

5 **Synthesis of Transit Practice**

Extraboard Management: Procedures and Tools

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5 Synthesis of Transit Practice

Extraboard Management: Procedures and Tools

LITTLETON C. MACDORMAN
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NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Administrators, engineers, and many others in the transit industry are faced with a multitude of complex problems that range between local, regional, and national in their prevalence. How they might be solved is open to a variety of approaches; however, it is an established fact that a highly effective approach to problems of widespread commonality is one in which operating agencies join cooperatively to support, both in financial and other participatory respects, systematic research that is well designed, practically oriented, and carried out by highly competent researchers. As problems grow rapidly in number and escalate in complexity, the value of an orderly, high-quality cooperative endeavor likewise escalates.

Recognizing this in light of the many needs of the transit industry at large, the Urban Mass Transportation Administration, U.S. Department of Transportation, got under way in 1980 the National Cooperative Transit Research & Development Program (NCTRP). This is an objective national program that provides a mechanism by which UMTA's principal client groups across the nation can join cooperatively in an attempt to solve near-term public transportation problems through applied research, development, test, and evaluation. The client groups thereby have a channel through which they can directly influence a portion of UMTA's annual activities in transit technology development and deployment. Although present funding of the NCTRP is entirely from UMTA's Section 6 funds, the planning leading to inception of the Program envisioned that UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a large number of problems each year.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Research Council as the Primary Technical Contractor (PTC) responsible for administrative and technical services, (2) the American Public Transit Association, responsible for operation of a Technical Steering Group (TSG) comprised of representatives of transit operators, local government officials, State DOT officials, and officials from UMTA's Office of Technical Assistance, and (3) the Urban Consortium for Technology Initiatives/Public Technology, Inc., responsible for providing the local government officials for the Technical Steering Group.

Research Programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the National Research Council for acceptance and administration through the Transportation Research Board.

Research projects addressing the problems referred from UMTA are defined by panels of experts established by the Board to provide technical guidance and counsel in the problem areas. The projects are advertised widely for proposals, and qualified agencies are selected on the basis of research plans offering the greatest probabilities of success. The research is carried out by these agencies under contract to the National Research Council, and administration and surveillance of the contract work are the responsibilities of the National Research Council and Board.

The needs for transit research are many, and the National Cooperative Transit Research & Development Program is a mechanism for deriving timely solutions for transportation

problems of mutual concern to many responsible groups. In doing so, the Program operates complementary to, rather than as a substitute for or duplicate of, other transit research programs.

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NOTICE

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, or the Urban Mass Transportation Administration, U.S. Department of Transportation.

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The Transportation Research Board evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society.

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to the transit industry. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire transit community, the Urban Mass Transportation Administration of the U.S. Department of Transportation has, through the mechanism of the National Cooperative Transit Research & Development Program, authorized the Transportation Research Board to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

*By Staff
Transportation
Research Board*

This synthesis will be of interest to transit administrators and others concerned with extraboard management; i.e., the assignment of transit operators to perform unfilled work to ensure the provision of scheduled transit service.

Administrators, engineers, and researchers are continually faced with problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to the available methods of solving or alleviating the problem. In an effort to correct this situation, NCTRP Project 60-1, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common transit problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCTRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific problems or sets of closely related problems.

A transit agency needs a list of extra operators (the extraboard) from which operators can be assigned to open work caused by vacations, sickness, etc. This report of the Transportation Research Board discusses the methods currently being used by transit agencies to manage the extraboard—to assign personnel to open work so as to ensure

delivery of scheduled service with minimal cost. A prototype automated extraboard management system is also introduced.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of public transportation agencies. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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W. Campbell Graeb, Engineer of Public Transportation, of the Transportation Research Board, assisted the Project 60-1 Staff and the Topic Panel.

Information on current practice was provided by many transit agencies. Their cooperation and assistance were most helpful.

EXTRABOARD MANAGEMENT: PROCEDURES AND TOOLS

SUMMARY

Although transit agencies employ sufficient regular operators to provide scheduled service, they also employ extra operators to cover work assignments that are temporarily unfilled. Often the unfilled work assignments are posted on bulletin boards along with the names of the *extra* operators assigned to conduct the work. Hence, the term *extraboard* was coined to denote the listing of unfilled work and the operators assigned to conduct such work.

Extraboard management may be generally defined as the process of utilizing available manpower to perform unfilled work assignments in accordance with labor agreement provisions and work rules to ensure the provision of scheduled transit service.

The challenge of extraboard management is to assign manpower to open work, ensuring scheduled service delivery with minimum cost. Although the work conducted for this synthesis did not address financial information, it is evident that significant cost savings or losses can result from extraboard management. Savings can be achieved or additional unnecessary expenses incurred because of effective or ineffective extraboard management practices that reduce or increase payment of unscheduled premiums and for unproductive time.

Extraboard management can be viewed as one of the final management actions that influences the efficiency and effectiveness of transit service delivery. Three general parameters define extraboard management.

- *Available manpower.* Although extra operators are the primary source of manpower assigned to unfilled work assignments, overtime labor may also be used. Operator staffing levels set through work force planning generally determine the number of extra operators retained at each operating location (i.e., division) of a transit system. This level may fluctuate daily because of attrition, transfers of operators between divisions, and extra operator absence. The use of overtime labor, an important source of available manpower, generally depends on the willingness of operators to volunteer for additional work duties.

- *Open Work.* Open work refers to unfilled work assignments. Open work establishes the need or demand for available manpower. It may fluctuate daily according to service additions and deletions, nonoperating work requirements, and operator absence.

- *Labor agreement provisions and work rules.* Labor agreement provisions and work rules define the allowable ways management can match available manpower (i.e., extra operators or overtime) and open work.

For any given open work and given available manpower situation, there are normally several alternative decision paths allowed by the labor agreement to formulate and make the match between manpower available and the demand for manpower.

Extraboard management decisions are affected by two types of activities and conditions:

1. those that are established by prior decisions or actions of the transit system, such as transit service planning, scheduling, and work force planning; and
2. those that change daily and even throughout the day, such as open work.

Both decisions may have service delivery and/or financial implications.

Managing the transit extraboard is a complex and demanding process—a process requiring the ability to react to change and uncertainty. Opportunities exist to improve the efficiency and effectiveness of the current state of the practice in extraboard management. Some transit systems have made significant improvements through computer-assisted techniques and procedures. The extraboard management procedures of a few transit systems include decision support capabilities.

Significant strides have been made that are accessible to others in the transit industry through contact and communication with those agencies in the forefront of extraboard management; however, opportunity to advance the state of the art remains. Current computerized methods, primarily focused on making the process of extraboard management more efficient, can be used as building blocks to structure more effective decision making for extraboard management.

INTRODUCTION

In today's public transportation environment of constrained budgets and limited resources, the objective of every transit manager is to provide effective service at the lowest cost. The provision of effective transit service is a complex and demanding business. It requires the ability to plan, organize, direct, coordinate, and control. In short, it requires managerial capabilities—capabilities that are continually being challenged by the events of an uncertain environment.

One of the more demanding responsibilities of transit managers is to ensure that service is efficiently provided as scheduled. This requires an adequate number of well-trained employees, sufficient vehicles in good repair, and the tools for making decisions that minimize cost within the boundaries established by the existing labor agreement and work rules.

EXTRABOARD MANAGEMENT: WHAT IS IT?

Although transit agencies employ sufficient regular operators to provide scheduled service, they also employ extra operators to cover work assignments that are temporarily unfilled. Often the unfilled work assignments are posted on bulletin boards along with the names of the *extra* operators assigned to conduct the work. Hence, the term *extraboard* was coined to denote the listing of unfilled work and the operators assigned to conduct such work.

Extraboard management may be generally defined as the process of utilizing available manpower to perform unfilled work assignments in accordance with labor agreement provisions and work rules to ensure the provision of scheduled transit service. Three general parameters define extraboard management:

- *Available manpower.* Although extra operators are the primary source of manpower assigned to unfilled work assignments, overtime labor may also be used. Operators staffing levels set through work force planning generally determine the number of extra operators retained at each operating location (i.e., division) of a transit system.¹ This level may fluctuate daily because of attrition, transfers of operators between divisions, and extra operator absence. The use of overtime labor, an important source of available manpower, generally depends on the willingness of operators to volunteer for additional work duties.

¹ The number of extra operators (i.e., size of the extraboard) is determined through work force planning and is presumed to be preestablished. Because extraboard sizing is an important related subject, it is discussed in Chapter 2 of the synthesis.

- *Open work.* Open work is a phrase used by transit systems to refer to unfilled work assignments. Open work establishes the need or demand for available manpower. It may fluctuate daily according to service additions and deletions, nonoperating work requirements,² and operator absence.

- *Labor agreement provisions and work rules.* Labor agreement provisions and work rules define the allowable ways management can match available manpower (i.e., extra operators or overtime) and open work.

Figure 1 presents the relationship among these three parameters. It represents a matching of the supply with the demand for available labor. For any given open work and any given available manpower situation, there are normally several alternative decision paths allowed by the labor agreement to formulate and make the match between manpower available and the demand for manpower. Each decision may have service delivery and/or financial implications.

IMPORTANCE OF EXTRABOARD MANAGEMENT

The challenge of extraboard management is to assign manpower to open work, ensuring scheduled service delivery with minimum cost. Although the work conducted for this synthesis did not address financial information, it is evident that significant cost savings or losses can result from extraboard management. Savings can be achieved or additional unnecessary expenses incurred because of effective or ineffective extraboard management practices that reduce or increase payment of unscheduled premiums and unproductive time.

CONTENT OF THIS REPORT

The first chapter of this synthesis report has briefly introduced and defined extraboard management. The second chapter discusses the context for extraboard management and provides background on related transit management activities and decisions that establish the framework for extraboard management. Chapter 2 begins with an overview of service planning and scheduling, discusses operator work force planning, and concludes with a discussion of open work, which creates the need for extraboard management.

² At many transit systems vehicle operators are periodically assigned duties other than driving a bus in scheduled service. These work assignments are generally referred to as nonoperating work. They include training, temporary assignment in a supervisory capacity, and so on.

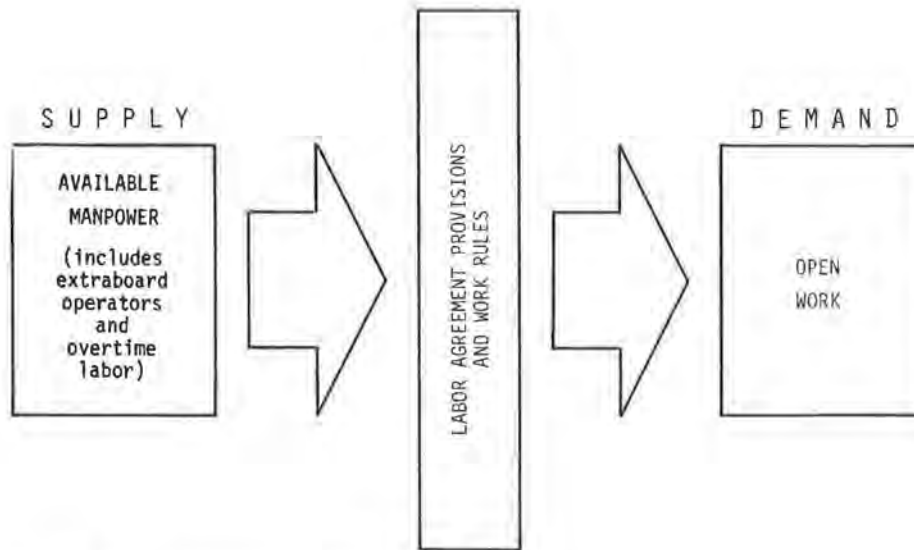


FIGURE 1 Parameters of extraboard management.

The third chapter presents the procedures and decision-making requirements for extraboard management. It includes discussions pertaining to:

- listing extra operators,
- preparing extraboard work assignments,
- dispatching stand-by operators, and
- collecting and using information.

The final chapter of this synthesis report introduces an automated extraboard management prototype. The prototype is intended to serve as a framework for improved information handling and decision making in extraboard management.

The synthesis report includes four appendices:

- Appendix A presents the survey instrument used to solicit information from 100 transit systems on their extraboard management practices and procedures and a summary of the survey results from the respondents.

- Appendix B includes a list of transit agencies that responded to the survey.

- Appendix C includes two case studies of current state-of-the-art automated extraboard management procedures. The case studies present an overview of the extraboard management systems currently operational at Mississauga Transit (in Ontario, Canada) and the Sacramento Regional Transit District (California).

- Appendix D introduces concepts for continued research. The discussion suggests that methods can be developed to project the service delivery and cost consequences of extraboard distribution and utilization.

CONTEXT OF EXTRABOARD MANAGEMENT

Extraboard management can be viewed as one of the final management actions that influences the efficiency and effectiveness of transit service delivery. Extraboard management decisions are affected by two types of activities and conditions:

1. those that are established by prior decisions or actions of the transit system, such as transit service planning, scheduling, and work force planning; and
2. those that change daily and even throughout the day, such as open work.

Figure 2 identifies these activities and conditions and their relationship to extraboard management.

SERVICE PLANNING AND SCHEDULING

The development of transit service plans and the subsequent scheduling of service determine how much, where, and when transit service operates. Background information on service planning and scheduling is useful to an understanding of extraboard management because these are important related transit management activities and responsibilities.

The development of the service plan depends, in large measure, on a combination of the public's demand for travel by transit and the resources available for transit service. The demand for transit may fluctuate because of many factors beyond the control of the transit agency including shifting patterns of urban growth or decline, automobile fuel shortages, and changing government policies and procedures. Transit's ability to attract patrons is contingent, in part, on the effectiveness of the service plan and the availability of resources to provide transit service.

Transit service planning considers numerous factors including:

- demographic and land-use patterns,
- network type and routing patterns,
- types of vehicles,
- route spacing and passenger accessibility,
- service frequency or headways, and
- fare structure.

The resulting service plan directly affects how operator work assignments are scheduled.

The development and scheduling of work assignments establishes how work is performed by individual transit operators and influences the cost of service delivery. Scheduling generally involves developing daily work assignments for operators using

a procedure that minimizes the total number of vehicle operator pay hours and maximizes vehicle utilization while remaining in accordance with the labor agreement provisions and work rules of the transit system.

OPERATOR WORK ASSIGNMENT CHARACTERISTICS

Daily work assignments are normally built into weekly operator schedules that include two days off. A weekly operator schedule may be built on the same daily assignment or varying daily assignments in accordance with the labor agreement. Some transit agencies incorporate varying daily assignments to balance the scheduled weekly work hours among operators (e.g., all weekly schedules are balanced near 40 work hours). This balance may reduce scheduled guarantee and/or overtime premium pay. Transit systems whose labor agreements contain provisions requiring eight-hour daily pay guarantees and overtime premium for work over eight daily hours generally do not realize the cost-saving benefits of balancing the weekly work hours among operators.

Scheduling transit services and minimizing operating costs within the guidelines of the labor agreement are important responsibilities of transit management. Although computerized techniques have made work assignment scheduling easier, these techniques do not provide comprehensive assistance to transit managers who must also consider operator requirements for work that is unscheduled or open.

The paragraphs below summarize the types of work assignments that generally characterize operator work and compensation.

Straight Run. Most labor agreements stipulate that full-time operators be provided with a guaranteed amount of daily and/or weekly pay. This guarantee is most efficiently realized when the scheduled work assignment requires the continuous service of an operator for a full day's work, e.g., eight hours. In transit, this continuous requirement is most often referred to as a straight run. Figure 3a shows how a straight run assignment appears as part of the total transit schedule of operator work.

Split or Swing Runs. As shown in Figure 3b, peak demand conditions may dictate that work assignments be divided into two or more parts in order to meet the labor agreement provisions that guarantee a full day's wages. Some labor agreements may not allow such division of work or allow only a specified number of divisions. These types of work assignment are known in transit as split or swing runs.

Trippers. Pieces of work that cannot be matched to achieve a straight or split run (i.e., a full day's work) are referred to,

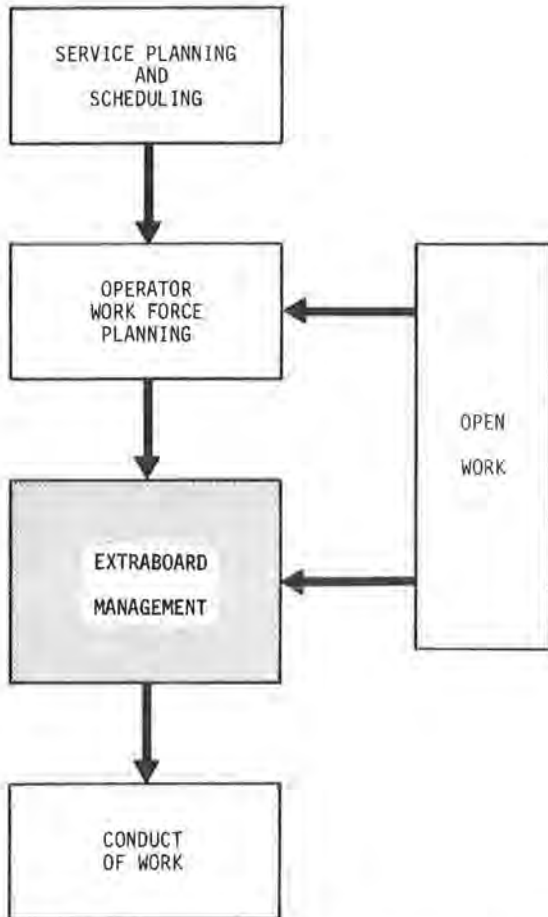


FIGURE 2 Context of extraboard management.

in transit, as trippers, miniruns, or frags. Figure 3c illustrates how trippers fit in the service schedule. Trippers constitute required portions of the service plan and are most often worked by operators who do not operate runs or as an additional overtime assignment.

Intervening Time. Payment for time between pieces of work (e.g., between the pieces of a split run) when such time is less than some prescribed time. For example, if the time between the end of a work piece and the beginning of subsequent work is less than one hour the operator may receive payment for this time interval.

Overtime Premium. Premium payment for work, generally at one and one half time base pay, for work that exceeds the prescribed daily or weekly hours of work (i.e., eight hours per day or 40 hours per week).

Report and Turn-in Time. Pay allowances for time spent by an operator to prepare for a work assignment and activities that take place in conjunction with finishing the assignment. These allowances may be made for each work piece in the assignment.

Spread Penalty Premium. Premium payments to operators whose beginning and ending time of work, regardless of the number of hours worked in between, spans more than a certain prescribed number of hours (e.g., if premium is paid for a work spread over 12-hours and an operator reports in at 6 a.m. and finishes work at 7 p.m., the operator will be granted at least an hour of premium pay regardless of actual productive work time).

Travel Time. A pay allowance made to operators for the time spent travelling from the report location (division or garage) to a specific relief point along a transit route.

OPERATOR WORK FORCE PLANNING

The objective of operator work force planning is to identify, achieve, and maintain the appropriate number and composition of vehicle operators to deliver transit services at the least cost. Work force planning includes consideration of the need for three types of operators: full-time regular operators, part-time operators, and extraboard operators.

The two primary tasks of operator work force planning relate to:

1. work force sizing and composition: identifying the optimal operator complement, which includes both the staffing level and the mix of the three types of operators; and
2. work force management: achieving and maintaining the optimal operator staffing complement.

Work Force Sizing and Composition

Determining the optimal operator staffing complement has traditionally been dependent on the personal experience and judgment of transit managers. Generally, this experience reflects success in:

- retaining enough operators to ensure, as nearly as possible, that no scheduled service is missed;
- avoiding, as much as possible, paying employee wages when no work is performed; and
- restricting the payment of overtime to the minimum amount necessary.

Transit managers have used straightforward methods for determining operator staffing complement to meet these general objectives.

In 1982, a survey was conducted of transit systems with more than 100 vehicles to determine the utilization of their operator work force.³ The most apparent finding from the survey was a general oversizing of the full-time operator work force. On average, transit systems utilized 7.3 percent more full-time operators than would be necessary under optimal cost conditions.⁴ This may be due to concern over meeting the service schedule during days of high operator absence, or to the increased burden placed on the operator dispatch function when few extra operators are available and use of overtime increases.⁵

Determination of the optimal operator complement involves making trade-offs between hiring more operators versus using

³ MacDorman, L. C. and J. C. MacDorman, "The Transit Extraboard: Some Opportunities for Cost Saving." Paper presented at the Annual Meeting of the American Public Transit Association, Boston, October 1982.

⁴ Some transit systems were found to have less than the optimal full-time operator work force size and others were found to closely match the optimal number.

⁵ The use of overtime is limited by some labor agreements.

overtime labor and making the best use of part-time labor within the existing labor agreement provisions.

More Operators vs. Overtime Labor

Because the number of regular operators is generally established according to the work assignments developed through the scheduling process, the principal issue in estimating the least-cost operator staffing levels involves the trade-off between covering open work by using over-time labor or by hiring additional operators (i.e., extra-board operators). Premium pay for overtime labor increases the marginal cost of delivering service whereas hiring additional operators increases fixed fringe benefits and may increase costs associated with unproductive labor (e.g., guarantee pay). As the amount and daily variability of open work increases, assessing the cost trade-offs for filling this work becomes more important.

Figure 4a shows how the cost of unproductive time and fixed fringe benefits increases as the number of extra-board operators increases. Conversely, the cost of overtime premium decreases as the number of extra operators increases, as shown in Figure 4b. Finally, Figure 4c combines the two preceding graphs, forming an aggregate marginal cost function. The low point on the curve corresponds to least cost and defines the associated number of extra operators.

Use of Part-Time Operators

Recent changes in many labor agreement provisions have made part-time operators an increasingly important manpower option. The extent to which part-time operators can be used is normally limited in labor agreements by:

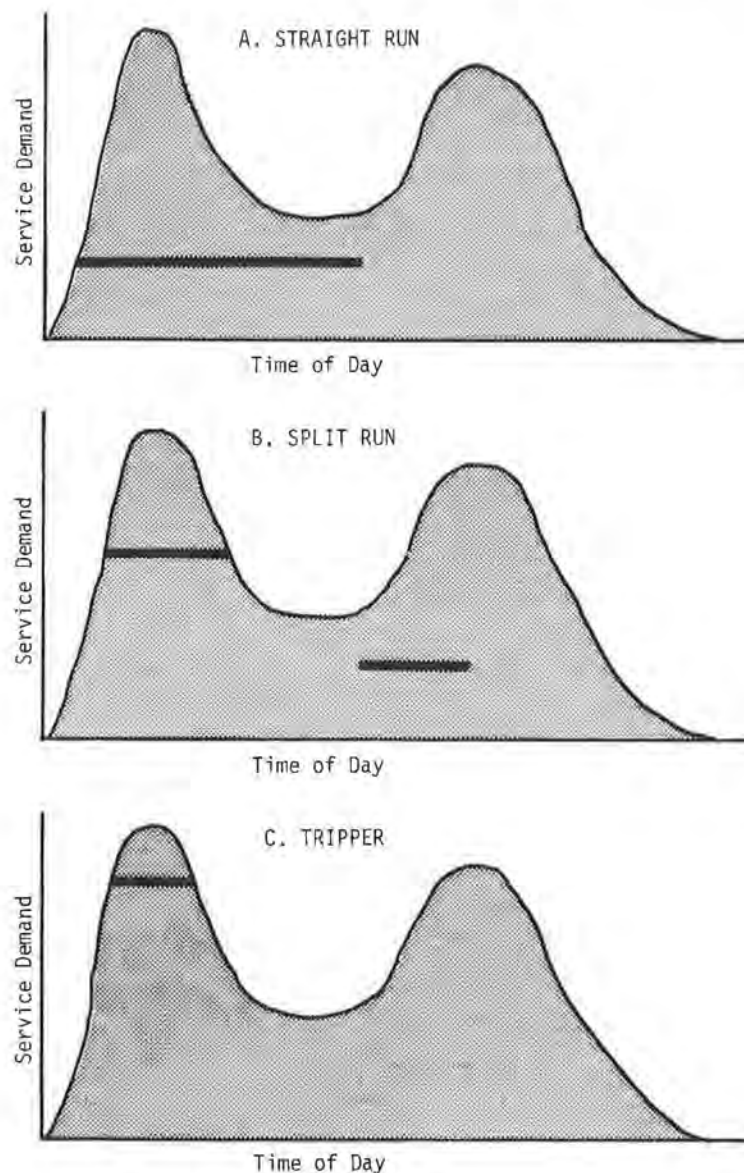


FIGURE 3 Basis for operator work assignments.

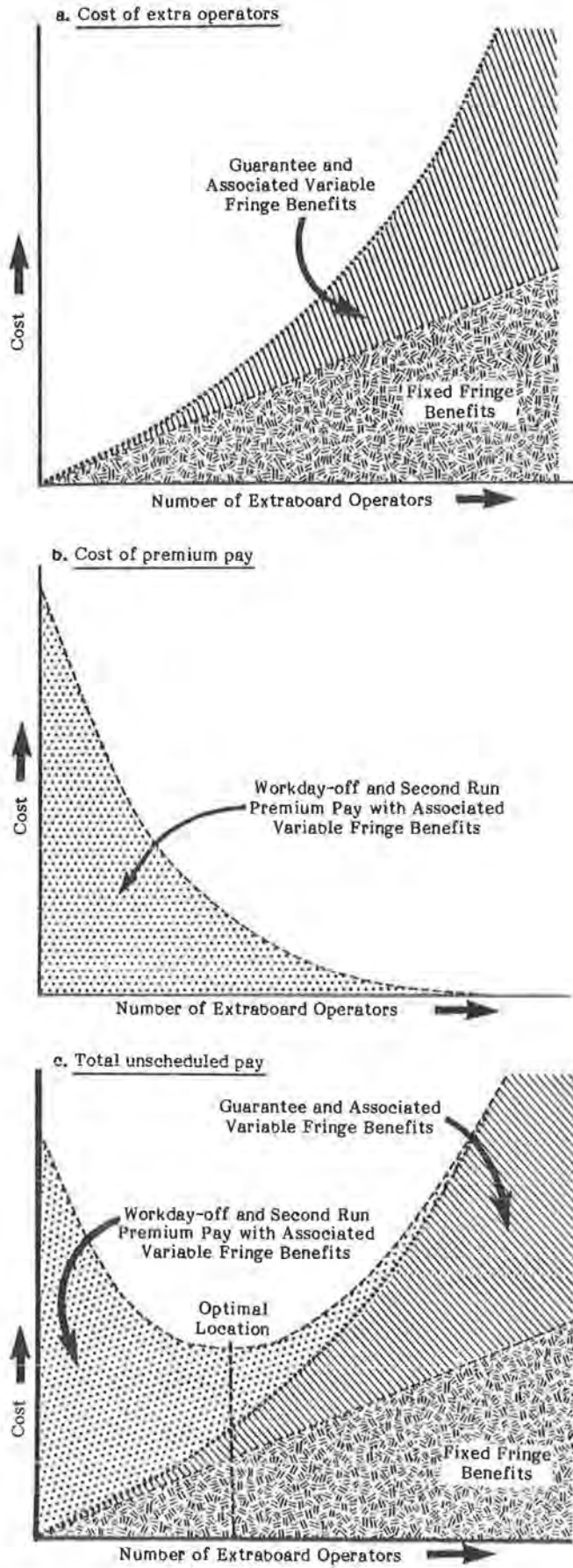


FIGURE 4 Extraboard operator cost trade-offs.

- the number of these operators allowed (e.g., 10 percent of the full-time operators),
- the amount of work hours allowed (e.g., 30 hours per week), and
- the type of work assignment allowed (e.g., trippers only).

Part-time operators are desirable to employ because their lower compensation rates (including fringe benefits) and limited premiums and guarantees make their work assignments less costly than full-time operators. Some transit agencies currently develop work assignments to maximize part-time operator work hours, whereas others concentrate on specific areas of cost reduction; e.g., minimizing full-time operators' spread time by using part-time operators to cover early a.m. and late p.m. trippers. Although there seem to be different philosophies as to utilizing them efficiently, part-time operators are emerging as a vital manpower option that transit agencies are including in their operator work force planning objectives.

A forthcoming NCTRP synthesis, Topic TS-10, entitled "Use of Part-Time Operators," will cover this subject in much greater detail.

Work Force Management

Achieving and maintaining an optimal staffing complement is the second major responsibility in operator work force planning. The proper management of operator availability requires close interface with other organizational units in a transit system. Optimal operator staffing may be adjusted in response to service modifications, labor agreement changes, wage and fringe benefit adjustments, and varying operator absence. Appropriate information provided in a timely manner is the basis for productive interfacing among organizational units of a transit system.

To ensure that optimal manpower is retained at all times, lead time is necessary for service planning, scheduling, work force planning, employee recruitment, and vehicle operator training. Even when optimal operator staffing can be determined sufficiently in advance to meet these conditions, operator attrition must be closely monitored to ensure that the appropriate number of qualified operators are ready to replace departing employees. Conversely, lead time is needed to take appropriate action to reduce the work force when there is excess manpower.

OPEN WORK

Open work creates the need for extraboard management. If there were no open work, transit management could rely on regular operators, and part-time operators if applicable, to meet transit service requirements. However, many factors cause open work and the nature and dynamics of open work influence how extraboard management decisions are made. The remainder of this chapter discusses the major types of open work and the nature and dynamics of this work.

Types of Open Work

The factors causing open work can be grouped into three general categories:

1. *Unassigned service* is the required portions of the daily service schedule that are not preassigned to operators. This may occur when:
 - a. scheduled service assignments are not offered for selection by operators during general sign-ups⁶ because they are not built into operator schedules (e.g., trippers),
 - b. available scheduled service assignments are not selected by operators during general sign-ups, and
 - c. minor service modifications between sign-ups create additional daily service [these modifications may be permanent changes (e.g., a new route) or temporary additions (e.g., charters)].
2. *Nonoperating assignments* are work assignments that require vehicle operators to perform work other than driving a vehicle in revenue service to support transit operations. Such work may include training, instruction, administrative duties, acting supervision, bus transfers, etc. The amount of nonoperating work assigned to transit operators varies considerably from one transit agency to another.
3. *Operator absence* is the most predominant cause of open work. Operator absence can be broadly defined as any time that operators do not report for work. This includes:
 - a. *Sick leave*. This type of absence represents lost time reported as employee illness.
 - b. *Injury-on-duty*. These absences result from injuries that occur while employees are working and for which they may receive worker's compensation.
 - c. *Contractual absence*. This form of absence includes the absences identified in the labor agreement for which employees are typically compensated, such as vacations, holidays, jury duty, union business, military leave, and funeral leave.
 - d. *Personal absence*. Diverse types of absence are included in this category, which may or may not be identified in the labor agreement, and for which the employee is typically not compensated. Such absences include personal business, illness in the family, child care, excused or authorized absence, tardiness, absence without leave (AWOL), or absence that is transportation related.
 - e. *Management requested absence*. This type of absence results from the suspension of employees as a disciplinary action or from withholding employees from active duty pending hearings and grievance proceedings.

Nature and Dynamics of Open Work

From the perspective of extraboard management, the cause of open work is not as important as its nature and dynamics. The nature of open work refers primarily to its predictability and the ability of managers to plan for the open work. More specifically, absences resulting from employee vacation, long-term illness, or military leave can be planned for in advance

⁶ General sign-ups occur when changes in public service cause scheduled operator work assignments to change. The provisions in the labor agreement typically require management to offer operators the opportunity to select assignments based on their seniority.

whereas absence resulting from tardiness, AWOL, or bad weather cannot be precisely predicted. The dynamics of open work refers to the variability and change in open work from one day to the next and throughout any given day. The nature and dynamics of open work are interrelated, and together provide the setting for extraboard management decision making.

In short, if the time frame and amount of open work were always known sufficiently in advance (e.g., vacations), transit managers could make the most cost-effective use of available manpower. However, all open work cannot be accurately anticipated (e.g., tardiness), and this increases the complexity of extraboard management.

CHAPTER THREE

EXTRABOARD MANAGEMENT: STATE OF THE PRACTICE

This section describes transit extraboard management from a general state-of-the-practice perspective. The information included in this section is based largely on the results of a survey of extraboard management practices that was conducted in the spring of 1984 for this synthesis report. More than 100 transit systems, largely in North America, were sent a questionnaire requesting both general and specific information on their approach to extraboard management. Appendix A includes the survey instrument and a summary of the survey results from the respondents. Appendix B lists the names of the responding transit systems. Most of the transit systems provided the following information: (a) a completed survey about their extraboard management practices; (b) written descriptions, guidelines, and training manuals on extraboard management and operating procedures; and (c) copies of their current operator labor agreement including work rules and procedures for extraboard operator assignment.

The next part of this chapter presents an overview of extraboard management, introducing the major elements of the extraboard management process. The remainder of this chapter discusses, in more detail, the characteristics of four specific elements of extraboard management found at different transit systems through the survey effort.

These elements are:

- listing extra operators,
- preparing extraboard work assignments,
- dispatching stand-by operators, and
- collecting and using information.

OVERVIEW OF EXTRABOARD MANAGEMENT

Extraboard management is a complex and dynamic process that can be characterized as reactive management. The following discussion includes a series of figures to explain, in overview, the many elements and dynamics of extraboard management.

Framework for Operator Work Assignments and Service Delivery

Figure 5 provides the basic framework for vehicle operator selection of work assignments and the conduct of work. This cycle includes all vehicle operators and scheduled work. The cycle begins with the box marked Service Modification and Schedule Change. Most transit systems periodically change their service or modify their service schedule based on their community's public transit needs or on changes in financing for transit.

The scheduled work, translated into operator work assignments, is selected by the vehicle operator work force in order of operator seniority during general signs-ups. Even if there were no transit service modifications or schedule changes, the labor agreement at most transit systems requires that vehicle operators have the opportunity to reselect their work assignment by seniority several times per year. This means that at all transit systems there is a regular cycle in which work is selected and then conducted by operators.

The final box in the cycle is the conduct of work, a continuous daily activity to be performed as scheduled.

Open Work

Figure 6 introduces three new boxes to the cycle. These boxes show that the cycle includes open or unfilled work, which creates the need for extraboard management. The figure shows the major causes of unfilled operator work assignments. As discussed in the previous chapter of this report, there are three basic causes of open work—with operator absence normally being the largest cause.

Available Manpower

Figure 7 adds three more boxes to the cycle. These boxes represent the labor available to fill open work. As mentioned

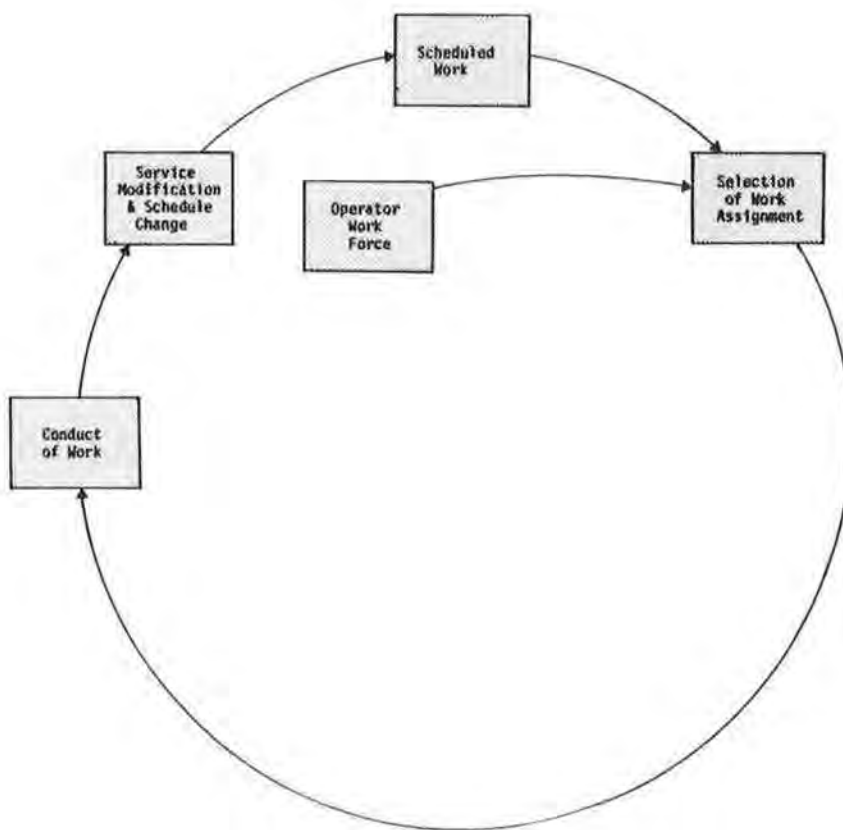


FIGURE 5 Extraboard management cycle: framework.

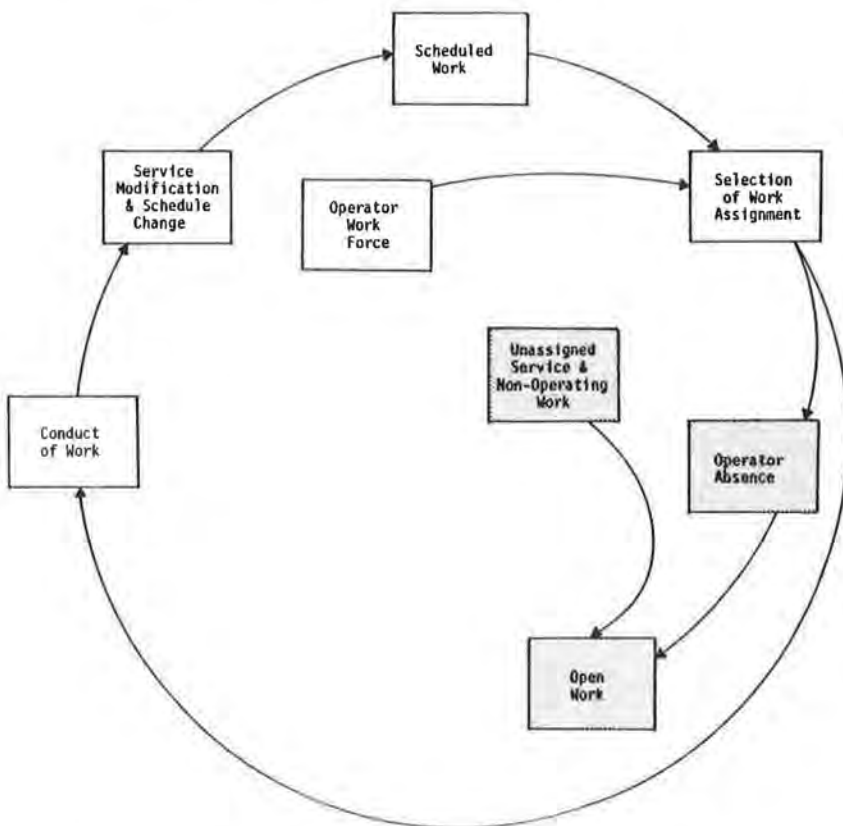


FIGURE 6 Extraboard management cycle: introduction of open work.

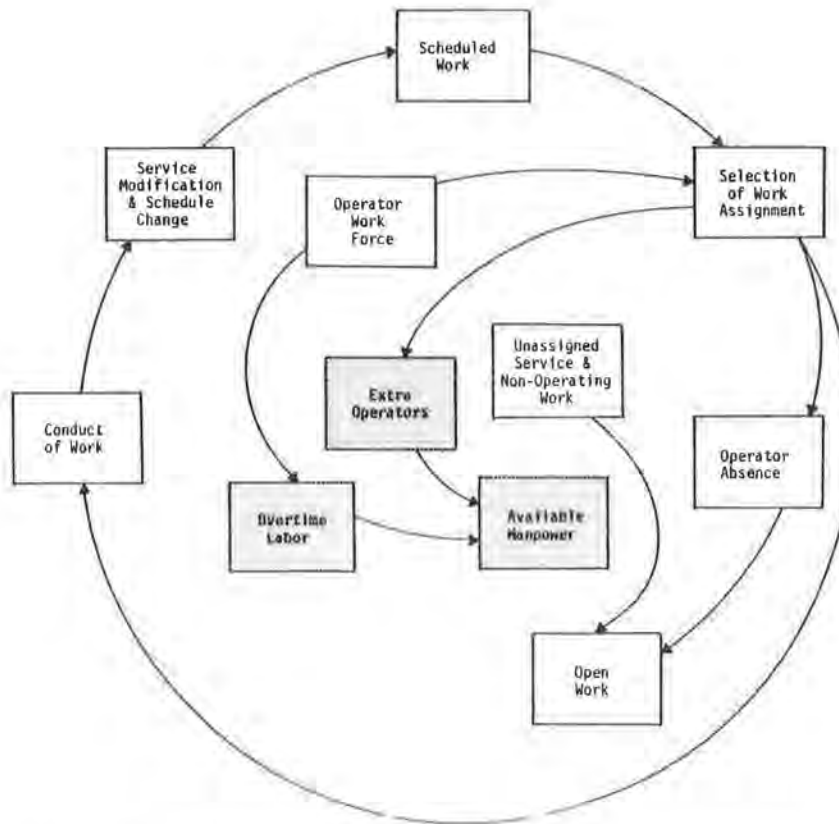


FIGURE 7 Extraboard management cycle: sources of available manpower.

in the introduction to this synthesis, there are two sources of this labor. The main source is a pool of extra operators hired by transit systems in recognition of the fact that open work will always exist. The second source is overtime labor usually volunteered by the operator work force.

Assignment of Known Open Work

Figure 8 shows the assignment of open work to available manpower. Generally, all open work known in advance is preassigned to available manpower in accordance with labor agreement provisions and work rules before the open work must be performed.

Figure 8 introduces the places in the extraboard management cycle where the labor agreement provisions and work rules must be considered in assigning labor to work. The provisions affect which operators are permitted to perform work, how the work is performed, and the associated costs. It should be noted that these provisions and rules are integral to the overall work assignment process in the general sign-up as well as in the continual decisions of extraboard management.

Assignment of Unanticipated Open Work

Figure 9 shows the assignment of unanticipated open work. Between the time that open work assignments are made in advance for all known open work and the time that vehicle

operators are to report for their work assignments, additional open work may be created by unanticipated operator absence or unscheduled work. This open work is filled by extra operators, often called stand-by operators, or by overtime labor.

Stand-by operators are assigned a report time to fill unanticipated open work instead of a specific known open work assignment. The report times are planned based on experience with the amount and timing of unanticipated open work. Whereas report times for stand-by operators are generally made a day or a shift in advance, the requests for overtime labor are generally made as the need for additional labor becomes apparent.

DETAILED CHARACTERISTICS OF EXTRABOARD MANAGEMENT

Having provided the above overview, the complexity of extraboard management and key similarities and differences in practices among transit systems are discussed in the next four subsections.

Listing Extra Operators

Vehicle operators are hired and trained by transit systems to provide scheduled transit service. Typically, operators may elect to work the extraboard if they choose, although extraboard

duties generally fall to operators with less seniority.⁷ Status as an extra operator generally continues during the period between general sign-ups.

In the context of this report, the listing of extra operators refers to the order that extra operators are listed or aligned to receive work assignments.⁸ According to the survey response, approximately 30 percent of the transit systems prepare a list of extra operators that generally remains constant throughout a sign-up period. A few transit systems allow the operators to select designated report times during the general sign-up, which determines the order for work assignment. Although one agency reported weekly rotation, the majority of transit systems use a list that rotates daily based on some set criteria. The criteria are either set through work rules established by management or contained in the labor agreement.

The survey results showed that the following approaches and criteria for listing extra operators are used by most transit systems:

1. List remains constant during the sign-up period:
 - a. based on seniority, or
 - b. based on report times selected at general sign-ups.
2. List rotates daily:
 - a. by a designated number of extra operators,
 - b. according to the previous day's pay hours, or
 - c. based on total accumulated pay hours in the payroll period.

Whether the listing of extra operators remains constant or rotates daily, other work rules and labor agreement provisions must be considered in preparing the list of extra operators. For example:

- Extra operators returning from absence are generally reinserted into the list based on the rotation criteria.
- Operators returning from suspension or incurring tardiness penalties often fall to the bottom of the extra operator list.

Once the list of extra operators is set, operators are either assigned work by the dispatch clerk or select available work generally according to their position on the list.⁹ The process of receiving work varies according to prevailing labor provisions and work rules and according to the nature of the work assignment.

⁷ Some transit systems build the extra operator duties directly into the work schedules so that operators might work the extraboard some days and have scheduled assignments on other days.

⁸ Transit systems may use more than one list if they divide the extraboard according to shift (e.g., a.m.) and/or nature of assigned work (e.g., stand-by status).

⁹ The title *dispatch clerk* is used in this synthesis to represent a position usually in the transportation department of a transit system that is responsible for assigning and dispatching work to ensure that scheduled and unscheduled service is delivered and other work is performed. The responsibilities of this position are divided among several employees at some transit systems.

Preparing Extraboard Work Assignments

In this report the process of preparing extraboard work assignments in advance is called *slating*. Dispatch clerks normally begin the slating process by reviewing all known open work for the next day or shift.¹⁰

Having identified all the known open work, the next step in the slating process is to arrange or piece together the open work to best utilize manpower while remaining consistent with the labor agreement provisions and work rules. The requirements for arranging or piecing together open work vary among transit systems. At some transit systems the labor agreement allows open work to be broken into multiple pieces, which provide the dispatch clerks with additional flexibility in the slating process.

At this time, decisions are made to minimize costs that may be incurred by compensation for:

- overtime premium,
- spread-time premium,
- stand-by time, and
- daily guarantee.

The dispatch clerk must also determine report times for stand-by operators. The number of stand-by operators and their report times are generally set according to past experience. Some systems specify certain times during the day for stand-by operators to report (e.g., early report—5 a.m., midday report—noon, late report—4 p.m., etc.), whereas other transit systems stagger the report times according to the timing of specific work assignments or some other factor(s).

When the listing of known open work and report times is completed, transit systems match available labor to open work by (a) posting the list of work so that extra operators can select a work assignment or report time, or (b) having the dispatch clerk assign the work. The majority of transit systems use the latter approach. In this approach, the assignment of work usually involves matching the list of known work and report times with the extra operator list according to provisions established by the prevailing labor agreement and work rules. The order in which work is assigned may be determined by characteristics of the work assignment such as:

- time of pull-out,
- time of pull-in,
- type of work (e.g., straight run, split run, tripper, or stand-by assignment),
- duration or length of work,
- amount of pay, and
- combination of the above.

At the same time, the dispatch clerk must consider contract provisions pertaining to the operators, such as the minimum rest period operators must have between two consecutive day's work.

¹⁰ Work that is known to be open for an extended period of time, e.g., a week or more, is often temporarily assigned to (i.e., held down by) an extra operator. This work may be bid on a periodic basis or assigned according to seniority or list position.

When dispatch clerks do not believe that the number of extra operators on the extra operator list is sufficient to cover known open work and stand-by assignments, they usually contact operators who have volunteered to work overtime.

Dispatching Stand-by Operators

This section discusses the real time assignment of stand-by operators to fill open work that was not anticipated or known at the time extraboard work assignments were prepared.¹¹ At most transit systems, this is the responsibility of the dispatch clerk. A straightforward and frequently used method assigns stand-by operators newly created work according to their report times. The operator with the earliest report time receives the first work assignments.¹²

If open work always occurred in accordance with the number of stand-by operators and their designated report times, unscheduled costs would be minimal. However, this is not the case, which causes costly imbalances between the number of available operators and the amount of open work. Consequently, one of the key decision-making activities in dispatching stand-by operators relates to fitting manpower to the dynamics of open work.

Too Little Manpower

During periods of high absences or when too few extra operators are available, the dispatch clerk may have to locate operators willing to work an additional assignment or on their day off, if the service schedule is to be met. Most transit agencies have a list of operators willing to work on their regularly scheduled day off or to work an additional assignment(s). These operators are used when the dispatch clerk foresees a need for manpower beyond the current supply of extra operators.

If a need for additional manpower arises, operators who have volunteered for overtime work are normally contacted according to their seniority. Although this is not always the most convenient or efficient order, the use of seniority is often specified in the labor agreement. The decision to use or forego this option has significant service delivery and financial implications. If the dispatch clerk elects to forego overtime labor, the transit system runs a higher risk of missing service because of the unavailability of operators. On the other hand, operators who volunteer to work on their day off are often guaranteed a substantial amount of compensation (e.g., 12 hours pay time) and normally cannot be used before the extraboard is exhausted.

¹¹ Operators who miss their regularly scheduled assignment are typically required to call in. This may give the dispatch clerk more opportunity to review the newly created open work before it is scheduled to pull out. The lead time may be used to piece open work together in somewhat the same manner as described for the slating process.

¹² Other criteria may be considered, such as pull-in time, the length of the assignment, the type of assignment (e.g., split run), and the pay for the assignment. Furthermore, the dispatch clerk must again consider contractual obligations, such as maximum spread and required rest periods.

Too Much Manpower

During periods of low absence or when there are too many extra operators available, dispatch clerks may need to reduce the amount of payment for unproductive time. When the extraboard is perceived to be overstaffed relative to the amount of work currently open, the dispatch clerk may attempt to reduce the amount of unproductive pay by allowing extra operators to leave work on their request. However, this opportunity for cost savings is usually contingent on the willingness of operators to take the day off, which may reduce their guarantee pay. Furthermore, it may be necessary to grant other operators the same opportunity to leave work if they have an earlier report time.

Another means of avoiding the payment for unproductive time is to reassign stand-by operators a later report time. Instead of holding an operator and paying additional stand-by time, the dispatch clerk may think it is more cost-effective to temporarily release and reassign the operator to a known open assignment or stand-by time later in the day. Some agencies have stand-by operators call in to check with the dispatcher for assignment. Often the call-in carries a contractual obligation, such as a minimum guarantee.

Clearly, throughout the decision-making process for the dispatching of stand-by operators, the dispatch clerk must be aware of the numerous factors affecting service delivery and cost.

Collecting and Using Information

Considerable data are collected in conjunction with extraboard management. The information gathered is used in preparing payroll calculations, maintaining attendance records, monitoring specific operator cost, monitoring service performance, and reviewing operator staffing levels and dispatching procedures.

The primary use of information collected by the dispatch clerk is to maintain accurate operator timekeeping data for payroll. It is normally the responsibility of the dispatch clerk to record any exceptions to operator schedules determined through the general operator sign-ups. Extra operator and other unscheduled work is recorded. The reason for the exception is usually noted by a longhand description or through a set of exception codes. Figure 10 provides a sample set of exception codes used by dispatch clerks.

In addition to supporting the payroll calculations, the survey responses indicated that approximately three out of four transit systems use timekeeping data to support operator attendance monitoring. The type of operator absence (e.g., workmen's compensation) is often designated by the exception coding. Other uses of timekeeping information collected by dispatch clerks include:

- individual operator pay hour statistics (e.g., stand-by time monitoring),
- pull-out and pull-in reports,
- manpower utilization reports, and
- daily dispatch reports (e.g., daily work activities of each operator).

In addition to timekeeping information, the dispatch function

<u>DCM Code</u>	<u>Title</u>
AF	Accident Reporting-Overtime
AO	Ask Off BG
AR	Accident Reporting-Straighttime
AT	Assign Tripper
AU	Leave of Absence-Unpaid
BG	Broken Guarantee
BH	Birthday Holiday Taken
BL	Bereavement Leave Taken
CP	Company Physical-Paid
CS	Customer Service
CW	Charter
FC	Fare Collection
FH	Floating Holiday Taken
FR	Full Run
HC	Handicap
JD	Jury Duty
LC	Late Pull-In-Reg
LR	Late Report
LX	Late Pull-In-Ext
M1	Miss Out-Report BG
M2	Miss Out-Partial
M3	Miss Out-Released
M4	Miss Out-Tripper
ML	Maternity Leave
MT	Military Leave
OD	Other Non-Operating Duties
OP	Other Absence-Paid
P1	Passenger Check-Full
P2	Passenger Check-Half
PR	Partial Run
RD	Reserve Duty-Unpaid
RT	Refuse Tripper
S1	Sick Leave-Full
S2	Sick Leave-Partial
S3	Sick Leave (Workmen's Comp)
S4	Sick Leave (Family)
SB	Standby
SH	Statutory Holiday Taken
SR	Sign-up Relief
SS	SAR
ST	Student Training
SU	Suspension
TA	Transportation Administration
TT	Teaching Time
UP	Union Business-Paid
UT	Unassign Tripper
UU	Union Business-Unpaid
VT	Vacation Taken
WD	Waiting Day
WH	Worked Holiday
WT	Witness Time
WR	Worked RDO

FIGURE 10 Illustrative exception codes (Sacramento Regional Transit District).

may gather data related to vehicle monitoring. This may include:

- on-time performance,
- vehicle availability,
- road call information, and
- accident and safety data.

The majority of transit systems currently have the dispatch (or timekeeping) clerks manually tabulate system or division information. The appropriate reports and forms may then be forwarded to the proper department(s) (e.g., payroll/MIS) for subsequent processing.

CHAPTER FOUR

PROTOTYPE AUTOMATED EXTRABOARD MANAGEMENT SYSTEM

Although labor agreement provisions, work rules, and operating policies are unique to each transit system, there are sufficient similarities in extraboard management practices among transit systems and sufficient opportunities for improvement in current practices to warrant consideration of an automated prototype to improve extraboard management. The survey respondents generally agreed that opportunities exist to improve the efficiency and effectiveness of extraboard management through automation.

This final chapter of this synthesis discusses the benefits and improvement opportunities attainable through an automated transit extraboard management system; introduces an automated extraboard management prototype, first in overview and then in more detail; discusses three elements in the prototype that represent the major decision support components of the automated extraboard management prototype; and presents concluding remarks on the potential for automated transit extraboard management systems.

OPPORTUNITIES TO IMPROVE EXTRABOARD MANAGEMENT THROUGH AUTOMATION

The use of an automated system will enhance extraboard management performance by:

1. increasing the availability of information in a format that facilitates decision making,
2. enhancing the timeliness and speed of information availability, and
3. improving the quality and consistency of decision making.

The use of computers will allow transit dispatch clerks, timekeepers, and management personnel to benefit from advanced data base management techniques. Such techniques make the transfer, manipulation, and access of large amounts of information more efficient and allow the people normally responsible for these tasks to use their time more productively. It should be noted that conversion from a manual to an automated system will require a significant investment of time and money.

The immediate benefits of automation are primarily directed at specific record-keeping and monitoring activities of extraboard management such as:

- performing timekeeping,
- recording exception transactions,
- maintaining absence files,
- monitoring costs,
- monitoring service delivery,
- monitoring manpower utilization,
- determining current available manpower,
- determining current open work,
- maintaining and manipulating operator work selection information, and
- maintaining and manipulating operator work assignment information.

As described in Appendix C, these capabilities are currently available and are operational or being implemented at several transit agencies. The automated extraboard management systems of the Sacramento Regional Transit District (SRTD) and Mississauga Transit demonstrate that improvements in the above listed areas may be realized.

In addition to improving the capacity for data handling, automation allows the implementation of analytical techniques that can support the critical decision-making activities inherent in extraboard management. The model presented below and subsequent discussion of potential automated decision support components introduce opportunities to advance the state of the art of extraboard management.

The framework or structure for the automated extraboard management prototype presented below represents a combination of (a) features of the automated extraboard systems developed to date and described in Appendix C, and (b) comments received from transit systems that participated in the survey on extraboard management concerning the desirable characteristics of a prototype automated system. The following is a list of these desired characteristics adopted from the Toronto Transit Commission's slip administration (i.e., extraboard management) proj-

ect. This list includes a wide variety of desirable characteristics concerning the size of computer hardware, the security of information, the ease of using computer software, as well as the ability of the automated system to perform numerous activities in extraboard management.

- Must be user friendly, with a minimum of training required.
- Must be similar to manual method so that new dispatch clerks will be able to understand the process that the computer is helping them to do.
- Must be a reliable system, as breakdowns mean that a manual process must be used as a backup (or, alternatively, must have a backup automated system available).
- Must be able to assign operators relatively quickly with a fast response time at the terminal.
- Must be compatible with other "spin off" applications anticipated to be instituted as a result of having a computer terminal at the division.
- Must be able to provide/receive daily input from/to files on the transit agency's central data base system, but be its own separate entity and not dependent on the mainframe computer (i.e., able to function on its own).
- Must provide simple access to certain files for clerks other than the dispatch clerk to access easily when required.
- Must be a physically compact system, to fit easily into current dispatch clerks' working environment.
- Must have proper security measures to prevent tampering with files (i.e., pay hours input to timekeeping).
- Must record all final detailing information for input into timekeeping and absence monitoring systems, as well as for manpower utilization analysis.
- Must be able to transfer manpower and the related files from one division to another when an operator is transferred, whether at the end or in the middle of a sign-up period.
- Must provide for a daily assembly of overtime volunteers into a list for the files.
- Must show all pertinent information about open work and available manpower (or as many as possible), as these factors are used in the decision-making process.

- Must be flexible enough so that the dispatch clerk can use the computer to analyze the various possibilities for assigning the open work.
- Must follow established work rules and minimize cost for the transit system (i.e., most efficient detailing of manpower).

AUTOMATED EXTRABOARD MANAGEMENT PROTOTYPE

Figure 11 presents the structure of the automated extraboard management system in overview. The information box in the figure contains data concerning (a) the work to be conducted, (b) the operator assignments determined from the general sign-ups, and (c) all known exceptions affecting the provision of service.

Using this information together with the output of the decision support element, which provides recommended actions or feedback on alternative actions, the dispatch clerk makes decisions concerning how unassigned or open work will be assigned and conducted. The results of these decisions are then fed back to the information box. This information is used to assist in making future decisions and reported to other departments of the transit system for their use; e.g., timekeeping, payroll, performance evaluation, etc.

Framework for an Automated Extraboard Management Prototype

The framework for the prototype extraboard management system is presented in Figure 12. This framework is structured for automated techniques that enhance the efficiency of extraboard management and emphasize the use of analytical decision support in determining how work is conducted. The elements of the framework are shaded to correspond with the general structure of the extraboard management prototype presented in Figure 11.

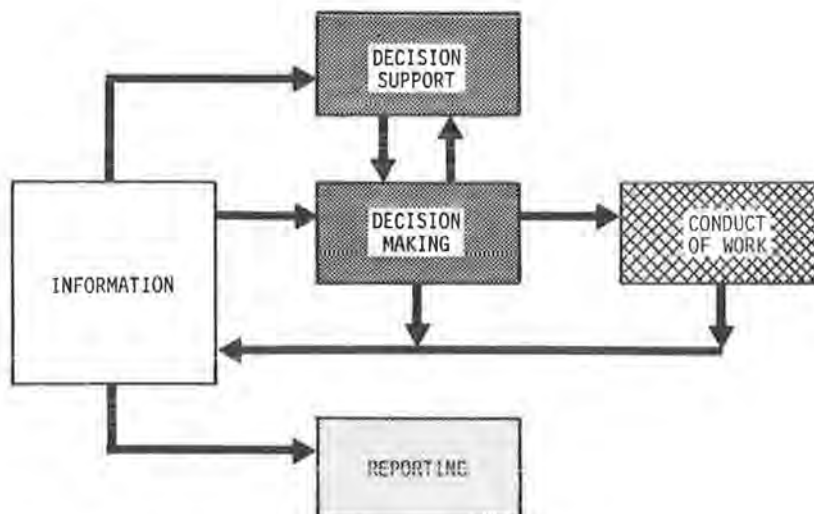


FIGURE 11 Extraboard management prototype: overview.

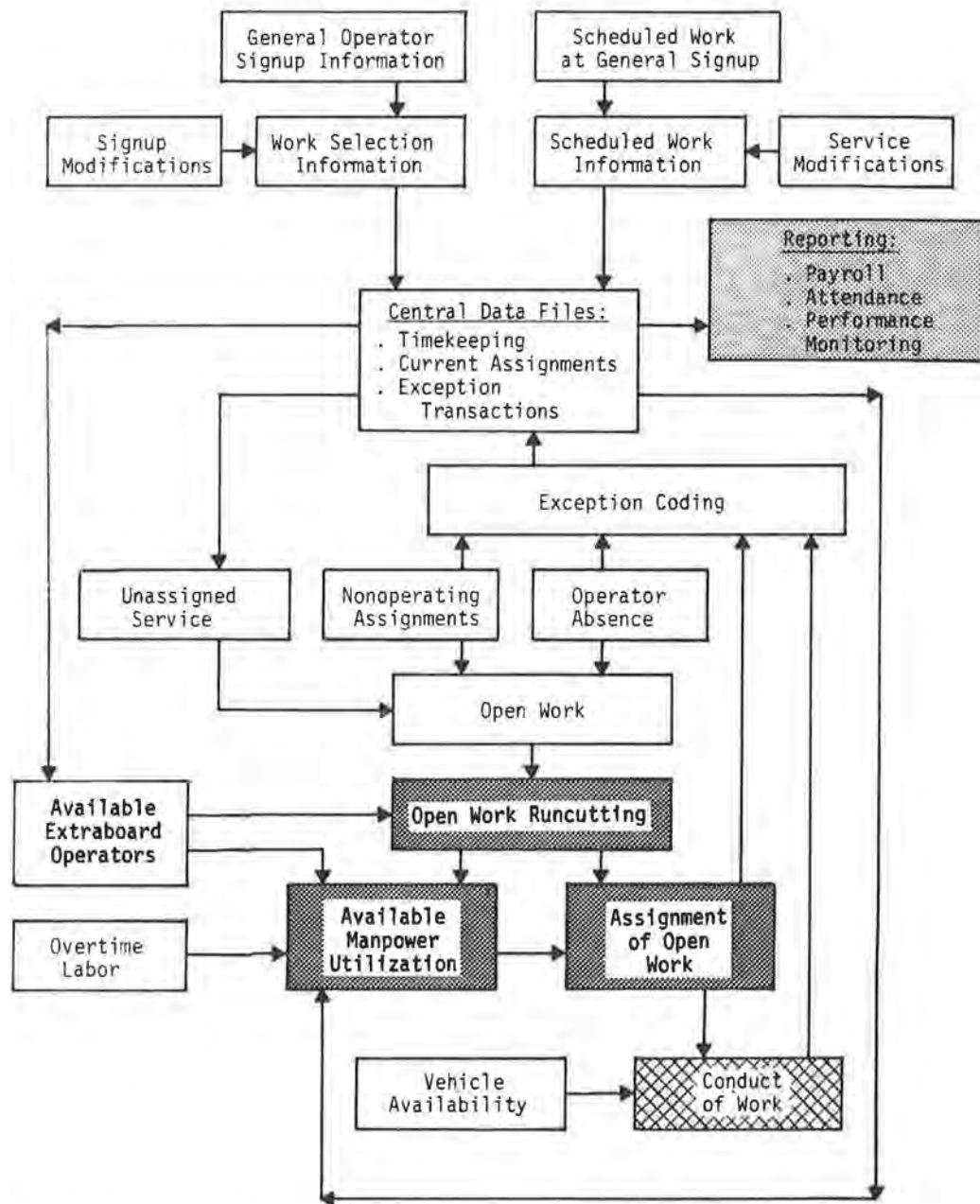


FIGURE 12 Framework for an automated extraboard management prototype.

The majority of the prototype elements relate specifically to the input, storage, and maintenance of information. These elements are shown as unshaded boxes in Figure 12. The information flows to the decision support and decision-making modules, shown by dark shading. These modules determine the conduct of work, which is shown by the cross-hatched box. The results of the assignment of open work and the conduct of work are used to update and modify information stored in central data files through exception coding. The information can be fed back into the decision modules and used for the purpose of reporting, as shown by light shading.

The flow of information and activity, identified by the arrows in the figures, connect appropriate elements. Ideally, these connections occur through direct computer-assisted transfer al-

though manual methods could tie the elements of the prototype together by using output from one component as input to the next (e.g., timekeeping to payroll). However, to take full advantage of automation, most of the system should stand as a single integrated unit.

As stated above, the prototype presented here is based, in large measure, on features of the automated systems developed for SRTD and Mississauga Transit. The current state of the art of automated extraboard management has demonstrated the opportunity for significant improvement in the handling of considerable information.

Certain elements of decision support have also been significantly improved. Opportunities for the addition of other decision support elements represent a proposed further enhancement to

automated extraboard management. The next section presents the concepts for additional improvements to decision support of extraboard management attainable through automation, focusing on available manpower utilization.

ADDITIONAL AUTOMATION OF DECISION SUPPORT

A prototype extraboard management system should not only provide increased information handling but also process the information to provide results that allow decision making to move towards optimal conditions; i.e., the system should not only be efficient but also be intelligent. An intelligent system might project the likely consequences of alternative decisions (e.g., cost estimates) or directly determine the best course of action. An intelligent system should also ensure that decisions are consistent with current labor agreement provisions and work rules.

The key extraboard management decisions are contained within three closely related activities (shown in dark shading in Figure 12):

1. open work run-cutting,
2. available manpower utilization, and
3. assignment of open work.

The decisions made during these activities are fundamental to effective extraboard management. Because these decisions are influenced by existing labor provisions and work rules, the customized elements of an automated system would largely occur in this part of the system. This section describes general methods of decision support that can be adapted to varying labor provisions and work rules. These methods should enhance the decision making in extraboard management and relieve dispatch clerks of the burden associated with complex interpretation of alternative actions.

Open Work Run-Cutting

The objective of open work run-cutting is to piece together open work in the most efficient manner given the prevailing labor agreement provisions and work rules. As discussed in Chapter 3 of this report, this activity occurs predominantly during the slating of work assignments, though it may also occur at any time during the operating day. Many transit agencies rely on the dispatch clerk to make this determination. However, automated run-cutting techniques are available and can be used to piece together open work efficiently and quickly.

As mentioned in Appendix C, SRTD is currently implementing an automated run-cutter for open work. This mini-run-cutter is structured as an interactive processing tool that allows the dispatch clerk to modify the computer results as needed.

The run-cutter suggested for the prototype model should not only consider the alternative arrangements for piecing together known open work within the work rules, but also consider how the work may potentially be accomplished; i.e. by extraboard operators or overtime labor. For instance, if no extra operators are available, it may be desirable to split certain runs to provide opportunities for second assignment (same day) overtime.

Available Manpower Utilization

The matching of manpower to open work is fundamentally an inventory problem. Decision support pertaining to the utilization of available manpower establishes and/or adjusts the distribution of additional manpower throughout the day. As discussed in the previous chapter of this report, this process includes slating known open work assignments and report times and manipulating manpower levels during the operating day in accordance with unanticipated open work. Both activities involve matching available manpower with open work, which is difficult, in part, because of the daily variation and dynamics of open work.

Determining the distribution of additional manpower to meet service delivery objectives at the least cost under conditions of uncertain demand is a complex process likely to benefit from automated decision support. Because there is little evidence that such support is currently available, improvement in this area of extraboard management would significantly advance the state of the art.

The prototype system should allow management to project the service delivery and cost implications of any manpower distribution strategy. The figures presented and discussed in Appendix D introduce concepts for further research to improve the utilization of available manpower; they could be incorporated in an automated extraboard management system.

Assignment of Open Work

As compared to available manpower utilization, assignment of open work has been considerably advanced through automation. Automation has increased the speed and consistency of assigning open work to operators in accordance with labor agreement provisions and work rules and reduced the possibility of misassigned extraboard.

As discussed in Appendix C, the SRTD currently has programmed its applicable work rules and labor agreement provisions into the software of its automated extraboard management system. The computer automatically assigns work to operators during the slating process.

A prototype system for extraboard management should extend these opportunities to the real time assignment of stand-by operators. This would enable stand-by operators to be automatically matched with unanticipated open work. Using the computer to make these work assignments will provide speed and consistency to the process of matching available manpower with open work.

CONCLUDING REMARKS

Managing the transit extraboard is a complex and demanding process—a process requiring the ability to react to change and uncertainty. Opportunities exist to improve the efficiency and effectiveness of the current state of the practice in extraboard management. Some transit systems have made significant improvements through computer-assisted techniques and procedures. The extraboard management procedures of a few transit systems include decision support capabilities.

Significant strides have been made that are accessible to others in the transit industry through contact and communication with those agencies in the forefront of extraboard management; however, opportunity to advance the state of the art remains. Current

computerized methods, primarily focused on making the process of extraboard management more efficient, can be used as building blocks to structure more effective decision making for extraboard management.

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Teleride/SAGE, "Sage Timeroll System Description for Users." Prepared for the Mississauga Transit, Ontario, Canada (December 1983).

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3. Work assignments which are assigned to extra operators by the dispatcher/clerk with the operator's option to pass include:
- 0% assignments held down for more than one day;¹
- 0% known open work posted for the next day (excluding hold-downs);
- 7% unanticipated open work, (e.g. misses);
- 24% other, (e.g. charters, special assignments, nonoperating work):
Extra work or work exceeding maximum spread time, platform time, etc.
- 67% not applicable

4. Work assignments which are assigned to extra operators by the dispatcher/clerk without the operator's option to pass include:
- 31% assignments held down for more than one day;
- 95% known open work posted for the next day (excluding hold-downs);
- 86% unanticipated open work, (e.g. misses);
- 71% other, (e.g. charters, special assignments, nonoperating work):

- 3% not applicable

5. Briefly describe any relevant assignment procedures used by your transit system not identified in questions 1-4:

Use of two or more extra boards, e.g. A.M. and P.M. Work assigned on basis of labor agreement provisions or work rules, i.e. prioritized according to pullout, pullin, type of work, payhours, etc.

6. May the dispatcher/clerk reassign work to extra operators after the extraboard is posted, (e.g. swapping work between operators)?
- 24% yes - unconditionally;
- 31% yes - granted the affected operators are in agreement;
- 21% yes - under a premium penalty, (describe):
Approximately two out of three penalties are incurred by the transit agency although operators may forfeit their guarantees.
- 31% no

¹ Considered a picked hold down assignment

7. Identify and briefly describe areas of your operator dispatch function which make use of computer-assisted processing or information:

- 22% making up the extraboard for next day's work, (e.g. pre-printed listing of extra operators in assignment sequence):

Most limited to pre-printed list of available extra operators
or known open work.

- 3% deciding which operator receives the current, (i.e. next), piece of unassigned work:

Limited to those with fully automated operator dispatch
systems.

- 3% adjusting the board, (e.g. calling day-off operators, letting extra operators off, swapping assignments or reassigning extra operators report times):

On line listing of operators volunteering for overtime work.

- 36% timekeeping activities:

Ranges from fully automated with direct feed to payroll
to semi-automated requiring manual input to payroll.

- 9% other, (e.g. recutting open work assignments):

Two report automated open work runcutting. Most are
miscellaneous listings.

8. The timekeeping component of your operator dispatch function is used to provide information to which of the following:
- 97% payroll;
- 76% attendance monitoring;
- 16% other: Individual payhour statistics, manpower utilization reports and daily dispatch reports.
9. Extra operators receiving no work or only a single tripper during their first show-up are generally:
- 74% released and given a time which they must later report in person;
- 12% released and given a time which they must later call in;
- 12% released for the remainder of the day;
- 17% other: Assigned known open work later in the day or held on stand-by. (note: generally relates to above categories)
10. Describe any procedures or work rules that determine the initial or subsequent report/callin times assigned to extra operators:
- Report times set according to experience. Stand-by time usually paid at straight time and may count towards premium pay. Each report usually guarantees some pay time.
11. The maximum number of times an extra operator normally reports in person or by telephone on a given work day is:
- Average = 2
12. State any work rules which you feel are restricting the efficiency of operator dispatching at your transit system:
- Maximum spread, minimum rest periods, guarantees, inability to use more overtime, part-time operator restrictions, present method of assignment.

13. Describe any special features or elements of your operator dispatching procedures that are specifically aimed at reducing costs:

Manpower utilization reports, breaking and recombining open work,
staggering report times, greater use of part-time operators,
use of overtime labor, weekly guarantees in lieu of daily guarantees.

14. List any tools/techniques which you feel would be useful in improving the operator dispatching process of your organization:

Most listed some form of automated support including: timekeeping,
bidding, slate preparation, optimizing work assignments, reports.
Others included improved work force sizing, scheduling and training.

* * * * *

Thank you for your time and cooperation in completing this questionnaire.
If you have any questions, please do not hesitate to call:

MacDorman & Associates
4808 North 29th Street
Arlington, Virginia 22207
(703) 237-8500

APPENDIX B

SURVEY RESPONDENTS

AC Transit - Oakland, California
 Brisbane City Council, Department of Transport - Brisbane, Australia
 Calgary Transit - Calgary, Alberta
 Capital District Transportation Authority - Albany, New York
 Central New York Regional Transportation Authority - Syracuse, New York
 Central Ohio Transit Authority - Columbus, Ohio
 Central Oklahoma Transportation & Parking Authority - Oklahoma City, Oklahoma
 Charlotte Transit System - Charlotte, North Carolina
 Chicago Transit Authority - Chicago, Illinois
 City Transit Service of Fort Worth - Fort Worth, Texas
 Dallas Transit System - Dallas, Texas
 Delaware Administration for Regional Transit - Wilmington, Delaware
 Des Moines Metropolitan Transit Authority - Des Moines, Iowa
 Duluth Transit Authority - Duluth, Minnesota
 Fort Wayne Public Transportation Corp. - Fort Wayne, Indiana
 Fresno Transit - Fresno, California
 Greater Cleveland Regional Transit Authority - Cleveland, Ohio
 Greater Manchester Transport - Manchester, England
 Greater Richmond Transit Company - Richmond, Virginia
 K-Trans - Knoxville, Tennessee
 Lane County Mass Transit District - Eugene, Oregon
 Lincoln Transportation System - Lincoln, Nebraska
 London Transit Commission - London, Ontario
 M T L, Inc. - Honolulu, Hawaii
 Madison Metro - Madison, Wisconsin
 Metro Area Transit - Omaha, Nebraska
 Metro Regional Transit Authority - Akron, Ohio
 Metro Transit - Vancouver, British Columbia
 Metropolitan Atlanta Rapid Transit Authority - Atlanta, Georgia
 Metropolitan Transit Authority - Houston, Texas
 Metropolitan Transit Commission - St. Paul, Minnesota
 Milwaukee County Transit System - Milwaukee, Wisconsin
 Mississauga Transit - Mississauga, Ontario
 Montreal Urban Community Transit Commission - Montreal, Quebec
 New Jersey Transit Corporation - Newark, New Jersey
 New York City Transit Authority - New York, New York
 Niagara Frontier Transit - Buffalo, New York
 North Suburban Mass Transit District - DesPlaines, Illinois
 OC Transpo - Ottawa-Carleton, Ontario
 Peninsula Transportation District Commission - Hampton, Virginia
 Phoenix Transit System - Phoenix, Arizona
 Pierce Transit - Tacoma, Washington
 Port Authority of Allegheny County - Pittsburgh, Pennsylvania
 Regional Transit Authority - New Orleans, Louisiana

Regional Transit Service - Rochester, New York
Regional Transportation District - Denver, Colorado
Rhode Island Public Transit Authority - Providence, Rhode Island
Sacramento Regional Transit District - Sacramento, California
San Diego Transit Corporation - San Diego, California
Santa Clara County Transit District - San Jose, California
Seattle Metro - Seattle, Washington
Southeastern Pennsylvania Transportation Authority - Philadelphia, Pennsylvania
Tidewater Transportation District Commission - Norfolk, Virginia
Toledo Area Regional Transit Authority - Toledo, Ohio
Toronto Transit Commission - Toronto, Ontario
Transit Authority of Northern Kentucky - Newport, Kentucky
Transit Authority of River City - Louisville, Kentucky
Tucson Transit System - Tucson, Arizona
VIA Metropolitan Transit System - San Antonio, Texas
Washington Metropolitan Area Transit Authority - Washington, D.C.
Winnipeg Transit System - Winnipeg, Manitoba

APPENDIX C

STATE OF THE ART OF EXTRABOARD MANAGEMENT

This appendix presents two case studies of transit systems that are in the forefront of extraboard management. These cases demonstrate the principles of efficient management methods using computer-assisted procedures that may be adaptable to other transit systems.

The cases presented here were selected using the results of a survey of 61 transit systems' extraboard management procedures. The survey responses were screened to identify transit systems that appeared to be practicing innovative management techniques and, in particular, those that have or are in the process of implementing computer-assisted extraboard management procedures. Telephone interviews were conducted with those transit systems that appeared to be candidates for case study development. These interviews resulted in a further narrowing of the transit systems considered for more detailed investigation through site visits.

The two case studies reported here are Mississauga Transit located in Ontario, Canada, and the Sacramento Regional Transit District in California. Although other transit systems reported similar extraboard management procedures, the procedures of these two transit systems are the most advanced of the survey respondents.

MISSISSAUGA TRANSIT

Mississauga Transit provides service primarily within the corporate limits of the City of Mississauga, a fast-growing urbanized area west of Toronto. The transit system serves a population of more than 260,000 from a single division using 260 full-time operators. Mississauga Transit conveniently interfaces at several locations with other transit systems including GO Transit (a commuter rail system serving Toronto and outlying regions), the Toronto Transit Commission, and Brampton Transit, which serves the City of Brampton to the north of Mississauga.

This case study includes:

- a review of Mississauga Transit's labor agreement provisions and work rules relevant to extraboard management;
- an overview description of the computerized extraboard management procedures, collectively called the Timeroll System;
- a summary of how Mississauga Transit assigns open work; and
- some highlights of planned future enhancements to the current computerized extraboard management procedures.

Labor Agreement Provisions and Work Rules

The management of Mississauga Transit's extraboard (which is called a spare board) is affected by its labor agreement provisions and work rules. Highlights of the labor provisions and work rules that influence the operator dispatching and extraboard management are provided below.

Pay Requirements

All operators are guaranteed eight hours pay daily and 40 hours pay each week. Operators required to work in excess of eight hours daily or 40 hours weekly are paid at the rate of time and a half for all hours worked in excess of the daily or weekly guarantee. Operators who work their regularly scheduled work week are paid time and a half for all hours worked in excess of the daily or weekly guarantee. Operators are paid time and a half for all work performed on their assigned day off if they worked their regularly scheduled work week. Operators called back to work after completion of their regular assignment are guaranteed a minimum of two hours pay at the rate of time and a half. All assignments are required to be completed within a spread of 12 hours and 1 minute. Operators are not required to work without eight hours rest following the completion of their last daily assignment.

Board Composition

The composition and alignment of the extraboard is determined at the time of operator bidding or general sign-up and remains unchanged until the next sign-up. When the work assignments are determined from the run-cutting process, extraboard operator assignments are prepared that specify report times and either a straight or split eight-hour assignment (i.e., shift). All vehicle operator assignments are posted and selected by operators in turn based on seniority. Those operators selecting extraboard assignments are guaranteed pay for the time of their selected report hours and are paid time and a half for work conducted outside the designated report hours.

Computerized Extraboard Management Procedures: The Timeroll System

Mississauga Transit currently uses elements of Sage Management Systems' Transit Information Communications and Control System, a modular system that combines computers

and telecommunications. The elements of the system affecting extraboard management procedures are called the Timeroll System.

The Timeroll System assists managers and staff by allowing them to rely on the speed and accuracy of the computer for the tedious but essential record-keeping and monitoring tasks. The system contains five modules, which are described below and shown in graphic form in Figure C-1:

- drivers and calendar,
- sign-up,
- driver dispatching,
- payroll timekeeping, and
- performance reporting.

Drivers and Calendar Module

The drivers and calendar module stores personnel information about each vehicle operator and a "calendar" of scheduled service. This information is used by the other four modules, and may be closely related to existing personnel system files. The information on each driver includes name, employee and/or badge and/or seniority numbers, seniority day and rank, address, phone, vacation taken and scheduled, miscellaneous other holidays, and disability codes with effective dates. Seniority numbers can be recomputed on demand, presumably before a sign-up. The "calendar" is a brief record whereby the user can tell the computer which service, service rates, and pay parameters to use in handling work for the day.

Sign-up Module

The sign-up module stores sign-up information. Screens and reports are provided to assist in the process of storing run-cut data, building weekly work assignments (called crews), printing sign-up sheets, and entering sign-up choices as they are made. Regular driver bids, spare or extraboard bids, and vacation relief bids can be entered. Information can be kept on multiple sign-ups, with the minimum information stored being the sign-up currently in effect and the sign-up currently being prepared.

Driver Dispatching Module

The driver dispatching module keeps information for each day's driver assignments and exceptions. The sign-up module and the calendar file allow staff to create, view, modify, and print each day's scheduled work and drivers a week or so in advance. They can modify this information before, during, and after the actual time of occurrence, using screens on computer terminals. Whenever requested, the Timeroll System will print records showing current work assignments, so that accurate listings of open work and unassigned drivers are always on hand for reference purposes. Driver dispatch personnel can enter exceptions as they occur during the dispatch day, keeping in the computer the information necessary for timekeeping. After the dispatch day is over, reports show what actually transpired and analyze use of "spare" or "extraboard" drivers.

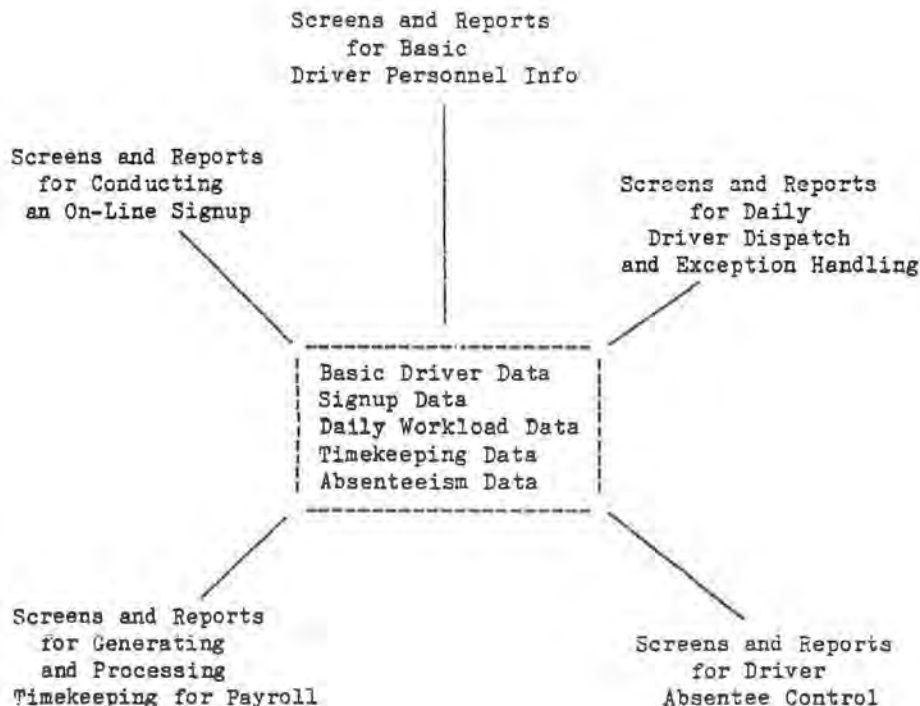


FIGURE C-1 Mississauga Transit's Timeroll system modules.

Payroll Timekeeping Module

The payroll timekeeping module generates from the day's driver dispatch information, using the rules of the property's union contract, the computer's "best guess" at the timekeeping transactions for the day. Property staff can view the information using terminal screens and reports that show each driver's scheduled and actual pay hours. The reports pinpoint drivers whose pay hours need verification, which greatly reduces the timekeeping staff's work. Changes are entered, and reports can be reproduced to show the final pay requirements for the day. Pay hours are accumulated and passed to payroll either daily, weekly, biweekly, or bimonthly.

Performance Reporting Module

The performance reporting module stores up to four "absentee codes" for each day, for each driver, adding each new day's entries from the daily exception entries in the daily driver dispatch module. Records can be kept for as long as desired, presumably at least one year. Screens and reports allow reference of individual driver absence, by individual day, by individual code, and in various group and summary forms.

Information Flow

The flow of information through the five modules as shown in Figure C-2 resembles the actual flow of information when these activities are conducted manually.

Assignment of Open Work

The task of logging in operators and filling open work is performed on-line in the dispatch center. The daily runs, along with the operator bids as per sign-up, are displayed on a terminal and may be adjusted at any time. Adjustments may entail a change in operators or a change in hours worked per operator. The final product at the day's end automatically generates timekeeping transactions for payroll.

Utilization of available extraboard to fill open work is handled in the following manner by Mississauga Transit:

- The dispatch screen may be set up to display all uncovered pieces of work at any given time. A hard copy of this is also obtainable at any given time and is generally the procedure used by Mississauga Transit.
- The dispatch screen will also display and produce a hard copy of all available extraboard operators for the day in question.
- The dispatching clerk then manually matches the open work with the extraboard operators, as efficiently as humanly possible.
- Once this initial match has been made, the clerk will then take the remaining uncovered work and break it down (run-cut) into smaller pieces to accommodate any extraboard operator who may be available. If the start or finish times are adjusted on the work assignment, all pertinent data are duplicated to ensure that trips are not lost.

- If there is any remaining open work after the extraboard operators have been fully utilized, it will be allocated out as overtime to operators, by seniority, who have indicated a desire to work an extra assignment.

- If the extra assignment overtime list is exhausted, the computer will produce a list, sorted by seniority, of all operators who have the day off, along with their phone numbers.

As a follow-up and operational tool, an extraboard analysis report is produced at the end of the day. This report shows:

1. which operators were on the extraboard and their actual assignments and hours of work;
2. the productive hours of work per extraboard operator; and
3. a total of the amount of extraboard hours scheduled, the amount of scheduled extraboard hours utilized, and a percentage utilization figure.

Future Enhancements

Mississauga Transit is developing the following enhancements that, when implemented, should allow easy access to data required to fill open work:

- A split screen (report) showing uncovered work and extraboard operator availability in chronological order.
- A possible automatic computer match of available operators and uncovered work based on property-specific parameters and contractual obligations.
- A procedure in which a portion of an operator's unused scheduled extraboard hours will be qualified for future consideration.
- An interface with an overtime availability report showing:
 1. what operators are available for specific types of work;
 2. access to the bids file showing the previous day's punch-out time and the next day's punch-in time (in consideration of spread time); and
 3. access to the personnel files configuring seniority (property-specific) and home telephone numbers.

SACRAMENTO REGIONAL TRANSIT DISTRICT

The Sacramento Regional Transit District (SRTD) provides service to an urban area of more than 750,000 persons. It currently operates from a single location using 300 full-time and 30 part-time operators. SRTD is currently implementing a light-rail system that will require expansion to a second division when the system becomes operational.

This case study includes:

- a review of SRTD's labor agreement provisions and work rules relevant to extraboard management,
- discussion of SRTD's pre-run-cutting procedures,
- a review of SRTD's computerized vehicle operator dispatching procedures,
- an overview of the dispatch control module of the computerized transportation management system, and
- a summary of the dispatch control responsibilities and reports.

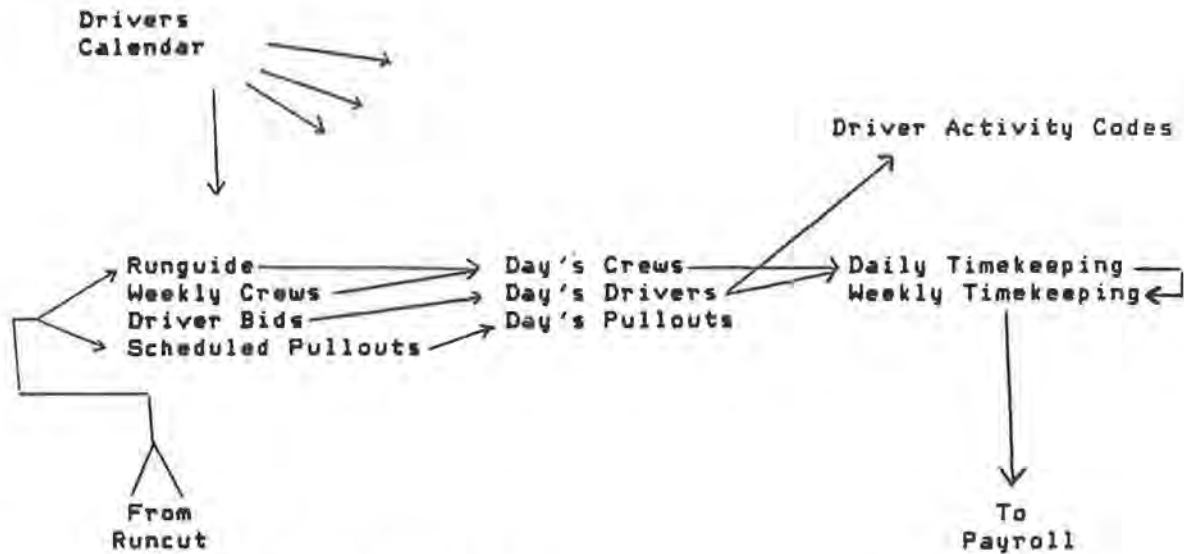


FIGURE C-2 Timeroll system information flow.

Labor Agreement Provisions and Work Rules

Before a discussion of extraboard management procedures, it is important to describe those SRTD labor agreement provisions and work rules that affect the context in which the work is conducted, including:

- pay requirements,
- board composition,
- posting of work assignments, and
- assignment of open work.

Pay Requirements

Each extraboard operator is guaranteed eight pay-hours for each of five consecutive weekly workdays. The eight-hour guarantee does not apply to any day an operator is tardy. Extraboard operators requested to report for the purposes of protecting the board receive a minimum of three hours of pay.

Time worked on an extraboard operator's regular day off is paid at the rate of time and a half but is not used in computing guarantee. Each piece of work assigned to an extraboard operator is guaranteed a minimum of one hour of pay.

Board Composition

The extraboard is established by listing in order of seniority all full-time operators not having selected available posted run assignments at the time of each general sign-up. Each day thereafter, the top six names on the board are dropped to the bottom of the list including those who may be on their day off or absent for any reason. Operators going to the board for any reason, including new employees, have their names inserted in order of seniority without reestablishing the board.

Posting of Work Assignments

Extraboard assignments are posted no later than 2:00 p.m. each day. Extraboard operators whose assignments are subsequently changed or added because of an emergency must accept all work if no other operators are available, except that which exceeds the following limitations:

- daily work time amounting to greater than 10 hours not including report time,
- work that results in less than a nine-hour rest period between daily assignments, and
- work that exceeds 12 hours spread time including report and pull-out time.

Assignment of Open Work

Operators are assigned to open work in the following order:

- extraboard operators on their regular work day,
- regular operators on their regular work day,
- extraboard operators on their day off, and
- regular operators on their day off.

An extraboard operator is not assigned a tripper in conjunction with a run unless there is no regular operator available.

Open work is assigned in the following order:

- all report assignments with the earliest report time first and so forth,
- combined work and report assignments with the earliest time first and so forth, and
- all combinations of work arranged with the greatest amount of work time first and so forth.

Pre-Run-Cutting Procedures

Before cutting the work assignments for regular operators, all work that does not lend itself to making up full-time assignments, such as school trips, express trips, and special service for handicapped riders, is set aside to be performed by part-time operators. This work, which is scheduled and available, is assembled into assignments that virtually ensure that the maximum allowable number of part-time operators (10% of full-time operators) and hours (30 hours per week) permitted by the labor agreement are utilized.

Computerized Operator Dispatching

SRTD is implementing a computerized management and operations information system with the assistance of Vista Systems Inc. of Princeton, New Jersey. Included in the system is an operator dispatch module with the objective of assisting in the efficient management of operators and work assignments. The dispatch module retrieves run and pay data for the run-cut currently in effect and stores and manipulates these data to assist in dispatching and timekeeping functions. The module provides the capability of maintaining operator pick data, recording operators' work activities, and providing a variety of reports. It also includes facilities for recording bus assignments and changes by block, for monitoring scheduled mileage, and for recording data on road calls or other in-service incidents.

This dispatch module consists of five primary functions:

- pick file maintenance,
- operator timekeeping,
- extraboard assignments,
- vehicle assignment, and
- road call and incident tracking.

The last two functions, vehicle assignment and road call and incident tracking, are not discussed further because they are not directly relevant to operator dispatching. The other dispatch module functions are described below.

Pick File Maintenance

- The Pick Data File is created as the output of the Operator Bidding Module and reflects the selections made at the last sign-up for work, holiday, and vacation bids.
- The dispatcher can modify the operator pick records to enter changes that may occur between sign-ups.
- The changes entered in the Pick Data File are automatically reflected in the Time Detail (i.e., central timekeeping) files if they were entered in advance of the creation of the Time Detail file for a given day. Otherwise, exception entries in the Operator Timekeeping program must be used to make changes.
- The dispatcher can produce a report of the contents of the Pick Data File sorted in either run number or pass number order, a monthly holiday calendar, or a weekly vacation calendar.

Operator Timekeeping

- The dispatcher creates a Time Detail File for all operators for each day of operation. The Time Detail File reflects scheduled work by incorporating the data in the Run Data File and the Pick Data File as of the time it is created.
- To record an exception to the data in the Time Detail File, the dispatcher enters an exception code and the time (clock time or pay time) associated with the exception. After the exception is entered, the operator's total pay is automatically recomputed and the time record is updated.
- There are three general types of exception codes: Work Assignments, Attendance Exceptions, and Extra Work Exceptions.
- When the dispatcher enters any exception code, the system writes a record of the transaction to the Exception Transactions File. This file is used to retrieve exception transaction reports and attendance history for each employee and to aggregate data for management reporting.
- For extraboard operators who have not been preassigned by the Extraboard Assignment function, the dispatcher enters work assignment data and times as the operators are given assignments. The system computes total work time and pay hours and monitors standby time.
- After exceptions have been entered, the dispatcher can request a Time Audit Report, which flags unassigned or over-assigned work, or a new Dispatch Diary, which summarizes the work and pay hours by operator. If errors are detected, the dispatcher can modify the data until the time records are free of errors and ready for payroll processing.

Extraboard Assignment

- The dispatcher "unassigns" all work that becomes open because of call-ins, ask offs, sick brought forward, jury duty, etc., by recording the appropriate exception for the assigned operator.
- Any changes previously made in the Pick Data File that resulted in unassigned work in the Time Detail File are automatically merged with newly unassigned work.
- The unassigned pieces of work can be displayed and reviewed before packaging unassigned pieces into work assignments.
- The unassigned pieces of work are processed through a mini-run-cut to produce an optimal set of runs. This is done by the system, either manually or automatically, and can be modified by the dispatcher.
- The dispatcher displays the packaged work and modifies it, as desired, by undoing runs or switching pieces. At this stage the dispatcher can build "combos" if needed.
- The dispatcher then enters the number of report operators desired by report time. The system automatically rotates the extraboard six positions and assigns "report" operators to report times (within required daily rest period constraints).
- The assignment of operators to work is done automatically by the system. The first driver not on report is assigned to the highest work time run. Combos are assigned before full extraboard runs. Assignments are made to be consistent with labor agreement provisions and work rules.

- If the number of available assignments is greater than the number of extraboard operators available, the dispatcher can add additional operators (those operators on their day off) through the exception timekeeping function.
- The dispatcher can also satisfy the requirements for extra operators by quitting this session without saving the work, modifying the number of report operators previously entered, and reassigning the extraboard.
- The extraboard slate and the description of extraboard runs are printed out and posted.

Dispatch Control Responsibilities

The dispatchers are responsible for:

- creating and maintaining the Time Detail Files for operator payroll input,
- maintaining the operator Pick Data File between sign-ups, and
- preparing the daily extraboard slate.

Scheduling is responsible for:

- maintaining the runs data file between sign-ups, and
- making short-term run changes in the Time Detail File records.

Employee leave balances and personnel data are maintained through the payroll process.

Dispatch Control Reports

The dispatcher can produce a series of reports that are based on the data gathered in the procedures discussed above. They are:

- Daily Check-Out Sheet—a chronological listing of runs by check-out time for a given time period.
- Daily Dispatch Diary—a summary of work time and pay hours for each operator on a specified day.
- Daily Time Audit—an exception summary of runs where scheduled work differs from actual work beyond a prespecified limit.
- Extraboard Run Detail—a list of the pay impacts of the extraboard runs for the next day.
- Exception Transactions Report—a detailed report of system transactions in order of occurrence for a day or a range of days.
- Summary Attendance Report—a summary of attendance transactions by type for a day or a range of days.
- Driver Review Report—a list of work performed, pay type categories, total pay hours, and other types of pay (e.g., passenger counts) for each day in the pay period for each operator.
- Late Pull-In Report—a list of late pull-ins by run, operator, and scheduled vs. actual pull-in time.

APPENDIX D

CONCEPTS FOR FUTURE RESEARCH

This appendix introduces concepts for future research. The discussion suggests that methods can be developed to project the service delivery and cost consequences of extraboard distribution and utilization. Three related areas are addressed:

1. determining manpower demand,
2. evaluating stand-by operator distribution strategies, and
3. evaluating manpower availability during the operating day.

DETERMINING MANPOWER DEMAND

The most important parameter in making the projections for available manpower utilization is the demand for manpower that is created by open work and influenced by how such work is pieced together. By charting the demand for manpower, it would be possible to establish a demand profile for a given operating day and to use this information to make effective decisions to distribute available manpower.

Figure D-1a shows an example of manpower demand for a weekday created by open work. The demand tends to follow the amount of scheduled service provided throughout the day. If additional manpower demand profiles for many weekdays were plotted on the same graph, a picture such as that depicted in Figure D-1b would develop. This figure shows the daily variation in weekday demand for additional manpower.

The range of demand for manpower may be described as shown in Figure D-1c. The dotted line in the figure is representative of the average weekday manpower demand profile for open work. Cross sections of the multiple profiles in Figure D-1b reveal the daily variation in manpower demand during the operating day. The cross section taken at 5 p.m. and shown in Figure D-1d indicates by the clustering of dots that during most days manpower demand is close to the average although a few days tend to stray to the boundaries (X_1 and X_2) of the range.

The cross-section information can also be developed into a profile describing the daily variation in demand for manpower at specific times during the day. Figure D-1e shows a profile of the cross section presented in Figure D-1d. The peak of the curve indicates that during most days manpower demand for open work at 5 p.m. is close to average demand.

The result of this information is a completed profile of the dynamics (i.e., change throughout the day) and daily variation of weekday manpower demand created by open work. Similar profiles could be developed for Saturday and Sunday as well. Weekday demand profiles could also be broken down by day of the week (e.g., Friday demand profiles). These demand profiles can then be used to evaluate and adjust manpower distribution strategies.

Manpower distribution strategies are most specifically directed at stand-by operators. Although the amount and timing of unanticipated open work is not certain, it is possible to use a representative manpower demand profile to make the best decision for stand-by operator distribution.

EVALUATING STAND-BY OPERATOR DISTRIBUTION STRATEGIES

Figure D-2a is the same weekday manpower demand profile presented in Figure D-1c. Figure D-2b shows a stand-by operator distribution strategy for a given weekday. The strategy requires 5 stand-by operators to report at 3 a.m., 25 at 6 a.m., 10 at 9 a.m., 25 at 3 p.m., and 5 at 9 p.m.

If manpower demand created by unanticipated open work is consistent with the average profile shown by the dotted line in Figure D-2a, the supply of stand-by operators at any time during the operating day can be described as shown in Figure D-2c. The decreasing slopes in the graph represent decreasing stand-by operator availability in accordance with the average manpower demand throughout the day. The vertical lines represent increases in manpower availability as stand-by operators report for work in accordance with the distribution strategy shown in Figure D-2b.

In this example, the demand for manpower never exceeds manpower supply. Therefore, service will not be missed because of unavailable manpower. However, unproductive time (e.g., stand-by time) will be incurred as represented by the shaded area underneath the sawtooth manpower availability function.

To properly evaluate the stand-by operator distribution strategy, transit management must not only consider the scenario of average demand for manpower, but the complete range and variation of manpower demand. By considering the complete profile of weekday manpower demand, the range of possible operator availability can be described by the manpower availability profile shown in figure D-2d.

The graph shows, for example, that for a given worst-day scenario, it is possible that the demand for manpower may exceed the manpower available around 3 p.m. The probability of this occurring is shown in the cross-section profile to the right of D-2d. In this particular instance, daily variation in demand indicates a 10% probability that service will be missed around 3 p.m. if no action is taken. This information could be combined with similar information pertaining to projected costs for standby operator distribution strategies. The combination of information (i.e., on the likelihood of missing service and the expected cost of stand-by operator distribution strategies) could be used to define an optimal or preferred strategy.

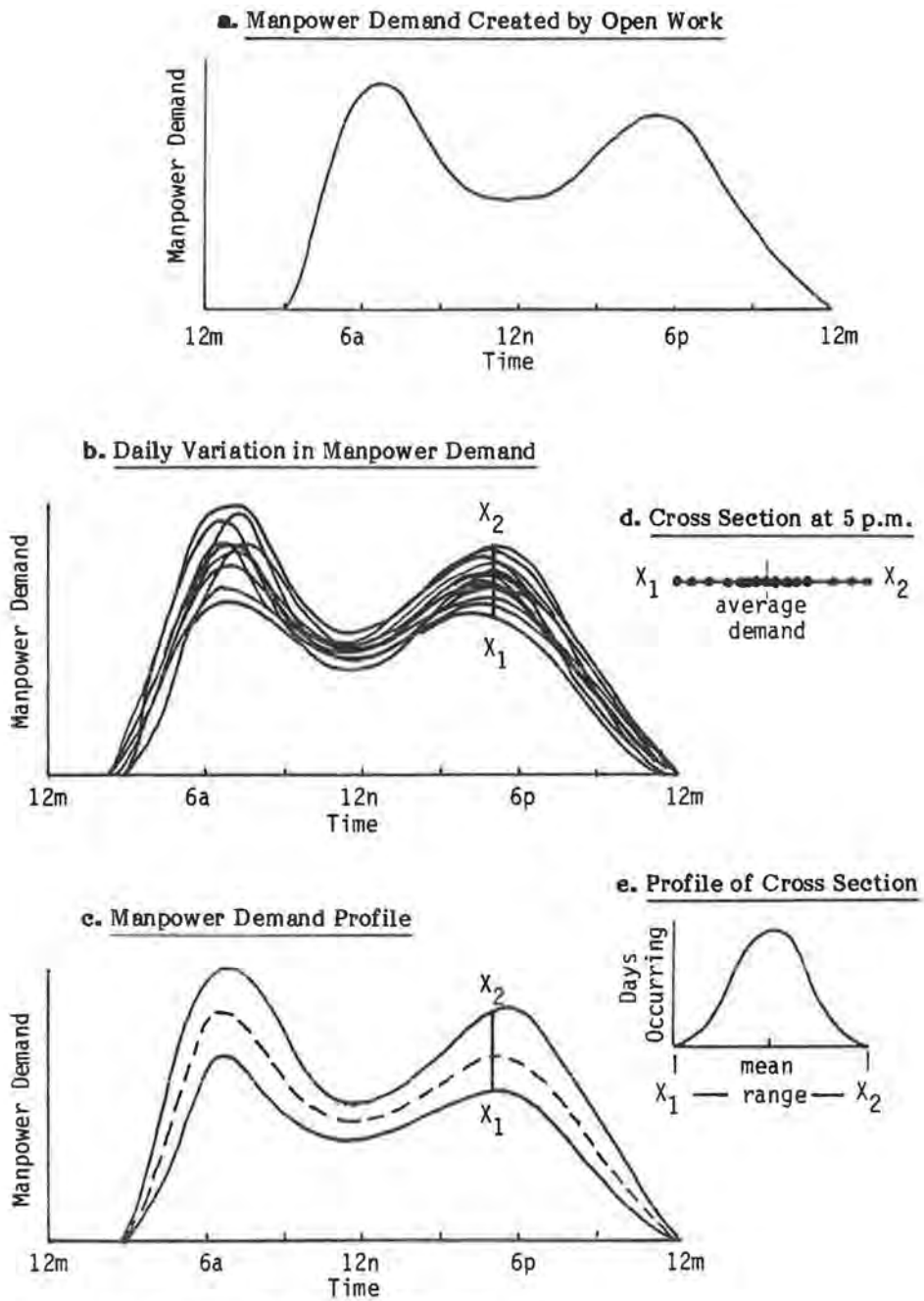


FIGURE D-1 Determining manpower demand.

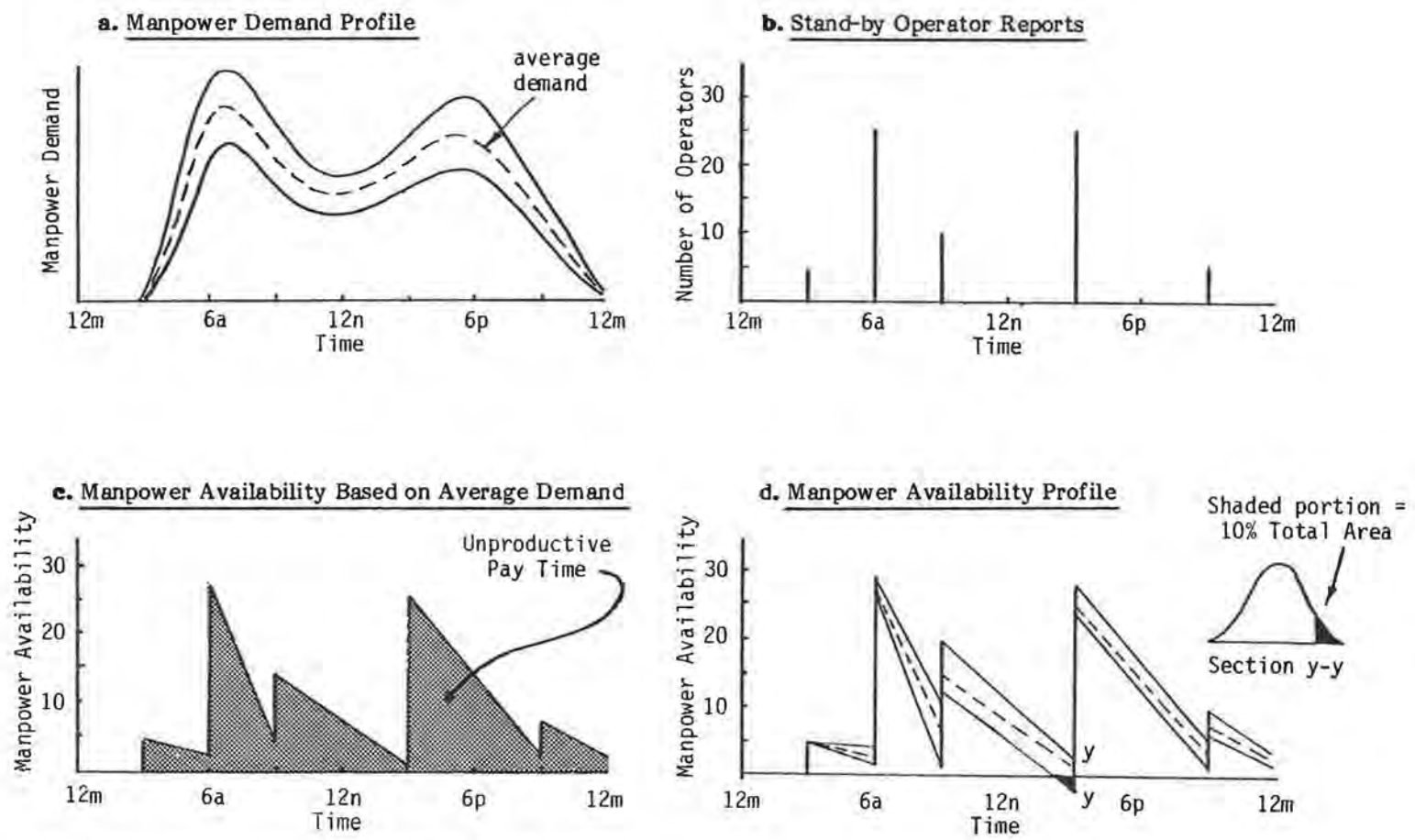


FIGURE D-2 Evaluating stand-by operator distribution strategies.

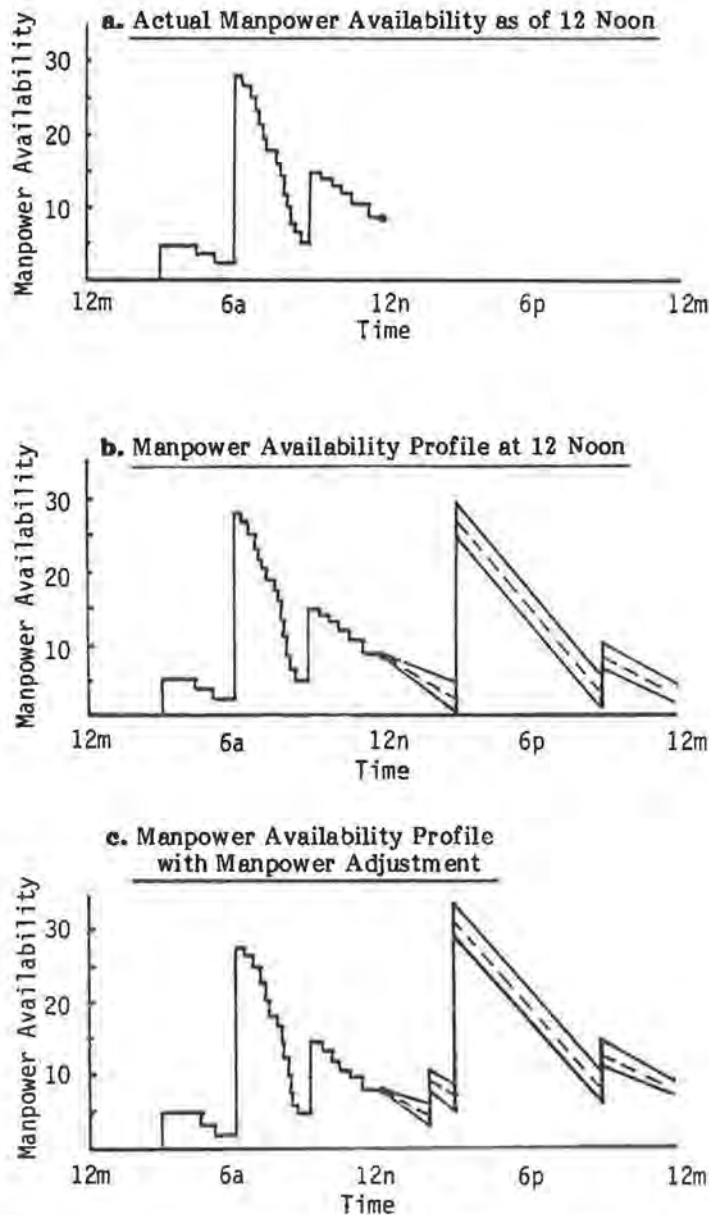


FIGURE D-3 Evaluating manpower availability during the operating day.

EVALUATING MANPOWER AVAILABILITY DURING THE OPERATING DAY

The same principle described above may be applied to project the service delivery and financial implications of given situations during the operating day (i.e., real time). Figure D-3a illustrates operator availability as it transpired up to a certain point in the operating day. Beyond this point, the demand for manpower is uncertain. However, by knowing when additional stand-by operators are to report for work and by applying a representative demand profile to the remainder of the operating day (as shown in Figure D-3b), expected costs and the likelihood of missed service can be statistically projected.

Adjustments to an existing manpower strategy may be made

on the basis of such projections and generally take one of the following forms:

- calling overtime operators,
- releasing extra operators, and
- reassigning extra operators to a later report time.

Each case calls for a modification of the planned manpower strategy that could easily be adapted from the manpower availability profile.

Figure D-3c shows how the manpower availability profile described in Figure D-3b would change if five overtime operators were called in at 2 p.m. Projected service and financial implications could be evaluated before such a change is actually made.