Railway age

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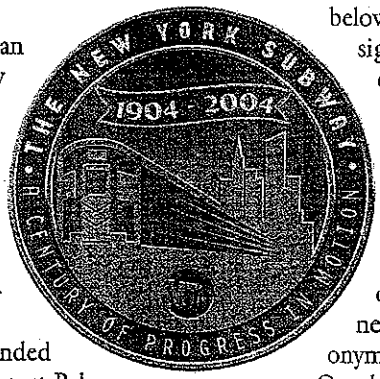
Une activité, encore en progrès.

"These are exciting times"

"The completion of the rapid transit railroad in the boroughs of Manhattan and The Bronx, which is popularly known as the 'Subway,' has demonstrated that underground railroads can be built beneath the congested streets of the city," the Interborough Rapid Transit Company wrote in 1904. "[It] has made possible in the near future a comprehensive system of subsurface transportation extending throughout the wide territory of Greater New York."



Did William Barclay Parsons (who later founded Parsons Brinckerhoff Quade and Douglas) and August Belmont, Jr., the subway's chief engineer and principal financier, respectively, foresee the system that exists 100 years later?

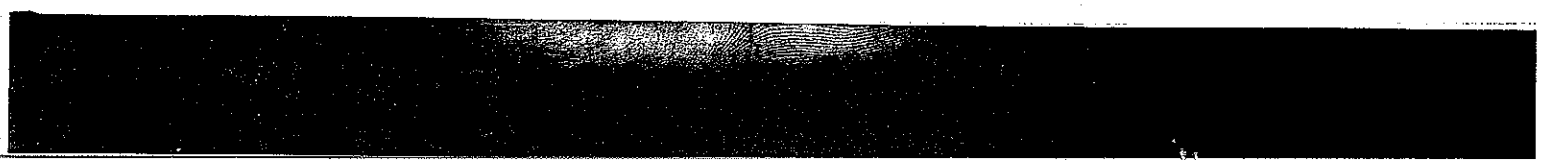
The building of New York's first subway, which was accomplished through a public/private partnership with the City of New York, was groundbreaking, both in the literal and symbolic sense. "The project posed an enormous challenge to the leading figures in the civil, mechanical, railway, and electrical engineering disciplines," according to engineering historian Joseph Cunningham. "The excavation and construction of the tunnel was a Herculean task in an era of manual labor. As the tunnel took form below the city's streets, the nation's leading power, signal, and rail vehicle experts were developing operating components more sophisticated than any predecessors. Energy was supplied by the world's largest coal burning power house. Power distribution rivaled that of the city's public utilities. The signal system advanced well beyond all previous notions of efficiency and safety. Car design was placed in the hands of George Gibbs, a railway electrical and engineering expert whose name was to become synonymous with innovation in railroad electrification."

One-hundred years later, the successors to those leading figures (in some cases, the supply and consulting firms that bear their names) are developing new technologies and expansion plans. The following pages of this special report reflect the subway's past, present, and future, as interpreted by the editors of *Railway Age*. Happy centennial, New York City subway!

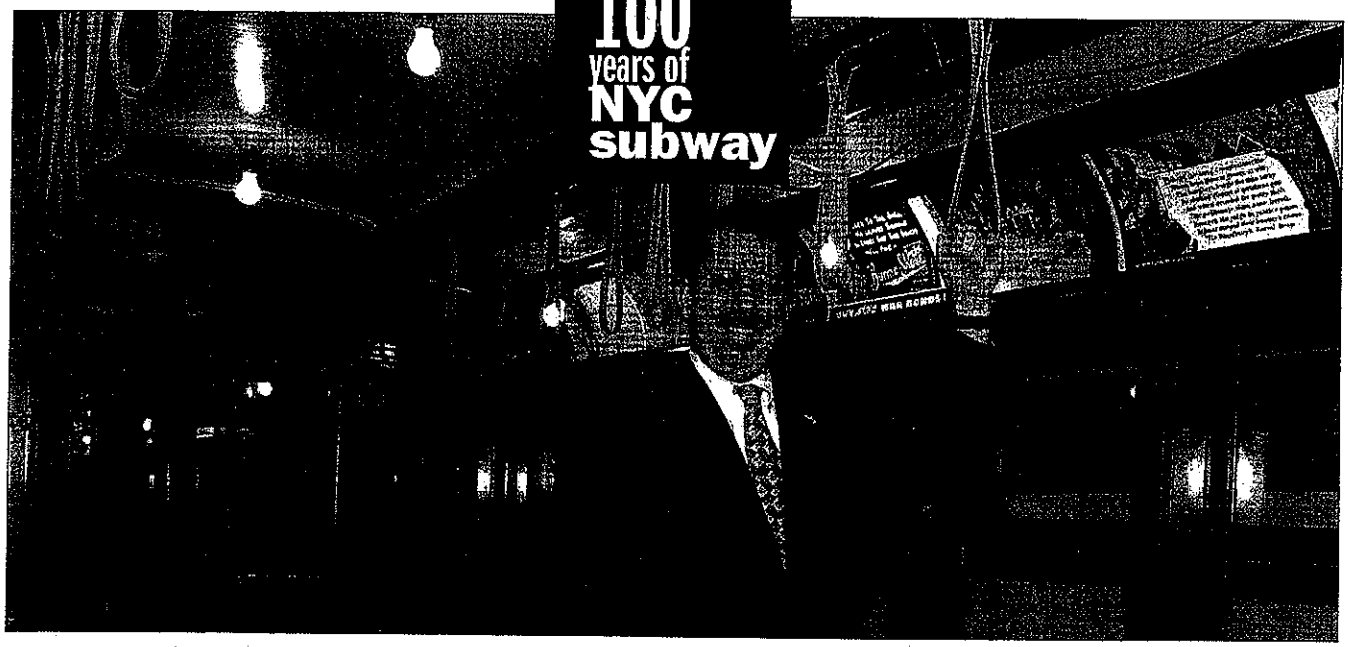
The building of New York City subway's first line was groundbreaking in every sense. A century later, the 600 route-mile system serving 1.4 billion annual riders plans a commemoration of sorts with the construction of the Second Avenue Subway (pictured, above), the first expansion project in nearly 60 years.

This special report on the centennial of the New York City subway system was prepared by the *Railway Age* staff: Editor William C. Vantuono, Executive Editor Marybeth Luczak, Senior Editorial Consultant Luther S. Miller, and Engineering Editor Tom Judge. Design by Simmons-Boardman Corporate Art Director Wendy Williams, with assistance from Art Production Manager Todd Blanchard and Associate Art Director Phil Desiere. We would like to acknowledge the following for their contributions or assistance: Roxanne Robertson, Director-Special Projects, and Miriam Tierney, Archivist, New York Transit Museum; Joseph Cunningham, engineering historian; and Robert Lobenstein, Systems Operations, Tracy Bowdwin, Department of Signals, Geoff Hubbs and Dr. Nabil Ghaly, New Technology Signals, and Charles Seaton, Public Affairs, MTA New York City Transit. Special thanks to Lawrence G. Reuter, President, MTA New York City Transit; Mysore Nagaraja, President, MTA Capital Construction; Randy Kennedy, The New York Times; and Joseph M. Calisi. Cover photo by Sandra Baker/Getty Images, 42nd Street subway.

MTA CAPITAL CONSTRUCTION



100 years of NYC subway



"Step in, and stand clear of the closing doors." Whether repeated by a carman or recorded voice, New Yorkers have been tuning out the same request for 100 years. But they haven't ignored MTA New York City Transit's subways, which—like food—they can't do without. About 4.5 million count on riding the 28 lines of the 600-route-mile system every day to get to and from work, school, and play.

"Ours is the most unique system in the world," says Lawrence G. Reuter, NYCT president, who notes that, unlike most other subways, NYCT has local and express tracks. They were built into the system a century ago. "We've combined three different systems—the IRT (Interborough Rapid Transit), BMT (Brooklyn-Manhattan Transit Co.), and IND (the Independent)—to make one relatively seamless transportation system."

Reuter is on his second tour of duty with the transit agency, having returned in 1996 after joining in 1982 and leaving in 1990 when he was senior vice president-operations, responsible for subways and buses. He's now heading up the largest subway system in the U.S.—carrying about 1.4 billion riders a year. Only Moscow, at 3.2 billion a year; Tokyo, at 2.6 billion; Seoul, at 1.5 billion; and Mexico City, at 1.5 billion, surpass it, according to the UITP (see chart, p. 4).

NYCT averages $2 billion a year in capital investments—the same as Union Pacific Railroad—and is the single-biggest market for suppliers of rail transit equipment and services. Since 1982, more than $39 billion has been poured into improvements to turn around a system that was near collapse. No longer are stations and cars decaying and coated with graffiti, or service disrupted regularly by mechanical failures.

Subways are now more accessible, stations artistically redesigned, communications systems updated for the 21st Century, cars replaced for better ride quality (p. 20), signaling systems modernized for safety and increased efficiency (p. 27), all the while maintenance-of-way occurs round-the-clock (p. 28). "When I gave speeches in the early 1980s, I used to mumble that I was from NYCT," says Reuter. "Now I'm pretty proud of what we're doing."

All the work—performed by some of NYCT's 48,000 employees while the subway operates on its demanding 24/7 schedule—is bringing the system the closest it's been to a state of good repair since opening on Oct. 27, 1904.

"Twenty years ago, our cars had a mean distance between failure (MDBF) of 6,000 miles—or a failure rate of about once a month," says Mysore Nagaraja, president of MTA Capital Construction, where he is charged with managing capital expansion, including federally funded projects to replace and improve tunnels and stations devastated by the 9/11 attack. "Today, MDBF is about 130,000 miles. As part of a major station rehabilitation program, we've rehabbed about 140 stations (out of approximately 490) so far. Track is in 100% state of good repair. We are about 50% there in signaling. The structures and all of the ancillary equipment like emergency fans are at 80% and pump rooms are at almost 90%."

"Ours is the most unique system in the world."

—Lawrence G. Reuter, President, NYCT (pictured above)

NYCT is rapidly moving forward on growth projects. Almost continuously modernizing and replacing its 6,464-car fleet, it awarded contracts for 660 new R160 cars to Alstom and Kawasaki in 2003. By 2008, options for another 1,040 could be exercised. In addition, new lines are in the pipeline to ease congestion—a $16.8 billion Second Avenue Subway from 125th Street to the financial district and a nearly $2 billion extension of the No. 7 line to the West Side. Capital improvement projects include the new $750 million Fulton Street Transit Center and $400 million South Ferry Station. Security—in the wake of the Madrid bombings—is tightening.

Moving ahead on projects isn't always straightforward due to battles over limited resources and conflicting agendas. "We're directed by our board and political influences," Reuter says. "But we're running full speed ahead to satisfy the needs of political constituencies and passengers."

It's no secret that political wranglings have been part of New York City's subways from the beginning. The IRT, BMT, and IND were designed to compete with one another, and even now,

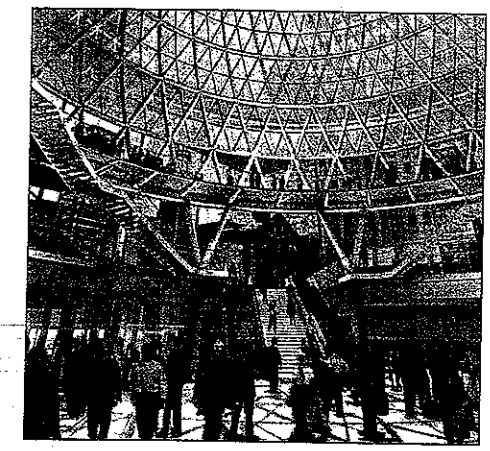
NYCT

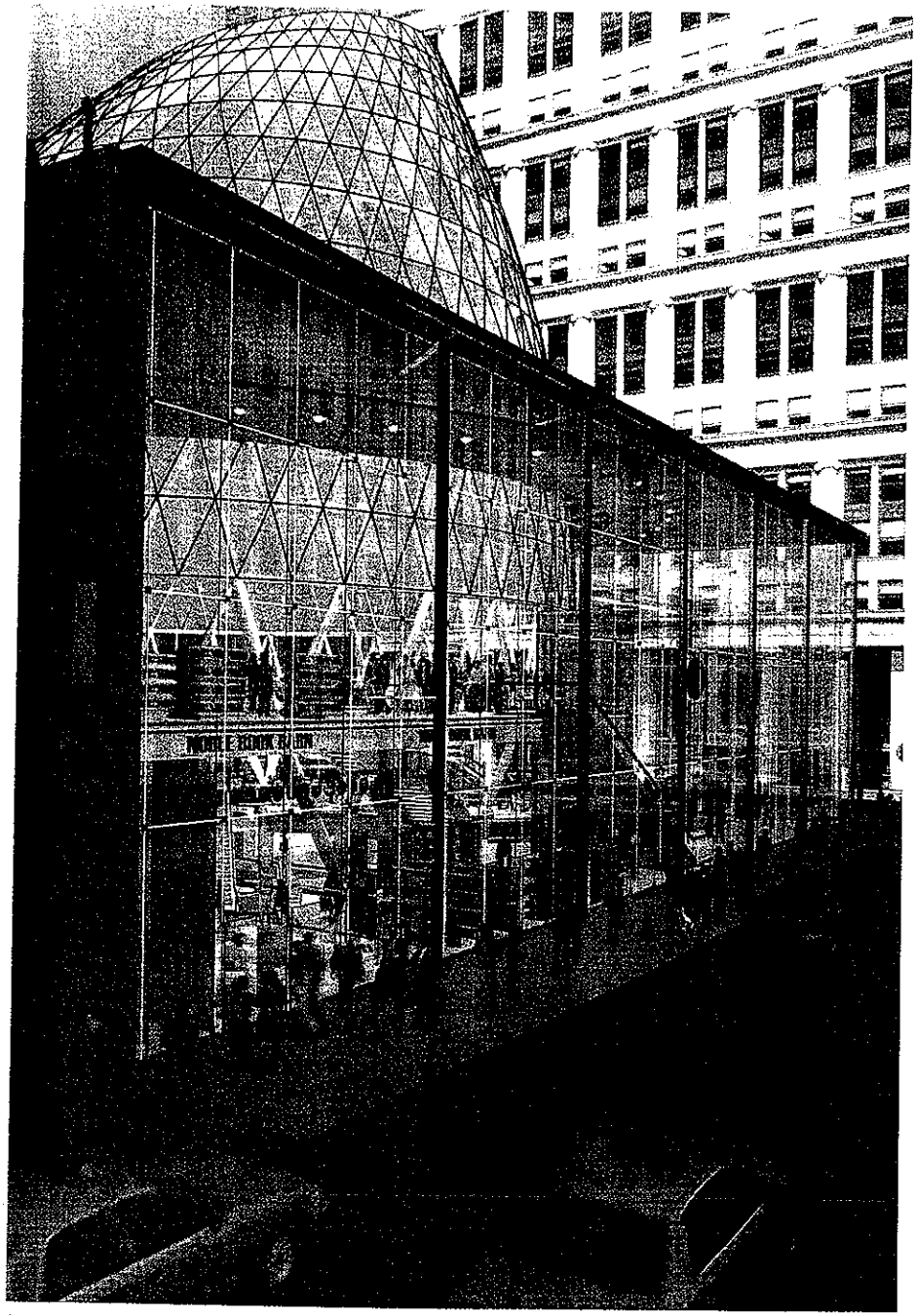
the subways' A Division—numbered lines formed from the IRT—and B Division—lettered lines stemming from the BMT and IND—remain separate and mostly incompatible, though they are linked.

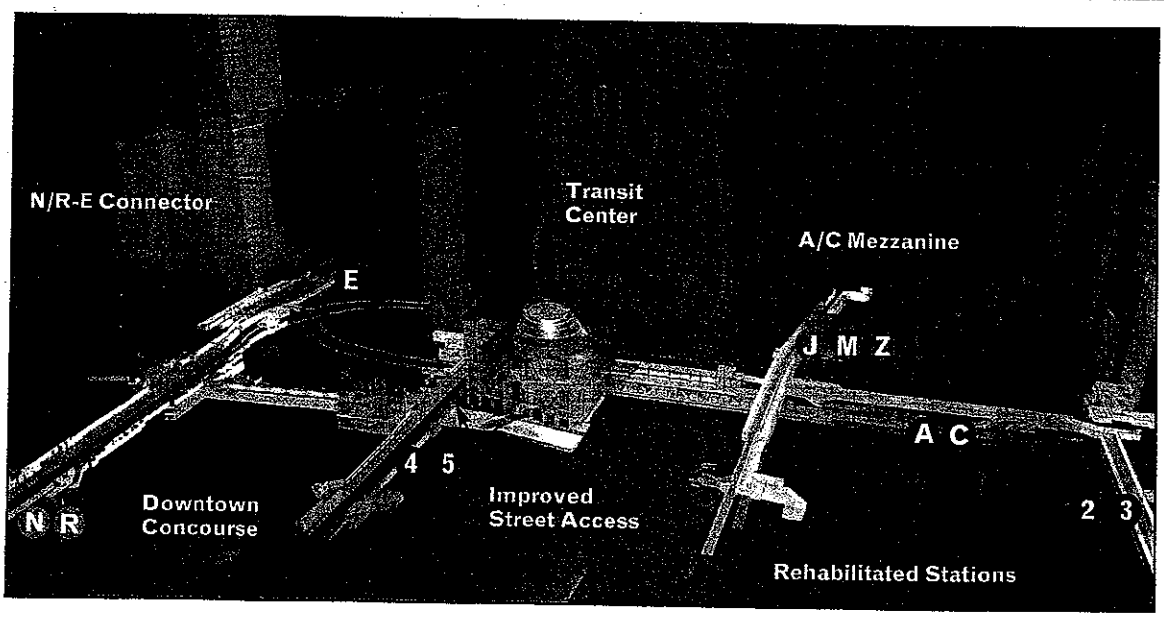
Among the projects on NYCT's priority list:

■ **Safety and security.** NYCT is an open system. "We have people walking into the system day in and day out, carrying briefcases, boxes, luggage," Reuter says. "So we always have to be diligent and vigilant and prepared. And we're making that happen." He cites two recent instances. "9/11 occurred right over our subway and we evacuated that morning with no serious injuries. It was a safe and total evacuation." About 1,000 feet of subway tunnel collapsed beneath the World Trade Center site, filling parts of the No. 1 and 9 lines with debris and water. Service to Manhattan's tip was halted due to the destruction of the Cortlandt Street Station and damage to the Rector Street Station.

"During the 14-hour blackout [on Aug. 14, 2003]—we were able to evacuate in just over one hour with no injuries or fatalities," Reuter continues. "This speaks to the training





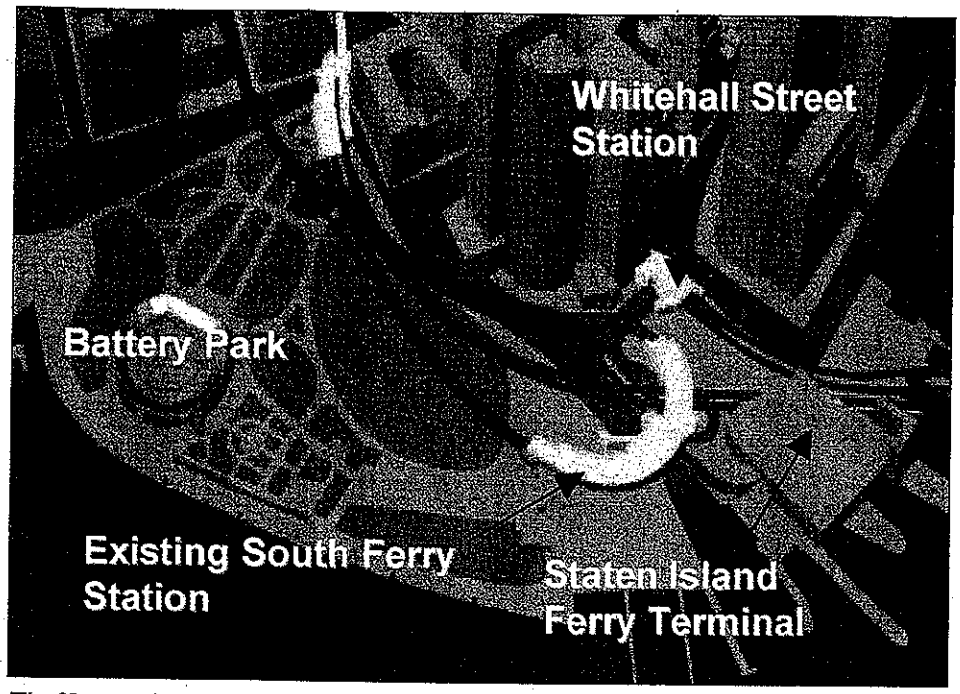


MTA CAPITAL CONSTRUCTION

Dubbed "the most complicated maze" in the city, the Fulton Street area will undergo a $750 million renovation. It will offer easier access to the 12 subway lines now situated in six separate stations (see diagram, left) through a main transit center designed by ARUP and Grimshaw Partners (pictured, above, and top left).

of our employees." The blackout halted 413 trains carrying 300,000-plus riders. Crews inspected hundreds of miles of track, thousands of signals, and hundreds of switches before service could resume.

While formal safety/security training programs have been in place since 1997, the focus has sharpened since 9/11. "We did an in-depth analysis identifying weaknesses and vulnerabilities, and then went about shoring them up," says Reuter. "We work very closely with the police to protect under-river tunnels as well as rooms and other areas in the subway system. There is a much greater police presence—police with dogs and detection devices for radioactivity. Our Access and Control effort is ensuring that we're locking up and securing places like towers, and we're inspecting them on a regular basis. There's also an internal effort by employees—our Eyes and Ears program. If employees see something suspicious, they are to report it to supervision. We have station announcements asking riders not to leave unattended packages in the station, and if they see them to report them immediately so that we can get the proper authorities to investigate."



The 98-year-old South Ferry Station is built on a curve as a single-loop track (pictured above), which slows operations. Planning is under way for a straight, two-track terminal that will allow all 10 cars to platform (instead of just five) and help reduce transit times for Staten Island commuters and Statue of Liberty and Ellis Island visitors.

MTA has earmarked $581 million for these and other system-wide security initiatives, which are overseen by Capital Construction. "We've identified 58 projects for prioritization," Nagaraja says, "and received approval to award consulting contracts, totaling $100 million." The consultants are Washington Group, Parsons Brinckerhoff, Parsons Transportation, Jacobs Engineering, and URS. "Hopefully, we'll get some additional funding from the Department of Homeland Security, because $581 million won't even cover half of the projects," he says.

■ **Second Avenue Subway.** MTA recently issued a request for proposals for building the Second Avenue Subway's first segment, from 96th Street to 63rd Street. "It will compete a dream that started some 50 years ago," Reuter says. When the Second Avenue Elevated was taken down in 1942, the Lexington Avenue subway lines (4/5/6) were left to accommodate the growing East Side population. In 1951, voters approved bonds for the Second Avenue project, and in 1956 the Third Avenue Elevated line in Manhattan was eliminated, in part, because the new line was to be built. About a decade later, construction started on a rail tunnel under the East River at 63rd Street and part of a subway line under Second Avenue. But the funds to complete the project evaporated.

"Our goal is to have the first segment operational by 2011," says Nagaraja. "On the first day of operation, we expect 202,000 people to ride this line—and they're already there. It will relieve crowding on the Lexington Avenue line, which is right now carrying 1.5 million people on a weekday." After all four phases are complete, ridership is expected to top 560,000 daily.

The full-length (8.5-mile), two-track, 16-station line will take 16

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Top subway systems in the world

Country	City	# of lines	Length of lines (miles)	Passengers/year (millions)
Russia	Moscow	11	433.18	3,200.00
Japan	Tokyo	13	424.44	2,600.00
Korea (South)	Seoul	8	464.78	1,537.75
Mexico	Mexico	11	326.25	1,396.41
U.S.	**New York**	**25**	**601.02**	**1,384.10**
France	Paris	16	341.82	1,283.30
United Kingdom	London	12	806.76	942.00
Japan	Osaka	7	186.30	931.00
Russia	St. Petersburg	4	159.73	818.54
China PR	Hong Kong	6	142.07	777.25
Brazil	Sao Paulo	4	93.31	696.26
Spain	Madrid	12	367.58	565.00

Source: Compilation of official sources and estimates of UITP.
Tokyo: figures for Tokyo Metro (previously TRTA), eight lines (plus one in construction) and TOEI metro (four lines) are estimated. Madrid: figures for 2003. Sao Paulo: figures for 2002. Hong Kong: figures for 2003 (including data for the airport express line). St Petersburg: figures for 2002. Osaka: figures estimated for the passengers carried. London: figures for 2002/2003. Paris: figures for 2003. New York: figures for 2003. Mexico: figures for 2002. Seoul: figures for 2003 incorporating the two companies SMRT and SMSC. Moscow: figures for 2002.

years to complete. The FTA New Starts share of the $16.8 billion price tag is estimated at $8.4 billion. Under its 2000-2004 capital plan, MTA has already allocated $1 billion for the first phase—which may cost some $3.8 billion. An FTA record of decision is expected this month, according to Nagaraja. "We have finished the planning report and the FTA has already approved the final environmental impact statement," he says.

■ **Fulton Street Transit Center.** Reuter has dubbed NYCT's subway complex around Fulton Street as "the most complicated maze" in the city—one that he uses daily on his way to and from work. The $750 million improvement project will "clean up the spaghetti mess of Fulton Street to make commuting easier for the 275,000 riders who pass through it every day," he says. It will incorporate into a single new Transit Center six existing lower Manhattan stations serving 12 subway lines. Three of the current stations bear the Fulton Street name. The others are Broadway-Nassau Street, Cortlandt Street, and Chambers Street-WTC. An underground shopping concourse—a "small Grand Central," says Reuter—will connect the 1/9 and N/R subways lines and PATH and the redeveloped World Trade Center site.

"Twenty years ago, our cars had a mean distance between failure of 6,000 miles, now it's about 130,000," and the subway is nearing 100% state of good repair.

—Mysore Nagaraja, President, MTA Capital Construction

"Right now, if you look at Fulton Street, you don't even know there is a subway complex there—it's difficult to figure out where it is," Nagaraja points out. "So what we're planning to do is, number one, have a presence, which will show the city that this complex is here." A new Transit Center at street and subsurface levels on Broadway between Fulton and John Streets will create a focal point for entry to the entire downtown subway system. ARUP and British architect Grimshaw Partners have designed a modern glass structure that allows sunlight to reach the platform level. "And, number two, we'll make transferring between subway lines easier," Nagaraja says. Because the lines were built at different times, by three different companies, "the connectivity is not there." Street access to various points within the complex will be added or improved, and existing stations will be rehabilitated and, in some cases, reconfigured to enhance connections.

The project will implement a "green" design strategy for energy conservation. "We will be putting in photovoltaic panels in the roof so that we can generate some electricity for the station complex," Nagaraja says, noting that the panels are already being installed with success in Coney Island's Stillwell Terminal, the Corona Maintenance Facility, and the Roosevelt/Jackson Heights station. (According to NYCT, the Roosevelt Station's panels transmit 35% of daylight while capturing a daily average of 57 kW of solar energy.) In addition, all contractors will be required to use ultra-low-sulphur fuel and have the latest low-emission engines for all construction equipment and vehicles they use that are above 60 hp. "We are going to be requiring contractors to control dust and noise also," Nagaraja says.

A contract was recently awarded to the joint venture of Parsons Brinckerhoff and Bovis Lend Lease to provide construction management services. Slated for completion in 2007, an EIS has been completed and submitted to the federal government.

Because construction will be under way on the World Trade Center site simultaneously, a meeting was held with all of the stakeholders to come up with "a common agenda so that we can work together," Nagaraja says. "We are looking at having a common staging area for materials, for instance." Work trains are another possibility, he adds.

■ **South Ferry Station.** The 98-year-old station, which is located beneath the Peter Minuit Plaza in Lower Manhattan and adjacent to Battery Park, serves as an intermodal link for subway, bus, and Staten Island Ferry service. Built on a curve as a single-loop track, it allows only the first five cars of a train to reach the platform, slows train operation, generates excessive noise, and limits train storage. Additionally, the required mechanical gap bridge plates are prone to breakdown, causing service delays.

Scheduled for completion by 2007, the new two-track station will be straight, allowing 10 subway cars to platform and reducing transit times for the Staten Island commuters and Statue of Liberty and Ellis Island visitors. The project also will accommodate more station entrances that are ADA-compliant, offer a new free transfer between the 1/9 and N/R subway lines at Whitehall Street, and retain existing track for storage.

The design is already complete, says Nagaraja, and "we've put out an RFP for the construction of the structural box."

■ **No. 7 line extension.** New York City Mayor Michael R. Bloomberg's $3 billion-plus West Side development project—including an extension of the No. 7 line from Times Square to 11th Avenue and 34th Street, expansion of the Jacob K. Javits

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Convention Center, and construction of a 75,000-seat football stadium for the New York Jets over the Long Island Rail Road's West Side Yard—is now in the works. The City of New York will finance the massive project—the subway extension alone could cost some $2 billion—which is expected to open up economic development opportunities and possibly advance the city's bid for the 2012 Olympics.

"When you take a look at it from a transportation and city planning perspective, extending the No. 7 line makes sense," says Reuter. "We could really use service to the West Side around the Javits Center." Now, public transportation near it is limited. And the new stadium could be used for the 2012 Summer Games.

The project is currently in the preliminary engineering and design phase, with Parsons Brinckerhoff as project designer.

"We're getting ready to award the first contract for extending the tunnel from Times Square to the Javits Center, and as soon as the city gives us the money, we're ready to proceed," Nagaraja says. "Our goal is to start construction early next year—before the Olympics Committee comes to New York City (in July 2005) to do a final evaluation. It should be completed by 2010."

■ **Communications systems.** NYCT is currently installing a new fiber-optic communication network. The new system, supplied by Siemens, will link to public address and ATS (Automatic Train Supervision) systems. ATS, part of an ongoing centralized dispatching program, will allow NYCT to track train movements, Nagaraja says. "Effectively, we'll have real-time information that we can provide to customers," he adds. Completion of the A Division is scheduled for year-end 2005; NYCT expects to award a B Division contract this year with completion planned in three to four years.

Once finished, the communication network could open up a variety of opportunities, including cell phone coverage in stations.

The 2005-2009 capital plan

MTA's upcoming five-year capital plan will identify state of good repair, normal replacement, and system expansion needs "at least as large as in the current (2000-2004) program," Katherine N. Lapp, MTA executive director and COO, told the New York State Legislative Fiscal Committee earlier this year. "These needs will present us with another set of financial challenges," she explained. "One such challenge will be maintaining the level of federal funds the MTA receives under TEA-21, which is up for reauthorization. We have been working closely with the Governor, the New York delegation, Congressional leaders, and the Administration, to increase that funding. Part of that effort has focused on securing New Start monies for East Side Access (bringing Long Island Rail Road trains into Metro-North's Grand Central Terminal) and Second Avenue Subway, but we have also focused an equal amount of attention—and rightly so—on formula funding, where we currently receive as much as $800 million a year for our capital program. And we will be seeking the necessary state and local support for the next capital program to ensure that the system's needs are met."

While the new program is "not completely fleshed out, there's a lot of meat on the bones," Reuter says, noting that a draft is expected in July and will go to Albany for approval in October.

The 2000-2004 capital plan was valued at $17.5 billion. NYCT's (subway and bus) portion accounted for about $10.2 bil-

lion, with $8.6 billion earmarked for rail improvements; $1.99 billion for new cars; $1.97 billion for station improvements; $1.35 billion for signals and communications; $809 million for track; $455 million for shops; and $441 million for yards.

Nagaraja estimates the new five-year plan will be valued at more than $20 billion, with the subway system garnering 65-70% of that or about $14 billion. Normally, Nagaraja says, the subway takes 80% of the NYCT budget, but because of the $800 million East Side Access project, that percentage has dropped slightly. Also included will be 60 to 80 station renovations and the exercise of an option to purchase about 1,040 more R-160 cars for the B Division from Alstom and Kawasaki.

On the move

NYCT posted ridership declines for full-year 2003 and January 2004. The subways carried 109.1 million riders in January, down from 115 million during the same period last year. In 2003, ridership fell to 1.384 billion from 1.413 billion in 2002. Reuter attributes the decrease, in part, to "residual effects of 9/11," which affected the economy overall. Another factor, he points out, was last year's fare hike from $1.50 a ride to $2.00. "Any time you increase fares, you see a short-term reduction in ridership," he says. "But we should see it come back in a year. Historically, it has come back and the economy is beginning to turn around."

Lapp told the New York City Council last year that "more and better service, along with the effects of inflation, mean our operating costs grow faster than ridership."

With incentives, the average fare is lower, though the one-day MetroCard pass increased from $4 to $7, the seven-day pass increased from $17 to $21, and the 30-day pass rose from $63 to $70. The average fare paid by customers rose from $1.04 to $1.30—lower than the $1.38 average (inflation adjusted) paid in 1995.

Reuter is credited with the successful implementation of the $700 million automated fair collection and MetroCard system, which was introduced in 1997. "We knew that revenue would take a hit, but it was a little more than we expected," he says. "At the time we decided to offer discounts, we were in the financial position to do it. Generally, more ridership is not enough to justify a discount, but we and the Board wanted to give something back to the riding public."

The next several years will continue to be a challenge, he says. "There is a $770 million deficit for all of MTA over the next year. And that should be increasing to a little over $1 billion in the next three years." Will a fare increase be considered? "Only as a last resort," he says.

Reuter and Nagaraja are optimistic about the future and point to building upon major accomplishments, like restoring 1/9 service within a year after 9/11. "These are exciting times," says Nagaraja.

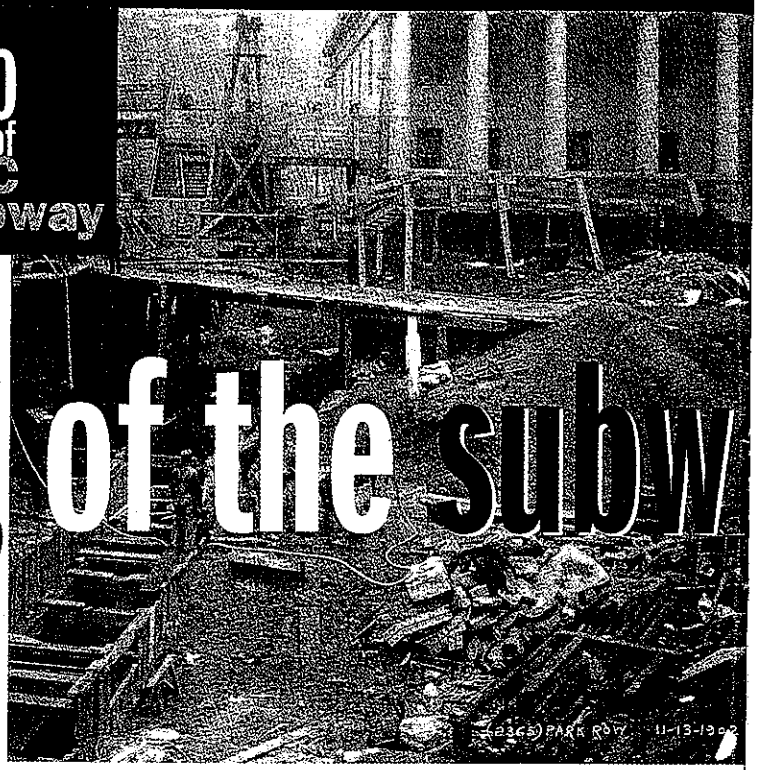
"It was the subway that took a New York that was choking on congestion and set in motion a dynamic that transformed it into a world-class economic powerhouse," Katherine Lapp has said. "Its health as well as the health of all parts of our regional transportation system, is as critically important to New York and the nation a century later. We can only hope that we will have the same vision, insight, and support to carry us into the next century."

100 years of NYC subway

"LET US MAKE NO MISTAKE ABOUT THE GREATNESS AND GRANDEUR OF THE UNDERTAKING..."

The coming of the subway

A history of the New York City subway as reported in the pages of *Railway Age* and *Railroad Gazette*.



***Railway Age*, Jan. 26, 1900**

The rapid transit problem on Manhattan Island will be pretty effectually solved by the completion of the underground railway, which is to carry passengers from the city hall to Harlem in fifteen minutes. The contract, which has just been awarded on a bid of $35,000,000, covers nearly 21 miles of tunnel and about 58 miles of tracks, of which 46 1/2 miles will be underground and about 11 1/2 miles elevated. There will be 43 local stations, five express stations and 10 station elevators, and 65,000 net tons of steel will be used in structures. The construction of this prodigious work in the short space of three years, as promised, will be a remarkable achievement.

***Railway Age*, May 23, 1902**

The Interborough Rapid Transit Company incorporated in Albany, N.Y., on May 6, with a capital of $25,000,000. The company are to operate the subway in New York City, and two routes are specified, one 14 and the other 7 miles in length. The terminals of the longer route are to be near the intersection of Broadway with Park Row, Manhattan, and a point near the present Kings Bridge Station of the New York & Putnam Railroad, Bronx Borough. Terminals for the other route are to be on the boulevard, near its intersection with One Hundred and Third Street, and near the intersection of Boston Road with Bronx Park, Bronx Borough.

***Railway Age*, Feb. 19, 1904**

The Interborough Rapid Transit Company of New York has just placed in service on its Second Avenue line an experimental all-steel coach of a type which it is proposed to use subsequently to a large extent in the subway, with such changes as tests of the present car may indicate to be desirable. The matter is of added interest, as the car in discussion is the one which was built at Altoona by the Pennsylvania last summer and fall, and which was designed primarily for use in the Pennsylvania-Manhattan tunnel. In the few days trial, the car has performed satisfactorily and 200 of similar construction have been ordered from the American Car & Foundry Company.

Above: The excavation of city streets during the construction of the subway weakened the foundation of many buildings located near the subway construction zone. Buildings were reinforced with wooden beams to shore them up. (112 Centre Street; 1901)

***Railway Age*, Sept. 9, 1904**

Without any blowing of trumpets, the Rapid Transit Subway Construction Company on Thursday, September 1, transferred the substantially completed underground railroad to the Interborough Rapid Transit Company.

***Railroad Gazette*, Sept. 16, 1904**

The quarter of a million passengers transported to the business district by the elevated and surface cars during the morning rush have been thus accounted for: 75,000 come down from above Twenty-third Street by the four elevated lines and 67,000 by the surface electric roads; 31,000 are brought from Long Island and Staten Island by the ferries, and 33,000 cross on Brooklyn Bridge cars to resume their journey in Manhattan Borough; New Jersey contributes 32,000, and 12,000 reach the Broadway and avenue cars by cross-town traction. Consider that 50 per cent of these passengers have to stand in the cars, enduring the greatest discomfort. To suppose that when the subway is running seats will be found for all

Italian artisans were hired to perform the tiling and mosaic work that adorned the subway. The dual mosaic tiling on the station walls served as a blueprint for the ornamentation of IRT stations. Using the tile work in the 28th Street station (above) as a model to work from, design changes and lettering were standardized. (28th Street and 4th Avenue; 1903)

ay to New York

Far left: Building is under way on the Lexington Avenue Line south of City Hall Station. (Park Row; 1902)

Left: Workers cover the subway tunnel as part of the cut and cover method. Metal girders along the width of the tunnel provided support for the street above. (42nd Street West of 5th Avenue; 1902)

who desire to ride is to be blindly optimistic. As for the surface cars, they will be as congested as ever, since they cannot handle long-haul traffic now and do not want it.

Though it be a foregone conclusion that the Rapid Transit Railroad of Manhattan Island and Bronx Borough, in view of constantly increasing traffic, will fail to solve for any considerable time the vexed problem, let us make no mistake about the greatness and grandeur of the undertaking, the difficulties to be overcome in building it, and the incalculable service it will render the community. In the course of the work, not less than 1,700,288 cubic yards of earth would have to be excavated, 773,093 to be filled back, 921,128 of rock to be excavated, and 368,600 to be tunneled. The steel to be used in construction was reckoned at 65,044 tons, the cast iron at 7,901, concrete 489,122 cu. yds., brick 18,519 cu. yds., and the water-proofing, 775,795.

***Railway Age*, Oct. 7, 1904**

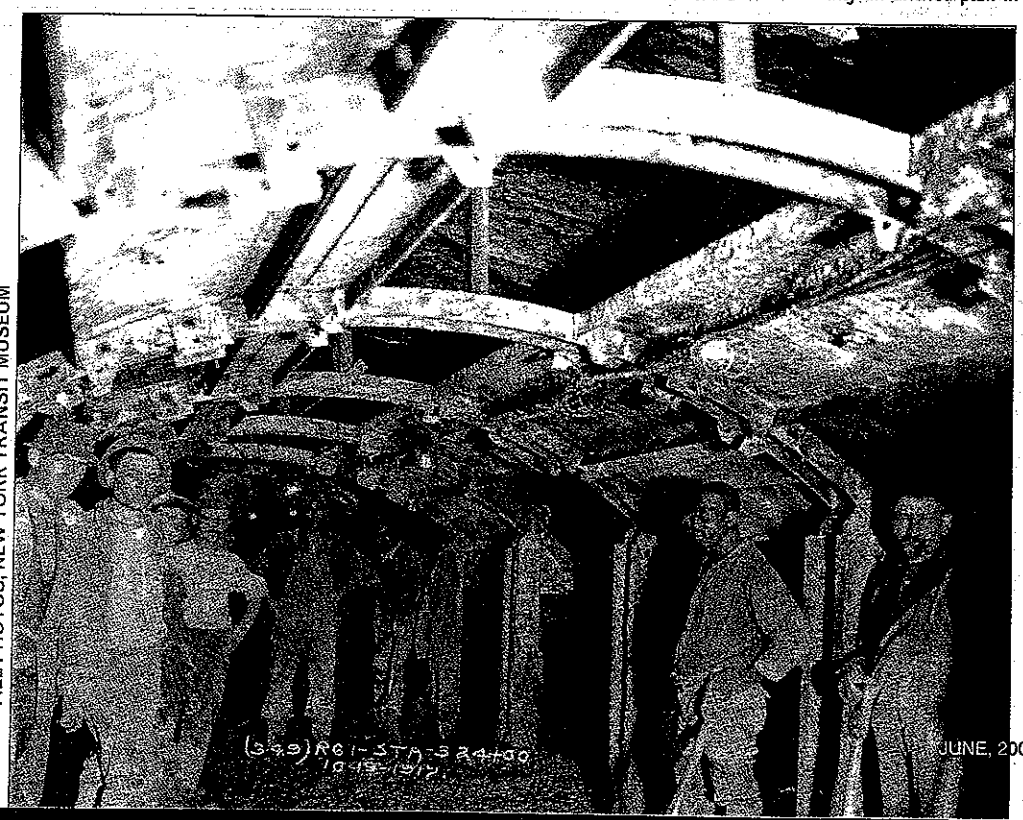
Monday afternoon, October 3, a train of six cars, electrically operated, made the fastest run to date in the New York subway, operated by the Interborough Rapid Transit Company. Over 100 representatives of the technical and daily press were the guests of Vice-President E.P. Bryan and General Manager Frank Hedley. The train consisted of two steel coaches. The 7 miles from the Brooklyn Bridge station to Ninety-sixth Street were covered in 10 minutes 45 seconds official time. Beyond the latter station, the train was slowed, by the time from City Hall to One Hundred and Forty-fifth Street was but 18 minutes, the distance being almost 9 miles. A speed of 45 miles per hour was reached on some stretches and the Grand Central Station was passed in 5 1/2 minutes from Brooklyn Bridge.

***Railroad Gazette*, Nov. 4, 1904**

The subway in New York City is now in actual operation and those who have watched its progress toward completion with many hopes and possibly with some misgivings can form some definite conclusions about its capacity, its sanitary conditions, and the success of the project in providing real rapid transit. Beginning Thursday evening, October 27, at seven o'clock, five hours after it had been formally opened, the subway from city hall to Broadway and 145th Street was thrown open for general use. The curious public swarmed into the station and crowded the trains to the utmost until late at night and the new road had a severe test. In the first five hours up to midnight, 111,881 tickets had been sold. On Friday, 24 hours, 319,000 tickets were sold; on Saturday, about 350,000, and on Sunday, 309,875. On Monday, the number of passengers carried dropped to about 240,000, and that is probably a fair estimate of the number of people who can be expected to use the new line regularly for the present.

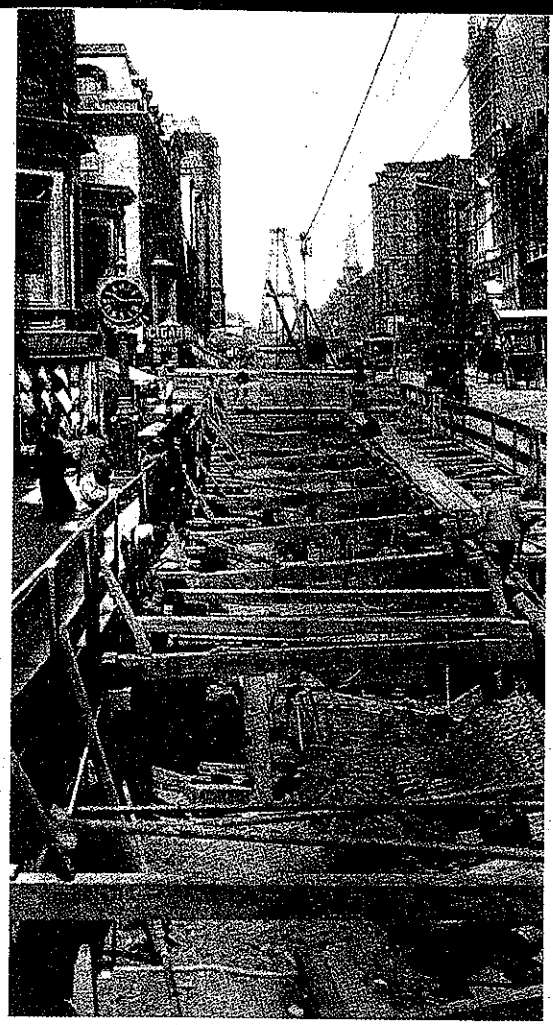
***Railway Age*, Nov. 4, 1904**

The opening of the New York subway a week ago has introduced an extremely interesting factor into the question of city transportation. It was substantially an untried plan in the United States, and even abroad scarcely is matched, for which reason it arouses an interest independent of its cost or engineering features, both of which are great, but which are lost sight of in the manifestations of public approval which already have followed the running of trains. The actual operation of subway trains at this moment makes the passenger situation a question of vivid interest, not only to New York City, but to every other large city in the world.



"Sand hogs" continue their work in the tunnel under Joralemon and Furman Streets. (60th Street Tunnel; 1919)

ALL PHOTOS: NEW YORK TRANSIT MUSEUM



Cut and cover construction was the principal excavation method used to build New York's subway. Workers peel back 42nd Street between Madison and Vanderbilt Avenue in the construction of a section of the original IRT subway line that would run from Grand Central Terminal to Times Square. (1902)

One of the major tasks was the relocation of water, sewer, and electrical lines to accommodate subway construction as this photo illustrates. (125th Street and Lexington Avenue; 1904)

***Railway Age Gazette*, Jan. 17, 1913**
The New York State Public Service Commission, First District, announces that both of the transportation companies which are to operate the dual system of rapid transit in New York City and contribute to the cost of construction of the new lines, have filed applications for the approval of bond issues needed to finance the project. The Interborough Rapid Transit Company proposes to issue bonds to the amount of $170,000,000. . . . The Brooklyn Rapid Transit Company, through the New York Municipal Railway Corporation, which was formed to enter into the proposed contract with the city, desires to issue $100,000,000. . . .

***Railway Age Gazette*, March 21, 1913**
After exasperating delays in the courts and elsewhere extending over more than two years, the New York State Public Service Commission First District, on Wednesday of this week signed contracts with the Interborough Rapid Transit Company and the Brooklyn Rapid Transit Company for the construction and operation of new subways, designed to complete the system of underground rapid transit in the boroughs of Manhattan, Bronx, Brooklyn, and Queens. The city government has appropriated $88,200,000 for this work, the estimated amount which will be necessary to pay for the share of the improvement which is to be paid for by the city.

1915: The Brooklyn Rapid Transit Company opened a new subway between Brooklyn and Manhattan.

***Railway Age*, Nov. 1, 1924**
The track mileage of the subways of the Interborough Rapid Transit Company is now 240, the car mileage for the fiscal year ending June 30, 1924, was 124,025,653, and 714,933,187 passengers were carried during that year.

1932: The Independent City Owned Rapid Transit Railroad began operating a third subway.

***Railway Age*, April 20, 1940**
Commenting on the purchase by the City of New York of the privately owned Brooklyn-Manhattan Transit Corporation and the Interborough Rapid Transit Company (municipal operation of which is scheduled within the next few months), an old Wall Street man, familiar with "tractions," wrote the following piece of lyric verse which appeared in the financial columns of the New York Sun: "Remember how they slammed us?/We were grasping and unfair./But now, thank God, our Mayor/Has the unions in his hair./They deplored the overcrowding,/Said our operations stunk;/All pleas for increased carfare/Were termed the merest bunk./But now they've bought this turkey/(Forgive us if we smile);/They'll probably raise the tariff/To fifteen cents a mile./Dear Fiorello, the system's thine,/From Van Cortlandt to Corona;/We've laid an egg right in your lap./We wish you joy as owner."

***Railway Age*, June 8, 1940**
The largest publicly owned transportation system in the country will be operated by the city of New York effective June 12, when unification of all intra-city rapid transit lines will be completed. After that date the municipality, through its Board of Transportation, will own and manage a $1,600,000,000 enterprise totaling 776 track-miles of rapid transit lines (subway, elevated and private way); 437 track-miles of street railways and 80 route-miles of urban bus lines, rivaling the gigantic system administered by the London Passenger Transport Board.

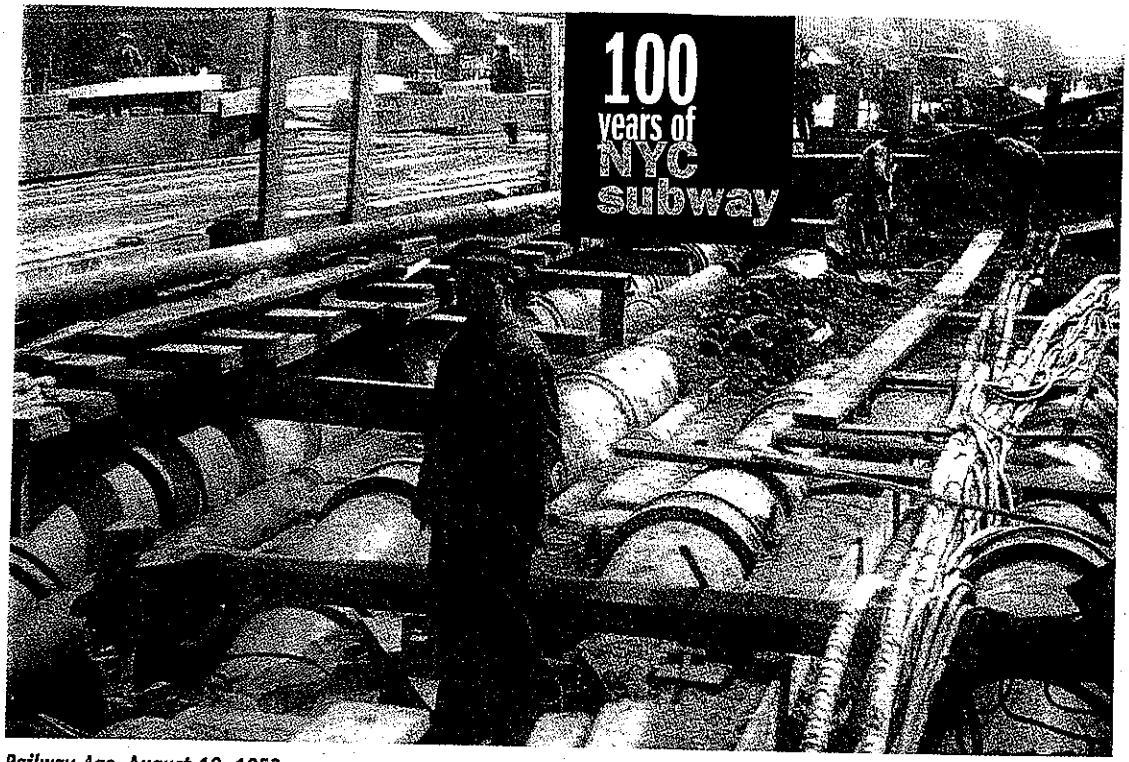
Dec. 23, 1946: New York City subways and elevated lines provided a standing record of rides: 8,872,244.

1948: After 44 years, fare rose from a nickel to a dime.

1953: The subway token was introduced.

Construction begins at 50th Street Station and Broadway. Workers break up the pavement to remove the first layer of many, in the complex job of cut and cover construction. Pick and shovel work in 1902 paid $1.50 for a 10-hour day.

ALL PHOTOS: NEW YORK TRANSIT MUSEUM



***Railway Age*, August 10, 1953**

A 50 per cent fare increase, from 10 to 15 cents, on New York City's publicly owned transit facilities, went into effect July 25. The increase was ordered by the city's new transit authority.

***Railway Age*, April 4, 1955**

Possibility of centralized control of all trains on the entire IRT division of the New York Transit Authority's subway system was indicated March 31 when the Union Switch & Signal Division of the Westinghouse Air Brake Company demonstrated to Transit Authority members a model of a machine designed for that purpose. The demonstration closely followed opening of the first section of a US&S-installed CTC system on the IRT's Flushing line.

***Railway Age*, Feb. 2, 1959**

The world's first regularly scheduled "crewless" trains may soon by running beneath the sidewalks of New York. The city's Transit Authority announced last week that it is exploring the possibility of converting 725 miles of running track in the subway system to completely automatic operation. It is now proposed to convert the Times Square-Grand Central Terminal shuttle subway line as a pilot automation project. This could be accomplished in less than a year at a cost of some $1,000,000, according to Transit Authority Chairman Charles L. Patterson.

***Railway Age*, Jan. 17, 1966**

Whatever else it may have done, New York City's subway strike has clearly shown just how valuable rail transit can be to the city. Most vivid demonstration is the Herculean job done by the Long Island, the New York Central, and other commuter railroads in handling overflow crowds of people who would normally ride to work by subway or bus. But some ingenious citizens are literally going 'round Robin Hood's barn to get to work by rail systems which they might never normally use.

***Railway Age*, Jan. 2/9, 1967**

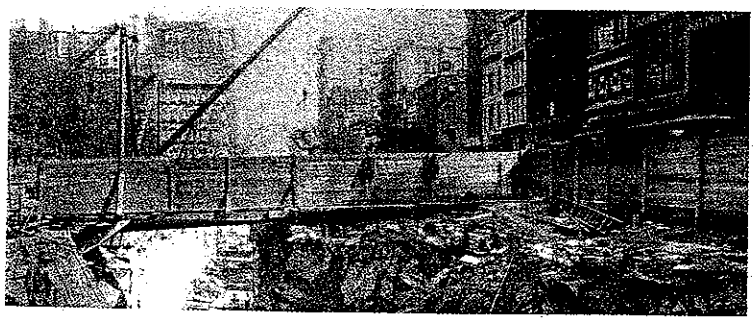
New York Governor Nelson Rockefeller said last week that he will ask the state legislature to approve a $2-billion "Highway-Mass Transportation-Capital Construction Bond Issue." He didn't disclose how the money would be divided—but he did say: "We must in the public interest make major capital investments in major mass transportation systems because the cost of building more super highways as an alternative would be prohibitive in money, land, and public convenience." A big chunk of the bond issue, an aide said, would go for new subway and commuter cars. Gov. Rockefeller also proposed a unification of New York City's mass transportation systems, bringing the Transit Authority and the Triborough Bridge and Tunnel Authority under the control of the Metropolitan Commuter Transportation Agency (which now operates the Long Island Rail Road).

***Railway Age*, Dec. 11, 1967**

New York City will have 600 new air-conditioned cars in operation by the end of 1969, Mayor John Lindsay disclosed last week. The decision to install air conditioning (at an estimated extra cost of $15 million) was reached after a testing period with a 10-car air-conditioned train. General Steel Industries is now working on an order for 400 new cars for New York's Transit Authority—and the last 200 of these, a spokesperson said last week, will have cooling units. New York installs an average of 200

Above, center: Electricians at 18th Street and 4th Avenue are working to reroute wires to accommodate subway construction. (1903)

Right: Lexington Avenue, south of Grand Central. Workers are excavating a portion of the No. 2 line just above the 14th Street Station. Note the use of a crane to pull out the rubble. (4th Avenue and 15th Street; 1901)

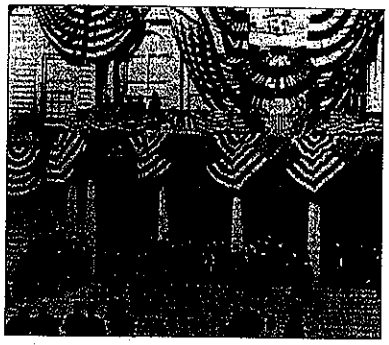


new cars a year—and all cars ordered through 1969 will be air-conditioned. There are 7,000 cars in the NYCTA fleet.

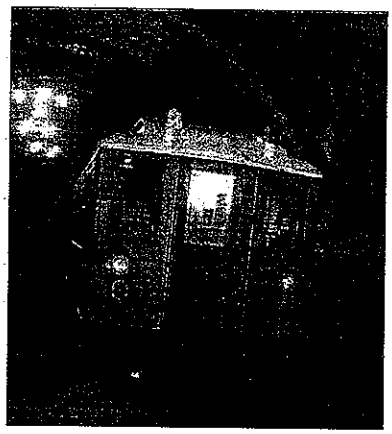
***Railway Age*, March 4, 1968**
New York may no longer be the world's biggest city, but in terms of transportation is it still a city of superlatives. On March 1, it became the home of the world's most powerful regional transport agency—the Metropolitan Transportation Authority. Two days earlier, MTA's chairman—Dr. William J. Ronan—unveiled the world's biggest urban-transport program, calling for $2.9 billion worth of rail-transit and commuter railroad improvements.

***Railway Age*, Nov. 11, 1974**
The New York City Transit Authority is now estimating a 1974 deficit of $325 million, some $38 million higher than earlier estimates, due primarily to a $36 million increase in electric power costs. And NYCTA is projecting a 1975 deficit of $422 million.

***Railway Age*, Aug. 11, 1975**
For 44 years, from 1904 to 1948, New Yorkers paid a nickel for a public transit ride. The fare rose to 10 cents in 1948, 15 cents in 1972—and on Sept. 1, 1975, it will go to 50 cents. In defense of this increase, which amounts to nearly 43%, Metropolitan Transportation Authority Chairman David Yunich observed, "When I came to New York in 1940, the subway fare was a nickel, and a loaf of bread cost 9 cents. Now a loaf of bread costs 69 cents and the fare is going to be 50. I think the relationship is pretty good."



On Oct. 27, 1904, the first subway operated by Interborough Rapid Transit opened. The 150,000 riders paid a nickel to ride from City Hall (below) to Harlem.

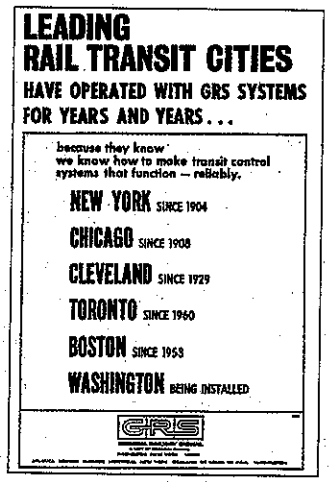


BOTTOM PHOTO: JOSEPH M. CALISI

***Railway Age*, May 12, 1980**
The nation's busiest passenger railroad. . .that operates mainly beneath the streets of New York was back in business April 11 after a crippling 11-day strike by the Transport Workers Union. For New Yorkers, the return of their trains marked the end of a crisis—one that brought them not to their knees but to their feet, as millions walked, bicycled, and even roller-skated to work. . . . In interviews with *Railway Age* Editor Luther S. Miller before and after the strike, NYCTA's senior executive officer and general manager, Steven Kauffman, talked about the TA's equipment shortage and plans for acquiring hundreds of millions of dollars worth of new and rebuilt cars this year; about a shortage of "knowledge workers" that he is trying to correct with a new manpower development program; about a long-range study that indicates the TA needs to spend $18 billion over the next 10 years to rebuild itself; and about a deepening financial crisis that tends to

Railway Age has for many years been the railroad magazine of choice for transit suppliers.

Historic advertisements from the pages of *Railway Age*: General Railway Signal (1976 ad, near right) and Okonite (1960 ad, center) were suppliers to the IRT in 1904. GRS, now Alstom Transport Information Solutions, is 100 years old this year. Vapor (1979 ad, far right), also 100 years old, still supplies door controls to NYCT. It's now a division of Wabtec Corp.



shove all other problems to the back burner.

***Railway Age*, January 1982**

For the 3,750,000 people who move into, out of, and all around the town each weekday on the subway and commuter trains of the New York MTA, the 1981 Christmas season brought uncommonly good tidings. On Dec. 23, MTA won final approval of a $7.9-billion capital improvement program that over the next five years promises to revolutionize the lifestyle of New York's huddled masses—who yearn not only to breathe free but also to get to work on time, neither of which is always possible under chaotic conditions that now prevail on the nation's largest (and most dilapidated) rail passenger system. The New York program is extraordinary in several ways. It calls for the largest car-acquisition program in the history of the American transit/commuter business—1,778 cars to be ordered over a relatively short time span at a total estimated cost of $2.25 billion.

***Railway Age*, May 1989**

After nearly 20 years of planning and construction, the New York City

Transit Authority's 63rd Street line is scheduled to enter service on Oct. 29. The 63rd Street line was conceived in the 1960s as part of a subway expansion program that was never completed. Construction on most of the new routes, including a Second Avenue subway, was halted during the fiscal crunch of the 1970s.

***Railway Age*, November 1995**
New York City Transit MetroCards are now accepted at 105 NYCT subway stations, and all 468 stations will be equipped for automatic fare collection (AFC) by the end of 1997.

***Railway Age*, June 1997**
Within a relative short span of 15 years—short for a system approaching 100 years in age—New York City's subways have undergone a rebirth, thanks to the infusion of billions in capital dollars. The New York MTA's continuing efforts to modernize the city's massive rapid transit network will take another step forward when construction begins this year on a fleet of what will be New York City Transit's most technologically advanced subway car to date: the R142, 1,080 of which will be in service on the A Division (former IRT, the number-designated lines) by the turn of the century. The sleek, smooth-sided stainless steel cars will be outfitted with a host of features that the MTA says will make them the most modern, rider-friendly of its 6,000-plus subway cars. The price tag is steep, $1.45 billion (excluding options for additional cars), but considering that the MTA was expecting to procure 740 cars at the outset, it could be a bargain. The order is split between two builders: Bombardier, which got the lion's share—680 cars—and Kawasaki, which will construct the remaining 400 cars.

***Railway Age*, March 1999**
East Side, West Side, all around the town there's talk of building new rail

100 years of NYC subway

For 44 years, from 1904 to 1948, New Yorkers paid a nickel for a ride. The fare rose to 10 cents in 1948, 15 cents in 1972, and in 1975, it went to 50 cents. "When I came to New York in 1940, the subway fare was a nickel and a loaf of bread cost 9 cents. Now a loaf of bread costs 69 cents and the fare is going to be 50. I think the relationship is pretty good," said former MTA Chairman David Yunich. Today, a one-way ride costs $2.00.

lines beneath the streets of New York. Both City Hall and the Regional Plan Association (RTA) have come out with plans for extending the MTA New York City Transit subway system. But they are miles apart on where the new lines should be located. The RTA, a tri-state (New York, Connecticut, and New Jersey) group that advises on transportation matters, wants to beef up the existing line on the East Side of Manhattan with extensions to Queens, Brooklyn, and the Bronx. New York City Mayor Guiliani has in mind a West Side addition to the subway. His plan is to extend the

No. 7 line from Times Square at 7th Avenue west to 11th Street, then south through a tunnel already in place to a domed sports arena that he wants to build over the Long Island Rail Road yard at West 33rd Street.

***Railway Age*, September 1999**
The New York MTA will conduct a hearing in September on four different plans to ease congestion on its East Side trains and buses. A plan with considerable support at the MTA calls for construction of a new subway line along Second Avenue from 125th Street to 63rd Street, connecting with existing N and R trains that run to the south of Manhattan. The new line would cost about $3.6 billion and take 10 years to build. Running the new line the whole length of Second Avenue has been ruled out since it would cost an additional $4 billion or more.

"On Dec. 23, 1981, MTA won final approval of a $7.9 billion capital improvement program that over the next five years promised to revolutionize the lifestyle of New York's huddled masses, who yearned not only to breathe free but also to get to work on time, neither of which was possible under chaotic conditions that now prevail on the nation's largest (and most dilapidated) rail passenger system."
—*RA*, January 1982

***Railway Age*, June 2000**
Train operators at the controls of new R143 subway cars on MTA New York City Transit's Canarsie Line in mid-2004 will have a new interlocking home signal aspect: a flashing green indication at the top of the signal head. It means the train is running under communications-based train control. The 23-track-mile Canarsie Line project is the basis for a long-term, total conversion of NYCT's traditional automatic-block signaling system to CBTC. Total conversion, which will require resignaling of more than 800 track-miles and equipping of around 6,000 subway cars, will take place gradually over 30 or 40 years, and will cost in the neighborhood of $3 billion, in today's dollars. But given CBTC's benefits—improved safety, greater train throughput, lower life-cycle costs—the investment will be well worth it.

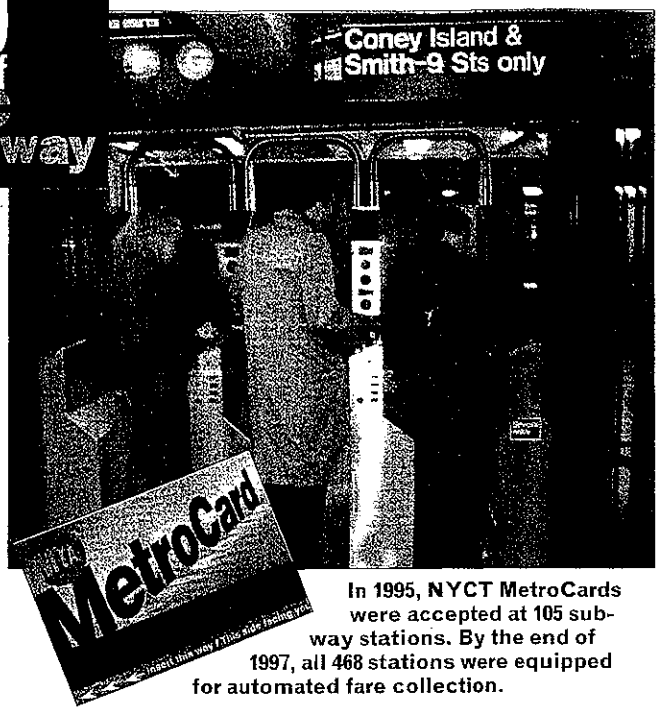
100 years of NYC subway

***Railway Age*, October 2001**

Railroad reaction to the terrorist acts of Sept. 11 in New York City and Washington, D.C., came swiftly, in the form of heightened security and an outpouring of compassion and offers to help those affected by the disaster. In New York at "Ground Zero," where the World Trade Center's 110-story twin towers once stood, there was a direct and devastating effect on one of the country's busiest rail commuter/rapid transit hubs. Beneath and around the WTC lay a complex of Port Authority Trans-Hudson (PATH) and MTA New York City Transit rail tunnels. . . . Parts of [NYCT's] No. 1 and No. 9 lines were choked with debris and awash in water, and 1,000 feet of subway tunnel collapsed. The Cortlandt Street station was destroyed and the Rector Street station was damaged, shutting down service to Manhattan's southern tip. No NYCT employees or customers were lost or injured on trains and buses operating in the area at the time of the attack. Experts said it could take years to restore service on the 1 and 9 lines. Stations on other lines near the WTC sustained damage but should be returned to service within a few months.

***Railway Age*, June 2003**

New York subway riders have not had a fare increase in nearly a decade, and for several months they knew the inevitable was going to happen. That did not prevent them when the fateful day arrived from registering surprise and indignation. The plan unveiled by MTA Chairman Peter S. Kalikow on March 6 increased NYCT's subway and bus fares from $1.50 to $2.00, the nation's highest basic transit fare. On the plus side, Kalikow promised there would be no service cuts or layoffs—a matter very close to the hearts of New Yorkers—"no full-time token booth closings and no more than 62 part-time closings." With incentives, the average fare would be lower, though the seven-day MetroCard pass would increase from $17 to $21, the one-day pass from $4 to $7, and the 30-day pass from $63 to $70. The costliest pass would provide the cheapest average fares in a city whose legions of poor may find it impossible or imprudent to invest $70 in a single farecard.



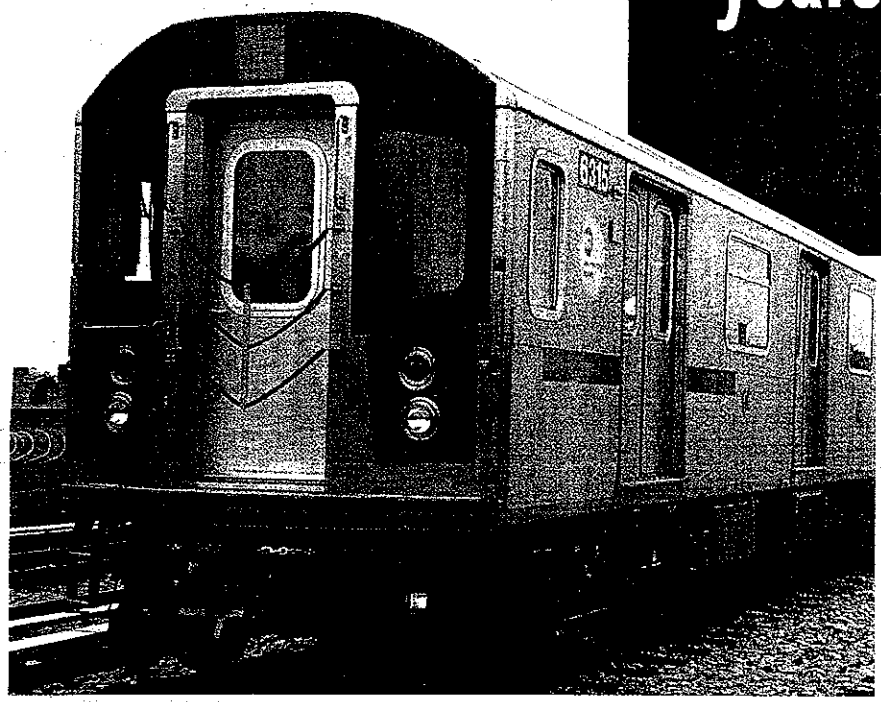
JOSEPH M. CALISI

In 1995, NYCT MetroCards were accepted at 105 subway stations. By the end of 1997, all 468 stations were equipped for automated fare collection.

2003: NYCT discontinues the use of tokens on subways and buses.

100 years of

One of NYCT's newest cars—Kawasaki's R142A—cost about 60 times that of the first R-series built in 1930 and 1931 for just under $40,000 each.

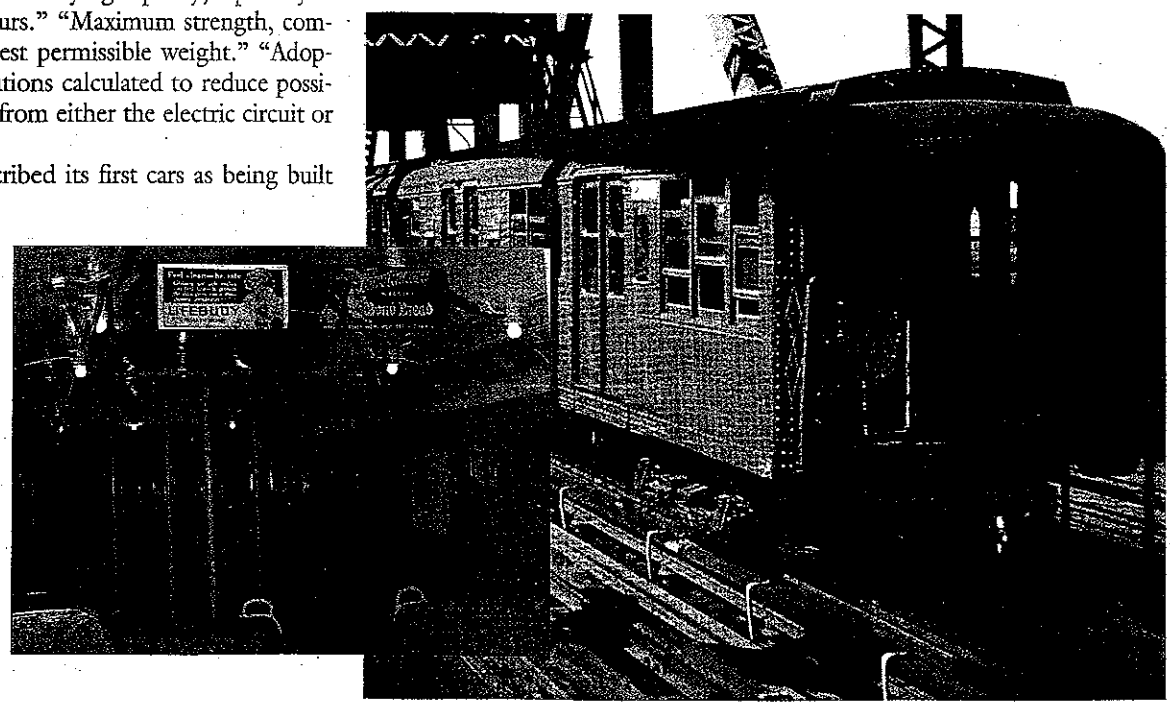


NYCT

One hundred years after the first "Composite" (steel framed, wood bodied) subway cars began rolling through the tunnels of the Interborough Rapid Transit, their high-tech successors are operating under similar criteria, as set by the IRT: "High schedule speeds with frequent stops." "Maximum carrying capacity, especially at times of rush hours." "Maximum strength, combined with smallest permissible weight." "Adoption of all precautions calculated to reduce possibility of damage from either the electric circuit or from collisions."

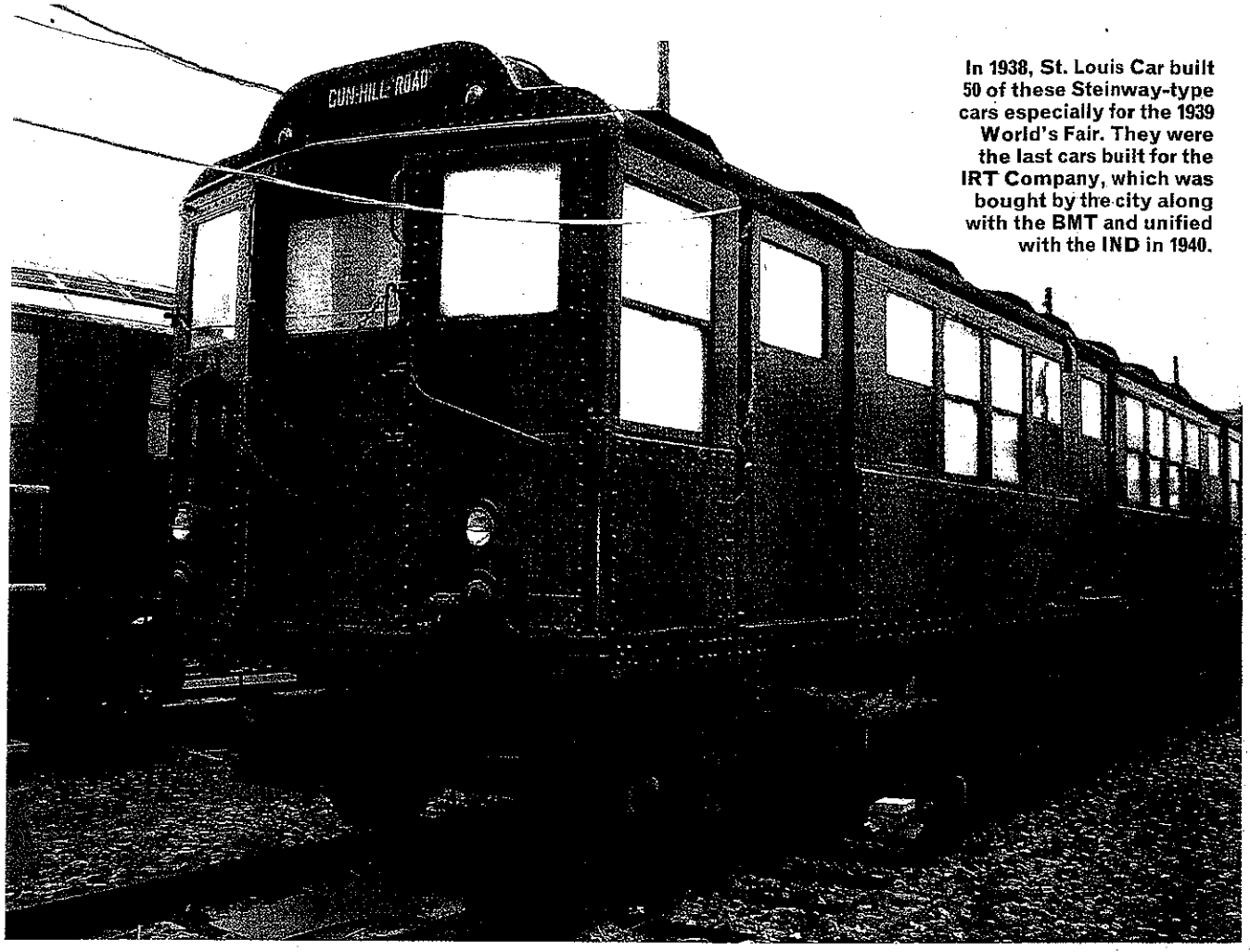
The IRT described its first cars as being built to satisfy "motive power requirements which were unprecedented in any existing railway service, either steam or electric. . . . [E]xacting schedule conditions . . . necessitated the design of cars, trucks, etc., of equivalent strength to that found in steam railroad car and locomotive construction, so that while it was essential to keep down the weight of the train and individual cars to a minimum, owing to frequent stops, it was equally as essential to provide the strongest and most substantial type of car construction throughout."

Legendary consulting engineer George Gibbs (who later founded Gibbs & Hill, a predecessor of today's Washington Group), had a monumental task when he set out to design and procure New York's first subway cars. Gibbs wanted an all-steel car, which had never been attempted, but no builder was willing to take the risk. Thus, in 1902, the IRT, rapidly moving forward on subway construction, awarded contracts for 500 Composites to four builders—Jewett,



BMT "Standard" cars, 150 of which were built between 1914 and 1924, were longer and wider than their IRT counterparts. They introduced destination roll signs, pneumatic center doors, and single conductor operation on an eight-car train.

COLLECTION OF JOSEPH M. CALISI/INSET BY MARYBETH LUCZAK

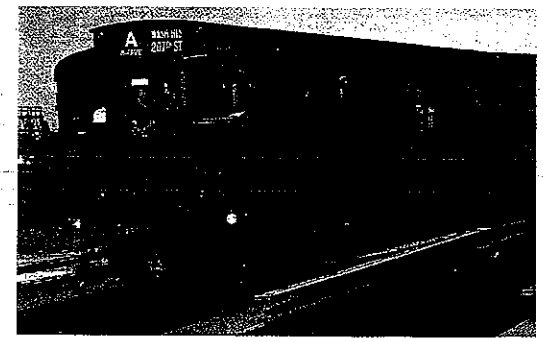


In 1938, St. Louis Car built 50 of these Steinway-type cars especially for the 1939 World's Fair. They were the last cars built for the IRT Company, which was bought by the city along with the BMT and unified with the IND in 1940.

BOTH PHOTOS BY JOSEPH M. CALISI

St. Louis Car, Stephenson, and Wason Manufacturing.

Nevertheless, Gibbs persisted in his search for steel. He enlisted the aid of Pennsylvania Railroad President Alexander J. Cassatt (one of his principal clients) to engage the railroad's Altoona Shops in designing and building two prototype all-steel cars. The first car was too heavy, but the design of the second was able to meet the IRT's groundbreaking criteria. In late 1903, a contract was awarded to American Car & Foundry (today's ACF Industries) for 200 of what are now recognized as the world's first all-steel railway passenger cars.



The R1-R9 series (R9 pictured) were built between 1930 and 1940. They were the first cars procured by the IND. The R stands for "Revenue Contract," a designation still used today.

During its first 75 years, New York's transit system purchased 11,655 cars from St. Louis Car (4,263), ACF (3,647), Pullman Standard (2,226, including 754 R-46s in 1972, at the time the largest passenger car order in U.S. history), Budd (611), Pressed Steel (872), Standard Steel (40), and Clark (6). Only two of these companies (ACF and Standard Steel) survive, but not as passenger car builders. Others, from origins considered unlikely 25 years ago, have taken their place.

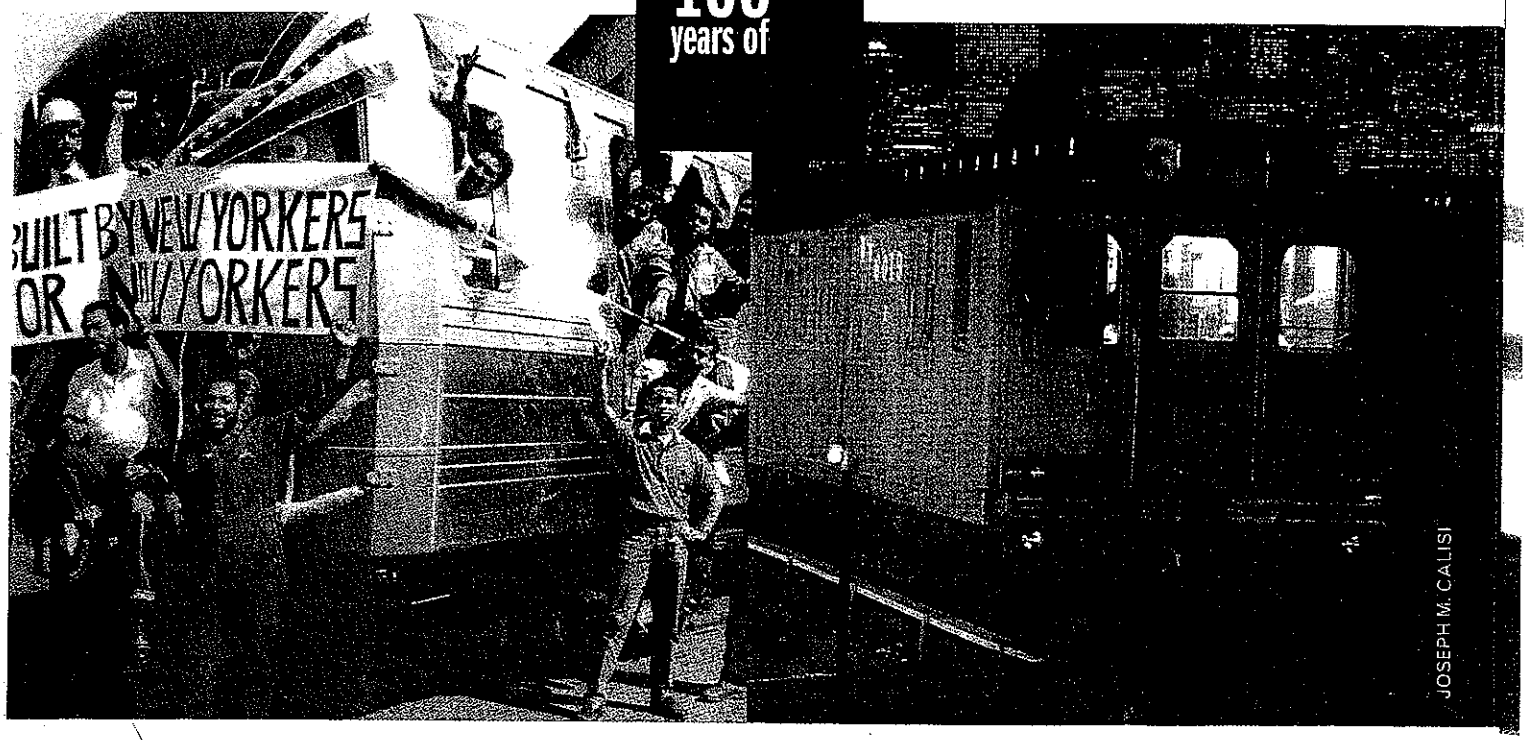
"The New York City Transit Authority now faces the prospect of having to go overseas for competitive bids," *Railway Age* reported in June 1979, just prior to the start of the subway's great renaissance in the 1980s. Over $280.5 million in capital had been earmarked by New York State for purchase of 250 new cars and rehabilitation of 280. A few years later, Japan's Kawasaki, followed by Canada's Bombardier, became the first non-U.S.-based carbuilders for NYC Transit with the R62 and R62A series, respectively.

Other than an order of 425 R68 cars from the French-based Westinghouse/Amrail consortium in 1986, Kawasaki and Bombardier have been NYCT's principal carbuilders over the past 20 years. Kawasaki and Alstom, the newest player in New York's demanding subway car procurement game, are sharing responsibility for building up to 1,700 (with options) R160s—once again, the largest passenger car order in U.S. history.

Through 100 years, there have been literally dozens of subway car types, from a wide variety of builders. Among the more notable:

■ BMT "Standard" cars, 950 of which were built between 1914 and 1924 by ACF and Pressed Steel. They represented a radical departure in subway car design, as they were longer (67 feet) and wider (10 feet) than their IRT counterparts. The Standards introduced destination roll signs, pneumatic center doors,

100 years of



Left: Workers and managers at the ANF-NEMKO Assembly and Testing Plant in the Brooklyn Navy Yard celebrate the completion of the last R68 subway car built under contract to Westinghouse-Amrail in 1988. Under the joint venture, a cooperative effort of Westinghouse and the major French manufacturers ANF Industrie and Alsthom, Inc., the R68 became the first subway car to be built in New York City with New York City labor.

Right: Vintage D-Types at Smith-96th Street, on an excursion run sponsored by the New York Transit Museum.

and single-conductor operation on an eight-car train.

■ BMT D-Type "Triplex," 121 sets (363 cars) of which were built by Pressed Steel in 1927. The 137-foot-long articulated D-Types introduced illuminated destination signs and color-coded car-end numbers.

■ R1-R9 series, 1,703 of which were built by ACF, Pullman Standard, and Pressed Steel between 1930 and 1940. These were the first cars procured by the city-owned and -operated IND. The R stands for "Revenue Contract," a designation still used today.

■ R11 Prototype. The Budd Company built only one 10-car trainset in 1949 for the (still unbuilt 55 years later) Second Avenue Subway. The R11 featured a shot-welded stainless steel carbody, porthole windows, a public address system, crank-operated windows, and an air filtration system equipped with electrostatic dust filters and ultraviolet germ-killing lamps. The New York Times called the $100,000 R-11 "the car of tomorrow." The 10 cars were rebuilt into R34s in 1964.

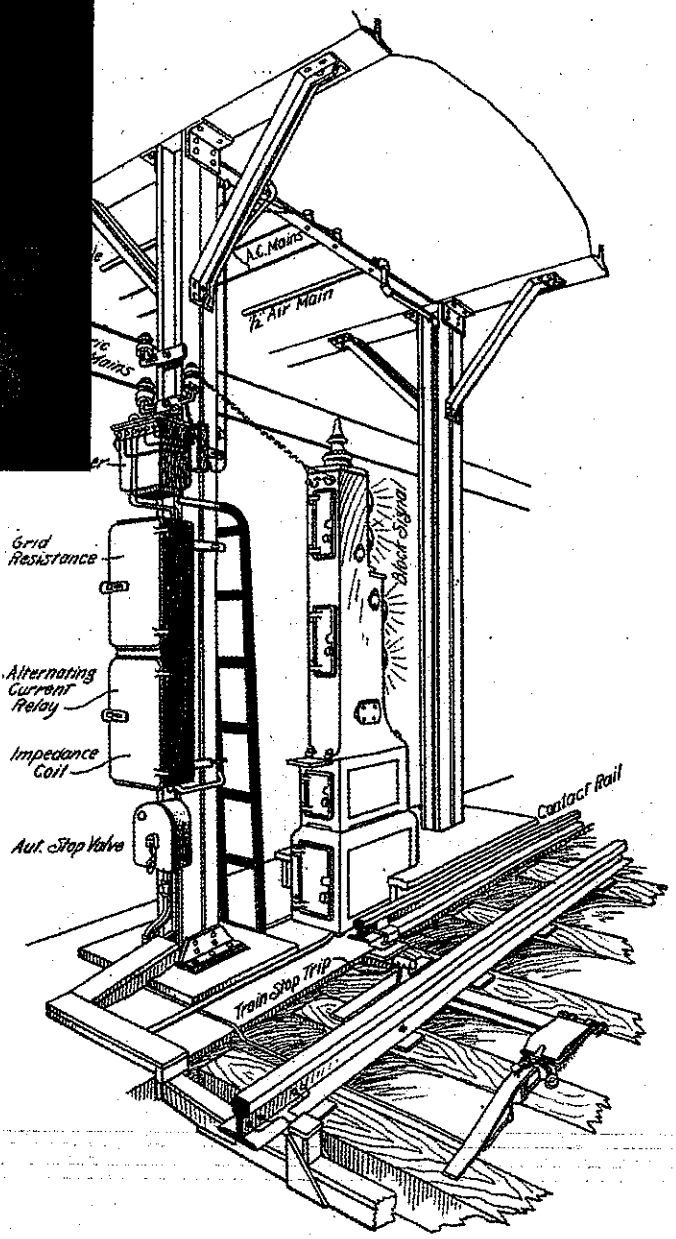
■ R40, 400 of which were built by St. Louis Car 1968-69. These Raymond Loewy-designed cars introduced air conditioning, semi-automatic door controls, and composition (as opposed to cast iron) brake shoes. Three hundred were originally constructed with sloped noses at the No. 1 end of each married pair.

■ R44. St. Louis Car built 300 of these from 1971-72. At 75 feet, they were 15 feet longer than their R1-R42 predecessors (and were similar in appearance to the 85-foot MU cars used on the Long Island Rail Road and Metro-North). They were the first cars equipped with ATO (automatic train operation) hardware. The last cars built by St. Louis Car, the R44s also hold the NYCT speed record, 87.75 mph.

■ New Technology Test Trains R110A (Kawasaki) and R110B (Bombardier). These prototypes, delivered in 1992, introduced such high-tech features as a.c. propulsion with regenerative braking, microprocessor-controlled doors and brakes, roof-mounted HVAC, fabricated trucks, computerized station announcements, and electronic strip maps. The R110s established technical, operational, and design criteria for the newest generation of NYCT subway cars, the R142, R142A, R143, and the soon-to-come R160.

NYCT's newest cars cost approximately 60 times that of the first R-series car, the R1, 300 of which were built for the IND between 1930 and 1931 by ACF for just under $40,000 each. They have an MDBF (mean distance between failure) of about 130,000 miles, which means they break down about once every two years. With that kind of reliability in an environment as demanding as the subway, New Yorkers are certainly getting their money's worth.

100 years of subway signals



The IRT signal head at top left is from US&S's 1904 automatic block and interlocking signal system (above), one of the most ambitious of its type. It used a modified version of railroad-type "AAR aspect" automatic block semaphore signals.

TOP LEFT: ROBERT LOBENSTEIN COLLECTION

TOP RIGHT: RAILWAY AGE

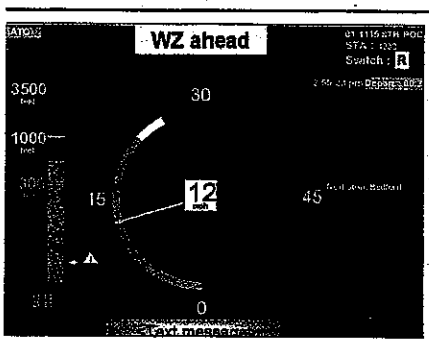
If there is one word that accurately describes signaling and train control at New York City Transit, it is this: awesome.

A Department of Signals staff of 1,172 operates and maintains, with a budget exceeding $100 million, a complex system to ensure the safe movement, every day, of nearly 6,700 trains carrying more than four million passengers over an 856-track-mile (600 route-mile) network. The equipment: 11,646 track circuits; 11,000 automatic train stops ("trip stops," many of which have been converted to all-electric operation from electro-pneumatic); 17,282 insulated joints; 198 interlockings (70% all-relay, 30% electro-mechanical or electro-pneumatic, one solid-state test installation); 327,156 relays; 12,080 wayside signals; 2,514 turnouts; 642 instrumentation rooms; 795 power control networks; 26 master towers; 361 storage batteries; 150 compressed-air supplies; 526 train annunciators; 285 smoke and fire detectors; and 26 wheel detectors.

That's not including a pilot communications-based train control system scheduled to enter revenue service on the Canarsie (L) Line by early 2005.

Regardless of the technology, New York's subways have dealt with the same challenge since 1904. A Railway Signal Engineer article in 1916 (p. 51) described the Interborough Rapid Transit's efforts to accomplish train spacing on 90-second headways:

"The extraordinary growth of traffic on the subway and elevated lines in New York City has given rise to many engineering problems of the first magnitude. Among them is the problem of providing a signaling system adequate to meet the unusual traffic conditions, not only as they exist at the time of the installation, but also to provide for conditions which will probably come up in the future, due to increases in traffic. In order to determine the probable future requirements, a considerable amount of engineering work is necessary. The tendency has been constantly toward longer trains, higher speed, and closer headway, or toward the maximum efficiency consistent with safe operation."



By June 2005, if all goes as planned, CBTC technology from Siemens Transportation Systems will have new Kawasaki-built R143 cars operating in ATO (Automatic Train Operation) mode with one-person crews on the entire Canarsie Line. Pictured is a CBTC train operator's display.

Indeed, little has changed in 100 years.

The history of signaling and train control on New York's subways is in many ways a history of railway signaling as a whole. "There's been a lot of 'cross-pollination' of railroad and transit signaling in New York," says Joseph Cunningham, a local engineering historian. For example, the Union Switch &

100 years of subway signals

The subway's first CTC installation occurred in 1948 on the A line at Euclid Avenue in 1948. GRS supplied its NX (eNtrance-eXit) system. Lower right: US&S supplied its UR (Union Route) CTC equipment for the 96th Street interlocking.

Signal automatic block and interlocking system employed on the IRT in 1904 used a modified version of railroad-type "AAR aspect" (then, American Railway Association) automatic-block semaphore signals.

The first IRT signal heads consisted of a cast-iron case fitted with two electrically-lit clear lenses, the upper for the home signal, the lower for the distant signal. In place of semaphores, which could not be used because of tunnel clearances, pneumatically-controlled colored filters that emulated semaphore color discs were used to change signal aspects. Trip stops automatically applied the air brakes on a train that passed a stop indication. The original electro-pneumatic signals were converted by 1920 to all-electric color-light signals, which are still in use. Initially, signals were employed only at interlockings, places of limited visibility, and express tracks (the first such transit installation).

There have been numerous technological innovations over the years. Some worked, some didn't.

With the advent of longer, electro-pneumatically-braked trains, which permitted operation on closer headways, the IRT in April 1909 first employed "station-time approach signaling," at 96th Street and Broadway. In July 1914, the BMT (Brook-

Maintaining a 24/7 operation

JOSEPH M. CALISI

Maintaining 699 main line and 157 yard track-miles, plus 1,784 main line and 878 yard turnouts—all under heavy train traffic—means NYCT's track people have their work cut out for them. To keep the track infrastructure safe and smooth, there are 2,700 employees in track and power distribution.

"We have two budgets," says Al Wojcik, chief officer of track and infrastructure. "The operating budget, which takes care of normal maintenance activities, is $116 million a year. On the capital side, in 2003, we spent about $150 million." In a typical year, NYCT spends about $7 million for special trackwork and $5 million on rail, for material alone.

NYCT has to make the most of scarce track windows. "We have nightly general orders where we only get a five-hour track outage, which gives us about four hours of useful time," Wojcik says. "We're really starting to pick up production on weekend general orders, where we get the track for 53 hours. On the 450 miles we have in the subway, we are pretty much limited to working at night due to train frequency. Even then, it's a 24-hour system, so most of our maintenance work is done under traffic. The capital construction portion is separated out, and we get the track outages under general orders. It's pretty tough because of the amount of work we're doing, as well as all the other capital work that's going on, such as signal rehabilitation, fan plants, and pump rooms."

"The biggest problem we have is corrosion, due to the constant infiltration of water into the subway tunnels," Wojcik says. "At the slightest hint of corrosion, rails are changed out. That alone accounts for about 1,000 pieces of rail a year. We have two grouting teams that plug water leaks—about 5,000 spots a year."

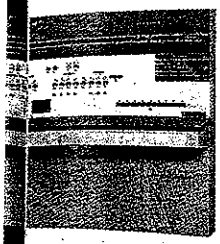
NYCT has had a problem with rail cracking. In some curve areas, rail must be replaced long before wear causes problems simply because of the corrugation and the vibration that results, and the noise complaints it brings. A new all-electric rail grinder from Harsco Track Technologies that runs off third-rail power (believed to be the first of its type) should be in use by year-end.

NYCT's track department has proposed raising its budget to $180 million per year for the 2005-09 Capital Program. "We're looking to completely reconstruct 22,000 feet of track per year in the subway, a slight increase over the past couple of years," Wojcik says.

Any way you look at it, it's a never-ending responsibility.

TOP TWO PHOTOS FROM THE NEW YORK TRANSIT MUSEUM

lyn-Manhattan Transit) introduced "rapid transit aspects" at the Broadway-Myrtle junction (today's M, J, and Z) to eliminate the red aspect from all interlocking signal indications, except for those meaning "stop." The upper light indicated track conditions (clear, caution, stop); the lower, the route (green for main line, amber for diverging). This was the first widespread use of all-electric interlockings; Hall Signal Co. supplied this equipment.



Also in 1914, on the BMT's Sea Beach and 4th Avenue Line (today's N), an experimental General Railway Signal two-aspect electromechanical cab signal system was tried. It used metal contacts installed within the rail gauge and under the car. Prone to metallic dust, dirt, and oil, it was dismantled in 1917.

In the 1920s, the IRT began to employ "single-try" (also known as "single-block" or "single-shot") time signals to improve train throughput in tunnels and large stations. A red over lunar white indication meant the signal would "clear" only if approached at a specified speed.

In the 1930s, the BMT employed a pushbutton routing system that used telephone-type relays to control interlockings and establish routes on its elevated lines.

In 1932, in a major development, the city-owned and -operated IND (Independent) opened on 8th Avenue (today's A,C, and E). It was fully signaled with a combination of GRS electric and US&S electro-pneumatic equipment. It was also the first use of "two-block" time signals.

In 1948, the first CTC system, from GRS, was installed on

the A line at Euclid Ave. The operator set the entrance and exit points and the CTC system automatically cleared a route. GRS's system was called NX (eNtrance-eXit); US&S competed with its UR (Union Route) technology. In 1956, US&S introduced IDENTRA (IDENTification of Trains and Routing Automatically) on the Flushing (7) line. IDENTRA was an inductive system that used a "describer loop" (passive coil) mounted on a bracket just outside the motorman's window that activated frequency-sensitive relays that in turn set a route. Used up until the early 1990s, it was able to set routes for Local, Express, and Super Express trains.

One of the more interesting experiments took place between 1960 and 1964. This was the "automated train," the brain-child of New York City Transit Authority Chairman Charles L. Patterson. Tests with a fully-automated three-car train began in 1960 on the Sea Beach Line between the New Utrecht and 18th Avenue stations (Railway Signaling & Communications, November 1960). An instrumentation car was sandwiched between US&S- and GRS-equipped cars. The idea was to use off-the-shelf equipment: R22 cars, cab signals, speed-coded track circuits separated by insulated joints using a 100-Hz carrier frequency. (It was actually 91.66 Hz, which was not subject to false commands caused by stray harmonics of 25 Hz from substation feeders and signal power, as well as any third-rail "ripple current.") On Jan. 4, 1962, the automated system entered revenue service on the Times Square-Grand Central Shuttle (today's S). It ran until it was damaged in a fire on an adjacent track in April 1964. (One urban myth says the fire was deliberately started by motormen who feared loss of jobs, but the system was due to be dismantled in June 1964, after a 30-month demonstration.)

It would be many years until CBTC, the current technological innovation, would begin to take shape. In 1955, a signal modernization program began on the A Division (numbered lines) that only now is virtually 100% complete. On the B Division (lettered lines), the former BMT (now B-1 Division) is 100% complete pending CBTC startup on the Canarsie Line. On the former IND (B-2 Division), of all the lines built prior to World War II, only the A line north of 50th Street has been modernized.

CBTC, says 35-year NYCT veteran Dr. Nabil Ghaly, is actually a continua-

tion of these programs.

A 1989 derailment at 14th Street and Union Square that killed five people jump-started NYCT's New Technology Signals Program. "After the accident, senior management decided it was time to pursue newer technology, such as ATP (automatic train protection) and ATO (automatic train operation)," says Ghaly.

An intensive consultant study and peer review process in the early 1990s soon blossomed into an all-out effort to procure a radio-frequency-based overlay CBTC system that would become NYCT's standard technology. NYCT specified that the CBTC platform would have to have open architecture, that is, be able to accommodate equipment from many suppliers over many years as NYCT moves forward with CBTC on a line-by-line basis. NYCT instituted a unique "Leader-Follower" contract process in which a Leader supplier provides interoperability specifications to Follower suppliers.

If all goes as planned, CBTC technology from Siemens Transportation Systems, the Leader contractor, will have new Kawasaki-built R143 cars operating in ATO Mode with one-person crews on the entire Canarsie Line by June 2005.

ATO Mode will be similar to WMATA and BART: Train operators will close the doors and give the command to proceed. Propulsion and braking are automatic. The fallback mode to ATO is ATPM (ATP-Manual) Mode, which is similar to traditional cab signals and provides overspeed enforcement. ATPM, which will precede ATO, is scheduled to enter revenue service on the Rockaway Parkway-Broadway Junction portion of the Canarsie Line in September 2004 and be deployed on the entire line by April 2005. ATO will operate simultaneously in "shadow" (background) mode.

NYCT motormen operating CBTC-equipped trains in either ATO or ATPM mode will be looking at a different wayside signals, now called AWS, for "Auxiliary Wayside System." The top aspect will show flashing green. They'll also be looking at a flat-panel onboard color LCD display.

The future? Equipping NYCT's entire 856-track-mile network will cost at least $3 billion, in 2004 dollars, and take several more decades as 20th-Century technology only now being installed nears the end of its useful life. The next line after Canarsie is the Flushing Line, followed by the Culver Line. If current funding levels hold, up to 50% of the B Division will have CBTC by 2025. At that time, installations on the A Division will begin.

New York's subways may be celebrating their 150th anniversary by the time ABS and trip stops are relegated to a display in the New York Transit Museum.

By Randy Kennedy,
for *Railway Age*

New York's perpetual motion machine

I'm not sure when the phrase first came into use, but during the three years I wrote a weekly column about the New York City subway I often heard transit officials and workers say it: "The miracle of daily service."

Sometimes, of course, it was used ironically, the implication being: "Can you believe we pull this off every day without a disaster?" During the nadir of the system in the 1970s and 1980s, it probably seemed like a genuine miracle that any trains made it to their crumbling destinations.

But even with the glorious revival of the system over the last decade, I always found the phrase to be particularly apt. Doing my job, I spent more hours than I can count in the subway—walking its tracks, wading through its waters, meeting its denizens and drifters, its court jesters and resident rats—and I had the privilege of watching very closely many of the men and women who keep the system running.

So I've never considered it much of an exaggeration to say that, over the last century, a kind of miracle has occurred every day below and above the streets of New York.

With the exceptions of a handful of transit strikes and blackouts, and one terrorist attack, the subway has been the city's perpetual motion machine, unceasing from the moment the third-rail switch was thrown.

The numbers boggle the mind. In fact, for a newspaper reporter, they were always comforting: I rarely ran the risk of exaggeration. A work force of 48,000 people moving 4.5 million riders a day, meaning, in essence, that they sluice the entire population of Norway through their tunnels in a 24-hour period. (I imagine that the Norwegians would probably be a little nicer about it than New Yorkers are.)

But the subway has always meant more to the city than a way to get to work and back home again. It has been, by turns, the city's lunchroom, library, dormitory, chapel, bazaar, concert hall, station wagon, saloon, maternity ward, and even deathbed. (I once calculated that the average New Yorker spends more than a year in the subway over the course of his or her adult life.)

And so the workers and managers who have pulled off this miracle of daily service since 1904 have done far more for us than move us around, though they have done that pretty well. Much more important, they have given the city its essential connective tissue, its biggest gathering place, the place where we all have to sit together—or, more likely stand together—for at least a little while every day.

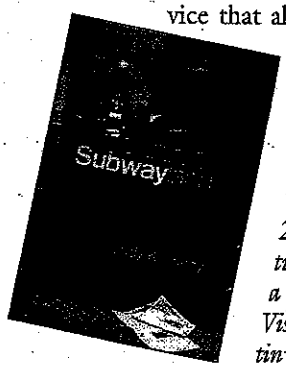
In my opinion, that experience—I like to think of it as an enforced neighborhood—has made New York more cohesive and tolerant than a city its size ever had a right to be, a true American anomaly.

That is accomplishment enough. But over the years, I watched many transit folks who did their difficult, unglamorous, not-especially lucrative jobs with a dedication—even a kind of joy, though as New Yorkers they would never admit to it—that defied explanation.

"Over the last century, a kind of miracle has occurred every day below and above the streets of New York."

There were the men who inspected the under-river tubes, going to work when the sun sets and going home before it rises; the "water guys" who fought an insidious enemy, ensuring that the subway did not fill up like an aquarium every day; Joe Hofmann, the senior vice president for subways, who could somehow restore service after an accident in less time than it would take me to replace a washer in my kitchen sink; Mysore Nagaraja, transit's chief engineer, who oversaw the rebuilding of 1,400 feet of crushed tunnel near Ground Zero in just six months' time; Glenis Shadrick, the "sheriff" of Grand Central, directing crowds in his ten-gallon hat; Millie Mendez, who worked as a platform conductor at Times Square and built a following there that would rival Aretha Franklin's; Robert James at the booth at 205th Street in the Bronx, not so much a booth clerk as the mayor of the block, dispensing career advice, prayers, poems, and even neckties, when needed.

For me, of course, there was always another invaluable service that all these people provided, one that will endear them to me forever. They told great stories.



Randy Kennedy is a staff writer for The New York Times. His weekly Tunnel Vision column appeared from 2000 to 2003. "Subwayland, Adventures in the World Beneath New York," a compilation of the best of the Tunnel Vision series, is available from St. Martin's Griffin press (www.stmartins.com).