

Service Planning, Scheduling, and Cost Analysis

The Scheduling and Service Planning (SSP) Department is headed by the Director of Scheduling and Service Planning who reports to the Director of Operations. The Director of SSP also acts as the Director of Operations when the Director is absent. The SSP Department has two full-time employees — the SSP Director and the Assistant Service Planner. In addition, there are three data collection checkers who are part-time employees and work under the supervision of the Assistant Service Planner. This staff is the right size for a scheduling function, but not for the workload represented by the planned service changes, representing the MTA in regional planning projects and system development planning (discussed below).

Service planning within SSP is oriented toward short-range decisions largely related to existing routes within the current MTA service area. This focus appears to be driven both by limited funds for new services and the small size of the planning staff. According to the SSP staff, when an immediate service need arises, SSP is asked to reallocate miles and hours from existing services rather than propose changes that produce a need for additional funding.

The staff has participated in planning for a number of service changes over the past several years in response to requirements such as planning for the Landports, Opry Mills service, and similar projects. There is a sound process for evaluating existing route performance on a routine basis, but there is relatively little regular activity dedicated to longer-term service opportunities prior to the current short and long range planning projects.

These longer-range, systems planning activities at the MTA have typically been addressed in five-year transit development programs prepared by outside consultants with input from MTA staff. Two current consultant studies are underway and about to be completed. These deal with short and long term service development programs

The SSP Director is MTA's principal planner and scheduler. Our interviews with him and our review of the SSP work suggest that he is a skilled and competent service planning analyst and schedule maker. Until the beginning of 2000, the SSP Director also acted as the system administrator for MTA's computer system. These additional responsibilities meant that the Director had to focus his attention on current and immediate scheduling and service problems rather future, longer-range service improvements and expansions. The remaining SSP staff provides good support to the Director, particularly in data collection. However, the staff does not participate significantly in the service planning analysis and scheduling preparation activities.

Use of Performance Indicators - SSP uses performance indicators in its work scheduling and planning transit service. Three performance indicators for each MTA route each month. Results for the three measures are reported for different service types — i.e., bus type, trolley shuttle.

The three indicators are:

- passenger revenue per revenue bus hour
- percent of *marginal* costs covered by passenger revenue
- passengers per revenue hour.

If each of the three indicators for a given route falls below 60 percent of the system (i.e., group) average, the service is reviewed and corrective strategies recommended to the MTA Board. As part of the review, any trip with less than five passengers is to be considered for termination. The 60% has been adopted as a policy standard by MTA and as such is well within industry norms.

The general structure of the performance indicators provides good service planning guidance to SSP. The three key route performance indicators reported to the MTA Board every month are consistent with the similar practices in the transit industry. There are some concerns, however, with MTA's current reporting of these performance indicators and service groupings. The first issue is the service type groupings. The second is the method used for estimating costs used in the measures. These issues are more fully explored below.

Service Type Groupings

The MTA now uses different service groupings than are stated in its service policy. The policy lists four service grouping; local bus, express bus, trolley and shuttle. In practice MTA uses local and express bus as one category. Additionally, the trolley and shuttle services are combined into a single category

Magnet school routes were implemented after the service standards were adopted and are considered a separate route category from conventional bus routes. However, discussions with MTA staff suggest that the routes are considered internally as conventional bus routes. This is reflected in the front page of the monthly report — System Service Comparison —where results for conventional and magnet school routes are reported in a combined result.

Methodology for Estimating Cost Values for the Performance Measures

The second issue related to performance reporting is the use of marginal costs and the method of cost calculation as reflected in the indicator *percent of marginal costs covered by passenger revenue*. Before a further discussion of this subject is possible a brief description of cost terminology is required:

Marginal Costs - Marginal costs are the out of pocket costs which change directly with changes in service levels. Examples are fuel and driver compensation.

Fully Allocated Costs- These costs include a share of all costs of the operation. Fully allocated costs would include a pro-rata share of overhead costs which are fixed in nature and do not vary with changes in volume. Examples of these fixed costs include executive salaries and building maintenance.

We examined the MTA's operating expenses as reported to the National Transit Database for fiscal year 1999 and estimate that fixed costs represent about 16 percent of MTA's operating expenses which corresponds to a ratio of fixed to variable expenses of 19 percent. This means that for every \$1 of marginal cost expense incurred by a break-even route, another \$0.19 is not included in the performance measure as reported at the MTA.

The use of marginal costs, rather than fully allocated costs, in the service metric *percent of marginal costs covered by passenger revenue* provides policy makers and the public only part of the picture when examining the percentage of operating costs covered by passenger fares. The use of only marginal costs exaggerates the percentage of costs covered by passenger fares, suggesting a route "breaks even" if its fare revenues cover its marginal costs.

Although the fixed costs do not change with minor levels of service changes, they are part of the operating costs and must be paid for by some funding source. The use of marginal costs in the fare revenue/operating cost indicator implicitly supports a policy that passengers should not be required to cover any portion of fixed costs. This contrasts with the practices of most transit systems that have a policy that passengers should support a stipulated portion of all operating costs — fixed and marginal.

The last point regarding the use of marginal cost versus fully allocated cost relates to the time allocation of fixed resources. While it is true that fixed costs do not change as readily as variable costs, it also is true that use of these resources would change when routes are added or eliminated. For example, the salaries for employees taking passenger surveys are a fixed expense. When routes are eliminated, the time spent surveying these routes can be reallocated so that more surveys can be conducted on the

remaining routes. Therefore, it is reasonable to “charge” routes for the time use of these fixed resources since they could be used elsewhere.

In addition to the use of marginal costs in the determination of route performance, the calculation of the true “marginal costs” used by the MTA is subject to question. The MTA estimates the marginal cost in a process that is shown in Table 4-1. These costs are based on two months actual data for the period July-August 2000. The steps are as follows:

- Sum the variable expenses (\$2,763,731)
- Subtract the estimated portion of the maintenance expenses (\$480,000) that are to be funded through the FTA capital program (the contra expense)— to yield the net total expenses (\$2,283,731).
- Divide the net variable expenses by the estimated number of vehicle hours (50,855) to produce an estimated cost per vehicle hour (\$44.92).

Table 4-1
MTA Performance Audit
Comparison of Marginal Costs With And
Without Contra for Capitalized Maintenance

<u>Expense Category</u>	
Total Variable Costs	\$2,763,730.76
Hours operated during period	50,855
Divided by Hours Operated	\$54.35
Subtract contra for capitalized maintenance	-\$480,000.00
Net marginal costs net of contra	\$2,283,730.76
Divided by hours operated	\$44.92

We agree with the general method of estimation of the marginal costs, with the important exception of the step in which the contra expenses are deducted. These expenses apparently are deducted by the MTA because they are funded using FTA capital funding. Using this approach suggests that these expenses should not be considered in a cost analysis.

Good practice would instead consider these expenses as part of the analysis of marginal costs for two reasons:

- The contra expenses are in fact operating expenses, no matter how they are funded. Excluding these expenses understates operating costs, and overstates the portion of operating expenses paid by passenger revenues.
- The contra expenses represent FTA capital which are used to cover operating expenses. This reduces the funding available for the MTA capital program. It is, therefore, proper that this transfer be assigned a cost value.

If the contra expenses were not deducted, a truer marginal cost per vehicle hour of \$54.35 would result. We confirmed this estimate using data reported to the National Transit Data Base for fiscal year 1999. We extended this analysis to estimate the *fully allocated cost* per vehicle hour at \$64.96. This is the unit cost value that most transit systems would use in their monthly performance reports.

To summarize, the range of cost for service changes represented by these various cost allocation approaches is thus:

- MTA estimated hourly marginal cost rate, with the contra deducted: \$44.92
- Hourly marginal costs rate, with contra included: \$54.35
- Rate with fully allocated costs and contra included: \$64.96

Building Cost Models

Most transit agencies use a variety of cost models designed for specific planning and analysis purposes. One agency that we have worked with maintains a set of 19 cost models. In the current short range planning project, the contractor (Urbitrans) used at least four different models in estimating service change costs for different types of services.

The basic package of used and useful transit cost models at a transit system often includes:

- A fully allocated cost model that includes all operating expenses – the essential starting point in developing a package of cost models
- A model for express service that reflects the different nature of variable costs related to express service
- A model for seasonal or one-time services that increase the peak vehicles required for service
- A marginal cost model for estimating the costs of service reductions or additions, that excludes most fixed costs
- A “step-wise” model for use in planning substantial service changes that require major changes in fixed costs such as facilities and supervisory personnel
- Mode specific cost models for fixed route, paratransit, trolley service, or other mode of operation.

Most basic cost models most often include coefficients for three variables:

- Hours of operation, to reflect the sensitivity of operations costs to the hourly costs of drivers wages and benefits
- Miles of operation, to reflect that sensitivity of maintenance costs to miles of operation
- Peak period buses, as a surrogate for the fixed costs related to facility maintenance and general and administrative costs.

Models that are used for determining the cost impact of small changes in service usually ignore the fixed costs, which do not vary with small changes in service.

The process of building a model consists simply of assigning percentages of the costs from all of the various lines in a chart of accounts to one or more of these three variables. The sensitivity of a given model can be changed to reflect the nature of the service to be evaluated, particularly to reflect changes in speed and the number of peak buses required for the service. The level of detail in the costs used in the model can also vary significantly

Applying a Two Factor Model to the MTA Services

The MTA uses a one factor model for most purposes: hours of operation. A common refinement on a one-variable model is to use a two variable model that estimates costs based on numbers of vehicle hours and vehicle miles operated. This approach recognizes that some costs such as driver's wages are primarily driven (or incurred) by the number of hours operated, while other costs such as vehicle maintenance are primarily driven by the number of miles operated.

This two-factor model using *hours and miles* is appropriate when there is significant variation in the operating speeds among bus routes. This is exactly the situation that exists at the MTA. We examined the scheduled operating speeds for the 52 bus routes operated in September 2000 and found that the average speed was 15.0 miles per hour. However, the operating speeds ranged from a low 9.9 miles per hour (44 MTA Shuttle) to a high of 25.7 miles per hour (97 RTA Murfreesboro Express).

Using MTA estimates and data reported to the National Transit DataBase for fiscal year 1999 we estimated that the *fully allocated* hours and miles cost (including contra expenses) as follows:

$$\text{Full Cost} = \$32.49/\text{vehicle hour} + \$1.93/\text{vehicle mile}$$

These are the unit cost values that most transit systems would use in calculating their operating expenses in their monthly performance reports.

We examined the affect using our hours and miles, full cost approach versus the current MTA approach that uses a marginal cost of \$44.92 per vehicle hour. Under both approaches, we grouped the MTA and Magnet school routes together and considered them one route class, rather than two separate groups as currently done.

The results of this analysis shows that more express routes fail the indicator *percent of operating costs covered by passenger revenue* when the hours/miles approach is used (Exhibit 4-1). When the marginal hourly approach is used, 11 routes fall below the 60 percent threshold. This 60% threshold represents 60% of the system average. Note that on the bottom of the Exhibit 4-1 the 60% system average under

the MTA approach is 26.8% versus 17.4% for our estimate using fully allocated hours and miles costs. When the full cost, hours and miles approach is used, the same 11 routes fail plus an additional four routes — three express routes and one local route.

The four additional “failing” routes operate at speeds greater than the system average. This means that they operate more miles per vehicle hour than the average bus route. It suggests that the RTA contract route (route #96 in Exhibit 4-1) pays only 54.3% of operating expenses, rather than 110.6% indicated with the use of the MTA model.

Since the hours and miles method is sensitive to these speed differences, it assigns more operating cost to these high-speed routes to reflect the additional expenses that result from the increased number of miles operated per hour.

Scheduling and Service Planning Decisions

As discussed, the SSP staff considers the three performance indicators when it makes service planning and scheduling decisions, usually in the form of route and schedule adjustments to current services. These indicators help identify routes that may require major service adjustments. SSP has been involved in service restructuring and developing new service proposals, much of which has not been funded. The focus of the group, however, has been short-range work on existing service

Longer-range planning activities are typically addressed in the five-year transit development program that is prepared by an outside consultant with some involvement from the SSP staff. SSP staff also is responsible for responding to changing street conditions due to construction, repair, and temporary closings. SSP tries to coordinate with the METRO Department of Public Works. While the working relationship has been good, SSP indicated that it is sometimes not aware of sudden changes because Public Works notifies SSP by letter mail which typically arrive after a street detour is in place.

Data Collection

SSP staff also manages a data collection program that is designed to support regular reporting, planning and scheduling activities. The planning activities focus on identifying and addressing low performing routes. The scheduling efforts focus on improving schedule adherence and minimizing crowding during peak periods. The data also support the monthly route status reporting. SSP primarily relies on data collected by the MTA drivers, largely via their farebox readings, and by its own SSP staff checkers.

As part of their fare collection duties, the MTA drivers assure that fare boxes properly register passenger boardings. The registering farebox keeps a running count of passenger boardings and the cash revenue received. SSP in turn monitors these passenger boardings and at the end of each month,

reconciles the farebox counts with the total passenger revenue and pass sales recorded by the finance department. SSP has developed a comprehensive spreadsheet process for allocating passenger revenues and passenger boardings based on the actual farebox readings for each route.

The spreadsheet process is logical, comprehensive and well documented. SSP annually compares the spreadsheet ridership estimates with those estimated using the sampling process for the annual National Transit Database statistics. SSP found that the two ridership estimates were within one percent of each other for last year. While the SSP processing and use of the fare box data is consistent with good industry practice, only the SSP Director has a thorough understanding of the spreadsheet logic used to process farebox data.

The second group of data collectors are the three part time SSP checkers who spend most of their time on ride counts. These counts require a checker to ride each bus trip at least once a year and record the number of passengers boarding and alighting at each stop. The checker also records the arrival times at each time point. The counts provide a wealth of information including key planning and scheduling data such as passenger usage and bus loadings by route segment and running time data. These boarding counts are updated annually so that SSP has current data on every scheduled trip. This is consistent with good industry practice.

On-Time Monitoring & Data Collection –SSP collects, summarizes, and reports monthly data on system on-time performance. The MTA uses the common industry standard (0 minutes early to 5 minutes late) for on time of service metrics. While MTA's goal is to operate all service on-time, it recognizes that factors such as weather and traffic congestion can delay service. Therefore, the on-time standard is 95 percent. Again, this is standard in the industry.

According to SSP, a maximum of 20 hours per week is spent to collect this system-level information. In addition to the annual ride checks of on time performance, the SSP checkers also collect data on system on-time performance at randomly selected time points each week. The objective of these checks is to measure on-time performance of the system as a whole over a period of time. Data are not systematically collected and reported by specific routes. MTA is meeting their system-wide standard for on-time performance.

Other Data Collection- SSP recently introduced a program to solicit input from the street supervisors. SSP designed a form for street supervisors to report information on the arrival of buses at the downtown transfer centers. This information includes schedule times, routes, and reasons for any late arrivals. This is an excellent method for collecting data on a large number of routes at a minimal cost. While the data may not provide statistical data on on-time performance, it is an excellent tool for pinpointing problems. SSP also distributes survey questionnaires to drivers and street supervisors before each

semiannual schedule change. The questionnaire asks for specific comments on current service problems, low ridership trips, and suggestions for service improvements.

SSP also considers suggestions from employees, and in particular from drivers. The SSP Director is actively involved with the MTA operators and visits with them daily in the drivers' room that is just down the hall from his office. This approach generates useful ideas and contributes to favorable employee morale.

Scheduling

SSP also has responsibility for preparing driver work schedules, a major determinant of the efficiency of the driver work force. Two such schedules are prepared each year, one starting the first week in March in the other starting the first week in September. Since transit is labor intensive, efficient schedule preparation has a significant impact on operating costs.

The efficiency of the scheduling function is evaluated by most transit systems by tracking the ratio of total scheduled pay hours to the number of hours actually used in driving a bus, or "platform hours". This indicator measures the performance of the schedule makers in efficiently scheduling operator labor to provide the scheduled transit services. Ideally, the value for this measure should be low and as close to 1.0 as possible. The achievement of the low values for this measure is limited by the service schedule, labor agreement provisions and work rules, plus the skill of the scheduling staff.

MTA 's system ratio of scheduled pay hours to platform hours consistently was 1.07 to 1.08 for the four-year period 1995 to 1999, as shown on Table 4-2. However, this ratio increased last year to 1.1. Some of this increase was due strictly to a computational change in the method of compiling the data. Another part of the change was a result in the increase in daily "report time" from 8 minutes to 15 minutes for each assignment each day negotiated in the last labor contract. This was a conscious decision to improve the quality of pre-trip inspections. The financial impact of this change is minimal. From the chart below, using the September year-over-year differences, there are approximately 350 "extra" hours per month in FY2000 than in previous years. Assuming half this difference is real and not a statistical fluke, this would equate to approximately 2100 extra hours annually ($350/2 * 12$). Multiplying this number by a wage rate of \$15/hr would yield \$31,500 extra cost per year. This ratio of 1.1 is still well within a range that is considered acceptable.

Table 4-2

**MTA Performance Audit
Scheduled Pay-Platform Ratios
Using March and September Hours**

<u>Year</u>	<u>Pay/Plat Ratio</u>		<u>March</u>		<u>September</u>		<u>Difference</u>
	<u>March</u>	<u>September</u>	<u>Pay</u>	<u>Platform</u>	<u>Pay</u>	<u>Platform</u>	
1995		1.088			5,723.9	5,260.4	463.51
1996	1.087	1.082	5,778.8	5,314.4	5,772.9	5,335.1	437.76
1197	1.084	1.085	5,902.5	5,443.5	5,994.1	5,524.8	469.32
1198	1.078	1.072	6,098.7	5,659.7	5,992.0	5,590.8	401.22
1999	1.072	1.075	6,385.2	5,957.3	6,554.8	6,095.5	459.28
2000	1.094	1.138	6,655.5	6,084.1	6,839.0	6,012.0	826.99

The SSP Director reviews the ratio of pay hours to platform hours that is produced by the SAGE computer program. This is an early 1990's scheduling package that was written for a DOS operating system. The SSP Director is the only MTA employee who knows how to use this software. More recent scheduling software is written for the Windows environment. The software is more user-friendly and interactive, which makes it easier for new schedulers to learn to use the system. Much better technical support also is available.

SSP also is responsible for determining driver requirements for regular and extraboard bus operators. The extraboard is simply a scheduling device used to ensure there are "extra" drivers available to fill in for drivers who are out with illness or to man unplanned trips. SSP uses a spreadsheet approach to determine the number of five-day work assignments that are needed to cover the seven-day service provided by the MTA. The approach is straightforward and clearly designed.

SSP also uses a spreadsheet approach to determine the staffing of the extraboard — the pool of drivers who fill-in for regular operators who are absent because of sickness, vacation, or other reasons. Extraboard drivers also operate some Magnet school service. When school is not in session, SSP schedules more operator vacations to use the five operators who ordinarily would operate the Magnet service. The overall extraboard management approach is clearly designed and is sensitive to the varying driver absence rates by day of week.

As with service planning, the SSP Director considers suggestions from employees, and in particular drivers, in schedule development. Since resources have been limited, the Director has tried to address passenger crowding through the deployment of large or small buses. When these changes are being considered, the Director discusses them with the affected drivers.

Conclusions

- The MTA has limited resources for service planning and market development. The SSP staff has focused on service scheduling, monitoring and evaluating the current services. Longer term service and capital planning activity common in many transit SSP departments is limited at MTA.
- The SSP Director is a skilled and competent planner and scheduler.
- The MTA uses different service groupings than are stated in its service policy.
- Contra expenses, capitalized maintenance expense, should not be excluded from MTA's marginal costing approach.
- MTA needs to develop more sophisticated cost models for use in measuring and evaluating service. An example, the two variable costing method using both hours and miles, is more appropriate for measuring marginal costs when there is significant variation in the operating speeds among bus routes — the situation that exists at the MTA. If MTA used this method, some planning attention would shift to some express bus routes with borderline performance.
- A model that includes the contra expenses and a factor for fixed costs should be used whenever representations of costs and costs recovery are made.
- There are communication problems between MTA and the METRO Department of Public Works regarding changing street conditions due to construction, repair, and temporary road closings that have an adverse impact on planning for and dealing with detours that are required as a result of public works activities.
- The ongoing data collection activities — ride checks, farebox readings, street supervisor reports, operator/supervisor questionnaires — are well designed to meet MTA's planning and scheduling needs for existing services.
- The reconciliation spreadsheets for the farebox readings are well documented. However, only the SSP Director truly understands the spreadsheet logic.
- SSP uses the SAGE computer program — an early 1990's scheduling package — that should be replaced. It is not user-friendly and is written for a DOS operating system that is approaching obsolescence. There is inadequate support available for this obsolete application.

- SSP has reasonable approaches for determining the number of regular operators needed to operate the scheduled service and the number of extraboard operators needed to cover “normal” operator absences.

Recommendations

- MTA should provide training to the Assistant Planner and others, as appropriate, on the service planning and scheduling functions performed by the SSP Director. This will provide the necessary backup protection for the SSP Director.
- The MTA should formally adopt expanded service design standards such as minimum service frequencies, hours of service, and days of service. Good starting points for this work are the informal standards now used by SSP and the possible standards being used in the current update of the transit development program. (One of the current planning projects is expected to recommend such service standards.)
- The MTA should update its service policy regarding the different service groupings.
- The METRO Department of Public Works should use email to communicate with SSP regarding changing street conditions due to construction, repair, and temporary closings.
- The MTA should replace its SAGE scheduling program with a new program that can be supported on new Windows operating systems. Care should be taken to ensure that the new program vendor provides good technical support that would enable more staff members to use the system.
- Contra expenses, capitalized maintenance expense, should not be excluded from MTA’s marginal costing approach.
- MTA needs to develop more sophisticated cost models for use in measuring and evaluating service. An example, the two variable costing method using both hours and miles is more appropriate for measuring marginal costs when there is significant variation in the operating speeds among bus routes — the situation that exists at the MTA. If MTA used this method, some planning attention would shift to some express buses routes with borderline performance.
- A model that includes the contra expenses and a factor for fixed costs should be used whenever representations of costs and costs recovery are made.

Cost Implications

- It is possible that the change in the cost model will produce some rethinking of the current services if the decision is to enforce the service standards on the services that fall below the acceptable performance standards.
- Costs associated with a new planning director and two additional planners are discussed in sections *Planning Structures and Governance*.
- Costs for a new planning and scheduling software program are estimated between \$75,000-\$150,000.