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And Traffic Engineering

University of California

Research Report No. 23

A STUDY OF EXPRESS BUS

OPERATION ON FREEWAYS

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ABSTRACT

In January 1956, the Municipal Railway of San Francisco inaugurated three express bus routes which use considerable portions of the Bayshore Freeway. It was the object of this study to analyze the problems of this type of transit operation. It is an operation which might possibly be expanded, as urban freeway networks are developed, into a major transportation facility providing access to the central business district.

For each of the routes data were gathered on physical characteristics, patronage, and financial statistics for the first 4-1/2 months of operation. Comparisons were made with corresponding data for service available in the same period of 1955. A postcard survey was conducted after 4 months of operation to determine the previous mode of transportation of the passengers using the new freeway routes and to obtain the passengers' opinions of the new services.

One of the new routes is an entirely new service. The other two are essentially replacements of previous services which had operated along city streets. These two routes are considerably longer than the previous routes, but the higher operating speeds result in time savings ranging from 7 to 18 minutes.

The patronage statistics indicate that the majority of the passengers on the three new routes have been diverted from other public transit. Only the entirely new service, Route 17X, appears to have attracted a significant number of passengers who previously entered the downtown area by private car. Of the passengers on this route, 24% have been attracted from the motoring public; on the other routes, not more than 7%. The total effect of these three services on the number of passenger cars entering the downtown area of San Francisco is almost insignificant — it is estimated that only one car in 500 has been left outside the central business district on an average weekday as a result of the establishment of the freeway express service.

An analysis of the revenues and operating costs on the new services indicates that a deficit is being incurred. The present fare on the transit system in San Francisco, including the new services, is 15 cents regardless of distance travelled. The study indicates that this fare is not sufficient to pay the cost of transporting the passenger for more than four to six miles. Nearly all the passengers on the new lines are making trips of five miles or more, tending to produce the deficit. Acting somewhat to keep this deficit low is the improvement in over-all speed of the service; the per-mile operating cost of a transit vehicle decreases as the speed increases, because the labor costs vary with time rather than mileage. On a fast route the hourly labor costs can be spread over a larger number of miles than on a slower line.

Through the postcard survey, the riding public generally expressed a very favorable reaction to the new services. Many respondents made specific references to time savings, even to the point of over-estimating them. This emphasizes the importance of travel time as a factor entering the decision between alternate modes of transportation.

The study indicates that buses operating on freeways are a feasible means of transporting passengers from the outer sections of a city to its central business district. It seems especially desirable to operate existing long routes over available freeways, unless extra route mileage is required, since the higher speeds would reduce operating costs.

New services will attract some new transit riders from private means of transportation, especially if the routes are publicized and advertised. However, the establishment of such services will have to be accompanied by a determination of public policy on the methods of financing.

INTRODUCTION

Access to the central business district is probably the most critical transportation problem in the future of our larger cities. The downtown areas of our cities attained their high level of density and business activity because they were at the focal point of the community. Transit systems radiating from them made access easy from other parts of the community and did much to promote and encourage consolidation of the central business district (c. b. d.). With the advent of the automobile, however, and with its intensive acceptance and use by workers and shoppers alike, reaching and leaving downtown has become increasingly difficult and time-consuming. Streets, never intended to carry large numbers of automobiles, are greatly overloaded. Transit systems have lost patrons steadily, except during the period of World War II, despite an overall increase in the population of all major cities.

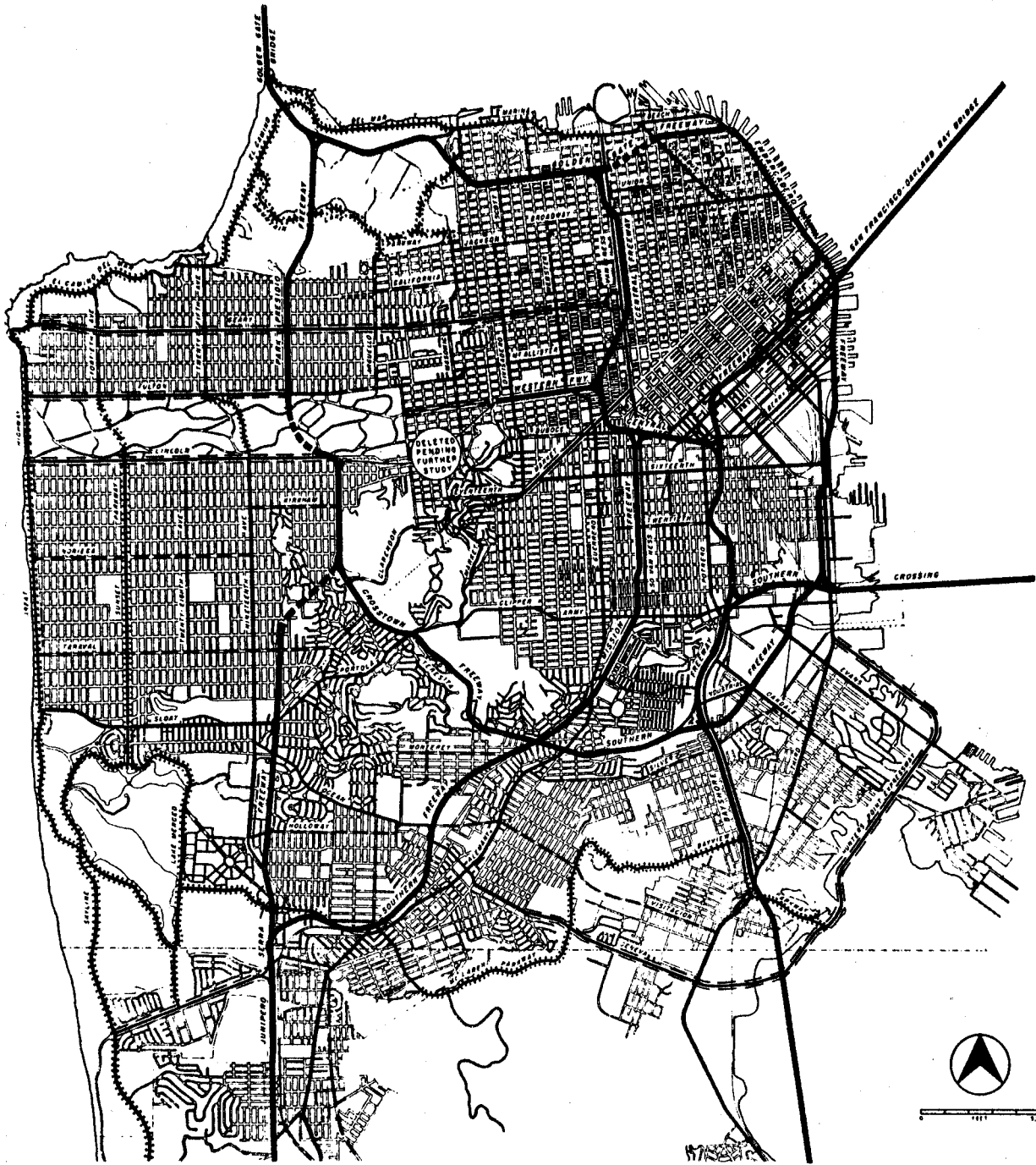
The urban transportation problem is aggravated by the sharp volume peaks which occur mornings and evenings of every workday. It is these peaks which determine the extent of the facilities required. Although the peaks occur with both private-vehicle and transit traffic, they are generally much sharper on the transit systems; for it is only during hours of high street congestion that people are more inclined to travel by transit than in their own car.

The transit system has the advantage of a much larger capacity than the private automobile. A transit route equipped with modern, 48-seat buses, operating on 15-second headways and with 25% standees has a capacity of 14,400 passengers per hour; a rail rapid transit line, using 10-car trains at 90-second headways can handle 40,000 persons per hour. But an 8-lane freeway, carrying maximum capacities (recently found in California to be 5,500 vehicles per hour in one direction at 45 mph¹) with an average occupancy of 2 persons per car will move only 11,000 persons in one direction per hour, or 2,750 persons per hour per lane. In addition there is the terminal problem at the downtown end of the trip. Transit passengers require no parking space, and the transit vehicle generally leaves the c. b. d. when it has discharged its load. Each private automobile, however, requires from 200 to 350 sq ft of parking space in an area of high land values.

There seems little doubt, therefore, that from the viewpoint of capacity a transit system is much better suited to provide access to the c. b. d. than the private automobile. The confusion and inconvenience which occur when a transit system in a large city is strike-bound give a vivid picture of the problems faced by the downtown area depending solely on private cars. The only alternative to a transit system would be the dispersion of the c. b. d. over a larger area thereby reducing the intensity of downtown land use. This is found to a limited extent in Los Angeles. It has been the policy of most cities, however, to preserve or even to strengthen the central area. This policy is implemented in part by the construction of radial freeways to the fringes of the c. b. d. and off-street parking facilities in the downtown area. On the other hand, the importance of transit service is also being recognized in some cities; privately owned systems in some cities are receiving some financial aid in the form of reduced or eliminated franchise taxes; publicly owned systems in some cities are expected to offset only their operating costs through fares, and to receive subsidies for financing charges and debt retirement. Freeways are being constructed with special turn-outs for bus stops (Los Angeles) or rail rapid transit median strips (Chicago); experiments are being conducted in the reservation of an entire lane in downtown streets for the exclusive use of transit vehicles (Chicago and Nashville).

The transit companies have met the competition of the automobile with varying measures of success. Rail rapid transit, being completely divorced from automobile traffic, has suffered no operational problems, and has lost the least proportion of patronage. Surface lines, however, have been slowed down with the rest of the traffic entering and leaving the c. b. d. The shift from surface operation to rail rapid transit lines would be a solution to making transit riding faster and more attractive to automobile users, but it is a very expensive one. Vast expenditures of funds have been recommended for such systems in recent months, both in the San Francisco Bay Area and in the Philadelphia-Camden Area.

¹Webb, George M. Freeway Capacity Study-1955 (Progress Report). California Division of Highways. Sacramento: 1955. p. 84.



TRANSPORTATION SECTION OF THE MASTER PLAN OF SAN FRANCISCO

- FREEWAY
- ==== MAJOR THOROUGHFARE
- - - - - SECONDARY THOROUGHFARE
- == == == EXPRESSWAY TREATMENT
- PARKWAY TREATMENT

THIS PLAN WAS ADOPTED BY RESOLUTION NUMBER 3948 ON JULY 17, 1951, AND AMENDED BY RESOLUTION NUMBER 4423 OF THE CITY PLANNING COMMISSION AT A REGULAR MEETING HELD ON MAY 19, 1955

RECORDED
Paul J. ...
 CLERK OF THE CITY
 APPROVED
Kenneth E. ...
 MAYOR

Fig. 1 — Trafficways Plan of San Francisco (From San Francisco Dept. of City Planning).

At the same time the question has arisen as to whether the objectives of a rail rapid transit system could not be in part achieved by more extensive utilization of urban freeways, where available. Such freeways have at least two of the features of a rail line: access control and grade separation. On the other hand they cannot be used exclusively for transit operations, cannot (at present) be signalized to make accidents virtually impossible, and have terminal problems at the downtown end — all of which pose problems not present in rail transit lines.

Only in recent years have sufficient lengths of urban freeways been open to traffic to make transit operations on them a possibility. So far such operations have been mostly of the inter-urban type. When it was learned, therefore, that the management of the Municipal Railway of San Francisco was planning to operate several bus routes over completed sections of the Bayshore Freeway, it was felt that a study of this innovation would provide much information which would be useful in indicating the future possibilities of such service.

SAN FRANCISCO TRANSPORTATION FACILITIES

Freeways

The extent of the presently proposed freeway network for San Francisco was defined by the City Planning Commission in the Trafficways Plan (Fig. 1). These freeways may be grouped for the purpose of this discussion as follows:

Radial freeways, which might be used for main trunk lines by express buses:

Bayshore Freeway — completed and open to traffic from the Bay Bridge approach to a point just north of the south city limits.

Mission Freeway — deferred to low priority at present.

Southern Freeway — some portions have high priority for construction both in state and city programs.

Western Freeway — presently deleted from plan pending further study.

Golden Gate Freeway — open to traffic from bridgehead through the Presidio.

Circumferential freeways, which might be used by crosstown transit lines although such operation seems hardly warranted by current crosstown traffic demand:

Embarcadero Freeway — partly under construction or financed.

Central Freeway — partly open to traffic.

Crosstown Freeway — in planning stage for construction by city.

Junipero Serra-Park Presidio link — in planning stage for construction by state.

The initial freeway express bus routes of the Municipal Railway utilize the 5-mile section of the Bayshore Freeway open to traffic.

Transit System

The Municipal Railway of San Francisco operates an extensive network of streetcar, cable-car, trolley-coach and motor-bus routes in the city and for a short distance into Daly City. The only other public transit service furnished within this area is by jitneys along two routes and by taxis. Service is generally on public streets, except for portions of several streetcar routes which operate through the Twin Peaks and Sunset tunnels for a part of their trips.

The system, owned by the City and County of San Francisco, is administered as a part of the city government under its Public Utilities Commission. Major policy decisions (level of fares, rerouting, change of equipment, etc.) are subject to approval by the Board of Supervisors, but the system is not under the jurisdiction of any state agency.

The Railway has operated some types of express services with gasoline and Diesel buses for several years. Until recently, these services were confined to the regular street system and were of two types: limited-stop service, which makes stops only at transfer points for a portion of its route; and express service, which runs non-stop over a portion of its route. Generally, such service is operated in peak hours as a supplement to regular lines, but some

lines operate all day weekdays and Saturdays. Speed of service on these lines has depended on traffic conditions existing on the streets. Some express lines are able to use one-way streets with progressive signalization to good advantage. The fastest schedule possible under these conditions is at 15 mph over a non-stop section of 2.5 miles.

DESCRIPTION OF STUDY

The establishment of three freeway express bus routes by the Municipal Railway on January 16, 1956, provided an excellent opportunity for a study of the problems and results of such operations. In the next section of this report, each of the three lines is described in detail. The data obtained and items studied for each line include the following:

Physical Factors

These include location and length of each route, travel times and speeds, overall speeds, and comparisons with the best service previously offered. These data were obtained from the maps and schedules of the Municipal Railway. Scheduled travel times and speeds were determined by the Railway after extensive trial runs and adjusted as necessary after actual operations started. Therefore they reflect actual travel times and speeds fairly accurately. Overall speeds, used to estimate the unit cost of vehicle operation, are the quotient of the total number of vehicle hours and the total vehicle-mileage. Included are the trips to and from the garage, the lay-over time at terminals between runs and the time allowed at the garage for turn-in of records and money by vehicle operators.

Patronage

Passenger statistics of the new routes, and of existing routes from which riders were expected to be diverted, were obtained from the daily and monthly records of the Municipal Railway. The Railway collects statistics on 15-cent cash fares, transfer passengers, school ticket passengers and pass privilege passengers (postal carriers) for each line on the system. The figures for cash fares are obtained from fare box counter readings, and such figures are accurate. However, if a vehicle operates on two different routes during the day, the revenue collected is generally credited to the line on which the vehicle operated the greater portion of the run. This eliminates time-consuming and costly paperwork by vehicle operators. For the routes studied this has only a minor effect on patronage and revenue statistics. Two routes over which many vehicles operate inter-changeably are considered as one line for all bookkeeping purposes. Unfortunately, one of the freeway express routes is in this category, and separate statistics are not available.

Transfer passenger figures do not reflect riding volumes exactly. The records show all transfers picked up by vehicle operators or conductors for each route. However, passengers making two or more transfers on one trip do not surrender their transfer on intermediate routes, and are therefore not recorded. School ticket and pass users are prorated among all routes from system-wide information on the use of these privileges, and do not accurately reflect the actual conditions of each route. (For example, each route is credited with a number of school rides, even if no school children ever use the line.) The proportion of riders in this group is fairly small, however, and affects the accuracy of the total patronage figures only slightly.

The patronage of the new and affected lines for the first five months of 1956 are compared to the corresponding months of 1955. Comparisons are generally expressed as percent increase or decrease. This enables direct comparison with the system-wide trend in transit riding. Where a line studied has had a smaller drop in patronage than the system-wide percentage, the difference is referred to as "passengers (or revenue) not lost". It is realized that other local factors may have influenced the patronage on the lines under study. No major causes for possible change in riding habits seem to have occurred in the affected area during the year, but some figures show patronage fluctuations which bear no relation to the new express service. The system-wide patronage trends for the months studied were as shown in Table 1. Also studied were the trends in riding on the freeway express routes from the 1st through the 22nd week of operation.

The previous mode of transportation of passengers was one of the items obtained from a

TABLE 1 -- SYSTEM-WIDE TRENDS IN PATRONAGE
SAN FRANCISCO MUNICIPAL RAILWAY

Month 1956	Increase or Decrease over Corresponding Month of 1955	
	Cash Passengers	Total Passengers
January	-4.41%	-4.08%
February	+0.11%	+1.11%
March	-2.74%	-4.06%
April	-3.71%	-0.89%
May	-0.35%	+0.41%

postcard survey conducted on May 23 and 24, 1956, (described below). Answers to the question on previous transportation were expanded by the factor relating the total passengers carried to the number of respondents to the survey. The total number of passengers carried was obtained from volume counts conducted at the entrance to the downtown area on the days on which the post cards were distributed, and checked by additional counts on June 6 and 7, 1956.

It is not possible to use the postcard survey results as a check on the statistics of the Railway of reflecting changes in patronage. While the survey can lead to an estimate of the number of new riders attracted from private automobiles, car pools, etc., no information is gained on any shift in the opposite direction, as riders who switched from transit usage to automobiles or moved to other parts of the city of course were not reached by the survey.

Financial Results

Financial data were obtained from monthly records of the Railway. These records accurately reflect the revenue collected and operating expenses chargeable to each route of the system (except that revenue from the sale of school tickets and from the Post Office is prorated among the lines of the system without regard to actual patronage by these groups of riders). Costs of accident payment and expenses, bond redemption and bond interest are then prorated among the lines and a net surplus or deficit is computed.

In order to indicate the extent of the surplus or deficit caused by the express service, operating costs were adjusted to eliminate increases in unit costs of operation which had occurred during the year. The computations show the financial results as they would have been had all operating costs remained constant. The system-wide operating cost trends for the types of vehicles used on the lines under study were as follows:

TABLE 2 -- SYSTEM-WIDE TRENDS IN OPERATING COSTS
SAN FRANCISCO MUNICIPAL RAILWAY

Month 1956	Increase over Corresponding Month of 1955		
	Two-Man Street Car	Trolley Coach	Gasoline Bus
January	1.1%	6.1%	5.2%
February	-0.1%	8.0%	4.4%
March	1.7%	7.5%	5.4%
April	3.0%	7.6%	8.3%
May	0.7%	5.3%	8.4%

A study was made of the actual cost to the transit system of transporting passengers on the freeway express system, in order to estimate whether the riders are paying a sufficient amount for the service offered, or by how much they fall short of doing so. There are several ways in which certain cost items may be allocated to the various operations of a transit system; in this study the method used by the Municipal Railway was followed. The Railway allocates all costs except labor costs on the basis of vehicle mileage; labor costs are charged on the basis of vehicle hours. A precise analysis would reveal certain inaccuracies in computing costs of bus operation: for instance, fuel consumption per mile has been found to decrease as the number of stops and starts is decreased, and to increase as speed increases. It is also possible that the cost of accidents on freeway express routes will be less than on routes using city streets; however, the legal processes involved in fixing costs of accidents often lag many months behind the actual occurrence, and it is therefore too early to estimate whether the amount provided for accident costs per vehicle mile is too high.

In this analysis, labor costs have been converted into cents per vehicle-mile, and total expenditures can then be estimated using the vehicle-mile as the common denominator. Because of the time value of labor, the cost per vehicle-mile is found to vary inversely with the overall speed of the vehicle, as is shown in Fig. 2.

As can be seen, costs per vehicle-mile decrease as the overall speed increases. It is apparent that the transfer of a bus from a city street to a freeway will lower the operating cost per mile. Each vehicle will require less time to complete a round trip, and less vehicles and operators may have to be assigned to the route.

In these calculations the costs prevailing during May 1956 were used. To the operating costs were added provisions for accidents and the bond interest and redemption requirements. The first of these items has been found to vary directly with the gross revenue of the system; accounting practice in the Municipal Railway is to estimate a monthly total provision for accidents (at present 6.75% of gross revenues), but to apportion this among the routes of the system in proportion to the vehicle mileage. Bond redemption charges are used in lieu of depreciation of vehicles. Bond interest is also a valid charge against each vehicle-mile operated. In the case of the leased buses, the rental charge per mile is used in place of the bond charges.

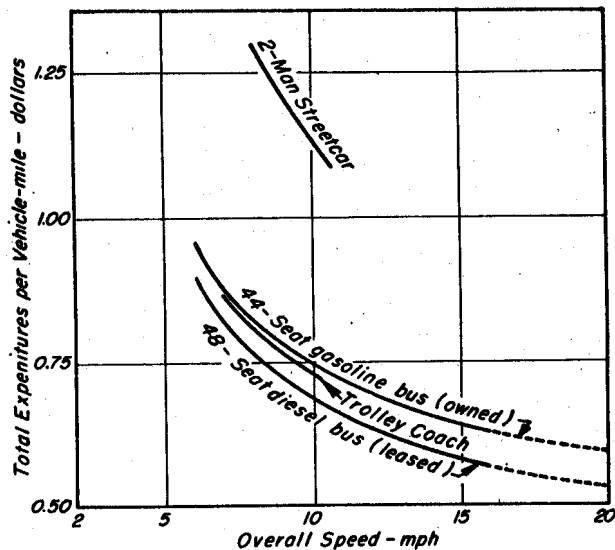


Fig. 2 — Variation in total expenditures for operating transit vehicles with over-all speed of operation.

Public Reaction

The reaction of the riding public to the new service was also obtained from answers to the post-card survey. This information has been given without expanding the sample to the total number of riders on the lines. It is felt that the sample obtained in the survey may be biased on this one point: persons having very positive reactions to the new service were more likely to mail back the cards than those who felt indifferent.

Comments of course varied greatly in style and content. In order to gage the over-all reaction of the public, comments were classified as follows:

- Group 1: Unqualified approval.
- Group 2: Qualified approval.
- Group 3: Critical comments and suggestions.
- Group 4: Other comments.
- Group 5: No comment.

The Municipal Railway and the Institute of Transportation and Traffic Engineering, University of California, are trying to find out how well this Express bus line is serving you. Please help us by filing out this card and dropping it in any mail box. Thank you.

Where did you start this trip?.....
(Give address, or name of well known building, etc.)

Where is your destination?.....
(Give address, or name of school, store, well known building, etc.)

How often do you make this trip? (Check one)
 Every weekday. 1 to 4 days per week. Less than once a week.

How did you usually make this trip before this express line was started?
(Check one).
 By Muni Route No. By jitney
 In a car pool In my own car
 Did not make this trip Other

Have you any comments on express bus service?

Fig. 3 — Survey Postcard

While the assignment of cards to such classes cannot always be made objectively, it is believed that a fair picture of the public reaction has been obtained.

The Postcard Survey

The postcard survey used to obtain certain information, as indicated above, conducted on all inbound passengers on Routes 14 and 17 on May 23, and for Route 30 on May 24, 1956. Business reply postcards were handed to nearly all passengers boarding on inbound trips by the operator of each vehicle. The card used is shown in Fig. 3.

Answers to all questions, except the first two, are incorporated in the appropriate sections of this report. It was impossible to make good use of the answers to the questions on origin and destination. It had been hoped to use this information to study the sphere of attraction to the freeway express lines in the outlying areas, and on terminal problems in the downtown area. Unfortunately the majority of the respondents gave, not the address or location of their true origin and destination, but the points at which they boarded and left the bus. This is evidenced by the results of a specially controlled set of cards. These were issued to passengers transferring from another transit line to an express route. Although the true origin of these passengers must have been at a point on the connecting route, 29 of the 43 cards returned (or 67%) listed the transfer stop as the location of the trip origin. Again, it was noted by observers that considerable numbers of passengers boarding at the outer terminals of the 14 and 17 lines are brought to those points by car, generally from the south. Yet, of 308 cards received by persons boarding at or near these terminals, only 3 gave a trip origin located more than a short walking distance from the lines.

While it is possible that a small number of persons may not wish to divulge their origin or destination for personal reasons, it seems evident that the majority of the respondents merely failed to read or understand the instructions. It is suggested that in future surveys of this type the phrase "NOT THE BUS STOP" should be added to the parenthetical instructions in an attempt to obtain the information actually desired.

The response to the postcard survey was good. Of the cards issued, 51.0% were returned, and 50.2% contained useful information. (The remainder had either been issued on outbound trips or filled out in a facetious or unintelligible manner.) Curb checks showed that about 68%

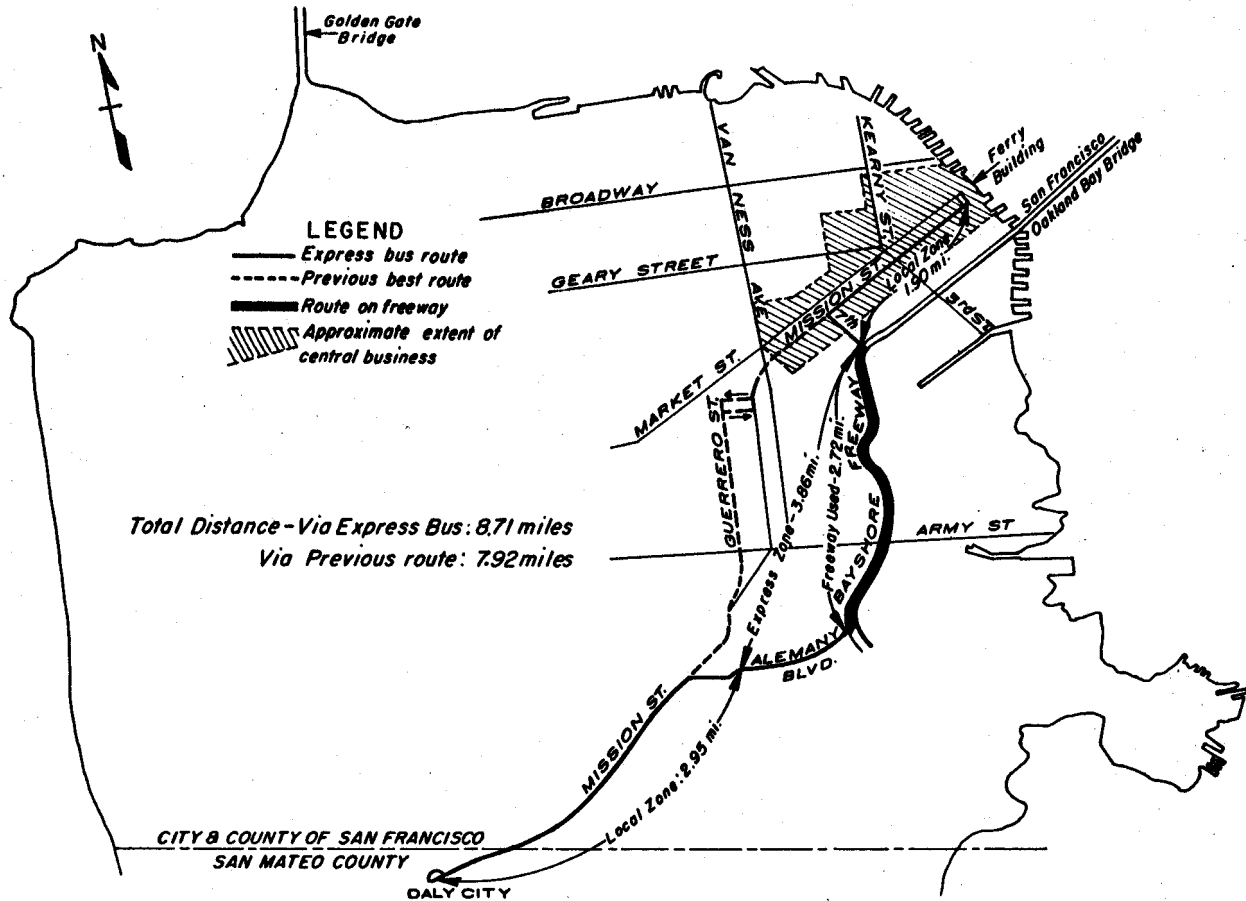


Fig. 4 — Express Bus Route 14X

of the inbound passengers received cards, the remainder either refusing to accept a card or being missed in the rush hour. Thus the information obtained from this survey is based on a 43.2% sample of the total passengers, or 32.5%, 57.6% and 43.5% for routes 14X, 17X, and 30X respectively.

FINDINGS ON ROUTE 14X

Physical Description

The approximate location of the freeway express route 14X is shown in Fig. 4. This route starts just south of the San Francisco city limits in Daly City and proceeds via Mission St., Trumbull St., Alemany Blvd., Bayshore Freeway, 7th St., and Mission St. to the Ferry Building. The area contributing passengers is residential, of medium to low density. Some feeder routes bring passengers from adjacent areas; a considerable number of residents of northern San Mateo county reach Daly City by private automobile and then transfer to this route.

This service is operated during peak hours only, mornings inbound and evenings outbound. Headways are from 4 to 6 minutes. During the rest of the day a limited stop service operates from Daly City to the Ferry Building entirely on Mission Street. Before inauguration of the ~~freeway~~ freeway express, the best service from Daly City and the Outer Mission was provided by an express line operating via Mission and Guerrero Streets. The following tabulation compares the freeway express route with the previous route via Guerrero Street:

TABLE 3 — COMPARISON OF ROUTE 14X WITH PREVIOUS BEST ROUTE

	Freeway Route	Guerrero Route	Difference
Length between terminals, miles	8.71	7.92	+0.79
Travel time inbound (Peak), minutes	30-36	37-45	-7-9
Average speed inbound (Peak), mph	14-17	11-13	
Travel time outbound (Peak), minutes	33-38	43-47	-9-10
Average speed outbound (Peak), mph	14-16	10-11	
Overall speed (incl. lay-overs etc.), mph	14	10	+4
Length of express zone, miles	3.86		
Length of freeway utilized, miles	2.72		
Speed in express zone, mph	25-30		

The new freeway express service was instituted by operating about two-thirds of the Guerrero Expresses over the new route, and adding several extra runs. Service on the 14 local line was slightly readjusted; the 26 line was not altered, pending a change in its route;* the total result was an increase of about 140 vehicle miles per weekday operated on the combined routes in May as compared to early January 1956.

Patronage

Coaches on 14 freeway express are used interchangeably on the 14 Guerrero and Limited Stop routes, and on a special shuttle line (40) between the Southern Pacific Railroad depot and downtown Market Street. To eliminate time consuming "turn-ins" of cash, transfers, etc. by operators for each route separately, all routes are treated as one for statistical and book-keeping purposes. This means (unfortunately for the purpose of this study) that the patronage figures available include services not a part of the routes being studied. The patronage figures of the 14 line are especially affected by inclusion of data for the 40 shuttle; this line carries a large proportion of the total passengers reported, and is subject to fluctuations caused by the weather. (The distance from the station to Market Street is walked by many commuters in good weather, but rain increases bus riding substantially.)

It is noted that there was higher patronage on the combined 14X - 40 routes than would have been expected from patronage figures of the previous year and the system-wide trends. How much of this increase actually occurred on the freeway express cannot be estimated. It is remarkable to notice, however, that the two routes which might have been expected to lose passengers to the new service, the 14 local line and the 26 line, do not seem to have experienced any such loss. Both lines carried more passengers than might have been estimated in view of system-wide trends. The differences between patronage trends on the Daly City lines and of the system as a whole are shown in the following tables.

The weekly passenger totals for the 14 Express lines are equally inconclusive. During the first week of freeway operation 51,768 cash passengers were recorded. This figure has remained relatively constant, being just 0.9% higher for the twenty-second week of operation. It seems evident that the 40 shuttle line statistics, which are included, are more responsible for the fluctuations found than is the effect of the new service. No conclusions can be drawn from Municipal Railway patronage statistics regarding the effect of the new 14 freeway express on patronage.

*The 26 line operated local and express service from Daly City downtown via San Jose Avenue and Valencia Street. Since completion of the field work of this study, this line has ceased to serve Daly City.

TABLE 4 — PATRONAGE TRENDS ON DALY CITY LINES (Cash Passengers)

Month 1956	Increase or Decrease Over Corresponding Month of 1955				
	14 Expresses 40 Shuttle	14 Local	26 Line	Four Lines Combined	System Average
January	-4.59%	-2.27%	-6.29%	-3.77%	-4.41%
February	+4.38%	+0.46%	+0.59%	+1.70%	+0.11%
March	-0.41%	+0.61%	+0.37%	+0.22%	-2.74%
April	-3.25%	-2.62%	-1.22%	-2.54%	-3.71%
May	+3.96%	-0.48%	+3.03%	+1.56%	-0.35%
Total: 5 months	-0.11%	-0.86%	-0.71%	-0.60%	-2.26%

The results of the postcard survey do indicate that the freeway service has attracted some new passengers to the system. Expanding the sample which responded to the total number of passengers (observed to be 1,232 persons on the day of the survey) the following figures are obtained:

Passengers previously using other transit routes	851
Passengers previously using jitneys	213
Passengers previously using private automobiles	48
Passengers previously traveling in car pools	24
Passengers previously not traveling in this area	68
Other (including Greyhound, not stated)	28
Total	1,232

The jitneys, which appear to have lost considerable patronage to the freeway express, are limousines operating at frequent intervals on Mission Street between the Ferry Building and the city line just north of Daly City. Many passengers traveling along Mission Street appear to show no preference for jitney service over that offered by the Municipal Railway, and will take whichever vehicle arrives first at their boarding stop. Jitney travel times are somewhat faster than those of 14 local and limited-stop vehicles, since they need pick up only eight persons each before being able to proceed non-stop to the destination of their passengers. The loss of patrons to the freeway express found in the postcard survey may well have been a part of the continual switching by some persons between the two modes of transit.

The attraction of 48 passengers from their private automobiles and 28 from car pools, while a lower proportion than that found on some other lines, nevertheless is not insignificant. All of these persons are daily users of the service. Assuming 4 persons in a car pool, some 55 vehicles do not enter the downtown area since their occupants have found the 14 freeway express more suitable.

Financial Results

The difficulties experienced in analyzing patronage data also occur in the financial data. The figures shown in the Municipal Railway books also include the revenues and operating costs of the 40 shuttle line.

It can be demonstrated — and this applies equally to the other lines studied — that the long-distance passenger does not fully meet the operating costs of this freeway express route. In May 1956, for example it cost the Municipal Railway \$0.65 per mile to operate a 44-seat gasoline bus at an overall speed of 14 mph. On this route of 8.71 miles, therefore, one trip costs \$5.65.

However, additional costs must be charged to this trip: considerable deadhead mileage is operated to return buses empty to outer terminals for additional trips downtown, and between terminals and garages; labor and vehicle costs accruing at off-peak hours when vehicles cannot be utilized must also be charged. In this analysis such additional costs have been expressed simply as "deadhead mileage" chargeable to each trip, and have been estimated very roughly on the basis of operating problems involved. This method of accounting is not used by the Municipal

Railway, which makes much more detailed analyses of costs; however, such a detailed cost study goes beyond the scope of this report.

For Route 14X some of the dead-head mileage can be charged to the 40 line, and to the mid-day limited-stop service along Mission Street. The additional mileage is therefore estimated conservatively at only 50% of the revenue mileage. Each trip should then produce \$8.50 in revenue to meet operating costs. Each inbound morning coach and outbound evening coach should carry 57 cash passengers and, at the ratio of 1 transfer passenger per 3 cash passengers which prevails in the system, 19 transfer passengers. In an express service of this type the load at the maximum load point is almost the same as the total number of passengers handled. Therefore 76 passengers would have to ride on each coach to reach the break-even point. This load is undesirably high. (The actual load on Route 14X is in the neighborhood of 1,200 passengers on 17 buses, or about 70 passengers per bus.)

The revenue required per cash customer can be reduced considerably by introducing new, leased buses in place of the old, city-owned vehicles. The new buses, with four more seats than the older ones, cost 6¢ per mile less to operate because of lower fuel consumption and maintenance costs. The new coaches are being introduced on various lines throughout the system as soon as delivered, and some have already been used on the 14X route.

Table 5 shows a number of financial break-even points which have been calculated to show the revenue required per cash customer under various conditions; deadhead mileage has been assumed at 50%.

The financial operating results for the 14X are improved by the inclusion of figures for the 40 shuttle. This shuttle, only about 1 mile in length, carries heavy loads of short-haul passengers. The limited-stop service during off-peak hours, on the other hand, exerts an opposite influence, since it carries much lighter loads. As the book figures do not reveal any separate data for the freeway service along, they are not used here to draw any conclusions.

It has already been shown that each of the three factors determining the financial results took an adverse turn between the first five months of 1955 and the corresponding period of 1956: patronage (cash passengers in this study) declined, although at a lesser rate than the system-wide average; unit operating costs rose; a small amount of additional vehicle mileage had to be operated. The change in unit operating costs, reflecting higher labor, fuel and material costs, would have been about the same regardless of any action taken on the establishment of freeway express service. But even if this factor is omitted, the other two both contribute to a larger deficit or smaller surplus.

TABLE 5 — BREAK-EVEN POINTS FOR ROUTE 14X

Assumed conditions	Average load in peak direction	Load factor	Cash passengers	Revenue required to break even	Revenue required per cash passenger
Present fare; 44-seat bus	76	1.72	57	\$8.50	15¢
Present load factor; 44-seat bus	70	1.59	53	\$8.50	16.0¢
Maximum desirable load factor; 44-seat bus	66	1.50	50	\$8.50	17.0¢
Present load; 48-seat bus	70	1.48	53	\$7.60	14.3¢
Average load factor (44-seat bus) which will give reasonable assurance that maximum load factor for any one bus will not exceed 1.50	55	1.25	42	\$8.50	20.2¢
Same load factor as line above; 48-seat bus	60	1.25	45	\$7.60	16.0¢
Guaranteed seat (club flier) service; 44-seat bus	44	1.00	33	\$8.50	25.7¢
Guaranteed seat; 48-seat bus	48	1.00	36	\$7.60	21.1¢

It might be suggested that the freeway express service prevented the drop in patronage from being at the system-wide rate. It is estimated that the Daly City lines and 40 shuttle carried about 670 more cash passengers per weekday after the express service was instituted than might have been expected. The increase in operating expenses was about \$74 per weekday:

Additional vehicle mileage: 140 miles at 14 mph (64¢)	\$90
Savings through accelerating 180 vehicle miles from 10 to 14 mph overall speed (from 73¢ to 64¢ per vehicle mile)	\$16
Net increase in operating expenses	\$74

Almost 500 passengers are required to pay this increase in operating costs; thus, if 500 of the 670 retained passengers were influenced by the new express service, the transit system did not incur a loss in supplying it. The remarkably good patronage retention on the 14 local and 26 lines indicate that the express line cannot be credited with such an influence, but that transit riding in the section of San Francisco served by these routes is following a slightly different trend than the city as a whole.

Public Reaction

A factor common to all lines studied is that the section of the riding public responding to the postcard survey had much to say about the freeway express service, and that the vast majority of their statements expressed approval of the new service. As stated previously, the survey sample is probably biased on this point: persons feeling indifference toward the freeway service were less likely to mail in cards than those who wished to express definite opinions.

The comments of the survey respondents on the 14 freeway express fall approximately into the following categories:

Unqualified approval	49%
Qualified approval	21%
Critical comments and suggestions	16%
Other comments	4%
No comment	10%

The proportion of unqualified praise among the comments is high, and the tendency to use the survey as a way of letting off steam and airing complaints is low. The approval was mostly of the enthusiastic variety; considerable mention was made of the time savings compared to previous routes. Critical comments concerned almost entirely the problem of crowded buses, and were generally made by persons boarding buses far from the terminal of the route at points where all seats had already been occupied. This condition is being alleviated rapidly by introduction of new, larger buses now being delivered to the Municipal Railway from the manufacturer, and by scheduling additional trips. It must be noted from the financial results, however, that at a 15¢ fare a considerable number of standees will have to be carried on each bus if the break even point is to be attained.

The 14X freeway buses operate only during the rush hours; therefore their patrons are almost all weekday commuters. This is indicated by the fact that 92.5% of the respondents stated that they use the service every weekday. It is, therefore, not surprising to find that suggestions for service extension to other hours or to weekends seldom appeared. The passengers sampled find the service to their liking, and any who might prefer freeway express service at other times were not questioned. It will be found later that on the other routes, which are used by both regular riders and shoppers, suggestions for extended service appear a little more often.

There was little difference in the type of comments made by persons who had previously used the Municipal Railway and those newly attracted to it. The proportion mentioning crowded bus conditions were no higher among passengers attracted from the use of private automobile than from those who had been using the transit system all along.

Summary

The 14X freeway express line is in the main rerouting of an existing service with considerable

time savings despite greater length of the route. While neither patronage nor financial statistics are clear enough to show exact trends, it appears that some riders have been attracted from other means of transportation, that the line has lost less patronage than the system as a whole, and that the institution of freeway express service has caused slight additional financial losses due to the additional vehicle mileage involved. The service has the approval of most of its riders, especially because of the time savings involved.

FINDINGS ON ROUTE 17X

Physical Description

The approximate location of the freeway express route 17X is shown in Fig. 5. This route connects the Parkmerced residential development with downtown San Francisco via Stanley Drive, Alemany Boulevard, the Bayshore Freeway and 4th Street. It loops via Market, 2nd and Harrison Streets back to the freeway.

Parkmerced, which contributes the largest part of the patronage, is a high-density residential area, containing eleven 13-story apartment buildings and numerous one-family houses and garden apartments. All units in the area are for rent only, and are owned and operated by an insurance company. The resident manager of the community was instrumental in promoting the freeway express service and in publicizing it within Parkmerced by printing and distributing bus schedules. Some of the favorable patronage trends to be discussed later can no doubt be

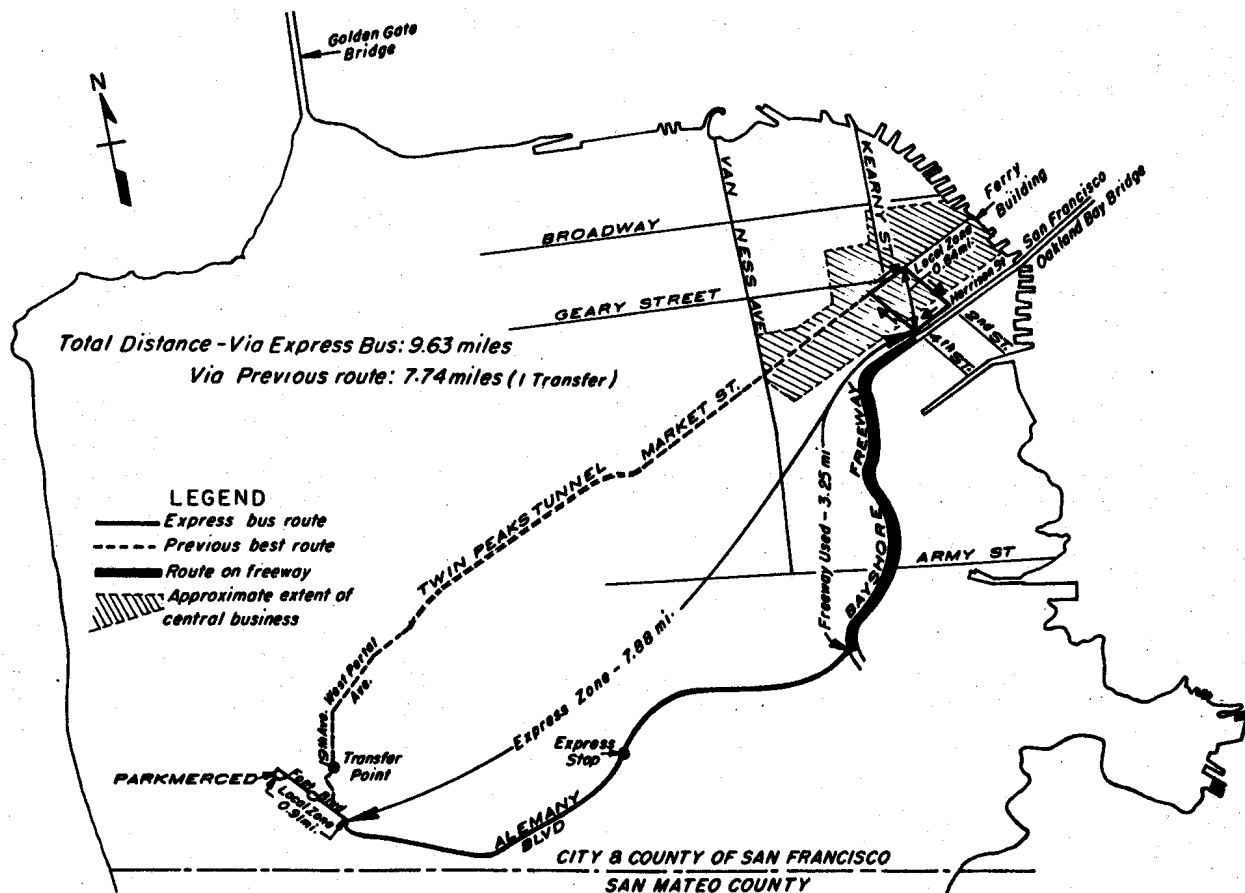


Fig. 5 — Express Bus Route 17X

TABLE 6 — COMPARISON OF ROUTE 17X WITH PREVIOUS BEST ROUTE

	Freeway Route	Twin Peaks Route*	Difference
Length between terminals, miles	9.63	7.74	+ 1.89
Travel time (peak), minutes	29-36	43	- 7-14
Average speed (peak), mph	16-20	11	
Travel time (off-peak), minutes	22-25	35-39	-10-17
Average speed (off-peak), mph	23-26	12-13	
Overall speed (including lay-overs, etc.), mph	19		
Length of express zone	7.88	2.26**	
Length of freeway utilized	3.25	—	
Speed in express zone (peak)	18-24	17**	
Speed in express zone (off-peak)	30	18**	

* - From west side of Parkmerced to 2nd & Market Streets, involves one transfer.

** - Data for Twin Peaks tunnel, which can be considered an express operation.

attributed to this. The line also attracts some patrons from the northern part of San Mateo county, especially the vast new developments at Westlake and Broadmoor. Passengers from these areas drive or are driven to the Parkmerced terminal, and transfer there from their automobiles to transit service. San Francisco State College is a short distance from the terminal, but has contributed little patronage to the line to date.

Service on the 17X freeway express is operated from 7:00 a. m. to 5:40 p. m. inbound, and from 7:30 a. m. to 6:05 p. m. outbound. Headways are from 7 to 10 minutes in peak periods, and 30 minutes during the rest of the day. The service is entirely new. Previously, the best service from the Parkmerced area downtown was via streetcar line M through the Twin Peaks tunnel. This line gives direct service to the east edge of Parkmerced; a feeder bus (17 Local) brings passengers from other parts of the community to the streetcar, and to nearby shopping areas.

Comparisons of the new freeway route to the streetcar route are given in Table 6. Exact travel times by the old route from the center of Parkmerced depend on waiting time at the transfer point from feeder bus to streetcar. In the tabulation no waiting time has been assumed.

The institution of the entirely new service via the freeway involved a considerable increase in total vehicle miles traveled. It was undesirable to reduce the vehicle mileage of the M streetcar line at the outset, because of its service to other residential areas, to a number of schools and to the state college. The 17 local bus also continues to run as before to provide service from Parkmerced to adjacent shopping areas, and to the streetcar, which is still the most convenient route for passengers destined for the Civic Center area of San Francisco and many other destinations. As a result the Municipal Railway now operates about 670 vehicle miles more each weekday in this area than before. However, as passengers continued to shift from the street-car to the freeway bus, it became possible to effect a reduction of about 75 streetcar miles daily in September, and to plan for further reductions in the future.

Patronage

The records of the Municipal Railway for the 17X and "M" lines are very valuable in this analysis. Vehicles operated on these lines are not freely transferred to other lines during the day, and statistics of no other routes except the 17 local service are included. Since the patronage of the 17 local may be assumed to be somewhat reduced by the new express service, such figures would have to be included for analysis in any case. The M car does not operate evenings or Sundays. (A bus service takes its place at these hours; its statistics are kept separate from those of the streetcars.) This makes a direct comparison of losses on the M line and gains on the 17X line even more precise.

TABLE 7 — CASH CUSTOMERS CARRIED ON PARKMERCED LINES

Month 1956	Increase or Decrease Over Corresponding Month of 1955						System Average
	M Streetcar		17 Local and Express		Total		
	Number	Percent	Number	Percent	Number	Percent	
January	- 8,267	-5.31	+ 13,643	*	+ 5,376	+ 3.22	-4.41
February	- 806	-0.56	+ 25,210	*	+24,404	+15.83	+0.11
March	-13,422	-7.52	+ 27,932	*	+14,510	+ 7.61	-2.74
April	-14,463	-8.84	+ 28,678	*	+14,215	+ 8.07	-3.71
May	- 4,220	-2.65	+ 32,714	*	+28,494	+16.68	-0.35
5 months	-41,178	-5.14	+128,177	*	+86,999	+10.13	-2.26

*Not comparable to previous year.

TABLE 8 — CASH CUSTOMERS CARRIED ON 17X LINE

Week of Operation of Freeway Express	Cash Customers (Local & Express)	Increase Since First Week
First	7,356	—
5th	8,562	+16.4%
9th	8,696	+18.2%
14th	9,720	+32.1%
18th	9,611	+30.7%
22nd	9,819	+33.5%

The 17X freeway express has attracted a considerable number of new users to the transit system. When it is remembered that the transit system as a whole experienced a patronage decline between the first five months of 1955 and those of 1956, the statistics, given in Table 7, become even more impressive.

There are indications that the patronage on the new service will continue to grow slowly for some time. The weekly passenger trends since the service was started show a continuing growth (see Table 8).

The postcard survey results also reflect this increase in patronage. On the basis of the responding sample, expanded to the total of 834 inbound riders, the previous history of the passengers is as follows:

Passengers previously using other transit routes	504
Passengers previously using private automobiles	151
Passengers previously traveling in car pools	50
Passengers previously not traveling in this area	113
Other (Jitney, Greyhound, not stated)	16
Total	834

The proportion of passengers attracted from private cars and car pools to the total riders is by far the largest of any of the routes studied; 24% of the riders are newly attracted to the freeway service and as a result 160 automobiles do not enter the downtown area. The number of persons who did not previously travel in this area is also significant. About 10 survey cards bore the comment that the respondent had moved to the Parkmerced area because of the new freeway express service. The management of Parkmerced had no figures available, but stated that certain types of apartments, which had not been readily rented in 1955, were easier to rent in 1956. The new freeway service is believed to have contributed considerably to attracting new

TABLE 9 — PASSENGER VOLUMES ON 17 PARKMERCED EXPRESS

Depart from Parkmerced	No. of passengers	Average load per bus	Percent of total	Cumulative % of total
7:00 - 7:59 a. m.	392	65	47.0	47.0
8:00 - 8:59 a. m.	179	60	21.5	68.5
9:00 - 9:59 a. m.	65	33	7.8	76.3
10:00 - 10:59 a. m.	48	24	5.75	82.05
11:00 - 11:59 a. m.	48	24	5.75	87.8
12:00 - 5:40 p. m.	102	7	12.2	100.0
All day	834	28	100.0	—

tenants to Parkmerced. The management of the community mentions the freeway express service in much of its press and radio advertising.

Since this line operates all day, the proportion of persons using the line less than 5 days a week was found to be quite appreciable; 19% of the total passengers fall in this category (compared to 7.5% on the 14X line, which operates only during peak periods). Nevertheless, the bulk of the passenger volume occurs in the peak hours. On the day of the survey, the inbound volume was distributed through the day as shown in Table 9.

Financial Results.

Despite the very favorable patronage trends discussed above, the revenue produced appears to be insufficient to meet the new operating costs incurred by this route. This is caused by the fact that every new passenger is a long-distance one, and the extra vehicle miles which must be operated for him are not covered by his revenue. During off-peak periods, passenger revenues are below the level which would balance the operating costs. An additional factor is the greater length of the freeway express route (almost 2 miles) over the old route; the passengers must be transported a greater distance than before.

An analysis similar to the one made for the 14X line on pages 10-11 would show the following: one trip of 9.63 miles costs about \$5.60 at the overall speed of 18 mph; "deadhead mileage" is estimated at 25%. (This is much less than the corresponding figure for a line operating during peak hours only, since some of the coaches remain on the route all day.) Each trip must produce \$7.00 in revenue, and requires 47 cash passengers, who will be accompanied by 16 transfer riders. As can be seen from Table 8, such loads are just reached in peak hours; it is important to note, however, that the average for the entire day is only 28 passengers per bus, far too little to support the cost of the service.

Table 10 shows some of the financial break-even points.

TABLE 10 — BREAK-EVEN POINTS FOR ROUTE 17X

Assumed conditions	Average load per bus	Load factor	Cash passengers	Revenue required to break even	Revenue required per cash passenger
Present fare: 44-seat bus	63	1.43	47	\$ 7.00	15
Present load factor for entire day: 44-seat bus.	28	0.64	21	\$ 7.00	33.3¢
Present patronage; 48-seat bus	28	0.58	21	\$ 6.30	30.0¢
Rush-hour-only operation, desirable load factor on 44-seat bus	55	1.25	42	\$11.20	26.7¢
Rush-hour-only operation, desirable load factor on 48-seat bus	60	1.25	45	\$10.00	22.2¢

TABLE 11 - DEFICITS ON PARKMERCED LINES

Month	M Car	17 Local & Express	Total Deficit	Excess Deficit 1956 over 1955	Excess Deficit per workday
January 1955	\$11,769	\$1,036	\$12,805		
January 1956	12,714	3,681	16,395	\$ 3,590	\$326.36
February 1955	11,544	1,081	12,625		
February 1956	13,232	5,141	18,373	5,748	261.27
March 1955	11,560	1,149	12,709		
March 1956	11,627	4,919	16,546	3,837	191.85
April 1955	10,994	973	11,967		
April 1956	11,779	4,296	16,075	4,107	195.58
May 1955	11,916	969	12,885		
May 1956	13,494	4,002	17,496	4,611	209.59
5 months				\$21,893	\$225.70

It might appear that the low passenger volumes in off-peak periods are a financial drag on the rest of the operation. It must be understood, however, that if this line were to be operated during peak hours only, the "deadhead mileage" would be about 100% of the revenue mileage, and the revenue required per cash customer would not drop as much as might be expected. Each run would have to produce \$11.20; at the present fare the load factor would have to be 2.25, which is beyond practical capacity.

Had the new service not been established, one might have expected the M and 17X lines to lose 19,400 passengers in the first five months of 1956 compared to those of 1955. Instead the lines gained 87,000 cash passengers. This represents about 1,100 cash fares "gained and not lost" for each weekday in the period of express operation. However, these fares were obtained at the expense of 670 additional vehicle-miles each day. The result is therefore as follows:

Additional operating expense, 670 vehicle-miles, 19 mph, at 58¢:	-\$165
Revenue "gained and not lost", 1,100 fares at 15¢ each:	388
Daily additional deficit on Parkmerced lines:	<u>\$223</u>

In September, when streetcar schedules were adjusted to compensate for the shift in patronage, a reduction of about 75 car-miles at \$1.12 resulted. The daily additional deficit was then reduced by \$84 to \$139.

The actual financial losses, computed from financial statements, have been almost exactly the same as the \$223 per day figure computed above by a theoretical method. (The close agreement of the two figures is possibly coincidental.) In Table 11, 1956 losses have been adjusted, by using corresponding 1955 unit operating costs, to eliminate the factor of rising costs of operation which would have occurred regardless of whether express service had been instituted or not.

Attracting additional long-distance riders from their automobiles to the express bus therefore appears to be an unprofitable undertaking especially if that passenger travels during the peak period. During such hours, additional riders require additional vehicle miles. With the growth of patronage, one additional peak-hour run in each direction has already been added to the schedules. Only if the new rider travels during off-peak periods, will his patronage help the Railway financially.

Public Reaction

The riders of the 17 line differ in some ways from the average bus rider in San Francisco. As has already been pointed out, the majority live in one housing community. They are all in a fairly high economic class. They are more "organized" than passengers on other routes, and react more concertedly. They appear to feel that the Parkmerced Express route belongs to them personally, and take a watchful interest in it.

This was shown in the results of the postcard survey: the percentage of cards returned was much higher than for any of the other routes -- 57.6% compared to an over-all average of 43.2%; only 6% of the respondents, lowest proportion of all lines, refrained from making any comments on their cards. Despite the fact that load factors on this route are lower than on the 14X line, more persons mentioned crowded buses on this route. Again, the community spirit was evidenced by the number of persons who stated objections to the use of the Parkmerced line by passengers from San Mateo county.

The comments of the survey respondents on the 17 express fall approximately into the following categories:

	<u>Daily users</u>	<u>Occasional users</u>	<u>All passengers</u>
Unqualified approval	22%	61%	29%
Qualified approval	33%	10%	29%
Critical comments and suggestions	31%	15%	28%
Other comments	9%	3%	8%
No comment	5%	11%	6%

The high proportion of unqualified approvals by occasional users (which will be found again on the 30 route) can be explained by the fact that these persons generally travel in off-peak periods when there are plenty of seats available. Most of the approvals were expressed in enthusiastic terms, and the critical comments were generally restrained. The latter referred mostly to high peak-hour loads on the buses; this problem has been alleviated recently by assigning new 48-seat Diesel buses to this route. Capacity has therefore been increased by about 9% and passenger reaction has been favorable.

A number of suggestions were made to extend service in the evening and to operate the express service on Saturdays. It would appear from the fact that 45 persons suggested the former, that two additional runs between 6 and 7 p. m. from downtown might be well patronized. Saturday service would probably carry only light loads; only 14 respondents requested such service without, of course, guaranteeing that they would use it if operated.

Summary

The 17 freeway express is an entirely new service operated to provide fast transportation from a high-density residential community to downtown San Francisco. It saves passengers an average of at least 10 minutes, despite the additional mileage of the route. It has succeeded in attracting new riders to the transit system from private automobiles, and has played a role in attracting new residents to the area it serves. However, it has not raised sufficient revenue to cover its costs and is not likely to do so; it appears impossible to carry passengers such long distances at a 15¢ fare without some financial loss. See Table 17. Although the residents of Parkmerced showed themselves to be more critical than others, they appear to think highly of the service. Their patronage furnishes additional proof of this.

FINDINGS ON ROUTE 30X

Physical Description

Route 30X, shown in Fig. 6, provides service to areas in the north and south sections of San Francisco. Only the southern portion utilizes a freeway. However, it was impossible to obtain statistics for one part of the route only, so the entire route has been studied. In some of the patronage and financial analysis the route as a whole is discussed. However, the replies received in the postcard survey could be sorted and analyzed for each half of the route separately. For convenience, therefore, this route is subdivided at Market Street; the southern portion will be referred to hereafter as Route 30S, the northern portion as Route 30N. Whenever the entire route is being discussed, the designation 30X will be used.

Route 30S. This route serves the Crocker-Amazon and Visitacion Valley areas of San Francisco near the city limits, and operates on the Bayshore Freeway and 4th Street to Market. The area contributing most of the passengers is of medium to low residential density. In the vicinity

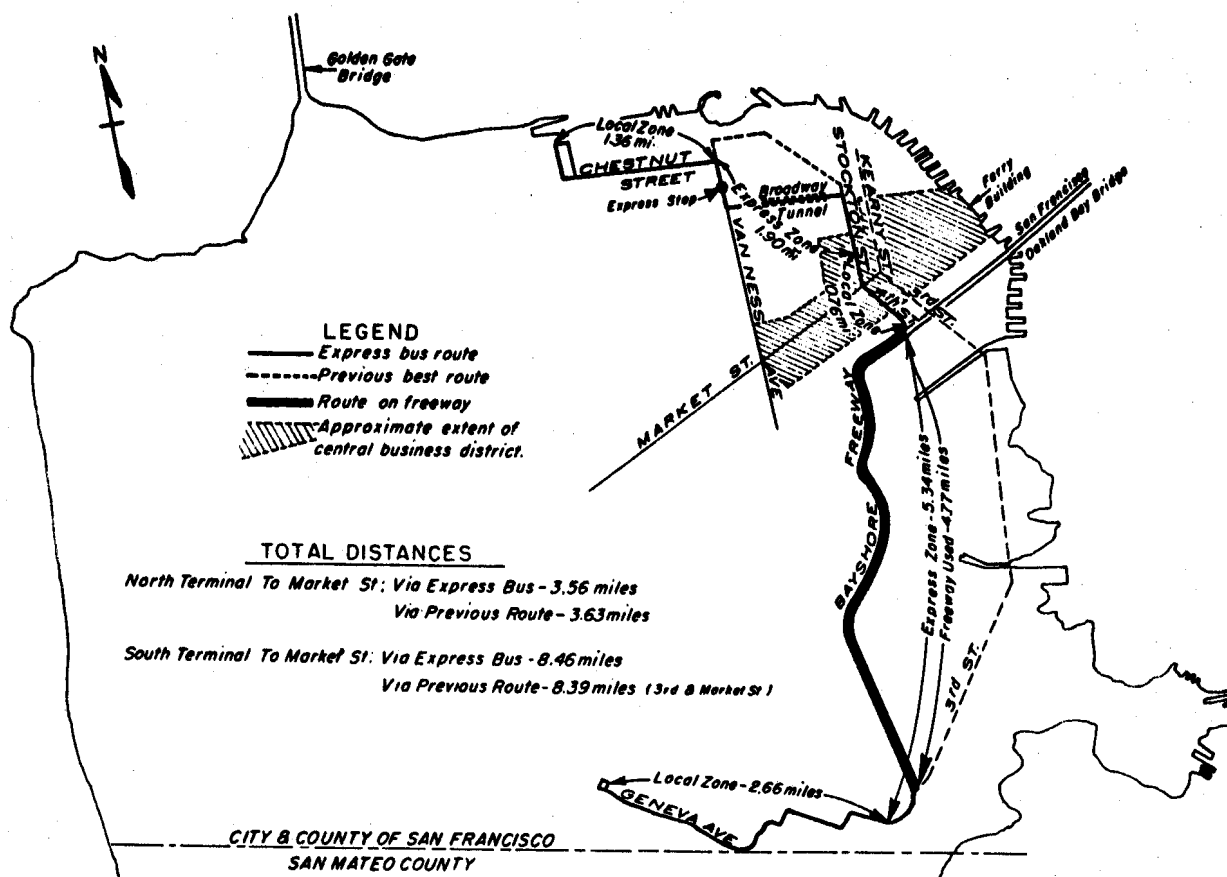


Fig. 6 — Express Bus Route 30X

of Bayshore Boulevard (near the southern limits of the express zone) there is an industrial area containing several large concerns. This area contributes a small but noticeable amount of traffic moving during peak hours in the direction of minor flow. This route uses a longer stretch of freeway than any of the others, and time savings are therefore notable. However, the temporary terminal of the freeway at Third Street during the peak hours is congested, and out-bound coaches in the evening are slowed considerably at this point. *

Service is operated from 6:45 a. m. to 5:45 p. m. inbound, and from 7:30 a. m. to 6:15 p. m. outbound. Headways are as low as 7 minutes in the peak periods, and 20 minutes during off-peak hours. Previous to establishment of this route the best service was via a limited-stop service on Route 15, which operated via Third Street. (Whenever these two routes are compared hereafter, Market and Fourth, and Market and Third are taken as the "terminals" of routes 30S and 15 respectively, and no allowance is made for the fact that these two points are actually one block apart. The Third Street location is somewhat more convenient for persons destined to the financial district and many of the major office buildings. The Fourth Street route is closer to the main stores and shopping areas.) The limited stop service on Route 15 has been discontinued, resulting in savings of some 660 vehicle miles per day. Route 25, which connects

* Since completion of the field work of this study, the line has been rerouted and now enters and leaves the freeway at ramps 1 mile north of the temporary terminal. Despite the added mileage on city streets and four new stops, the rush hour outbound time has remained almost unchanged.

Visitation Valley with 5th Street via San Bruno Avenue has lost some passengers to the 30S route, but it was only possible to reduce the vehicle miles operated thereon by 20 per day initially. Further, more substantial cuts, due to continued trend toward the express bus line, are being planned as this report is being written.

Comparisons between the new and old routes are given in Table 12.

Route 30N. This route connects downtown with the Marina District, a dense residential area along the Golden Gate. It operates as a local line from its outer terminal along Chestnut Street to Van Ness Avenue, then proceeds as an express via Van Ness Avenue (making an express stop at the intersection with Route 24 at Union Street) and the Broadway Tunnel to Stockton and Sutter Streets. It then calls at all stops to Market. Beyond this point about 60% of the coaches continue along route 30S previously described; the remainder go to the Southern Pacific Depot. The route does not use any freeway, but is the first line of the Municipal Railway to travel through the Broadway Tunnel. The tunnel provides 3,000 feet of access-controlled intersection-free highway, along which traffic travels at about 35 mph under a congested, hilly part of the city.

TABLE 12 — COMPARISON OF ROUTE 30S AND PREVIOUS BEST ROUTE

	Freeway Route	Third Street Route	Difference
Length between terminals, miles	8.46	8.39	+ 0.07
Travel time (peak), minutes	30	35-40	- 5-10
Average speed (peak), mph	17	13-14	
Travel time (off-peak), minutes	20-23	38-40**	-17-18
Average speed (off-peak), mph	22-25	13	
Overall speed (including lay-overs, etc.), mph	19		
Length of express zone, miles	5.34	4.91*	
Length of freeway utilized, miles	4.77	None	
Speed in express zone (peak), mph	23-26	14-17*	
Speed in express zone (off-peak), mph	38-43	13-14**	

* Data for limited-stop zone — Arleta Street to Southern Pacific Depot.

**No limited stop service in off-peak hours. Data for local service through limited stop zone.

TABLE 13 — COMPARISON OF ROUTE 30N AND PREVIOUS BEST ROUTE

	Express Route	Local Route	Difference
Length between terminals, miles	3.56	3.63	-0.07
Travel time (peak), minutes	24-26	30-31	-5-6
Average speed (peak), mph	8-9	7	
Travel time (off-peak), minutes	20-24	25-31	-2-9
Average speed (off-peak), mph	9-11	7-9	
Overall speed (including lay-overs, etc.), mph	8.5		
Length of express zone, miles	1.90		
Speed in express zone (peak), mph	12		
Speed in express zone (off-peak), mph	14-15		

TABLE 14 — CASH CUSTOMERS CARRIED ON THE MARINA AND VISITACION LINES

Month 1956	Increase or Decrease over Corresponding Month of 1955										
	Route #15		Route #25		#30 Local		#30 Express		All Lines		System Average
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Percent
January	-34,093	-4.99	-10,259	-6.04	-63,476	-11.11	+ 48,810	*	-59,018	-4.14	-4.41
February	-31,536	-4.97	- 3,222	-2.03	-61,640	-11.63	+ 93,359	*	- 3,039	-0.23	+0.11
March	-54,109	-7.45	- 6,466	-3.46	-87,963	-14.36	+109,854	*	-38,684	-2.53	-2.74
April	-57,222	-8.29	-12,088	-6.82	-97,163	-16.82	+102,842	*	-63,631	-4.40	-3.71
May	-33,175	-4.83	- 2,472	-1.41	-79,879	-13.93	+113,666	*	- 1,860	-0.13	-0.35
5 months	-210,135	-6.14	-34,507	-3.98	-390,121	-13.62	+468,531	*	-166,232	-2.32	-2.26

*Not comparable

TABLE 15 — SURPLUS AND DEFICITS ON THE MARINA AND VISITACION LINES

Month	Surplus (+) or Deficit (-)					Excess Surplus (+) or Deficit (-) 1956 over 1955	Excess surplus (+) or Deficit (-) per workday
	Route #15	Route #25	#30 Local	#30 Express	All Lines		
January 1955	-13,482	-13,950	+29,754	—	+2,322		
January 1956	-17,642	-13,456	+24,682	-3,275	-9,691	-12,013	-1,001.08
February 1955	-13,696	-13,206	+26,100	—	- 802		
February 1956	-14,179	-12,423	+23,190	-4,364	-7,776	- 8,578	- 428.90
March 1955	-14,436	-14,283	+32,086	—	+3,367		
March 1956	- 8,050	- 9,967	+29,621	-2,513	+9,091	+ 5,424	+ 246.45
April 1955	-10,890	-12,208	+30,175	—	+7,077		
April 1956	-10,106	-10,940	+23,972	-3,928	-1,022	- 8,079	- 384.71
May 1955	-12,268	-13,021	+30,460	—	+5,171		
May 1956	- 8,072	- 9,984	+24,480	-2,818	+3,606	- 1,565	- 71.14
5 months						-24,811	- 255.78

TABLE 16 — CASH CUSTOMERS CARRIED ON 30X LINE

Week of Operation of Freeway Express	Cash Customers	Increase Since First Week
First	18,976	—
5th	23,243	22.5%
9th	24,745	30.4%
14th	25,170	32.6%
18th	24,963	31.6%
22nd	27,093	42.8%

This route operates from 7 a. m. to 6 p. m. Headways are 6 minutes in peak hours, 10 minutes at other times. The previous best service was via the local route 30, operated by trolley coaches through Chinatown. The vehicle mileage of the local route has been reduced about 500 per weekday as a result of the diversion of traffic to the express route. Comparisons between the express and local routes are as in Table 13.

Route 30X. The vehicle mileage operated by the entire route is about 1480 per day. Reductions in vehicle miles on affected routes is 660 per day for Route 15, 20 per day for Route 25, and 500 per day for Route 30 local. Thus there is still an excess of 300 vehicle miles per day now operated over the amount prior to institution of the freeway express. Initial changes made on 15 and 25 routes provided liberal service during the period of adjustment. Now that the extent of the shift from these lines to the freeway bus has been ascertained, new schedules are being prepared which will cut some of this service. Eventually the excess vehicle mileage may be eliminated altogether.

Patronage

The Municipal Railway's patronage figures for Route 30X are accurate. Coaches operating on this route do not run over any other route. The same may be said for Routes 25 and 30 local, two of the three affected routes. Only in the statistics of Route 15 do some extraneous factors appear. Route 15 and another route, 42, are operated as a single unit, and all patronage and financial statistics appear together. Route 42 serves the Hunters Point Naval Shipyard, and its patronage fluctuates with the level of employment at that installation. However, there were no major changes in shipyard employment during 1955 and the first half of 1956.

The changes in patronage of the Marina and Visitacion lines from 1955 to 1956 are shown in Table 14. It would appear that the new express service has attracted few new riders to the transit system. In two of the five months, February and April, the performance of the routes concerned was slightly below the system average; for the other three months, the percentage of riders lost is only slightly less than the system average. The summation for the five months shows almost no difference between the Marina-Visitacion routes and the system average. These figures are somewhat surprising, since the postcard survey indicates a small number of new riders (while not, of course, showing how many persons during the same period changed from transit to other means). Some of the drop in patronage for 1956 can be blamed on the poorer weather in January, February, and May. Route 30 local, through Chinatown and the North Beach area of nightclubs, carries a large number of tourists; its patronage can be expected to suffer somewhat under adverse weather conditions.

Weekly totals of cash passengers show that patronage of the express service is still building up. However, it does not necessarily mean that new passengers are being attracted to the system; the build up may be only a continuing shift from local lines to the express line. The weekly totals are in Table 16.

The postcard survey results, which show some passengers attracted from other means of transportation, are as follows:

	30S	30N
Passengers previously using other transit routes	995	1807
Passengers previously using private automobiles	69	88
Passengers previously traveling in car pools	16	24
Passengers previously using jitneys	71	0
Passengers previously not traveling in this area	39	98
Other (Greyhound, not stated, etc.)	17	28
Total	1207	2045

TABLE 17 — INBOUND PASSENGER VOLUMES ON
ROUTE 30 MARINA-VISITACION EXPRESS

Depart from Terminal	Number of Passengers	Average Load per Bus	Percent of Total	Cumulative Percent
Route 30S				
6:44 to 6:59 a. m.	96	48	8.0	8.0
7:00 to 7:59 a. m.	437	62	36.2	44.2
8:00 to 8:59 a. m.	196	39	16.2	60.4
9:00 to 9:59 a. m.	99	33	8.2	68.6
10:00 to 10:59 a. m.	76	25	6.3	74.9
11:00 to 11:59 a. m.	34	11	2.8	77.7
12:00 to 5:59 p. m.	269	11	22.3	100.0
All day	1207	25	100.0	
Route 30N				
7:00 to 7:59 a. m.	549	69	26.8	26.8
8:00 to 8:59 a. m.	558	70	27.3	54.1
9:00 to 9:59 a. m.	208	30	10.2	64.3
10:00 to 10:59 a. m.	177	30	8.7	73.0
11:00 to 11:59 a. m.	128	21	6.3	79.3
12:00 to 5:59 p. m.	425	10	20.7	100.0
All day	2045	26	100.0	

TABLE 18 — ESTIMATED ADDED DAILY EXPENDITURE,
MARINA AND VISITACION LINES

Line	Equipment	Over-all Speed (mph)	Travel Added or Saved (vehicle-miles)	Unit Cost (vehicle-miles)	Increase or Decrease in Expenditure
30X	Motor Coach	11.5	+1,480	69¢	+\$1,025
15	Motor Coach	10.5	- 660	71.5¢	- 475
25	Motor Coach	10.5	- 20	71.5¢	- 15
30L	Trolley Coach	6.9	- 300	86¢	- 258
Net added expenditure					+\$ 272

Neither the South nor the North portions of this route attracted a large number of persons from private automobiles and car pools; respectively, only 7.0% and 5.5% of the total riders previously rode in cars. This is in the same range as the attraction by the 14 line, but much below the same factor for the Parkmerced Express. Such a small proportion of new riders may easily be outbalanced by fluctuations of tourists or shipyard workers on other routes being considered. The reason for the small proportion of new riders on Route 30N is doubtlessly the fact that there are less automobile users to be attracted. The residents of the Marina have always patronized the transit system in large numbers. The southern part of the route attracts a slightly higher proportion of riders than the 14 line, which serves an adjacent area. Time savings on this route are as great or greater than on the Parkmerced route, but there has not been a concerted advertising campaign in the area served by this route as there was in Parkmerced. As in the case of Route 17, most of the passengers travel in peak hours. The distribution of volume, as observed on the day of the postcard survey, was as shown in Table 17.

Financial Results

Since the patronage figures for Line 30X and the other affected lines combined show no variation from the system-wide downward trend, an increase in the operating deficit of these lines

TABLE 19 — BREAK-EVEN POINTS, ROUTE 30S

Assumed conditions	Average load per bus	Load factor;	Cash passengers	Revenue required to break even	Revenue required per cash passenger
Present fare; 44-seat bus.	55	1.25	41	\$6.15	15¢
Present load for entire day; 44-seat bus.	25	0.57	18	\$6.15	34.2¢
Present load; 48-seat bus.	25	0.52	18	\$5.50	30.5¢

is to be expected to reflect the increased vehicle-mileage. Under the initial schedule changes (to be revised now that the extent of patronage shift has been ascertained) the change in total expenditures might be estimated as in Table 18.

Actual financial figures are shown in Table 15. These figures fluctuate sharply from month to month. January losses were heaviest, partly, no doubt, because of the poor weather. In March, there was (theoretically) a larger profit than in the previous year. The five month average, however, shows a new loss of about \$256 per day, not far removed from the cost of operating the excess vehicle mileage. As before, the 1956 operating figures in Table 15 have been adjusted, using 1955 operating costs, to eliminate the factor of rising costs of operating buses and trolley coaches.

It is of interest to note that the deficit for routes 15 and 25 has sometimes been smaller in 1956 than in 1955. In the case of Route 15, part of this is attributable to the fact that this line has lost mostly long-distance passengers who had not been paying sufficient revenue for the operating costs they entailed. Another reason, applicable to both lines, was the introduction of new, Diesel buses, replacing the old gasoline vehicles.

The revenue required per passenger on the southern portion of this route follows the same pattern as for the two routes previously discussed. One trip of 8.46 miles costs about \$4.90. In this case "deadhead mileage" is estimated at only 25% since all coaches continue to the north portion of the route. Each run, therefore, must produce \$6.15 and requires 41 cash passengers, who will be accompanied by 14 transfer passengers. (see Table 19). Such loads are acceptable during peak hours, and are reached and exceeded at that time. But riding during the rest of the day, and in the direction opposite to the peak flow, fails to reach such an average.

For the much shorter north portion the passengers come close to paying the cost of operation. One trip on this route of 3.56 miles, at the overall speed of 8.5 mph, costs \$2.80. "Deadhead

TABLE 20 — BREAK-EVEN POINTS, ROUTE 30N

Assumed conditions	Average load per bus	Load factor;	Cash passengers	Revenue required to break even	Revenue required per cash passenger
Present fare; 44-seat bus	31	0.71	23	\$3.50	15¢
Present load for entire day; 44-seat bus.	26	0.59	20	\$3.50	17.5¢
Present load, 48-seat bus.	26	0.54	20	\$3.25	16.3¢
Present fare and present load in 44-seat buses. Overall speed increased to about 13 mph.	26	0.59	20	\$3.00	15¢
Present fare and present load in 48-seat buses. Overall speed increased to about 10 mph	26	0.54	20	\$3.00	15¢

mileage" is again estimated at 25%, increasing the cost per trip to \$3.50. This amount is paid by 23 cash passengers who, together with 8 transfer passengers, comprise a load of 31. This is just 5 persons above the figure actually achieved. It is therefore apparent that the northern portion of route 30X almost meets its cost, and that the bulk of the total deficit is incurred on the southern half. Average loads and revenue per bus are about the same on each half of the route. However, on the southern portion the passengers are transported about twice as far for the same fare.

Route 30N demonstrates the effect of slow overall speed on operating expense. See Table 20. If this speed could be increased from the present 8.5 mph to 13 mph (reducing operating costs from 79.5¢ to 67.5¢ per vehicle mile) the present volume of passengers would be sufficient to pay for the service at the 15¢ fare. Using 48-seat coaches, the speed would have to be raised only to 10 mph. This shows that even minor improvements in traffic conditions on a transit street, which will improve speed of operation, can have a very beneficial effect on the financial results of the transit operation.

Public Reaction

Route 30S. Once again it appears obvious that freeway express service is highly popular with the riding public. In the case of this route it is not difficult to see why. The route saves considerable amounts of time — especially in off-peak periods — and had lower load factors (up to the time of the postcard survey) in the peak period than any of the others. As a result the comments included a higher proportion of unqualified approvals and the least amount of critical comments of any of the lines studied.

	<u>Daily users</u>	<u>Occasional users</u>	<u>All passengers</u>
Unqualified approval	55%	73%	59%
Qualified approval	17%	8%	15%
Critical comments and suggestions	8%	4%	7%
Other comments	5%	3%	5%
No comment	14%	12%	14%

It appears clear that little relationship exists between the public approval as expressed in survey cards, and the number of new riders attracted. The patrons of the Parkmerced line, which has gained many new passengers for the Municipal Railway, were much more chary with their praise than those of this route, which has attracted few new riders. It was interesting to note that 72 of the respondents made specific reference to the time saved, although the number of minutes mentioned by some of them were much in excess of the actual savings achieved by the route! The few critical comments made again concerned crowded conditions during peak hours. A few requests for later evening service, Saturday service or more off-peak service were made.

Route 30N. The reaction of the riders of this route followed the general pattern of Route 14, having the following distribution of comments:

	<u>Daily users</u>	<u>Occasional users</u>	<u>All passengers</u>
Unqualified approval	44%	68%	50%
Qualified approval	26%	12%	22%
Critical comments and suggestions	18%	6%	15%
Other comments	5%	3%	5%
No comment	7%	11%	8%

As was generally the case, occasional users had even less criticisms to offer than daily users, generally because they travel during off-peak periods. It was again interesting to note that riders were impressed by the time savings offered by the new route, many of them exaggerating the amount of time actually saved. Ninety-eight persons made some comment on this topic. There were again a few requests for evening and Saturday service but, since the Marina District has very frequent service during these periods via local line 30, such requests were

not very common. A number of persons suggested that operations along Chestnut Street might be on a limited-stop or express basis east of Fillmore Street. This suggestion seems worth consideration; load factors are rather heavy on this line during peak hours, and the largest number of passengers have their origins and destinations near the end of the line (71% of the respondents to the survey had origins in the area west of Webster Street and north of Greenwich Street).

Summary

Route 30X replaces a limited-stop service over city streets in the southern portion of its route, and is an entirely new service in the northern part of the city. Time savings are considerable, especially over the freeway section. However, the service has failed to attract enough new passengers to cover the increased operating costs. The northern portion, being only 3 1/2 miles long, is almost paying its way, but the longer southern part, like the other freeway routes studied, will probably continue to lose money as it attracts more peak-hour passengers. Passenger approval of this route, especially the southern part, is very high.

SUMMARY

From the data collected in this study for the freeway express lines, certain patterns appear. Each of the four lines has certain particular physical characteristics peculiar to itself. Route 14 is a peak-hour-only operation along the outer part of a very heavily traveled trunk artery. Route 17 serves a high-density closely knit residential community. Route 30S receives its patronage from areas of lower density, and from an industrial zone. Route 30N, which is not really a freeway express, receives heavy patronage from a high density apartment house district.

Only Route 17 has attracted a large number of patrons from their private automobiles. Table 21 shows this clearly.

One reason for establishment of the freeway expresses is to reduce the number of private cars entering the downtown area. It is estimated that these express lines have persuaded 320 persons to leave their cars at home or at the outer terminals; some 30 car pools have also been disbanded. The success of Route 17 in this respect is, no doubt, partly attributable to the publicity this line received within Parkmerced, and the distribution of schedules. These 350 vehicles are only 0.2% of the 171,000 private cars entering the central business district of San Francisco from 7 a. m. to 7 p. m. on the average weekday.

While this shift, however small, from private automobiles to transit may increase the transit system's patronage, it does not brighten its financial picture. Every new passenger is a long-distance passenger, and his 15¢ fare is not sufficient to pay for the operation of the bus line. Each new passenger, especially the peak-hour rider, adds to the losses incurred by the system. The traffic pattern on an express line is such that the maximum load on each trip is the total load. The bus picks up its passengers in the first local zone, carries them through the express zone, and discharges them in the other local zone. (On the local lines, on the other hand, the ratio of maximum load to total passengers carried on a trip may be well below 1.0, since many passengers may have alighted before others board.)

TABLE 21 — PREVIOUS MODE OF TRANSPORTATION OF EXPRESS BUS PATRONS

Previous Mode of Transportation	Percent of Passengers on Route:				
	14	17	30S	30N	All
Other transit routes	69	60	83	89	78.0
Jitney lines	17	1	6	0	4.4
Private automobiles	4	18	6	4	7.4
Car pools	2	6	1	1	2.3
Did not travel in same area	5	14	3	5	6.4
Other	3	1	1	1	1.5

TABLE 22 — COST OF OPERATING EXPRESS BUS SERVICE

Type of operation	Average load factor	Deadhead mileage	Cost per mile*	Cost per cash passenger per mile	Miles covered by 15¢ fare
<u>Rush hour only</u>					
44-seat buses	1.25	100%	\$1.19	2.8¢	5.4
48-seat buses	1.25	100%	\$1.07	2.4¢	6.3
<u>All day, weekdays</u>					
44-seat buses	0.60#	25%	\$0.74	3.7¢	4.1
48-seat buses	0.55#	25%	\$0.67	3.3¢	4.6

*At assumed over-all speed of 19 mph, as obtained on fastest of present lines.
 #Load factors assumed to give riding volumes found at present on all-day lines.

Table 22 shows the actual cost of carrying passengers on an express route. It can be seen that the 15 cent fare covers a mileage which is less than the length of the freeway express routes. (Unit costs used are those of May 1956.)

The institution of freeway express service in all cases involved an increase in the number of vehicle miles operated, and consequently in operating costs. A number of factors contribute to this:

1. The route via the freeway is longer in two out of three cases than the best previous route. The freeways were not located primarily along the desired lines of transit riders served by these routes. The freeway route is the shortest in time from many parts of the city, but routes along city streets are often shorter in distance.
2. At the outer ends of the express lines some duplication with existing local lines is inevitable, even though passenger volumes do not require the additional service. To eliminate this duplication entirely would require many passengers to make an additional transfer of vehicles and, as a result, decrease the convenience of the service offered.
3. It is not immediately possible to cut mileage on the lines from which traffic is diverted to the new express route in proportion to the patronage drop. In the long run this goal can be approached or even achieved. But at the time of the initial change, and for several months thereafter, cuts in service must await determination of the changes in passenger riding habits which the new services have caused.

Somewhat compensating for the additional mileage is the improvement in over-all speed obtained. As Fig. 2 shows, unit operating costs per vehicle mile drop considerably as the over-all speed increases. It is certainly to the financial advantage of a transit system to carry its long-haul passengers on freeways, if this can be done without appreciable increase in vehicle mileage.

CONCLUDING REMARKS

This study has of necessity been limited to only a few express routes using portions of a still incomplete freeway system. The conclusions which are drawn from this study are therefore not necessarily applicable to similar operations in other cities, or in the San Francisco of the future. The completion of each new section of freeway will make it possible to accelerate transit service and make it more attractive to the user. On the other hand, it will also reduce the travel time of the motorist using his private car to reach downtown. It is difficult to estimate the total effect of a new freeway section will be on the distribution of passengers among public and private modes of transportation. It appears probable that the choice of mode of transportation will be guided more by terminal conditions downtown (availability of parking) than by a minor difference in trip times.

Freeway bus operations may be of two types. In one, buses of many routes use a freeway, leaving it at various points and serving different areas. The buses do not stop on the freeways,

and no special facilities need be provided on the freeways. This method of operation has the advantage of providing direct service to many outlying sections of a city. The other type of operation is a trunk line connecting with crosstown feeder lines. Such service requires intermediate stops to be made at crosstown connections. At diamond-type freeway interchanges stops may conveniently be made at the intersections of the ramps and the cross street. At other interchanges special bus turnouts, loading platforms, and pedestrian connections may have to be included in freeway design. Under this method service to each area can be provided at more frequent intervals with better utilization of vehicles than under the first method described, but many passengers will have to make a transfer on their trips. The capacity of a trunk line operation may be limited by the capacity of the bus turnouts. For example, if there is room for loading two buses at each interchange, and loading time is 30 seconds per bus, about 15,000 passengers can be handled per hour.

It appears evident that freeway express buses are attractive to some motorists under present conditions. The effect of this attraction on traffic volumes has been negligible so far. The transit company is faced with new financial problems. It seems probable that if the Municipal Railway of San Francisco were to begin an extensive campaign to attract new freeway express bus riders at the present fare, its deficit incurred in these operations would rise together with the number of newly attracted passengers. It might be desirable from the viewpoint of downtown businessmen, traffic engineers and the general public itself if a shift from private automobiles to freeway expresses were to take place, but the resulting financial problem would have to be resolved.

On the other hand, the transit company would gain financially if it could transport all its present long-distance passengers on freeway routes, provided the change could be affected with little or no increase in vehicle mileage. Such passengers are already causing a deficit, which would be reduced as the operating costs were lowered through improvement of the overall speed.

While it is beyond the scope of this study to make recommendations on the financial procedures of transit operations, the data collected in this study do raise the question of the feasibility of these and future freeway express buses. These problems are equally applicable in any city which contemplates this type of transit service. The alternative solutions appear to be the following:

1. Allow the freeway express routes to operate at a loss. This might be justified on the basis of their role in the transportation network. Such loss would have to be recouped by the rest of the system. Where the transit system is publicly owned, the subsidy can be obtained from general tax funds.
2. Establish user charges in relation to the cost of service offered. This would mean that the long-distance rider (whether on local or on express vehicles) would be charged more than the passenger making a short trip. The only practical method of levying this type of charge is by zone fares. However, the collection of such a zone fare requires extra time, special tickets, and the like, and has never become widespread in the United States². One of the chief advantages of an express bus route, the rapid trip time, would be reduced if prolonged stops had to be made to collect the zone charge or hat checks.
3. Establish user charges in relation to the value of the service received. This principle is used widely in utility pricing. The value of the express route is greater than that of the local route to the passenger, since he can save time by using the express route. Thus a special express bus fare could be charged. This method is in effect in Cleveland. No major operational problems would result in collecting such a fare; passengers boarding without a transfer would pay the full express bus fare; passengers boarding with a transfer would pay the differential between the express and the local fare.

It is quite likely that a higher express bus fare would result in some persons returning to the use of their private cars, thus detracting from the purpose of the express bus. Others would, if the difference in fares were sufficiently great, revert to local lines. However, in view of the time savings offered, the express lines would probably retain much of their patronage.

²Kennedy, Norman. A Study of Zone Fares in the Transit Industry. Berkeley: Institute of Transportation and Traffic Engineering, University of California. Research Report No. 16, April 1954.

A special express bus fare may also solve one minor problem. During peak hours some passengers ride the express buses within the local zone only, and add to the congestion of these buses, while the local vehicles are carrying a lighter load. This has been observed in this study along Chestnut Street. Local riding would be discouraged if it cost 5¢ or 10¢ more on the express bus. A disadvantage, on the other hand, is that the express bus would not carry local traffic at times when it is well able to do so. In off-peak hours or at the outer ends of the lines additional local service might have to be furnished along the same streets on which half-full express buses operate.

4. The last alternative method of obtaining the revenue needed to cover the costs resulting from attracting new long-distance passengers would be by a general, city-wide fare increase. This method seems to have least justification on an economic basis, and would probably meet with the most adverse reaction from the public.

The survey leaves no question as to the popularity of the existing freeway express lines. It is difficult to estimate the effect of charging a higher fare, by any of the methods mentioned above, on future patronage trends. But if the express bus offers travel times which compare favorably with those of the private automobile, they may well retain the passengers they now have and continue to attract a few motorists.

The problems mentioned above are those peculiar to freeway express operation. There are also, of course, those of the transit industry as a whole. In recent weeks labor costs in San Francisco have risen again, and the operating costs of May 1956, which were used in this study and in Fig. 2, are already too low.

Financial considerations apart, an extension of freeway expresses would certainly meet with the approval of the public and attract at least a few passengers from the private automobile. Travel times will be improved with each new mile of freeway opened and with the completion of distribution facilities downtown. However, it would be unsound to expect a swing from private cars to mass transit of such magnitude that the downtown traffic problem would be noticeably alleviated. The present lines have attracted only 1 car user out of every 500 and others have doubtlessly taken their place in the traffic stream. This suggests that there is still much to be learned about the factors which determine the individual's choice of his mode of transportation. How rapid must a mass transit service be to satisfy the average passenger and to attract the average motorist? How close must it pass to his origin and destination? What is the longest acceptable interval between vehicles? What is the highest acceptable rate of fare? It is hoped that such questions can be investigated in future projects, and that studies of express buses in other cities can be made to provide more material on this subject.

