The subway has shaped New York City. More than any other public works program or municipal project, the subway has shaped the city’s development and sustained its global competitiveness over the past 100 years. The subway’s profound impact on the city’s growth and development—particularly in the outer boroughs—surpasses that of the city’s other widely acclaimed infrastructure projects, such as the Brooklyn Bridge and Robert Moses’ highway network.

The innovative, early 20th century transit system still serves the 21st century metropolis well—a tribute to visionary planning and advanced engineering design. The October 2004 centennial of New York’s first subway line provides an occasion to look back at how dramatically the city was transformed in the years that the subways were built.

Forging a Vision

New York City’s rapid transformation into the leading metropolis of the United States was linked inextricably to improvements in the transportation infrastructure that overcame a challenging geography. An urban archipelago, New York capitalized in the early 19th century on an unusually good system of rivers and bays to grow from a settlement of 60,000 clustered in southern Manhattan to a booming port city of almost 3.5 million by 1900, when it was second in the world only to London.

Establishing itself as the nation’s leading financial center and a magnet for business and employment, New York faced a troubling paradox. The most congested and populous city was attracting ever-increasing numbers of immigrants. Yet at the same time, the waterways that had spurred the city’s initial success had become the most serious impediment to sustained
growth by severely limiting the areas where people could live within a practical commute to jobs.

To serve the booming population, early forms of rapid transit emerged in the 19th century. Many of these transit modes—including horse cars, cable cars, electric trolley cars, and elevated steam trains—began to change conventional notions of commuting distance and time. The opening of the Brooklyn and Williamsburg Bridges to transit operations also facilitated these changes.

But no change would be as radical and quick as that introduced by the underground, electrically powered subway system, which began operating in 1904. The first subway, however, was severely overcrowded from the day it opened and was too limited in geographical coverage to relieve the city’s population congestion.

Visionary municipal leaders saw that New York’s continued economic success and prosperity could lead to its downfall without managed growth. These leaders promoted construction of a more extensive citywide subway network to serve as an instrument of modern city planning efforts to rationalize urban development. The plan benefited New York City to a far greater extent than could have been imagined.

The subway influenced New York City’s growth and development by improving the quality of life for a range of citizens, by spurring commercial development and the creation of the skyscraper skyline, and by increasing real estate values and broadening the city’s tax base.

Catalyst for Residential Development

Between 1900 and 1910, most of New York City’s population was concentrated in older, severely overcrowded tenement districts. The largest, Manhattan’s Lower East Side, was within walking distance of the thread-and-needle trades and light industries and had the highest population density in the world.

Other tenement districts had been built along the old 19th century elevated steam railways and the first subway in such areas as Harlem, Hell’s Kitchen, the
South Bronx, and Brooklyn’s Williamsburg and Bushwick neighborhoods. New immigrants, many from southern and eastern Europe, continued to crowd into a limited supply of low-quality tenement buildings in these districts.

The tenements lacked natural light and fresh air flow, and the cramped apartments did not have hot running water or private bathrooms. Contagious diseases and a variety of criminal activities proliferated. This bleak situation persisted despite the availability of vast expanses of open or underdeveloped land in other parts of Greater New York.

Manhattan’s average population density in 1910 was 189 residents per acre (RPA), compared with Brooklyn (45 RPA), the Bronx (21 RPA), and Queens (5 RPA). These less crowded sections composed nearly three-quarters of Greater New York’s land area but housed less than 20 percent of its population, because the daily commuting time and cost to and from Manhattan’s employment districts were not practical.

The threats from population congestion to the wider society spurred the massive expansion of New York’s subway system between 1913 and 1940. During this era, the city built 180 route-miles of subway lines—including 12 bridge and subaqueous tunnel crossings—effectively overcoming the river barriers to integrate Manhattan geographically with Brooklyn, Queens, and the Bronx.

As a result, a greater amount of land was opened for development than at any other time in the city’s history. Developers followed the new subway lines and extensions to construct decent, affordable, low-density housing for middle-class and working-class families. The bucolic, rural landscape of the city’s outlying areas was quickly replaced by long rows of tree-shaded streets with a mix of apartment houses, private single- and two-family homes, and open recreational spaces.

The expanded subway’s low-cost five-cent fare, devalued by significant inflation during World War I, was within the reach of even the poorest person in the city. This was the primary catalyst for the development of new residential neighborhoods in the outer boroughs, allowing dispersal of the city’s growing population.

Most of the city’s net population growth from 1910 to 1940 occurred within the new transit-oriented developments, as the population density outside of Manhattan increased with the construction of new subway lines (Figure 1). The city’s population rose steadily until about 1930, when the Interborough Rapid Transit (IRT) and Brooklyn-Manhattan Transit (BMT) subway lines were largely completed. Growth continued at a slower rate until 1940, as the Independent (IND) subway lines were built.

The IRT and BMT lines reached into undeveloped areas; the IND reinforced many lines already in service. By 1940, nearly 90 percent of the city’s population of 7.5 million lived within one-half mile of a subway or an elevated rapid transit line.

By reducing the early 20th century problems of population congestion, the subway improved the quality of life for New Yorkers—an enduring legacy.

**Building a Vertical City**

Four technological innovations of the late 19th century enabled the skyscraper—the “ultimate architecture of capitalism” and the symbol of New York’s financial preeminence—to dominate Manhattan’s skyline. These were the passenger elevator; metal-skeleton construction, which replaced load-bearing masonry walls with cast iron and later with structural steel; electric power and light; and rapid transit.

By reducing the early 20th century problems of population congestion, the subway improved the quality of life for New Yorkers—an enduring legacy.

**FIGURE 1 Population follows transportation:** the opening of new subway lines relieved overcrowding by shifting population density and growth to the outer boroughs.
Pivotal in spreading out the city's residential areas geographically, the subway also played a role in New York's development into a vertical city of skyscrapers. The subway made possible an extraordinary density of daytime worker populations in Manhattan's central business districts—the subway's capacity, speed, and affordability enabled hundreds of thousands of people to commute to jobs in Manhattan; moreover, the subway provided Manhattan-based businesses with access to labor, influencing continued growth.

When the subway opened in 1904, Lower Manhattan already was the world's largest office building district, served by earlier forms of rapid transit, including the Manhattan elevated steam railways and the Brooklyn Bridge's elevated cable railway. With the construction of additional subway lines in Lower Manhattan, more and taller office buildings were built to meet the demand for office space in prime locations.

With the completion of the IRT and BMT lines, subway station entrances were near every concentration of employment. Without this accessibility, traffic congestion would have stunted New York's economic growth and development.

Midtown Manhattan's transformation from a fashionable 19th century residential area into a leading retail district began before the first subway opened. In 1902, Macy's Department Store relocated from 14th Street and Sixth Avenue to Herald Square, one block from the planned construction of the Pennsylvania Railroad Station, and other department stores and specialty shops soon followed. The subsequent construction of the IRT and BMT lines, together with the reconstruction and improvement of Grand Central Terminal, added impetus to the northward movement of development.

Throughout the 1920s, although the financial district remained the focus of new office building development, the Midtown area evolved into Manhattan's second central business district. By 1935, the 60 million square feet of office space in Midtown surpassed the 55 million in Lower Manhattan.

Manhattan's signature art deco skyscrapers, the Chrysler and Empire State Buildings, were constructed close to Midtown subway lines. Times Square, at the nexus of several subway lines, quickly developed into the city's premier hotel, theater, and entertainment district and became known as the “crossroads of the world.”

The subways brought huge crowds to the skyscrapers and theaters. This type and density of development, in turn, made the need for subways acute.

**Broadening the Tax Base**

As the subways brought the previously wooded and farmland areas of Brooklyn, Queens, and the Bronx within a reasonable and inexpensive commute to Manhattan's central business districts, the demand for—and value of—the land increased. The accessibility that the subways provided was a primary facilitator, along with a strong regional economy, the market demand for new development, and proactive public policy support.

The greatest rise in values occurred in the previously undeveloped areas of the outer boroughs, as the population followed the construction of new subway lines. By 1935, the average value of land in Brooklyn, Queens, and the Bronx within one-half mile of a subway line was seven times that of land farther away.

In Manhattan, as land became more expensive, new office building developments grew denser and taller to sustain profitability. This necessitated more subways, increasing the land values of commercial development sites adjacent to the new subway stations.

The subway's construction had a redistributive effect on land values in Manhattan. The building of subways after 1913 accelerated Midtown growth, until it outpaced Lower Manhattan in size and importance. New Midtown office developments filled up at the expense of Lower Manhattan’s older buildings. Consequently, as more subways were built through each business district, land values increased in Midtown but remained stable in Lower Manhattan.

The construction of the IRT and BMT subway lines provided the accessibility necessary for opening up all parts of the city to development. New York experienced a 160 percent increase in land values during
the 25-year span from 1905 to 1929. The increased real estate tax revenues financed many other municipal infrastructure improvements, including the construction of the IND subway lines during the 1930s.

**Coming Full Circle**

When the subway system was largely completed in 1940, the city’s growth had reached a maturation point, with a population of 7.5 million and 2.9 million workers—not much different from today’s 8.1 million residents and 3.6 million workers. The subway continues to be New York’s lifeline, sustaining its economic and physical vitality. Without the subway, it is unlikely that New York would have remained a great city, the world’s leading city in finance, commerce, and culture for much of the past century.

At the beginning of the 1980s, New Yorkers experienced life without a safe and reliable subway when the system nearly collapsed after many years of neglect. The Metropolitan Transit Authority (MTA) then embarked on one of the biggest public works rebuilding efforts in American history—a series of capital programs worth more than $40 billion in current dollars—to restore and reinvigorate the infrastructure. The programs began in 1982, and after nearly a quarter of a century of continuous investment, the results of the MTA capital programs are apparent. The dramatically improved subway system has regained passengers in record numbers, making it a primary factor in New York City’s resurgence.

In the 21st century, the subway remains crucial to the city in keeping and attracting business, holding and creating jobs, and strengthening the tax base. Continuing the current levels of capital investment is critically important in the capital program for 2005 to 2009 and beyond, to maintain progress and momentum to bring the entire subway system into a state of good repair, helping to ensure safe, reliable, and efficient service. The capital program will make strategic investments in new subway infrastructure to relieve congestion and to open up new areas of the city for development—as was done 100 years ago.

**Resources**


The subways encouraged Manhattan’s dense commercial growth. The city’s iconic skyscrapers would have been impractical without the capacity, speed, and affordability of subway service for Manhattan’s hundreds of thousands of workers.
When New York City celebrated the centennial of its subway system in October 2004, no name was invoked more often than that of William Barclay Parsons, who designed the system that opened on October 27, 1904.

One hundred years later, Parsons’s design—including his decisions to use cut-and-cover tunneling, third-rail electric power, and a four-track express system—was acknowledged as visionary in anticipating the future growth and needs of New York City. The system Parsons designed provides fast and efficient transportation to those who live in, work in, and visit New York.

Solid Foundations

Parsons was born in New York in 1859 to a prominent family that traced its history to the Revolutionary War. He received most of his early education in Europe. After earning a degree from Columbia College, he enrolled in the Columbia School of Mines, setting the record for the highest grade point average when he graduated in 1882. He then went to work for the Erie Railroad and published two technical manuals, the first of many publications.

Parsons married Anna DeWitt Reed in 1884. The following year, he established a consulting engineering business at 22 William Street in Lower Manhattan, in partnership with his younger brother, Harry de Berke-
ley Parsons, a mechanical engineer. The brothers collaborated on railroads, bridges, water supply systems, and hydroelectric plants. The firm continues today as Parsons Brinckerhoff, with headquarters in New York City and 9,000 employees in 150 offices worldwide.

Subway Dreams

Plans for subterranean mass transit in New York City date to the mid-19th century. In 1870, inventor Alfred Ely Beach built a block-long pneumatic tube subway, powered by a large fan, underneath Broadway. Although the scheme elicited amazement, it was not a practical, large-scale solution to the city’s need for mass transit. New York continued to rely on a network of elevated railroads, streetcars, and horse-drawn carriages. Meanwhile, London opened the world’s first subway in 1863.

Parsons initially allied with the Arcade Railway group, which offered a plan first proposed in 1866 to create an underground street below Broadway with a four-track rail flanked by sidewalks and stores. Parsons eventually broke away from the Arcade Railway and in 1885 joined the rival New York District Railway.

The District Railway proposed a shallow excavation with an improved ventilation system designed by Parsons. In 1887, New York Mayor Abram S. Hewitt publicly identified Parsons as the leading expert on subways, and when the city formed a Rapid Transit Commission in 1891, Parsons was named deputy chief engineer.

The commission sought bids for its plan but received none. In 1894, the commission reorganized and chose the 35-year-old Parsons as chief engineer—an appointment that met open skepticism from some.

“When I look back now I am glad I was not older,” Parsons later remarked. “I doubt if I could now undertake or would undertake such a work under similar conditions…. If I had fully realized what was ahead of me, I do not think I would have attempted the work. As it was I was treated as a visionary. Some of my friends spoke pityingly of my wasting my time on what they considered a dream.”

In 1898, before he began work in earnest on the New York City subway, Parsons traveled to China to chart the course of a railroad from Hankow (Wu-Han) to Canton (Guangzhou) through Hunan Province. For a stretch of 500 miles, Parsons was “the first foreigner ever seen,” according to his memoir, An American Engineer in China.

Parsons also took time to study firsthand the great underground transit systems in operation or planned in Europe. He traveled to London, Paris, and cities in several other countries. This survey convinced him that electric power would be superior to coal-fired steam, and that a system of shallow tunnels built by cut-and-cover construction would be preferable to the deep tunnels of the London Underground. The commission adopted his report as the guiding document for the New York subway.

Parsons’s Design

Parsons’s plan called for a rapid transit system beginning at City Hall in downtown Manhattan and extending northward through Harlem to Washington Heights and the Bronx. From City Hall, the line proceeded north on the east side to what is now Grand Central Terminal on 42nd Street, then turned west to Times Square and north toward Harlem along the west side.

Below 96th Street, the system employed a four-track system—two tracks for local service and two tracks for express. At 96th Street, one leg continued north to Washington Heights and the Riverdale sec-
tion of the Bronx; another leg veered east and terminated near the Bronx Zoo.

The initial system traversed 20.5 miles, including 5 miles of viaduct and 3 miles of deep-bore tunnel. Most of the line was built with cut-and-cover construction—workers dug a shallow trench, removed or rerouted the utilities, covered the trench, and built a rectangular box for the subway underneath.

Although it was the preferred construction method, cut-and-cover disrupted normal life and commerce. During construction, the subway was derided as “Parsons’s ditch.” More than 3 million cubic yards of earth and rock were excavated to make way for the subway.

Three sections required deep tunneling—along Park Avenue from 34th Street to 42nd Street; under the northwest corner of Central Park; and from 157th Street to Fort George in Washington Heights. The tunnel under the Harlem River was built with an early version of the immersed tube method. The Manhattan Valley viaduct included a renowned trussed arch bridge still standing today at 125th Street.

Most stations were accessible by stairs, which accommodated larger crowds than would have been possible with elevators or escalators. Glass-block ceilings and grates provided natural light. Electric power was supplied from a remote generating station—a huge powerhouse on the city’s west side—and conveyed to the trains via a third rail (co-invented by Parsons’s eventual partner, Henry Brinckerhoff).

The stairways and “blowholes” in the roof ventilated the subway. Although the air quality was docu-
mented as satisfactory, excessive heat and insufficient ventilation were complaints—Parsons had used six layers of waterproofing to control water inflow. In 1905, work began on adding ventilation chambers, sidewalk gratings, mechanical fans, automatic louvers, and an experimental cooling plant at the Brooklyn Bridge station to improve ventilation.

The Rapid Transit Construction Company, controlled by financier August Belmont, built the subway under a concession granted by the city. John B. McDonald was the contractor, and 10,000 to 12,000 men were employed to build the 20.5-mile system at a cost estimated by newspapers of the day at $50 million to $65 million, including equipment.

As chief engineer of the city’s Rapid Transit Commission, Parsons had “sweeping powers of supervision” during the construction, according to an account produced by Belmont’s Interborough Rapid Transit (IRT) Company. The IRT subway line was an early and outstanding example of a public–private partnership for producing public infrastructure through a design–build–operate–maintain arrangement.

**Opening Day**

The initial leg of the system, from City Hall to 145th Street, a distance of 9.1 miles, opened to the public just four-and-a-half years after construction began in 1900. The opening ceremony, October 27, 1904, was a lavish public spectacle. Mayor George McClellan took the controls of the first train to leave City Hall and piloted it—somewhat haphazardly, according to accounts—to 103rd Street; an official motorman then drove the train to 145th Street. The inaugural ride, at an estimated 25 miles per hour, took about 26 minutes, reaching 96th Street—the traditional boundary of Harlem—in 17 minutes, more or less justifying the slogan, “From City Hall to Harlem in 15 minutes.”

An estimated 150,000 New Yorkers rode the subway on opening day. Newspaper reports varied.

“There was lots of noise of the hilarious, buoyant sort, a great deal of celebrating of the inoffensive kind, no end of joking and holiday spirit,” according to The World. The New York Daily Tribune, however, reported “indescribable scenes of crowding and confusion, never before paralleled in this city.”

The public and the press greeted the new subway with almost universal acclaim. “The subway is a beauty,” said Mayor McClellan. “It is greater than any of us dared dream.”

The Sun declared, “This is the finest, handsomest, most complete and best equipped underground railway in the world.”
The New York Times called the subway “the greatest achievement of the time in municipal engineering” and noted that Parsons “had [proved] that great public works may be carried to completion with an unsullied reputation and clean hands.”

The Globe wrote that the subway “will stand on the records as an enduring monument to [Parsons’s] genius.”

Parsons resigned from the Rapid Transit Commission shortly after the opening, although he collaborated again with August Belmont on the Steinway (Queensboro) Tunnel. The tunnel opened in 1907 and brought the subway to Queens under the East River.

Parsons also consulted on transit systems around the world. He was advisory engineer to the Royal Commission on London Traffic and was appointed a director of the London Tube in 1908. He chaired the Chicago Transit Commission, contributed designs for subways in Boston and Philadelphia, and served as a transportation adviser to San Francisco, Toronto, and Detroit.

The Subway After Parsons
Parsons foresaw that the subway system he designed would grow to meet the demands of the city’s rapidly expanding population and the movement of people from downtown to the outer boroughs. The day after the opening, he said, “The railroad is not expected to be all that New York City should have, but...is hoped to be but a beginning of a comprehensive system such as future generations of New Yorkers and the inevitable growth of the city will require.”

As Parsons predicted, the subway expanded during the early 20th century as rival concerns, including the Brooklyn–Manhattan Transit Corporation (BMT) and the city-owned Independent Subway System (IND), built lines that competed for passengers. In 1940, New York City took control of the three lines—the IRT, BMT, and IND—and consolidated them. New York City Transit, an agency of the Metropolitan Transportation Authority, now owns and operates the system, which includes 722 miles of rapid transit, with 26 lines and 468 stations in four boroughs, and which transports 7.7 million passengers each weekday.

Canals and Other Projects
After his resignation from the Rapid Transit Commission, Parsons was appointed to the Isthmian Canal Commission and the Board of Consulting Engineers to develop recommendations for the Panama Canal. President Theodore Roosevelt overruled the board’s recommendation for a sea-level canal and opted instead for a canal with locks.

Parsons went on to design a sea-level route for the Cape Cod Canal in Massachusetts, a formidable project he undertook in partnership with Belmont. At the 1907 groundbreaking, Belmont likened previous attempts to build a canal to the experience with the subways: “The subways in New York went through the same [thing] for 20 years or more. Our engineer, William Barclay Parsons, is just as sanguine about this as he was about them, and so am I.”

Nonetheless, Belmont and Parsons underestimated the difficulty of constructing the canal. When
it opened in 1914, the canal proved difficult to navigate and did not fulfill the intended goals. In 1928, the U.S. Army Corps of Engineers assumed control of the canal and made it commercially successful, by deepening, widening, and lengthening it, making it then the widest artificial waterway in the world.

**On Engineering**

In his writings, Parsons offered opinions on the role and the obligations of the engineer in society. He rejected the view that engineers are narrow technical specialists, and argued that engineers and engineering can influence social and economic development: “Of all human activities, engineering is the one that enters most into our lives, that gives us our means of living, and permeates every fiber of the social fabric.”

He said that an engineer must have two abilities: “First, the technical skill; and second, the mind and the knowledge to conceive that which is useful and will be for the convenience of mankind in the long run…It is not the design that governs [a project] but its adaptability to the economics and social needs of the time.” He argued that engineers must “have the imagination to conceive all solutions and the courage to innovate.”

Parsons was also prescient in noting that the complexity of designing and building modern infrastructure would demand that engineers be well-rounded managers in addition to technicians. “The engineer of today, and more especially of the future, will…be concerned not only with his calculations but also will have to study men and their needs, questions of industrial demand, the law of finance, and much in regard to legislation. His it will be to conceive, to plan, to design, to execute, and then to manage.”

**Renaissance Man**

Best known for his work on the New York City subway, Parsons also was a renowned military engineer, a prolific author, and a respected community leader in New York City.

When the United States entered World War I in 1917, Parsons was 58 years old, but he left his engineering practice to command the legendary Eleventh Engineers Regiment—the “fighting engineers”—of the First Army. The Eleventh Engineers built roads, railroads, bridges, and docks and also engaged in combat. In Cambrai, France, in 1917, some fought with picks and shovels before retrieving their weapons during a German attack.

For his service to the Allied cause, Parsons received many honors, including the Distinguished Service Order of Britain, the Office of the Legion of Honor of France, and the Order of the Crown of Belgium. In 1919 he was promoted to Brigadier General, although he preferred the title of Colonel, which is carved on his gravestone.

Parsons recounted the experience of the Eleventh Engineers in his book, *The American Engineers in France*. Profoundly moved by the devastation of the war, he dedicated the book to “the memory of all the American engineers who fell in France…as a small tribute of admiration and respect.”

A prominent citizen of early 20th century New York, Parsons served as a member of the board of trustees of the New York Public Library from 1911 to 1932 and as a trustee of his alma mater, Columbia University, for 35 years, including terms as chairman from 1917 to 1932. He also chaired the administrative body of Columbia–Presbyterian Medical Center; he drove in the structure’s final rivet on May 24, 1926. He was a vestryman and warden of New York’s Trinity Church, a trustee of the Carnegie Institution, and a fellow of the National Academy of Arts and Sciences.

Parsons’s interest in Mayan culture led to the discovery of significant archeological artifacts in the Yucatan Peninsula. He admired the engineer and inventor Robert Fulton and authored the book, *Robert Fulton and the Submarine*.

Parsons devoted the latter part of his life to researching and writing the 651-page *Engineers and Engineering in the Renaissance*, an exhaustive account of the major figures and their accomplishments. After doing research at the Vatican library, he proposed a cataloging system that was approved by Pope Pius XI and implemented with assistance from the Carnegie Institution.

Parsons died in 1932 at the age of 73, with outstanding accomplishments in engineering, letters, military service, and philanthropy. His friend, Nicholas Murray Butler, president of Columbia University, said that Parsons was “a true representative of the culture and refinement of old New York, and his interest in education, in religion, philanthropy, and in public service all came as naturally to him as did the ordinary incidents of life.”

Parsons had explained his own accomplishments with characteristic modesty, pointing only to perseverance and hard work.

“I have failed utterly to discover any substitute for hard work,” he wrote. “I have found nothing to take the place of midnight oil. I am at a loss to know how to succeed except by plugging.”

**Resources**

