AN AMERICAN RAPID TRANSIT LIKE NO OTHER

BART TURNS 50

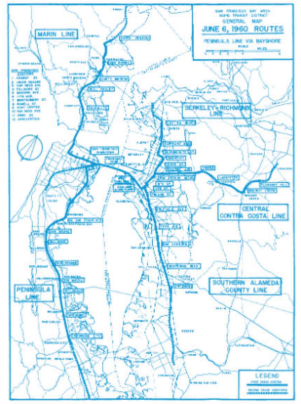
GORDON LLOYD JR./PHOTOS FROM THE LLOYD TRANSPORTATION LIBRARY

Fifty years ago we were watching "The Godfather," "Cabaret," and "The Poseidon Adventure"; President Richard Nixon made a historic diplomatic trip to China; the Allman Brothers' "Eat A Peach" and the Eagles' eponymous debut album both made marks on the popular music charts; and the divisive Vietnam war raged on. Of interest to railfans, General Motors' Electro-Motive Division introduced the enduring "Dash 2" line of locomotives, and Illinois Central absorbed Gulf, Mobile & Ohio to create Illinois Central Gulf. That same year, San Francisco's Bay Area Rapid Transit opened to the public for the first time.

People who have stood on either shore and gazed across San Francisco Bay have longed to travel to the opposite side. Freight, in the form of building materials or foodstuffs, also sought a way to traverse the choppy waters. Starting in the 1850s, ferry boats served the purpose well. Passenger vessels departed from a multitude of East Bay terminals, or "moles," for San Francisco; after 1898, the destination was likely the landmark Ferry Building. Located at the foot of Market Street, the Ferry Building was also a terminus for streetcar lines that then fanned out into the city. Ferry service dominated cross-bay travel well into the 1930s.

Ferry traffic patterns changed abruptly in 1936 and 1937 with the completion of the San Francisco-Oakland Bay Bridge and the Golden Gate Bridge. The longer of the two crossings, the Bay Bridge, had two distinct spans, east and west of Yerba Buena Island. Built in just three years by the American Bridge Co. (a United States Steel subsidiary), the total length of the bridge is nearly 4.5 miles.

In 1938, Western Pacific's Sacramento Northern, Southern Pacific's Interurban Electric Railway, and Key System trains all began operating across the lower span of the Bay Bridge destined for Transbay Terminal in San Francisco. Once located on Mission Street, between First and Fremont streets, the terminal was where connections could be made with streetcars enabling still more distant travel. For both IER and SN, the end came quickly, with both abandoning Transbay service across the bridge in 1941. But



OPPOSITE: Two trains pass at Daly City on July 19, 2019. The delivery of the C-cars improved operating efficiencies, as they could be placed anywhere in a train. GORDON LLOYD JR./ANTHONY J. SCHILL-LTL

TOP: Conceptual artwork from 1965 gave a glimpse of the future of rail transit. BART ARCHIVE

TOP RIGHT: Industrial designer Carl W. Sundberg poses with a full-size model of a BART rapid transit car. These state-of-the-art cars would eventually be built by Rohr in California. BART ARCHIVE

ABOVE: To facilitate testing of train control and automation systems, BART employed three "laboratory cars" designed by Budd Company, but constructed in the Western Pacific shop in Sacramento, Calif. The stainless-steel shells were filled with electronics and test equipment. Lab Car A is being delivered in 1970. ROBERT P. TOWNLEY-LTL

Key System soldiered on, literally. Traffic was heaviest for Key System during the World War II years, declining steadily thereafter, with Key System regularly requesting permission from the California Public Utilities Commission to adjust fare increases or modify service to help cover the increasing costs of operation.

Transbay Key System service ended unceremoniously on April 20, 1958. The transit franchises were purchased by the newly formed Alameda–Contra Costa Transit District (AC Transit), and National City Lines acquired Key System in 1946, and immediately began cutting train service in favor of bus operation.

continued to operate as bus lines. Just months later, in July, the last Southern Pacific ferry made its final trip across the bay, leaving private automobiles and AC Transit buses as the only way to convey commuters across the cold waters.

Birth of BART

As all these transit changes were taking place, in 1957 the Bay Area Rapid Transit District was formed. The district included representation from five counties — Alameda, Contra Costa, Marin, San Francisco, and San Mateo, and when approved by voters, was granted taxation authority. Thus, planning for a revolutionary new public transit operating authority was initiated, along with assessing the reality of the costs.

Citing limited value to its constituents, both Marin and San Mateo counties opted out by 1962, leaving Alameda, Contra Costa, and San Francisco counties to bear the full brunt of implementing a potential new rapid transit system. Despite the departure of the two counties, planning forged ahead. Public meetings to determine best routing and potential station locations were held. Discussions

ABOVE: Deliveries from the Rohr plant in Chula Vista, Calif., created this recurring scene for years. Northbound car 227 winds its way through Gaviota, Calif., on April 19, 1973. GORDON LLOYD JR.-LTL

ABOVE RIGHT: Plymouth 50-ton CR8 industrial locomotives usually found a home in rough-and-tumble work environments. BART L1 drags a work train of hoppers and flatcars through a work site as construction progressed on the wide gauge 5-foot 6-inch railroad through 1971. ROBERT P. TOWNLEY-LTL

RIGHT: MacArthur Station in Oakland was a main transfer point to the other lines, but Transbay Tube service to San Francisco was still more than a month away from its debut in this scene from August 3, 1974. GORDON LLOYD JR.-LTL

BELOW RIGHT: BART A-cars 214, 167, and 160 strike their unmistakable poses at MacArthur Station in the early days of BART operation, which still did not connect the three-county system. The linkage provided by the tunnel under San Francisco Bay had yet to open at the time of this 1974 view. GORDON LLOYD JR.-LTL

included both rights-of-way and structures, with aerial, subway, and surface options under consideration.

Initially, a $792 million bond issue was approved, which excluded $130 million for an underwater tunnel stretching from Oakland to San Francisco; that was to be funded through new bridge tolls in the Bay Area. Included was a 3.2-mile tunnel bored through rock in the hills of Berkeley. A fleet of 250 advanced rapid transit cars was also encompassed in the initial projection. A nearly 75-mile route with 37 stations was proposed to address initial public need; larger-scale plans for expansion would be added later. The proposal envisioned trains operating at up to 80 mph, averaging nearly 50 mph with station stops, which were intended to be about 20 scant seconds in duration. Clearly, this was not intended to be a reprise of previous transit systems that relied on slow surface routes and pre-war-designed equipment.

Optimistically, BART was intended to open in the East Bay in 1968, Transbay service in 1969, and the complete system in 1971.

Illustration by Otto M. Vondrak. Not an official map.
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ABOVE: "Looks like NASA" was the reaction from President Richard Nixon as he toured the BART system with his wife, Pat, on September 16, 1972, just days after opening to the public. BART ARCHIVE

BELOW LEFT: The Fremont Line was the first part of the BART system to open. Just three days after opening, BART 125 and a twin stop at Hayward to discharge passengers on September 14, 1972. By this date, there were about 60 cars on hand to serve the public. Two-car trains such as this quickly became rare as deliveries from Rohr increased fleet size. GORDON LLOYD JR.-LTL

Building a New System

The official groundbreaking took place on June 19, 1964, with President Lyndon B. Johnson in attendance. In early 1965, boring for the Berkeley Tunnel was initiated; in 1966, work began on the Oakland subway structure and the under-bay tube; in 1967, work started in San Francisco on the subway tunnels.

To test and verify components of the train control system, a four-mile test track was built between Concord and Walnut Creek. The test track permitted extensive testing and improving upon advanced ideas for automation and safety. Three laboratory cars were acquired to verify operation in a real-world setting, with electrical engineers carefully monitoring installations and operation. The three cars were known as A, B, and C, the first of which was delivered in August 1970. As their purposes were different, the lab cars predated the prototype cars.

Civil engineers dealt with the close proximity of this project to both the San Andreas and the Hayward earthquake faults. The underwater tunnel needed to be able to cope with seismic motion; in fact, it was designed to withstand tremors greater than the devastating earthquake that struck San Francisco in 1906. The 57 330-foot sections of the tunnel (each longer than a football field) would be fabricated on-shore by a Bethlehem Steel shipyard, floated into position, then sunk into the trench dredged into the bay floor. Divers would supervise final positioning, thus enabling the 10,000-ton segments to be welded together. Installation occurred at the rate of one section about every two weeks for two years.

Less obvious than the mountains of earth being moved, a state-of-the-art train control was being designed. The train control system was intended to manage 100 or more trains simultaneously. Automatic train control (ATC) designed by Westinghouse Electric was the key to enable operation at high speeds not typical in transit systems of the era and close headways. The automatic operation would take the uncertainty of manual control out of the equation, with built-in safety provisions through advanced electronics. Train acceleration was held closely to 3 mph per second to maintain schedules and passenger

ABOVE: Aerial structures such as this in Oakland permitted BART to avoid traffic congestion on the highways which plagued predecessors such as Key System. A midday four-car train with A-car 221 in the lead soars overhead in August 1973. ROBERT P. TOWNLEY-LTL

RIGHT: Emerging from the tunnel at the Millbrae transportation complex on July 19, 2019, a "Fleet of the Future" car showcases its striking new appearance. In all, Bombardier will build 775 FOTF cars, intended to replace all older equipment.
GORDON LLOYD JR./ANTHONY J. SCHILL-LTL

comfort. In actual practice, based upon embedded schedules, the train control system had the ability to make up lost time with reserve speed capacity. Although each train was staffed with an attendant, the human does not operate the train, with the ATC system making most decisions regarding train departure, acceleration, deceleration, and braking.

The self-service fare collection system was intended to minimize patron delay and reduce overall costs. Vending machines dispensed tickets with a magnetic strip which would manage card value throughout each transaction. Devised by the general engineering contractor Parsons Brinckerhoff-Tudor-Bechtel (PBTB), IBM was awarded the contract to design and install the system. The ticketing structure had the ability to discern travel distance and implement a graduated fare schedule, the value deducted from the fare card as the patron exited the system. Previously, inspectors kept patrons honest regarding graduated fares. The in-house BARTD publication *Rapid Transit* suggested in its August 1971 issue that the "Ingenious Fare Machines are Half the Fun of [a] BART Ride."

Revolutionary Transit Vehicles

As the physical plant was built and installed, planning for the vehicles to operate on the modern system was underway. In July 1969, aerospace and aircraft component builder Rohr was awarded the contract for 250 cars, beating out more traditional builders like St. Louis Car Co. and Pullman-Standard. Budd Company, which designed the three laboratory vehicles, did not bid on the contract.

Rohr's plan was to utilize aluminum extrusions for many major components, thus keeping vehicle weight down and reducing energy requirements. The Aluminum Company of America (Alcoa) would provide the sections to build car sides and roofs. A welded and riveted aluminum-alloy underframe would provide strength yet reduce weight, while steel end sills would provide security in the event of collisions or derailments. Vehicle weight was a remarkably light 800 pounds per linear foot.

The car would come in two versions — A-cars equipped with formed-fiberglass control cabs and B-cars intended only as mid-train equipment. A-cars would be positioned at each end of each train. Of the 250 cars in the original order, 150 were 75-foot A-cars, the remainder 70-foot B-cars. A consideration was originally given to the control cabs being detachable, moving from vehicle to vehicle as necessary; the concept was termed a "pod."

To achieve the performance expected, the cars were designed for 1,000-volt direct current power, with four 150-hp traction motors, utilizing silicon-controlled rectifier (SCR) chopper control, then a new concept. The track gauge was 5-foot 6-inch, perhaps a regrettable decision, as virtually anything designed to operate on the track had to be specially built, or modified. Rail for that non-standard track was 119-lb.

Here Comes BART

During construction, inflation soared to near 7 percent, lawsuits delayed

LEFT: BART's extension to Antioch, known as eBART, is an anomaly. The standard-gauge line uses Stadler GTW diesel multiple-unit equipment. A cross-platform transfer at Pittsburg/Bay Point affords patrons an additional 10 miles of highway avoidance. GORDON LLOYD JR.-LTL

BELOW: At South Hayward, 10 FOTF cars glide into the station in July 2019. D-car 3021 leads the way, followed by eight E-cars and another D-car in the "trail position," as BART designates that role. The 775 Bombardier FOTF cars will not work in multiple with other members of the BART fleet. As deliveries of these cars increase fleet size, older members of the BART system will be retired.
GORDON LLOYD JR./ANTHONY J. SCHILL - LTL

TOP LEFT: In an effort to further speed the loading and unloading of trains, BART D- and E-cars have three doorways instead of the traditional two. Interiors are easier to clean and maintain as well. These new Bombardier cars will soon be the face of BART when deliveries are complete. GORDON LLOYD JR.-LTL

ABOVE: BART 410, a C-car, enters Fruitvale Station on a pleasant July afternoon in 2019. C-cars came in two groups — 150 C1 cars built by Alstom, and 80 C2 versions built by Morrison-Knudsen. Due to ongoing performance and maintenance issues, the C2 fleet has been retired. GORDON LLOYD JR./ANTHONY J. SCHILL-LTL

RIGHT: The 5-foot 6-inch-wide gauge is apparent in this view looking down from the pedestrian overpass at Daly City in July 2019. A 10-car train — the maximum length — threads the interlocking under the control of the central computer in Oakland. The train is a mix of A-, B-, and C-cars, with 1252 leading the way. GORDON LLOYD JR./ANTHONY J. SCHILL-LTL

construction projects, and changes to original designs notably drove costs beyond original estimates and funding. Making up those shortfalls was a priority for BART leadership.

After numerous delays, BART began hauling revenue passengers 28 miles between Fremont and the MacArthur Station in Oakland on September 11, 1972. As construction was completed, other routes came to life — January 29, 1973, marked the start of service between Oakland and Richmond; four months later, on May 21, 1973, service began on the Concord line; and in November 1973, two openings in the San Francisco area saw service begin between Daly City and Montgomery Street — for a total of 63.5 miles of brand-new rapid transit lines. On September 16, 1974, slightly more than two years after service began between Fremont and Oakland, Transbay service opened, completing the 71.5-mile BART system.

The next 50 years saw substantial expansion. The original routes between Daly City, Richmond, Concord, and Fremont have been extended, and new destinations added. Route extensions included North Concord, San Francisco International Airport, and the terminus in Millbrae, plus the three-station route addition to Dublin/Pleasanton diverging from Bay Fair.

BART gets ever closer to the Silicon Valley too, as the Fremont line was extended to Berryessa/North San Jose. This is the latest BART extension and today the transit system is 131 miles long, serving 50 stations.

Although technically part of BART, BART to the Oakland Airport and BART to Antioch (also known as eBART) are distinct systems unto their own. These were placed in service in 2014 and 2018 respectively. BART electric trains do not operate over these routes. The Oakland Airport Connector extends from the Coliseum station, with an elevated automated guideway cable system, and features four cars. BART to Antioch utilizes eight Stadler diesel multiple-unit (DMU) cars, configured in trains from two to three cars. As the name implies, the cars are diesel-powered, operating on biodiesel fuel. The line utilizes standard gauge trackage. In effect, eBART is an extension of the Concord Line, with a cross-platform transfer between trains at the Pittsburg/Bay Point Station.

The BART Roster

Throughout these 50 years, BART has utilized a large roster of cars, configured in several variations. The 250 original A- and B-cars came from Rohr. Later, 174 additional Bs and 26 As were acquired to address ridership increases. Alstom contributed 150 C1 cars. These blunt-end cars could be entrained anywhere in a consist, adding significant flexibility. Morrison-Knudsen contributed 80 C2 cars, similar in design to the C1 version, but with too many unreliable traits. Their problems led to early retirement; the entire group of C2 cars is now decommissioned and off the roster. What longevity they had — diminished as it was — can likely be attributed to dedicated maintenance staff.

In the late 1990s, a program was begun to refurbish remaining members of the A- and B-car fleet, with work being accomplished by Adtranz/Bombardier. As part of this rebuilding, a number of A-cars were converted to B-cars. More than 400 cars were included in the program, the significant majority being outshopped as cabless B-cars.

The latest cars are known as "Fleet of the Future" (FOTF), designed and built by Bombardier Transportation (now Alstom). Although a Canadian company, they are being built in the U.S. at Plattsburgh, N.Y., and Pittsburg, Calif. Similar to the original Rohr cars, these are equipped with a cab for end-of-train use, and a cabless version strictly for mid-train deployment. The cab-equipped cars are known as D-cars while mid-train cars are called E-cars. D-cars can be used mid-train when necessary, but passengers cannot pass between the cars at the cab end (unlike C-cars). D- and E-cars cannot be used with A-, B-, and C-cars.

The D and E fleet started with a 260-car order and an option for 150 additional cars, for 410 in total. Subsequently, 365 more cars were added, with a requirement to speed up delivery. In total, 775 FOTF cars will populate the roster — 310 D-type cars and 465 E-type cars. Eventually, this new fleet will replace all remaining A-, B-, and C-series cars with a goal of uniformity and maintenance simplification. Software and reliability issues delayed deliveries for one year during 2021.

Celebrating 50 Years

The San Francisco Bay Area is full of interesting railroad operations for the visiting fan. South of San Francisco, you'll find the Caltrain commuter rail operation, which is in the midst of a major electrification program that will see its fleet of classic F40PH locomotives sidelined in the coming years. Meanwhile, in the city itself, San Francisco Municipal Transportation Agency (better known as Muni) has a fascinating transit operation all its own, with everything from iconic cable cars and classic PCC streetcars (painted in heritage schemes) to modern light rail vehicles.

Taken all together, those operations would quickly fill a visit to the Bay Area. But one would be mistaken to overlook the fascinating and groundbreaking BART on their next trip to the city by the bay.

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