst the ranks of his employees—in a manner suitable to the successful captain of industry. By 1913, when President Woodrow Wilson appointed him Secretary of the Treasury, McAdoo was without a doubt a member of one of the most elite fraternities in the American business community. ✓

What kind of man was William Gibbs McAdoo? A close look at the relationships he built between his employees, his passengers, and his public give us fresh insights.

One can fairly describe McAdoo's relationship with his employees as both idealistic and intimate. He was idealistic in the sense that he expected his charges to work as hard and enthusiastically for company goals as he did. To encourage this attitude, he regularly manned the front of the store — so to say — by dropping in unpredictably on various company operations to see how his workers were carrying them out. Mr. McAdoo tried to set aside some time of each working day so that he personally could tour his rail system, making on-site inspections. He would regularly engage his employees in conversations during such inspections. In this way, they felt that he cared about their tasks, no matter how small, and at the same time McAdoo could make mental notes on employee performance and productivity. This open line of communication to the top of the corporate pyramid tended to promote both loyalty and cooperation.

McAdoo stressed to his employees that the primary concern of his railroad was the passenger. Consistent with this, speaking as a guest lecturer at Harvard in 1910, he said that "the condition of a railroad's equipment and the manners of a railroad's employees, give a good picture of management." Along with employee courtesy at all times, McAdoo insisted that H&M stations and cars be cleaned every day.

It was not uncommon to see McAdoo personally supervising the operation or construction of tunnels and stations. In this sense, he built an intimate relationship between himself and his employees. At the construction site at Hudson Terminal, for example, he once climbed on to a steel beam which was about to be hoisted to the top of the building. Against arguments to the contrary, he let himself be lifted to the top of Hudson Terminal -- 275 vertical feet -- in order to closely survey the construction. Workmen at the top of Hudson Terminal were alarmed to see their company president teetering so precariously in mid-air. McAdoo just smiled--and said in a confident voice, "Good morning, Gentlemen".

Among the employee activities initiated by the H&M Railroad was the publication of a monthly employee magazine, replete with photographs and graphics, entitled The H&M Review. News of broad interest was carried by this magazine, ranging from professional information on the management of power stations, to personal information announcing the birth of a new child to a company employee. Articles were often written by employees themselves, providing a forum for opinion. There was even a column which published poetry. A lively gossip column called "Heard Thru the Tubes" provided some harmless humor on the lighter side.

Various recreational clubs and athletic teams were also organized by the company, so that people who worked together might play together, too. The baseball team was particularly popular, regularly

playing against a similar team from the Pennsylvania Railroad. For the musically inclined, a thirty piece H&M Brass Band entertained at several outdoor events throughout the year.

It is interesting to observe that at a time when women were fighting for the right to vote in elections, Mr. McAdoo insisted on paying his female employees on an equal scale with men. He had a reputation for fairness.

In addition, McAdoo initiated a rigorous public relations program, which pledged first and foremost to please the H&M passenger. "The public be pleased" was the company motto. Instead of relying strictly on a professional public relations staff to maintain good company relations, Mr. McAdoo placed the ultimate responsibility for good passenger relations on the shoulders of all company employees.

McAdoo had been enraged by the remark of Commodore William Vanderbilt's son years earlier. The young Vanderbilt, whose father founded the New York Central Railroad, had said "the public be damned!", in reaction to public criticisms of this railroad.

The public relations policy McAdoo espoused was indeed old fashioned compared to the sentiments expressed by young Vanderbilt's cavalier remark. Yes, McAdoo held fast, insisting that passengers aboard his trains would receive the first-rate treatment they deserved. A few days before his railroad opened in 1908, he spoke in person to all his employees. "The employees are the people upon whom the success of the railroad depends," he told them. "Our railroad was not ~~...~~ built for the stockholders, for its officers, or for its employees: it was

built for the public." He emphasized on that day in February, as he would say repeatedly in succeeding years, that the first consideration of his railroad must always be the safety, comfort, and convenience of its patrons.

Included in his "public be pleased" program was an extensive advertising effort telling metropolitan area commuters what the "McAdoo System", as it was sometimes called, had to offer them. In fact, H&M train schedules were printed in both English and German for distribution aboard incoming ocean liners, two days before their arrival into New York.

Brochures were also distributed to the public detailing all subway and railroad connections which were part of the New York transportation network.

Even the occasional rider of the Interborough city subway system knew about H&M service, since H&M car advertisements were frequently placed inside city subway cars.

In the final analysis, McAdoo's tireless efforts to communicate to the public that their traveling comfort was of first importance to him,

won his company early success. In large measure, the heart of this success was that McAdoo translated his good words about the public into good public deeds. Once gaining the confidence of the public, its passengers, its employees - the Hudson and Manhattan Railroad under McAdoo went on to win large profits.

1? *Details*

Clearly, William Gibbs McAdoo was a captain of industry in the finest sense. Having completed New York's first underwater rail system, and having served under the Wilson administration in Washington - where he also married the President's daughter, he sat down in 1931 and wrote his autobiography, entitled The Crowded Years. In his autobiography, he looked back on the first official train to inaugurate the H&M system with wry humor. He recalled that dignitaries on the first official train "... sat in rows, leaning on their canes, and looked a little uneasy as they glanced out of the windows and saw the curving (tunnel) walls flash by." Since the early days, over ^{himself} a million annual passengers were to ride through those same tubes ~~by~~ ⁱⁿ the year 1930 with hardly a care.

CARS, MAINTENANCE, POWER PLANTS

When the first H&M Class A cars for the system were ordered around 1908, the company had no facilities for the installation of electrical equipment. Hence, an arrangement was made with the Interborough Rapid Transit Company (IRT) to do the electrical work on the cars. Consequently, the builders delivered the cars directly to the IRT which did the electrical work in the 129th Street shops of the Manhattan Railway Division. When this work was completed, the cars were tested without passengers over the tracks of the Second and Third Avenue elevated lines. Since they operated satisfactorily, the H&M Class A's travelled over the Third Avenue el line to the 99th Street yards in preparation for final delivery. From this point, the cars were transferred at night to the Lexington Avenue streetcar tracks via a temporary connection. They were then towed down to 34th Street and over to a dock on the East River. A car float barge took them across the river to New Jersey, where they were unloaded at Hoboken. Once at Hoboken, an H&M car elevator located west of Hoboken station lowered the new cars down into the tunnel, ready to run.

It was necessary to design electrically powered cars built to H&M specifications in such a way that they could be operated over the tracks of both the steam railroads for travel to Newark as well as over the regular H&M tracks. As noted earlier, H&M cars were multiple unit cars capable of being operated independently of each other.

Class B cars, built by the Pressed Steel Company, were placed into Jersey City-Hoboken-33rd Street service in 1909, with a new fleet of Class B's added to the system in 1928. These cars each seated 48 people, and they weighed almost 70 tons. McAdoo

delivered?

*who built
Class A's?
How many?
Specs*

*photo
of old
cars*

*How many?
Specs*

estimated that his cars provided a maximum seating capacity per hour of approximately 10,000 passengers. These cars were made from steel and were advertised as fireproof.

Inspection, repair, storage, and maintenance of cars, switches and signal equipment were functions normally carried out at, or from, the Henderson Street Yard ^{in Jersey City.} It opened on November 10, 1910. Henderson Yard was bounded by Steuben, Warren and Henderson Streets, and Railroad Avenue, in Jersey City. It was strategically located almost ~~smack~~ in the middle of the H&M system. The central location of the yard was advantageous, helping reduce empty car mileage by placing cars in and out of circulation near their normal routes. It had a total capacity of 123 cars. Moreover, the Henderson Yard was well suited for maintenance of rolling stock, providing the direct sunlight necessary for close inspection of equipment. This open daylight environment was far better than the alternative of working on cars from inside the tunnels under limited lighting conditions.

While the yard itself could accommodate 123 cars, the repair shop at Henderson Street accommodated just six cars at a time. The shop was equipped with two 15 ton traveling cranes which had a yoke capable of raising up one end of a car body. When a car body was raised in this fashion, trucks could be swiftly removed and replaced under the car.

The nine-boiler generating plant which issued power to the H&M system was built at roughly the same time the downtown segment of the railroad were under construction. Power was generated by steam, and was transmitted at 11,000 volts alternating current to three substations. The three substations were located at Hudson Terminal, Christopher Street Station, and inside the main power station itself, located on

Washington Street, in Jersey City. The substation transformers and rotary converters together reduced the voltage to 600 volt direct current. This 600 volt current was then fed to the third rail from the substation bus bars.

The Hudson and Manhattan Railroad Company generated its own power until November 15, 1920. On that day, an agreement went into effect delegating the operation of the plants to the New York Edison Company. The reason for this new arrangement was two-fold. First, the old power plant was desperately in need of repairs and improvements. Secondly, due to difficulties in financing these repairs, the funds needed were not available. Turning to New York Edison thus made good sense. Over the years, power plant facilities continued to wear out, and additional power was supplied by the Edison Company. Finally, in 1929 the power station was shut down. All the equipment there was sold for scrap.

Today, more than forty years later, the Public Service Electric and Gas Company of New Jersey supplies power to the tunnels. The closing down of the old rotary converter substation at Hudson Terminal occurred in 1971. The rotary converter was replaced by a new substation equipped with silicon rectifiers, serving PATH's World Trade Center terminal. This replacement marks the final phasing out of all the original power sources of the Hudson and Manhattan Railroad.

*more on
PATH power
system*

HUDSON TERMINAL CONNECTIONS WITH JERSEY CITY, HOBOKEN, AND 33rd STREET, NEW YORK

Although all Hudson Terminal service was handled through the two downtown tunnels, at one time plans called for the construction of two additional downtown tunnels. These additional tunnels were planned to run under the Hudson between Erie Station (now Pavonia Station) and Hudson Terminal. Erie Station, located in Jersey City between Exchange Place, and Hoboken Station, was the terminus of two double-track railways, the Erie Railroad and the New York Southern & Western Railroad. If these direct tunnels to Erie Station had been constructed, then presumably the trains of these two additional railroads would have terminated at Hudson Terminal also. All the stairways and exits of the old terminal were designed with this link to Erie Station in mind.

When service from Hudson Terminal was begun on July 11, 1909, this service terminated at Exchange Place, across the river in Jersey City. At that time, trains were turned around on the pocket track west of Exchange Place. This pocket track was built for the sole purpose of redirecting shorter service runs, and was called "Penn Pocket."

The H&M connections from Exchange Place to Erie Station were completed and opened to the public on August 2, 1909. Likewise, H&M connections from Erie Station to either Hoboken Station or direct to the uptown 33rd Street Station, in New York City, were opened to the public on that very same day.

In addition, by special agreement Pennsylvania Railroad passengers could use "interline tickets" on the Hudson and Manhattan Railroad. Thus, in 1909 a PRR passenger could board H&M trains at Exchange Place. From Exchange Place, the passenger could go to Hudson Terminal or all the way up to 33rd Street Station, in uptown New York City. Pennsylvania Railroad passengers who terminated aboard H&M trains in uptown New York City, benefited greatly by this interline agreement. The reason it was so helpful to them at first was due to the fact that

PRR tunnels under the Hudson River, from New Jersey to Pennsylvania Station in uptown New York, were not opened until 1910. In this sense, PRR passengers were accommodated to their great advantage by the Hudson and Manhattan tunnels which opened in 1908.

On September 6, 1910, train service was extended westward from Exchange Place to Grove Street, in Jersey City. Grove Street Station itself, however, did not open until November 26th of that same year. Incidentally, the year 1910 saw 130,000 commuters riding aboard the H&M system every weekday.

HUDSON TERMINAL--NEWARK SERVICE

The Hudson and Manhattan Railroad signed a special agreement on April 18, 1906, with the Pennsylvania Railroad. This was an agreement to operate a joint service between Hudson Terminal and a new station to be built by the Pennsylvania Railroad in Newark, New Jersey. Both companies agreed to furnish the new trackage and facilities required for its operation. The earnings and expenses which would be entailed were to be prorated on an equitable basis. H&M crews would operate trains on this joint service, and the crews were required to pass a PRR train rules test.

This joint Pennsylvania Railroad--Hudson and Manhattan service to Newark established certain additional responsibilities between the two corporations. First, it was agreed that tunnels extending from Exchange Place to a point west of Grove Street would be run on PRR tracks. Secondly, it was agreed that from this point tracks would emerge to surface level and run in the center of the railroad right-of-way to a station in the Jersey Meadows, called Manhattan Transfer.

Manhattan Transfer was one of the most ^{unusual} ~~unique~~ station stops on the H&M system. It was here that Pennsylvania steam powered trains were substituted for DD-1 electric powered trains which carried all PRR through passengers to

Pennsylvania Station, New York City. Alternatively, it was possible for PRR passengers to board H&M trains at Manhattan Transfer and go to Hudson Terminal, Exchange Place, or Hoboken Station—among other destination points. Train service began at Manhattan Transfer on October 1, 1911, and this station could be reached only by train.

Ninety-six cars were purchased jointly for this PRR-H&M service between Grove Street, in Jersey City, and Newark, New Jersey. Approximately two months after Manhattan Transfer opened in 1911, service was extended from Manhattan Transfer via an elevated structure to a new three-track stub-end station called Park Place, in Newark. There was an intermediate station, also, at Harrison.

The cars serving passengers on this route were Class D cars made by the Pressed Steel Car Company. These cars seated 52 passengers each, and weighed 73,000 lbs. In many respects, they were similar to H&M Class D, E, F, and G cars. These PRR-H&M cars were replaced in 1958 by fifty Class K's of a considerably more modern design.

The 1911 H&M commuter paid .17 cents one-way to ride between Hudson Terminal and Manhattan Transfer, and 30 cents round-trip. This ~~joint~~ ^{trip} took less than 18 minutes, and trains sometimes traveled as fast as 65 miles an hour. During the weekday rush hours six-minute headways were maintained, with 20 minute headways preserved during off-rush hour periods. The lone exception to these scheduling patterns occurred at late night and early morning hours, during which time trains ran at 30 minute intervals.

With the opening of Pennsylvania Station in Newark on June 21, 1937, joint PRR-H&M service into the red brick Park Place Station, Newark, was disbanded and re-routed into this new Pennsylvania terminal. On this same day, Park Place, the old Harrison Station, and Manhattan Transfers were shut down.

There was no need for Manhattan Transfer anymore; all PRR trains leaving Newark bound for New York City now ran exclusively on electric power. With no more steam powered trains to change over from, Manhattan Transfer had outlived its usefulness. It was torn down along with Park Place and the old Harrison Station. A new Harrison Station was built, however, along with a new Jersey City Station called Summit Avenue Station. ~~Summit Avenue~~ was opened to the public on April 14, 1912, and was later renamed Journal Square, ~~it was~~ located in downtown Jersey City between ~~Exchange Place~~ ^{Grove Street} and Harrison Station.

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SOME LATER DEVELOPMENTS

The years between 1915 and 1940 saw some comparatively minor developments on the Hudson and Manhattan system, almost all concerning station modifications.

In the Jersey City area, an underground passageway was built connecting Exchange Place with Erie Station to the north. This pedestrian passageway, opened in 1911, was originally planned as a temporary facility. The ~~Erie~~ ^{H&M} Railroad had intended to develop a new station ^{close} to replace Erie Station in the near future. Incidentally, a "speedwalk" conveyer belt for pedestrians was installed in the old passageway in 1954. This speedwalk was later removed.

In addition, improvements at Journal Square (formerly Summit Avenue Station) were carried out in 1925. Access routes were built there for easier transfer between Public Service trolley ^e lines and the H&M system. Located in ^{the} commercial center of downtown Jersey City, Journal Square was ^{also} the transportation hub of that ^{city} suburb.

It seems appropriate to clarify a few details not mentioned earlier about the opening of Pennsylvania Station in Newark. To wit, the Pennsylvania Railroad electrified their mainline trackage between New York and Washington, D.C. in the early 1930's. This meant that electrical power replaced steam driven PRR trains. It follows that it was no longer necessary for PRR trains

to change motive power, as they had done for years, at Manhattan Transfer. Instead, PRR trains could run directly through to New York City.

Moreover, the Pennsylvania Railroad, in conjunction with other railroads, the City of Newark, and the Public Service Railway, cooperated ~~together~~ in the rebuilding of this new station in Newark. The goal which united these parties in a mutual effort, was precisely the goal of consolidating all transportation in the Newark area into one central station. Like many other railroads, the H&M Railroad began servicing passengers at Penn Station, Newark, from the day the station opened. This was part of the general consolidation plan. Although Manhattan Transfer and Park Place Station were demolished, the bridge over the Passaic River--traveled by H&M trains to Park Place, Newark--was preserved. This bridge was converted from rail to automobile service. Also in the late thirties, a new lay-up track was constructed alongside the PRR right-of-way for approximately one mile south of Newark, ending at South Street.

Very few PATH passengers are aware that 33rd Street Station, in ~~uptown~~ ^{midtown} New York City, is actually at 32nd Street. How did this opaque state of affairs come about?

In the mid-1930's, the INDependent Subway's Sixth Avenue line began construction. A plan was approved which called for the construction of IND local tracks to be built so that these tracks straddled the H&M Sixth Avenue tracks. The H&M tracks were, of course, under the very center of the street. The long range goal behind this IND plan was ~~pretty~~ ^{rather} complicated. The IND hoped to recapture the H&M Sixth Avenue franchise which would be up for review with New York City in the near future. The agreement signed between the Hudson and Manhattan Railroad and New York City's Board of Rapid Transit Commissioners back in 1905 made the surrender of this franchise possible, pending review. Herein lies the tale.

If the IND had won the Sixth Avenue franchise rights from the H&M, then the inner H&M tracks would have been incorporated into the new city subway as express tracks. This plan would have required the H&M Railroad to terminate its uptown New York service at 9th Street and Sixth Avenue. Assuming that its plan was sound, the IND subway said it was necessary to close down and demolish the H&M Station at 33rd Street. Why so? Because the city subway was to be built over the cross town tunnels of both the Pennsylvania and Long Island Railroad at 32nd and 33rd Street. The H&M station at 33rd Street was in the way of all this, and thus on December 20, 1937, it was shut down and later razed.

While the City of New York pushed ahead with its new subway plans during this time, all H&M uptown trains terminated at 28th Street Station, with a temporary entrance built at 29th Street.

But suddenly, the City of New York did an "about face." The original plans for the IND subway were changed. The city decided that it would be too expensive to enlarge the H&M tunnels for its larger trains--a requirement for converting Sixth Avenue H&M tracks to IND express service. This decision entailed: (a) that the Hudson and Manhattan Railroad would have a better chance to renew its Sixth Avenue Franchise (which it did), and (b) that the city was obligated to rebuild the H&M terminal it demolished at 33rd Street (which it did).

Generally speaking, when the city rebuilt 33rd Street Station, it followed the building plans of the original station. The major exception to this, however, was that the rebuilt station was constructed at 32nd Street. Construction of a station at 32nd Street could be carried out with greater ease. The rebuilt station provided an exit at 30th Street, and neighboring 28th Street station--just two blocks away--was closed. Passenger volume on

the H&M system had dropped almost 50 per cent between the years 1930 and 1940, and economy measures were being taken.

THE DECLINE OF THE HUDSON AND MANHATTAN RAILROAD

Given the information which has been presented about McAdoo's maverick leadership, and about the many advantages of the tunnels to area commuters, it is hard to picture the Hudson and Manhattan Railroad going bankrupt. But in 1954, the company did in fact ~~go bankrupt~~, initiating formal bankruptcy proceedings in court.

Between the years 1954 and 1961, the Hudson and Manhattan rail system made some gallant attempts to improve its deteriorating service. For example, under the aegis of Mr. Herman Stichman, a court approved company administrator, the company put into service the first fleet of air-conditioned rapid transit cars in the United States. Fifty of these cars went into service between Hudson Terminal and Newark in July, 1958. Their purchase was obviously a bold step in the right direction, but this pleasant surprise looked to many observers like the last gasp of a failing enterprise. They were right. The signals, switches, stations, and tunnels of the H&M system were in need of comprehensive repairs. Since the company had little money to finance these expenses, it could no longer afford to operate its train service. Moreover, word was out that the company had been insolvent since 1930, and there were few investors confident enough to lend the H&M money for improvements. Some newspapers speculated that the tunnels would be closed. Some H&M passengers began to feel that riding through the delapidated tunnels was unsafe. Throughout the late 1950's, fears that the tunnels would be abandoned loomed large in the minds of New York area commuters. No one really wanted this to happen: the H&M system was a vital link between New York and New Jersey residents.

H&M/Amosy
jointly
purchased
by

X

Consequently, the Port of New York Authority was called upon by the States of New York and New Jersey to help save the Hudson and Manhattan Railroad. In 1962, following passage of legislation by these two neighboring states, the Port Authority Trans-Hudson Corporation (PATH) was created to acquire, operate, and modernize the old H&M system. PATH is a subsidiary of the Port of New York Authority.

Beginning on September 1, 1962, PATH initiated a long-range, multi-million dollar rehabilitation and modernization program. While no attempt will be made here to evaluate PATH's extensive program, a brief outline of its scope is helpful:

- A. ~~The~~ acquisition and design of 252 air-conditioned cars at a total cost of \$34 million.
- B. ~~The~~ design and construction of the new ^{\$35 million} World Trade Center Terminal opened on July 6, 1971--New York City's first air-conditioned subway terminal.
- C. ~~The~~ Rebuilding of the signal system.
- D. ~~The~~ Rehabilitation of track, tunnel drainage, and utility systems.
- E. ~~The~~ Installation of a two-way radio communication network throughout the system and on all trains.
- F. ~~The~~ Replacement of the electric traction power ~~station~~ ^{system}.
- G. ~~The~~ Construction of ^{the} Journal Square Transportation Center, in Jersey City, to be opened in late 1973 at a cost of \$80 million.

In the eight years between 1962 and 1970, PATH spent \$145 million for the property acquisitions and capital improvements necessary to this modernization program. The entire program will total \$230 million dollars when it is completed, benefiting the more than 145,000 weekday metropolitan area commuters who ride the PATH system daily. Miraculously enough, by 1965 PATH had transformed the bankrupt Hudson and Manhattan Railroad into the world's first fully air-conditioned rail rapid transit system. This system, however, is no profit maker: PATH operates at an annual \$12 million deficit.

CONCLUSION

*Influence of
Holland Tunnel
one of several factors
contributing to H&M bankruptcy*

The question remains: if the old Hudson and Manhattan Railroad was needed so badly by daily commuters, why did it fail financially?

The decline in passenger revenues of the H&M Railroad is traceable in large measure back to November 12, 1927. On this date Holland Tunnel, named after the renowned tunnel engineer Clifford Holland, was opened. It was the first vehicular tunnel ever built under the Hudson River, connecting Jersey City with Canal Street, in Manhattan. Before the Holland Tunnel, cars were exclusively dependent on the ferries for transport across the river. Because ferryboat service had been limited and slow, taking a car into Manhattan was less practical than riding the H&M system. But with more and more people relying on the automobile for general use, the speedy Holland Tunnel increasingly encouraged a preference for auto over train transportation. In 1937, the first tube of the Lincoln Tunnel opened to driving commuters, and in 1945 the second tube opened. As a result of this trend, H&M passenger revenues dropped drastically. The automobile was coming into its own.

Another thing that occurred in 1927 was that the state of New Jersey started a large scale road building program which indirectly hurt the H&M Railroad. When bus lines began operating, they were granted handsome franchises which permitted them to use these new highways. In addition, bus lines were permitted to travel through the Holland Tunnel between New Jersey and New York City--an enormous blow to the railroads! One bus route, for example, took passengers from Journal Square to 33rd Street in Manhattan, placing itself in direct competition with the H&M Railroad. This particular route, established on February 27, 1928, surpassed all H&M parameters:

it provided a cross town extension to 9th Street and Fourth Avenue. This was no doubt a painful lesson for H&M officials, who once envisaged cross town connections to 9th Street and Fourth Avenue themselves--but gave up.

Worse yet, bus carriers were not required to pay real estate taxes, or file tax returns on their operations. This seemed grossly unfair to the railroads, especially the Hudson and Manhattan. Free from the taxes the railroads had to pay, the bus lines severely undercut the fares and services of their major competitors. What did the bus companies have to lose? Predictably, the result was that new bus commuters were won at the expense of H&M train profits.

As the bus and automobile gained in popularity and economy in comparison with rail transportation into New York City, H&M patronage decreased steadily from the late 1920's on. The Hudson and Manhattan Railroad faced mounting operational, maintenance, and labor costs it could not pay for.

To keep increasing costs down, efforts were made to cut back excesses wherever possible. For example, when the lease on the property above 19th Street Station terminated, it was decided to close this station down rather than renew the lease. The Public Service Commission approved of this decision because another H&M station was nearby at 14th Street. Besides, the decreased use of 19th Street Station by H&M passengers more than warranted this action. Consequently, it was closed according to plan on August 1, 1954. Uptown passengers aboard the PATH system speed by these deserted platforms to this very day.

The downward financial trend of the Hudson and Manhattan Railroad persisted between 1930 and 1956, resulting in bankruptcy, as noted earlier.

The company had indeed fallen on hard times. After 54 years of operation up to 1962, dividends on H&M preferred stock were paid a total of ten years during its long history. Dividends on common stock were paid for seven years. But the saddest and most significant index of defeat was this: in 1930 a total of 107 million commuters rode the H&M system. The total number of commuters to ride the system twenty-seven years later in 1957 was just 30 million.

Mathematically speaking, the decline of the Hudson and Manhattan Railroad is easily enough explained. But not well enough explained, unless the bald mathematical figures are buttressed by historical insight.

X
In 1965
26.5
mill.
lowest
ever

In 1927?
highest
113 million

Need tables of fares, cars, pass. volume
old photos + illustrations
More on PATH program
+ "rebirth idea"
Speculators + gangster
managements in later years
Trend Use for freight ever contemplated?
More info on financial status of H&M
profits/losses.

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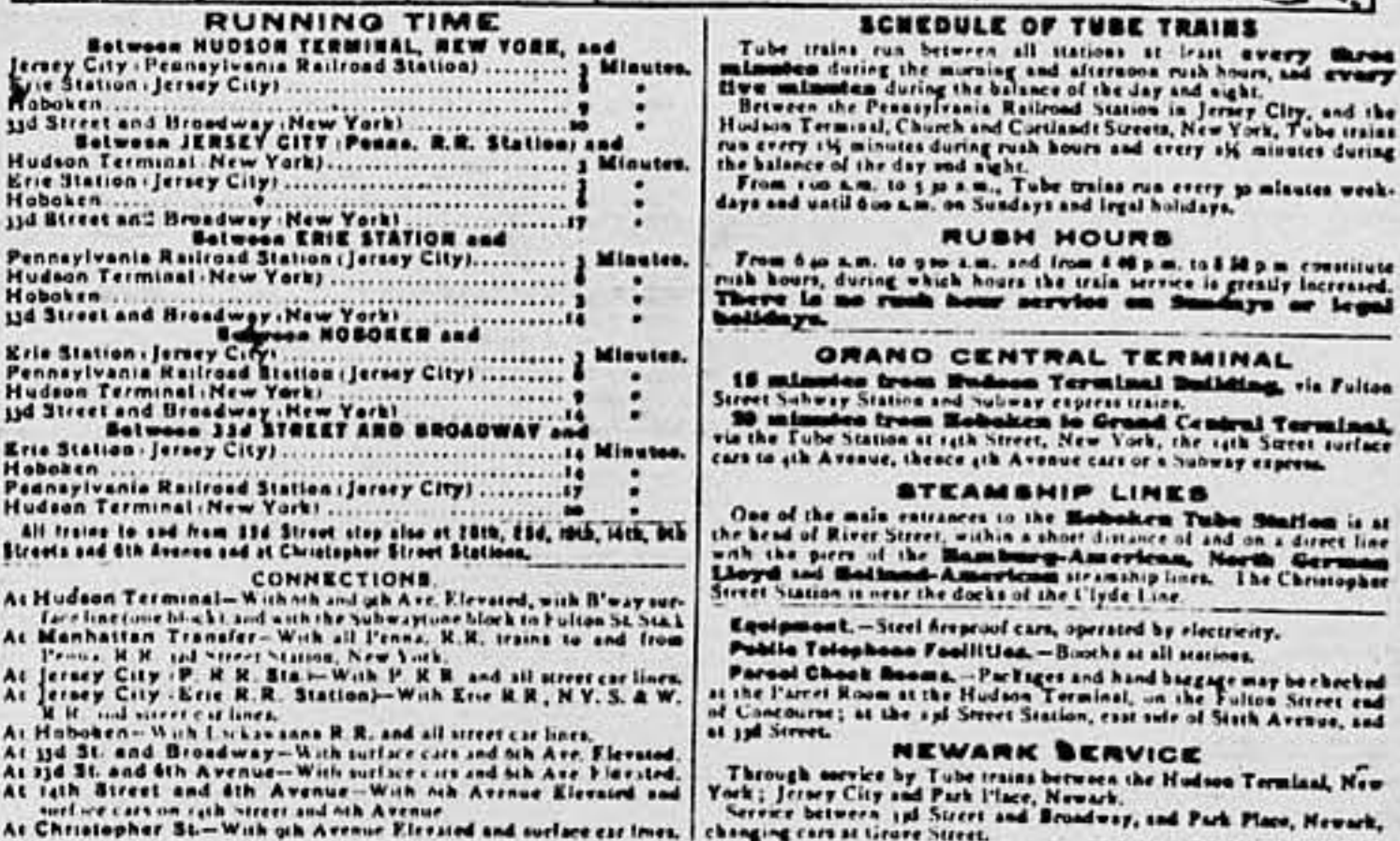
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