BUS AND RAIL OPERATIONS

Introduction

What are the critical success factors for continued or improved ridership levels?
What impact do planning, scheduling, and maintenance decisions have on transit operations?

Key Concepts

Key Concept 1: Critical Transit Success Factors

Continued or improved ridership levels are an underlying goal of every aspect of bus and rail operations. This goal cannot be achieved without attention to these critical success factors:

- Access - convenience for the passenger
- Frequency and headways
- Reliability
- Safety
- Security
- Comfort
- Cleanliness

Key Concept 2: High-Impact Transit Operations

Planning, scheduling, and maintenance decisions all affect transit critical success factors.

1. **Planning** determines the types of routes and the type of network the agency will use (i.e. hub and spoke, grid)
2. **Scheduling** determines the number of vehicles based on several variables and assigns those vehicles and their drivers to routes.
3. **Blocking** is determining vehicle schedules.
4. **Runcutting** is assigning driver/operators to runs carved out of blocks.
5. **Maintenance** can be categorized into four types depending on frequency and aims to keep the service reliable.

Planning Overview

The many steps for planning routes and schedules begin with five basic steps. These steps assume the majority of service is driven by demand.

The Basic Five

1. Set headway policies: Time between vehicles.
    - Example: 3 minutes between trains.
2. Define passenger load standards: By what number should passengers exceed seats?
    - Example: Volume of passengers should not exceed 120% of seats. For a 65-seat bus, 85 passengers would constitute overcrowding if the goal is not to exceed 120% of seats for a specific period of time such as peak or 10 minute increments.
3. Calculate the number of rail cars or buses based on headways, routes, and travel speeds.
    - Example: To maintain 15 minute headways and accommodate passenger loads of 120% of seats, the Southeastern routes must have 130 vehicles.
4. Determine peak demand: Determined by taking actual counts of ridership at maximum load points on any line or route, considering the direction of peak travel.
    - Example: On Route #36, 600 passengers per hour are expected at peak demand times.
5. Calculate in-service vehicle requirements according to policy headways and projected passenger demand.
    - Example: For all routes, there must be 1,000 buses to meet 15-minute headways and accommodate passenger loads.

Completing the Planning Process (after the Basic Five)

1. Determine strategic reserve/ready reserve vehicles: these are manned spare vehicles held in reserve during peak periods.*
    - Example: As many as 10% of scheduled buses might be needed for strategic, filler purposes. For instance, if a particular line is running very late, a strategic might be deployed to help make up the time.
2. Calculate peak vehicle requirement=vehicles in service + strategic vehicles.
    - Example: Scheduled buses = 750, strategic buses = 8, Peak vehicle requirement = 758
3. Calculate operating spares necessary to meet peak vehicle requirement: Usually expressed as a percentage of scheduled fleet.
    - Example: Peak vehicle requirement = 758, Scheduled Maintenance requirement = 90, unscheduled Maintenance = 22
4. Determine total fleet requirement = Peak Vehicles + Operating Spares.
    - Example: Peak vehicle requirement of 758 plus 90 scheduled maintenance plus 22 unscheduled maintenance = 870

* Note that some agencies do not differentiate between ready reserve and spares.

Module 2:
Bus and Rail Operations

Scheduling: Terms and Steps

Lesson objective

Identify and define terms and variables involved in scheduling transit service.
Identify impact of scheduling on transit system success.

Scheduling Goal and Variables

1. Goal: least possible number of vehicles and operators to deliver the service design
2. Key variable is platform time. Platform time is the total of these elements:
   - Pull-out allowance (deadhead): Time taken to get the vehicle from the garage to the route start?
   - Revenue trip: In-service time plus layovers
   - Pull-in deadhead: How long from the end of the route to the garage?
3. Blocking is determining vehicle schedules
4. Runcutting is cutting the blocks into operator (driver) assignments.

Blocking is determining vehicle schedules. Here are some examples:

1. Calculate cycle time:

Running time from A to B	27 minutes
Running time from B to A	26 minutes
Running time total	53 minutes
Layover at A	4 minutes
Layover at B	3 minutes
Total cycle time	60 minutes

2. Calculate number of vehicles required for running times, layover times, and headways:
   If headway is 60 minutes, 1 vehicle is needed
   If headway is 30 minutes, 2 vehicles are needed
   If headway is 15 minutes, 4 vehicles are needed

3. Consider "inefficient" routes, where headways and cycle times don't match.
   Running time 63 minutes total
   Layover at A 4 minutes
   Layover at B 3 minutes
   Cycle time 70 minutes, but Headway is 60 minutes so 1.167 vehicles are required.

   Problem: Partial vehicles are not possible
   Solution 1: Increase layover to 57 minutes, requiring 2 vehicles (120 minutes, 60 minute headway)

Solution 2: Increase headway to 35 minutes

4. Put the round trips together to make blocks of close to 8 hours.

5. Add a pull-out deadhead allowance at the beginning, say 15 minutes depending on how close the route is to the garage.

6. Add a pull-in deadhead allowance at the end, say 15 minutes.

7. Calculate efficiency: Platform time, time the operator is at the controls, is combined revenue and non-revenue time.
    - Revenue = say 7 hours 30 minutes
    - Non-revenue = deadhead allowances = 30 minutes
    - Efficiency is 7.5/8.0 = 93.75%, which would be pretty good!
    - Creating efficient blocks lays the basis for efficient operator runs

Runcutting

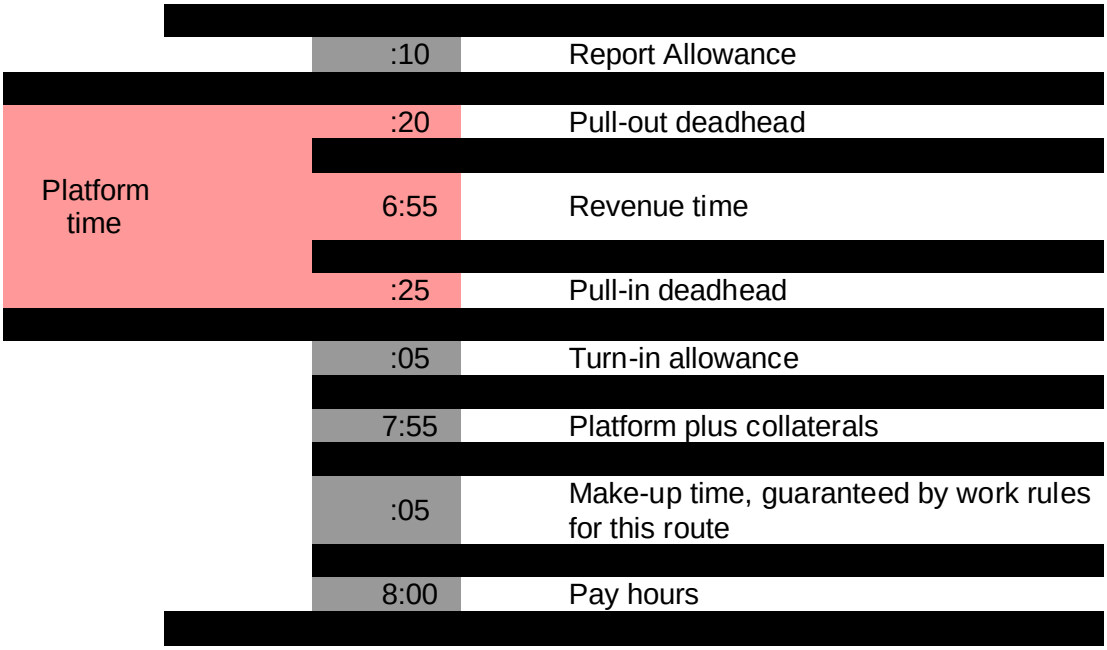
Runcutting is cutting blocks into operator (driver) assignments. Most agencies cut runs several times annually to make route changes. When runs have been cut, drivers bid on them (usually depending on seniority.)

Runcutting's goal is to put together runs to maximize in service revenue time for the fewest dollars. However, an unavoidable portion of every run is non-revenue, non-productive time. These portions are "collaterals." Time at the controls is "platform time."

Every agency has work rules that govern how runcutting can be done. Example: Allowances for checking the vehicle out and in are set in minutes according to work rules.

Straight run: Continuous, totaling about 8 hours, or two block pieces with a paid break in between. The following display is an example of a straight run:

Times are expressed as hours:minutes.



Split run: Two or three pieces of a block totaling about 8 hours with an unpaid break between pieces, called a *swing*.

Pay to Platform ratio
Ratio of pay to platform time is a key operating statistic for transit agencies. Because of the non-productive time built in, pay-to-platform ratio is always more than 1. In the straight run example above, 8 hours/7:40 hours or 8/7.67 or 1.04.

Platform to revenue ratio
Since deadhead can be so different depending on the routes distance from the yard, the ratio of revenue service time to platform time is an operating statistic that is also used. As with Pay to Platform, the ratio is always more than 1. In the straight run example above, 8 hours/6:55 hours or 8/6.92 or 1.16.

Maintenance: Types and Costs

Lesson objectives:
- Classify maintenance types
- Demonstrate relationship of various factors to maintenance costs
- Identify impact of maintenance on transit system success

Maintenance Goal and Variables

Module 2:
Bus and Rail Operations

Goal: keep the maximum number of vehicles in service at all times, balancing the costs to do so.
Key variable: Whether the maintenance is scheduled or unscheduled.
Key cost variable: Maintenance salaries
Key operating variable: Operating spares ratio (OSR)

Based upon historical experience, the agency must plan for some number of vehicles to be out of service at any time, both for scheduled and unscheduled maintenance. Once these spares have been added to the peak vehicle requirement, the operating Spare ratio can be determined. See the example below for calculating the OSR:

Peak Vehicle Requirement:	1,161
Vehicles for Scheduled Maintenance:	139
Vehicles for Unscheduled Maintenance:	36
Total Vehicle Requirement:	1,336
Operating Spare ratio:	175/1161= 15.1%

Types of Vehicle Maintenance

Scheduled - for many agencies, scheduled maintenance constitutes 70% of maintenance activity. Emphasis is on making pull-out. In most agencies software controls the schedule both for vehicles and maintenance personnel assignment because of the complexity of scheduling numerous vehicles and their hundreds of component parts. Employees review their assignments daily (365 days/year) in the system.

Scheduled Maintenance Categories - This chart shows how WMATA (Washington Metropolitan Area Transit Authority) categorizes preventive maintenance activities.

Type	Rail Maintenance Activity
Daily	Cleaning Graffiti check Visual inspection interior, exterior Functional test safety components, lighting, emergency evacuation equipment
Monthly	Visual inspection of electrical and mechanical components
A. Every 60 days	Major cleaning Preventive cleaning of motors Test functionality of designated components

B. Semi-annually	Clean aluminum All under A, plus Brake calipers check, coupler checks
[redacted]	
C. Annual	All under A and B, plus Routine overhaul of selected electrical and mechanical components
[redacted]	
Scheduled car body refurbishment	Interior - replace carpet every 5 years, paint every 10 years
[redacted]	

Unscheduled – This type of maintenance is incurred when vehicles break down. Estimated historical failure rates help the agency to determine how many buses are needed to cover those out of service because of unscheduled "corrective" maintenance.

Vehicle Maintenance Costs

Most of the transit critical success factors mentioned in the Operations Overview are directly related to a well-managed maintenance program. The factors related to maintenance are:

1. Reliability of vehicles
2. Safety of vehicles and therefore of passengers
3. Security and comfort of the passenger
4. Cleanliness of stations and vehicles

This relationship implies that managing maintenance costs requires intelligent trade-offs--an effective maintenance plan emphasizes preventive costs.

Maintenance costs are affected by the scale of service, vehicle reliability, maintenance policies, and prevailing cost rates.

Centralized heavy maintenance – Many agencies save costs by performing heavy maintenance in one facility. While the costs of transporting equipment may be higher, the agency saves money by only having one set of specialized and one group of mechanics trained in heavy maintenance.

Productivity Increases in Maintenance

The economic slowdown has had an impact on the levels of operating revenue relied on by public transit agencies. This economic climate is prompting public transit agencies to rethink current practices and business methods, including maintenance. Maintenance department budgets are typically the second largest component of the total operating costs of a transit system. Maintenance budget reductions are forcing transit agencies to further improve the productivity and efficiency of their maintenance practices.

Employee union concerns must be a prime consideration when emphasizing productivity improvements. Unions must be willing to work as part of a team effort to improve productivity.

Module 2:
Bus and Rail Operations

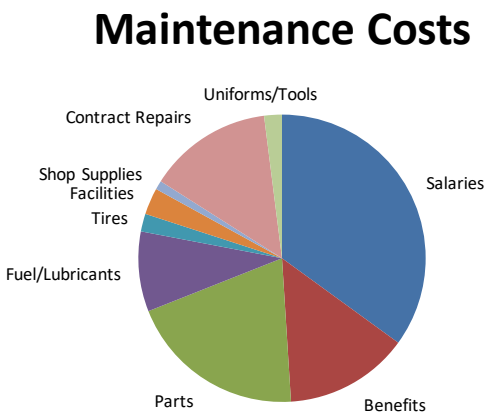
The efficient use of personnel is a key element in a productivity improvement plan, and a transit agency should consider the introduction of repair work time standards into the collective bargaining agreement.

Facility Maintenance

All agencies must take facility maintenance costs into account in budgeting. These include ongoing costs for cleaning and routine maintenance, but also capital costs for major repairs and replacement of systems such as HVAC, security, etc.

Major Categories of Maintenance Costs

The categories and proportions of maintenance costs shown on the pie chart below would be typical for most transit agencies. Salary-related costs are clearly the dominant ongoing cost element--about 49% in this case, considering both salaries and benefits.



Sources

- Transit Cooperative Research Program, Synthesis 54, Published 2004.
- Abrams-Cherwony & Associates, 7/99. **Introduction to Transit Operations Planning** is a large volume that provided many examples supporting the transit operations success factors.
- Interviews conducted by T-FLEx members at Dallas Area Rapid Transit, Regional Transportation Commission, Sacramento Regional Transit, Valley Transit Authority, and Washington Metropolitan Area Transit Authority contributed to the statements, concepts, and conclusions in the overview and in the Scheduling and Maintenance sessions.
- Pepperdine courses for operations managers run biannually include some good basic information and examples about route design, blocking and runcutting examples from which these examples and exercises were drawn. These were provided to T-FLEx by Valley Transit Authority.