different from that of the Houston CPI.
1. Inflated dollars. Costs are computed by using the inflation rates defined in Table 1. These costs, deflated by the Houston CPI, equal the 1982 dollar costs.
2. 1982 dollars, no incremental inflation. Costs include no inflation whatsoever and are based solely on the FY1982 base year unit costs, wages, and salaries. These costs can be considered as the costs to operate the FY2000 systems in 1982. Thus, these costs can be useful in comparing the model results with current transit industry experience (7).

Table 5 presents FY2000 employees for each alternative. These values are determined during the course of the cost model computations and are useful in explaining some of the differences in costs. In addition, they can provide guidance to management in the consideration of service expansion plans.

CONCLUSION

The transit operating cost model presented in this paper has several important features that make it a useful analytical tool for transit management. First, the model is rich in detail, capturing the cost effects of staffing levels, labor productivity standards, unit prices, and inflation for different cost components. Second, the model is user-oriented. It is formulated on the basis of data commonly developed in the budgeting process. Its responsibility center-based organization provides for both ease in comparing projections with current conditions and ease in updating various data values. Finally, the model can be applied either manually or on a computer. Simplified worksheets allow for organized computation. Both mainframe and microcomputer applications have been successfully performed.

There are fundamentally two potential applications of the cost model. For short-range planning, the model can be used in the budgeting process for quick-response sketch planning. It could be used in many of the what-if questions typically asked by management regarding the cost effects of alternative service changes or potential labor productivity changes. It can also be useful in the context of sensitivity analyses concerning rates of inflation or other unknowns.

In long-range planning, the model can apply current and anticipated cost experience to project operating costs in the financial and cost-benefit analysis of major capital investments. The cost model described in this paper provides a strong analytical foundation for multyear analysis of transit investment in Houston, Texas. Other such applications should certainly be possible.

REFERENCES


Tri-Met Bus Operator Costing Methodology

JANET JONES

Traditional financial planning techniques are rapidly becoming inadequate as public mass transit confronts an environment characterized by limited and fluctuating revenues, funding shortfalls, and rising costs. The Tri-Met operator costing model is a part of a financial forecasting system approach toward the planning process in which short- and long-term consequences of alternative operating policies and performance can be determined. Tri-Met has drawn on past experience, research and review of existing methodologies, and future needs assessments to develop a costing methodology that combines the positive features of cost build-up and historical cost approaches and represents a sensitivity to the causal relationships underlying fixed and variable cost items at a marginal cost level. Bus operator costs are projected on a monthly basis over a six-year time frame as a function of service levels, service characteristics, work rules, productivity, and economic conditions. Common applications of the model range from service and scheduling changes to union labor contract provisions, assessments of part-time drivers, benefits, productivity, and absenteeism. The forecast technique has proved to be an invaluable tool of cost management and control, minimizing the risks involved in critical policy decisions.

Traditional financial planning techniques were sufficient tools of cost-revenue management when costs remained relatively stable and revenues were predictable and even sufficiently available. But growing complexities that characterize today's financial policy decisions require sophistication in planning, anticipation, and coping with financial uncertainties. Transit planning is increasingly complex due to demands to apply new and better tools for handling the dynamics of limited and fluctuating revenues, funding shortfalls, and rising costs. As a result, transit operators are directing greater attention toward cost effectiveness, efficiency and control, productivity, and performance analysis. It is fundamental to the responsibilities of transit operators to not only manage existing revenues and
cultivate new resources but also to better anticipate, monitor, and control costs.

Although there are many types of approaches applied to address these needs, financial forecasting provides a forward-looking economic planning tool. It steps beyond the customary budgeting process--financial forecasting in its most basic form--to assess the often profound financial implications of certain courses of action. And, unlike budgeting, it captures a consideration of the real causes and consequences underlying many revenues and costs. This is especially useful when incorporated into the planning process to assist in shaping and evaluating alternative plans and policies. However, because costs and revenues are controllable only within certain limits, financial forecasting can bring about a greater awareness of marginal cost-revenue impacts of alternative policies and the extent to which they are within management control.

It is difficult to measure the usefulness of financial forecasting. Recognizing, however, that transit reaps the result of decisions and not the result of plans, financial forecasting is effective in increasing the opportunities for making better (or at least better-informed) decisions and minimizing the risk of making a poor decision. It can be an invaluable interface between the planning process and the decisionmaking process.

FINANCIAL FORECASTING SYSTEM

Tri-Met faces a continuing need for accurate, timely financial projections that are readily responsive to policy issues. Answering this need, Tri-Met has made strides toward the development, improvement, and application of forecasting for use in the financial planning process and in program planning, including an automated version of a bus operator costing technique, which is discussed in this report.

The financial forecasting system is composed of a set of models and a planning structure. The planning structure serves as an analytical framework within which the models reside. Financial forecasting is the process in which a number of techniques, or models, which share a common data base, calculate future costs and revenues in terms of cash flow. Each model, supported by one or more subprograms, forecasts a distinct segment of costs or revenues within the comprehensive system structure. (See Figure 1.)

The concept behind this modular approach is to achieve a great deal of flexibility for testing what-if kinds of questions that require varying appropriate levels of detail. For example, a six-year cash flow annual summary report may be desired, requiring application of all of the cost and revenue models, or any model can be run individually if a monthly breakdown of detailed departmental line item costs is required.

The models represent mathematical relationships between cost-revenue items and a simulation of cause and effect. The causal factors are input data (independent variables) and the effects are the cost and revenue output (dependent variables). Results of the models are calibrated to match observable data and validated against available historical data.

The planning structure provides an organized method to input, access, and analyze data and control parameters, and specify output reports. The structure contains a multi-option variable processor, coded in FORTRAN, which incorporates such features as parameter-driven inputs and built-in default values. It allows flexible interpolation of missing values and extrapolation of input data on growth-inflation factors. It facilitates input data file editing and labeling capabilities. Reporting is...
allowed at various levels of detail and aggregations may be made on a quarterly or annual basis from monthly projections.

These features were developed in light of several characteristics that were considered desirable attributes in a financial forecast system. Flexibility was a high priority because in setting up a system, one cannot hope to predetermine all requirements. Therefore, the system was structured to allow for model changes and enhancements as development proceeded. It was also recognized that the system should be relatively simple to work with from a user standpoint. The models were built within a framework designed to accommodate a variety of input options, built-in default values, and convenient data interpolation-extrapolation features with a modular format that will permit independent subroutines for testing or future enhancement. Another requirement was sensitivity within the models to small changes at a marginal cost level. This is especially useful where a change in assumptions might make a difference, but it is not clear how much difference it might make. Perhaps the most important attribute to be considered was the value of the system in application. The system has been successfully applied in policy alternatives analysis for major decisions at Tri-Met. It has provided quality information that has minimized the risks involved in critical policy issues.

TRI-MET APPROACH TO BUS OPERATOR COSTING

Organization of Bus Operator Model

The bus operator costing model was designed to provide detailed, accurate financial information that would reflect sensitivity to operational policy and performance changes at a marginal cost level and would also capture the primary interrelationships among fixed and variable costs and their causal factors. With expanding applications ranging from service and scheduling changes to union labor contract provisions, assessments of part-time drivers, benefits, productivity, and absenteeism, it became clear that overly simplified techniques were not only inflexible, but inadequate as well. Tri-Met has drawn on past experience, research and review of existing methodologies, and future needs assessments to develop costing techniques.

The methodology of the model combines the positive features of cost build-up and historical cost approaches. The unit cost build-up approach is used to develop labor requirements based on service characteristics (e.g., peak to base ratio, service hours, and miles). The historical cost approach is used to develop labor cost factors per productivity unit (e.g., extraboard, work rule constraints, supervision, fringe, etc.) based on historical data. The historical cost approach captures the inefficiencies of exception pay, replacement labor costs as a function of absenteeism, and some work rules under existing conditions. However, it does not achieve the sensitivity to costs incurred due to major changes in service and operating characteristics, which is better accomplished by the cost build-up approach.

The bus operator model represents a dynamic costing technique designed to project future costs as a function of service level, service characteristics, work rules, productivity, and economic conditions. The model is initially driven by daily-level service hour input and further responds to any alterations in the type of service such as changes in the peak to base ratio, adjustments in weekday versus Saturday or Sunday service, or a shift from urban radial to time transfer service. Productivity factors reflect the efficiency of service provided in terms of ratios between service hours, platform hours required to support a particular service level, and operator pay hours required to assure to certain reliability at that service level.

Underlying the operator cost component calculations are assumptions that reflect work assignment provisions such as extraboard rules, constraints on the use of part-time drivers, and specifications for wage rates, cost-of-living adjustments, and benefits. Productivity assumptions take into account absenteeism, extraboard requirements, and unscheduled overtime. Based on the number of scheduled operators, additional operators are figured in to cover absence exceptions such as sickness, vacations, holidays, and other miscellaneous absences. This is achieved by applying various productivity factors, efficiency ratios, and unit costs to derive total operator requirements and direct labor costs. Finally, economic assumptions impact variable overhead costs including benefits and pension and payroll taxes.

Structure of Model

The bus operator costing process is structured in a hierarchical manner, starting from basic service units (service hours, miles, and vehicles) and working back to resource units (consumable items for which the transit operator must pay directly such as labor hours). The conversion from service units to resource units is accomplished through a series of productivity factors (such as pay hours per platform hour) that are based on primarily historical experience of Tri-Met and other transit operators. Once resource units are derived, they are converted to expenditures by applying (unit) cost factors. This general process is illustrated in Figure 2.

The bus operator costing model is divided into eight principal sections. These are discussed in sequence in this section, supported by flow chart diagrams (Figures 3-5).

Variable Declaration and Identification

Variables are processed primarily through the main program. All variable arrays are identified, in-
Figure 3. Bus operator model flow chart (A).

Program control parameters are input through the FORTRAN NAMELIST function. "&PARAM" is used to set the base year of the projections and "&SELECT" is used as a report parameter and contains arrays to control the output reports. The values assigned to these arrays call the appropriate subroutines, such as the bus operator model, and specify the desired output report.

Input/Computational/Output Variables are separated into two types of variables. The first type of variable includes time-based monthly data such as growth rates, unit cost factors, and operations costs. Each has a capacity for 72 time periods and is categorized by variable function. Each variable also is associated with a 20-character variable label and a 12-character units label, and it can be tied to a 12-digit accounting code. The second type of variable is characterized by changes that do not occur on a monthly basis, such as service levels and productivity factors. These values may be input with up to only nine changes, although they are calculated on a monthly basis.

Both types of variables require a label card that performs three functions. First, it simply defines the variable. Second, it designates an appropriate interpolation-extrapolation code to be performed on the variable, and third, it indexes the variable labels to correspond to the data cards.

dexed, and declared as integer or real and are passed through the bus operator model using COMMON statements. The variables are input through a separate data file.

Program control parameters are input through the FORTRAN NAMELIST function. "&PARAM" is used to set the base year of the projections and "&SELECT" is used as a report parameter and contains arrays to control the output reports. The values assigned to these arrays call the appropriate subroutines, such as the bus operator model, and specify the desired output report.

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Both types of variables require a label card that performs three functions. First, it simply defines the variable. Second, it designates an appropriate interpolation-extrapolation code to be performed on the variable, and third, it indexes the variable labels to correspond to the data cards.
Initial Input Data

The basis of all future cost estimates is the description of the future alternative transit service networks. These are quantified through the computerized simulation urban transportation planning system (UTPS) program, INET. This process converts the basic network description (route alignments, headways by time interval, running times, and layovers) into estimates of service units (revenue service miles, hours, and vehicles by time period by mode). The output must be refined to reflect actual conditions through several steps. Since INET is not a perfect simulation tool, evening peak and daybase statistics require adjustment by using calibrated factors: pure revenue hours (no layover) -- peak, 0.80 and daybase, 0.99.

To derive "pure" revenue hours for all service periods in agreement with an actual run cut, as performed by RUCUS, INET/RUCUS conversion factors are applied. This is done in order to eliminate layover time included in the INET revenue hours summaries and to adjust systemwide statistics to realistic figures. (Assumed service period factors are shown in Figure 6). RUCUS simulations would yield more precise figures than INET, but RUCUS is data-intensive and quite difficult to use as a forecasting tool. The need for INET can be substituted by a SAS simulation, used to determine vehicle and service hour estimates of service changes.

Data availability can be a problem when estimating potential changes in service levels or service characteristics, so the program is constructed to handle several input options. Flags are used for indication of the desired input entry level. For example, if service hour data are unavailable for the evening peak and daybase, total weekday hours may be input instead. Input can be any of the following combinations: (a) weekday evening peak and daybase revenue hours; (b) weekday revenue hours; (c) weekday, Saturday and Sunday revenue hours; (d) weekday, Saturday and Sunday revenue hours plus weekday, Saturday and Sunday articulated bus revenue hours; or (e) weekday, Saturday and Sunday platform hours.

INET produces revenue hour figures in terms of the evening peak and daybase service levels. After these figures are factored to reflect actual conditions, the assumed service factors are employed to develop total weekday service levels from evening peak and daybase figures.

Non-peak weekday revenue hours are derived as a function of the daybase. Peak weekday revenue hours are derived as a function of the evening peak. The sum of weekday peak and non-peak revenue hours represents total weekday revenue (in service) hours.
Saturday and Sunday revenue hours are derived as functions of total weekday revenue hours.

Platform time, which includes hours of scheduled service operated (revenue hours) plus deadhead and layover time, is calculated in the next step of the process. No overtime, guarantee, or report-clear time is included. The conversion from revenue hours to platform hours requires ratios applied on the basis of the weekday, Saturday and Sunday relationships between total daily platform hours and daily revenue hours. The ratios, which account for deadhead and layover time combined, average about 1.32 under present service conditions:

<table>
<thead>
<tr>
<th>Item</th>
<th>Weekday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layover</td>
<td>0.20</td>
<td>0.26</td>
<td>0.27</td>
</tr>
<tr>
<td>Deadhead</td>
<td>0.12</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>Revenue</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Total</td>
<td>1.32</td>
<td>1.30</td>
<td>1.34</td>
</tr>
</tbody>
</table>

The composition of these ratios in terms of proportion of layover and deadhead varies by time period as well as by weekday, Saturday and Sunday. This relationship for weekday service is shown in Figure 7.

Layover is a function of running time and remains fairly constant throughout the day. Deadhead is a function of peak service during the day and amount of tripper service. The proportion of deadhead time increases at the beginning and the end of each concentration of service hours as drivers begin and end their runs, and remains at a minimum during peaks of service. Whereas non-peak revenue hours include all service outside the morning and evening peaks, platform hours falling in the non-peak time periods include not only deadhead and layover time for off-peak service but also deadhead time for service that is provided during the peak. Consequently, in order to accurately evaluate the cost of peak service (and assess the portion of platform hours falling in the off-peak associated with service during the peak), it is necessary to allocate a cumulative portion of the off-peak deadhead to the peak revenue hours.

In comparing weekday, Saturday and Sunday hours, there is a higher proportion of deadhead time on weekdays than on Saturdays and Sundays because of the nature of tripper service that provides service exclusively to the peaks. Trippers, operating only on weekdays, have a high ratio of deadhead to layover time. Straight shifts, which generally involve a much greater number of repeated runs, have a larger proportion of layover time and a smaller proportion of deadhead time as compared in Figure 8. Additional comparisons of platform hour components revealed that although a low peak to base ratio is
Figure 6. Service period factors.

<table>
<thead>
<tr>
<th>Period</th>
<th>Time Interval</th>
<th># Hours</th>
<th>Factor</th>
<th>1980 Service Hours</th>
<th>1980 Service Hours/Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week Hours</td>
<td>1:00 - 5:00 A.M.</td>
<td>4.0</td>
<td>0.95 X Midday</td>
<td>35.3</td>
<td>9.0</td>
</tr>
<tr>
<td>A.M. Shoulder #1</td>
<td>5:00 - 7:00 A.M.</td>
<td>2.0</td>
<td>0.80 X P.M. Peak</td>
<td>30.4</td>
<td>151.7</td>
</tr>
<tr>
<td>A.M. Peak</td>
<td>7:00 - 8:00 A.M.</td>
<td>1.0</td>
<td>1.00 X P.M. Peak</td>
<td>35.9</td>
<td>383.6</td>
</tr>
<tr>
<td>A.M. Shoulder #2</td>
<td>8:00 - 10:00 A.M.</td>
<td>2.0</td>
<td>0.71 X P.M. Peak</td>
<td>510.2</td>
<td>258.1</td>
</tr>
<tr>
<td>Midday (Base)</td>
<td>10:00 - 1:30 A.M./P.M.</td>
<td>4.5</td>
<td>0.80 X Midday</td>
<td>883.3</td>
<td>195.3</td>
</tr>
<tr>
<td>P.M. Shoulder #1</td>
<td>1:30 - 4:30 P.M.</td>
<td>2.0</td>
<td>0.75 X P.M. Peak</td>
<td>336.1</td>
<td>271.1</td>
</tr>
<tr>
<td>P.M. Peak</td>
<td>4:30 - 5:30 P.M.</td>
<td>1.0</td>
<td>1.00 X P.M. Peak</td>
<td>359.4</td>
<td>359.4</td>
</tr>
<tr>
<td>P.M. Shoulder #2</td>
<td>5:30 - 7:30 P.M.</td>
<td>2.0</td>
<td>0.70 X P.M. Peak</td>
<td>302.7</td>
<td>250.6</td>
</tr>
<tr>
<td>Evening</td>
<td>7:30 - 1:00 P.M./A.M.</td>
<td>5.5</td>
<td>0.91 X Midday</td>
<td>041.6</td>
<td>80.1</td>
</tr>
</tbody>
</table>

Total Daily Revenue Service Hours = 6.95 X Midday + 7.16 X Peak = 6.95 X 196.3 + 7.16 X 359.4 = 3,937 hours

Total Saturday Revenue Service Hours = 9.62 X Midday = 9.62 X 196.3 = 1,888 hours

Total Sunday Revenue Service Hours = 5.10 X Midday = 5.10 X 196.3 = 1,001 hours

Total Annual Revenue Service Hours = 2,548 X Midday + 1,926 Peak

Figure 7. Comparison of platform hours to revenue hours.

The reciprocal ratio of platform time to scheduled pay hours serves to identify the percentage of scheduled operators pay that applies to productive platform service. This efficiency factor generally ranges from 90 to 91 percent. The RUCUS programming system strives to optimize the various runs within the work rules for the best efficiency and thus the lowest system cost per platform hour.

In converting from platform hours to pay hours, the peak to base ratio is incorporated into the model in order to account for its relationship between regular scheduled pay hours, scheduled overtime pay hours, and minirun (tripper service) pay hours. As a function of the peak to base ratio, the allocation of these pay hours can be determined associated with a large proportion of layover time, a higher ratio is characterized by a small proportion of layover and greater deadhead requirements as shown in Figure 9.

Scheduled Pay Hours

Scheduled pay hours serve to identify the percentage of scheduled operators pay that applies to productive platform service. This efficiency factor generally ranges from 90 to 91 percent. The RUCUS programming system strives to optimize the various runs within the work rules for the best efficiency and thus the lowest system cost per platform hour.

In converting from platform hours to pay hours, the peak to base ratio is incorporated into the model in order to account for its relationship between regular scheduled pay hours, scheduled overtime pay hours, and minirun (tripper service) pay hours. As a function of the peak to base ratio, the allocation of these pay hours can be determined.
as shown in Figure 10. The peak to base ratio is found on the horizontal axis and the percentage of total pay hours along the vertical axis.

Currently at Tri-Met, 14 percent of the number of existing full-time operators are employed as minirun operators. At the current 2:1 peak to base ratio, there are 180 trippers worked by minirun operators, comprising 7 percent of total pay hours. Beyond a 2:1 ratio, minirun trippers remain constant at the maximum allowable level, and unassigned (open) trippers occur. For each 15 additional trippers, there is a corresponding 1 percent increase in overtime pay hours. As shown in Figure 10, as the peak to base ratio increases, especially beyond 2:1, the proportion of overtime and open trippers continues to increase and the proportion of regular pay hours declines. Weekday, Saturday, and Sunday scheduled pay hours are interdependently assigned in the model based on the weekday peak to base ratio in order to reflect these relationships.

At this point in the model, daily platform hours are converted to total weekday, Saturday, and Sunday pay hours per quarter. They are then aggregated to sum quarterly (a) regular operator pay hours, (b) scheduled overtime pay hours, and (c) scheduled minirun pay hours. These quarterly pay hours take
into account all of the scheduled pay hours required for scheduled service.

Operator Requirements

Regular and Minirun Operator Requirements

The number of regular operators required is based on a weekly aggregated number of scheduled regular operator pay hours plus overtime pay hours that exceed the 8-h limitation. Similarly, weekly scheduled minirun pay hours determine the number of minirun operators required. The number of minirun operators is limited to 14 percent of the number of full-time operators, however, by current union contract provisions. Should the number of minirun pay hours dictate a requirement of minirun operators in excess of this limitation, the "unassigned trip­pers" are allocated to regular operators.

Regular and minirun drivers perform work that is assigned to them, according to their preferences, exercised on the basis of seniority, through periodic "sign-ups". These individuals sign up for various runs as well as two days off per week and vacation or holiday time. A considerable portion of transit service cannot be assigned in this manner, however, and there is also service (although unassigned) that must be filled due to scheduled operator absence. It is the function of vacation relief and the extraboard to meet these needs on a day-to-day basis. Minirun drivers are never allowed to perform work on the extraboard.

Extraboard Operator Unscheduled Overtime

Extraboard operators are assigned their work on a day-to-day basis. Unlike regular and minirun operators, extraboard operators are first contacted to report back and stand by for additional work, then those on a regular day off are asked to come in, and, finally, regularly assigned operators who have either completed their regular work or are on a regular day off. When this occurs, costs expand to include minirun operator hours of pay, plus report time and any unscheduled overtime, at overtime rates for all operators called in on a regular day off. Alternatively, maintaining an abundance of extraboard operators requires a minimum guarantee of eight hours pay, five days a week, as well as fringe benefits, payroll taxes, and other variable overhead costs for each additional extraboard operator.

Enlarging the extraboard, while reducing unscheduled overtime and increasing guarantee time, assures an available supply of operators for work assignments that would otherwise be handled by unscheduled overtime or missed entirely. The benefits derived from increasing service reliability must be balanced against the high overhead costs of additional operators. To accurately simulate an ideal extraboard size that minimizes cost would require a submodel to address such issues as optimization, given the trade-offs between guarantee time and overtime; optimal size of the report crew, given probabilities of absence patterns on a daily basis; and sensitivity of extraboard costs to changes in absenteeism, work rules, and schedules. Such a submodel, currently under development, will serve to greatly
enhance this costing technique and will be accommo-
dated as more data and resources become available. The
costing model bridges these considerations by using
productivity factors based on historical data to derive
total unscheduled overtime.

Wages

Total operator wages are separately calculated for
productive labor that includes straight time, sched-
uled and unscheduled overtime and premium pay, and
for unproductive labor that consists of the total of all
exception pay. Regular straight time labor includes
wages paid to regular operators, minirun operators,
and extraboard operators. These "regular" overtime
hours consist of the paid and unpaid exception hours of regular and minirun operators. Note, however, that extraboard exception hours are not included as part of "regular" extraboard hours because extraboard operators do not have regularly scheduled pay hours requiring specific replacement by another operator. Because extraboard require-
ments are a function of exceptions and not exclusi-
vously a service level, it is clear that if the exception rate improved, fewer extraboard operators would be required. Overtime labor includes sched-
uled overtime worked by the extraboard. Premium pay
includes an additional $0.50/h for time spent driv-
ing an articulated bus. The components of total driver pay hours follow: regular operator scheduled pay hours, regular operator exception pay hours, regular operator scheduled overtime pay hours, extraboard "regular" pay hours, extraboard exception pay hours, extraboard unscheduled overtime pay hours, minirun operator scheduled pay hours, minirun operator exception pay hours, articulated bus sched-
uled platform hours, exception wages--regular opera-
 tors, exception wages--extraboard operators, and
exception wages--minirun operators.

In order to derive total regular operator produc-
tive wages, the model first sums regular operator
scheduled pay hours and scheduled overtime. This
represents total regular operator scheduled pay
hours. Regular operator exception pay hours must be
subtracted from this to separate out the unproduc-
tive pay hours. The ratio of scheduled regular-
scheduled overtime pay hours to total scheduled pay
hours is then applied to the proportions of regular and
scheduled overtime pay hours. The scheduled
overtime pay hours are then multiplied by 1.5
times the pay rate. Both regular pay hours and
overtime pay hours are then multiplied by the appro-
priate wage rate to derive total regular operator
productive wages.

Minirun total scheduled pay hours are separated
according to the productive and nonproductive pay
hours by subtracting the exception pay hours. Pro-
ductive pay hours are then multiplied by the appro-
priate wage rate to derive total minirun productive
wages.

Extraboard pay hours consist mostly of "regular"
pay hours, comprised of the regular operators' and
minirun operators' scheduled pay hours that are not
worked due to a variety of exceptions. There also exist
unscheduled overtime pay hours that result
primarily due to variations in the sizing of the
extraboard, depending on the number of extraboard
operators available to perform the work at straight
time. The number of unscheduled overtime pay hours
is multiplied by 1.5 times the pay rate. Both the
productive "regular" pay hours and overtime pay
hours are then multiplied by the appropriate wage
rate to derive total extraboard operator productive
wages. Exception wages calculated for regular,
extraboard, and minirun operators are combined to
sum total exception (unproductive) wages.

All operators receive an additional $0.50/h for
time spent driving an articulated bus. Total artic-
ulated bus platform hours are derived from articu-
lated bus revenue hours, the multiplied by the
premium pay rate.

Fringe Benefits

Fringe benefits include the cost to Tri-Met of
providing life, medical, and dental insurance and a
pension plan to its employees. Operator pension
costs (which are expensed as defined by a standard
actuarial study) are based on a cost-per-operator
factor, multiplied by the number of regular and
extraboard operators. Other bus operator fringe
costs are determined by the total number of regular
and extraboard operators and the small number of
eligible minirun operators, multiplied by a cost-
per-operator factor for life, medical, and dental
insurance coverage. The sum of these costs equals
total bus operator fringe cost, yielding nearly a 12
percent additive to the cost of operator wages.

Indirect Labor Costs

Indirect labor costs include employer-paid overhead
costs of payroll taxes including Social Security,
workers' compensation, and unemployment compensa-
tion. A tax rate (currently 0.0670 percent on a
taxable base of $32,900 annual individual income) is
applied to total labor costs to determine Social
Security taxes. The rate of taxation is subject to escalat-
ing changes as shown in the current Social Security
Administration's schedule as past, present, and
proposed rates, shown below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Base ($)</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>25,900</td>
<td>6.13</td>
</tr>
<tr>
<td>1981</td>
<td>29,700</td>
<td>6.65</td>
</tr>
<tr>
<td>1982</td>
<td>32,900</td>
<td>6.70</td>
</tr>
<tr>
<td>1983</td>
<td>33,900</td>
<td>6.70</td>
</tr>
<tr>
<td>1984</td>
<td>38,100</td>
<td>7.05</td>
</tr>
<tr>
<td>1985</td>
<td>42,600</td>
<td>7.15</td>
</tr>
</tbody>
</table>

Maximum tax levels are established each year in
association with the above bases and rates and are
also subject to change. Workers' compensation is
similarly calculated by applying a tax rate to total
labor costs, excluding vacation and merit bonus
pay. (Unemployment taxes are paid on an individual
basis, rather than as a taxable rate paid to the
State of Oregon. The cost model simplifies this
calculation by applying an average cost-per-operator
factor to the number of operators. Total indirect
labor costs represent approximately an 11 percent
additive to total wages.

Output

Report output is specified using the "#SELECT" option in the main program. Optional informational
reports are available including a distribution of
weekly, Saturday and Sunday pay hours, a breakdown
of operator requirements by type, and exception pay
hours and costs by operator type. Final reports can
be printed showing monthly, quarterly, and/or yearly
costs. Variable and data listings are also avail-
able. Output report options include operator sta-
tistical reports--distribution of weekday, Saturday
and Sunday pay hours, operator requirements, dis-
tribution of exceptions by operator type; and bus
operator cost reports--monthly, quarterly, and
annual.
Figure 11. Sample financial forecast.

<table>
<thead>
<tr>
<th>NON-CAPITAL COST REDUCTION REDUCED/DEFERRED CETIP</th>
<th>FY 81</th>
<th>FY 82</th>
<th>FY 83</th>
<th>FY 84</th>
<th>FY 85</th>
</tr>
</thead>
<tbody>
<tr>
<td>NON-CAPITAL REVENUES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farebox Revenues</td>
<td>19029</td>
<td>19990</td>
<td>23338</td>
<td>26978</td>
<td>29098</td>
</tr>
<tr>
<td>Other Operating Revenue</td>
<td>1041</td>
<td>2025</td>
<td>1644</td>
<td>2031</td>
<td>1631</td>
</tr>
<tr>
<td>Payroll Tax</td>
<td>34565</td>
<td>37620</td>
<td>40701</td>
<td>45760</td>
<td>50950</td>
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<tr>
<td>State Operating Revenue</td>
<td>---</td>
<td>1000</td>
<td>1100</td>
<td>1150</td>
<td>1200</td>
</tr>
<tr>
<td>Federal Operating Assistance</td>
<td>5890</td>
<td>5890</td>
<td>3877</td>
<td>1994</td>
<td>---</td>
</tr>
<tr>
<td>Federal Tech/Demo Assistance</td>
<td>1566</td>
<td>1300</td>
<td>---</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>( 12</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Interest</td>
<td>2319</td>
<td>2100</td>
<td>1900</td>
<td>1600</td>
<td>1200</td>
</tr>
<tr>
<td>New Revenue Source</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL NON-CAPITAL REVENUE</td>
<td>64798</td>
<td>70125</td>
<td>72680</td>
<td>79613</td>
<td>86179</td>
</tr>
</tbody>
</table>

| NON-CAPITAL COSTS                                |       |       |       |       |       |
| Bus Operators                                    | 25710 | 25909 | 31772 | 32854 | 35517 |
| Fuel                                            | 4944  | 5415  | 6312  | 7157  | 8139  |
| Maintenance                                      | 11718 | 12911 | 13934 | 15085 | 16489 |
| Operations & Support                            | 5940  | 7278  | 9628  | 10694 | 12046 |
| General & Administrative                        | 11137 | 12903 | 13935 | 15050 |       |
| Banfield LRT Project                            |       |       |       |       |       |
| TOTAL OPERATING COSTS                            | 59360 | 68076 | 74519 | 79275 | 87241 |
| Debt Service                                     | 336   | 399   | 400   | 480   | 967   |
| TOTAL NON-CAPITAL COSTS                          | 59696 | 68475 | 74912 | 80090 |       |

| NET WORKING CAPITAL PROVIDED FROM OPERATIONS      |       |       |       |       |       |
| CONTINGENCY                                      | 5102  | 1650  | ( 2230) | ( 592) | ( 4029) |
| BEGINNING WORKING CAPITAL                        | 17181 | 18831 | 15592 | 14000 |       |
| ENDING WORKING CAPITAL                           | 17181 | 18831 | 15592 | 14000 | 8971  |

APPLICATIONS

Tri-Met Experience

Tri-Met commonly uses the bus operator costing model in assessing operating policy and performance, and short- and long-range financial impacts resulting from changes in economic conditions. Probably the most common application is the assessment of service improvements or expansion in the short range. This application also takes into account the associated marginal costs of new increments of service, with leading costs such as the hiring and training of new operators in advance of implementation. It is less effective, however, in the application of assessing reductions in service hours, necessitating layoffs on a low seniority basis, and changing the distribution of the run cuts.

The bus operator model, when applied in concert with all of the cost/revenue models, yields a cash flow status in terms of working capital after all the current period’s revenues are summed, less costs, from the previous period’s ending working capital figure. Through cash flow analysis, overall financial consequences can be quickly determined. This process provides a tool of cost management, and perhaps more important, an understanding of degrees of cost control. Through a process of sensitivity analysis, in which key variables are changed and the cost impacts are noted, comparisons can be made among alternatives to determine to what extent costs are controllable, and to what degree costs are impacted by policy and performance assumptions.

An example of the cash flow forecast is shown in Figure 11. An analysis was conducted to assess the impact of amounts of proposed new service and timing adjustments regarding implementation under a range of pessimistic, optimistic, and most-likely conditions. The result of these forecasts was the guidance to a series of decisions to pare the proposed amount of service by one-third and defer implementation by nine months. Six-year projections indicated that despite a financially healthy situation today, the expansion of a $7 million service improvement (roughly equivalent to 10 percent of Tri-Met’s current annual operating budget) during a period of dwindling revenues threatened to produce a deficit within three years. Sometimes the role of the financial forecaster is to raise a red flag before the agency commits itself to a costly long-term improvement plan.

It is acknowledged that the forecasts are only one input among many other less-structured inputs within the institutional and political processes that simply depend on sound judgment. Adding forecasting to these processes does not make the financial uncertainties any less unpleasant, but by increasing the awareness of those who must make policy decisions, financial forecasting offers direction and depth of insight.