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Mass Transit Management: A Handbook for Small Cities. Second Edition, Revised September 1980. Part III

Indiana Univ. at Bloomington

Prepared for

Urban Mass Transportation Administration
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16. Abstract

The aim of Mass Transit Management: A Handbook for Small Cities is to provide information for the management of mass transit, particularly for samll-scale operations in smaller cities. A modern, systematic approach to transit management has been worked into the material, while recognizing the financial constraints and limited degree of specialization possible in a small transit system. The consumer-oriented approach to marketing is stressed throughout the handbook. For convenience, the handbook is split into four parts: Part I Goals, Support, and Finance; Part II Management and Control; Part III Operations; and Part IV Marketing.

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MASS TRANSIT MANAGEMENT:

A HANDBOOK FOR SMALL CITIES

Volume 3: Operations

REVISED EDITION

Prepared by

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INTRODUCTION TO THE SECOND EDITION, REVISED

In most fields of transportation, management--rather than equipment, location, or operating rights--is the key to success. Urban mass transportation is no exception. Despite its importance, transit management has received surprisingly little attention, especially in terms of modern business practices. The aim of this handbook is to provide information for the management of mass transit, particularly for small-scale operations in smaller cities in the United States. For the purposes of this handbook, a small city is defined as one that operates 101 buses or fewer. This cutoff point for small transit systems is one used by the federal government. Because of the scale of transit enterprises involved, the handbook assumes that management faces two major constraints: (1) the amount of money available and (2) the degree of specialization possible with the limited manpower of a small enterprise.

Staff members at the Institute for Urban Transportation (IUT) in Bloomington, Indiana, investigated the practices of smaller transit systems in many parts of the United States to discover firsthand some of the methods and problems of such properties. The best methods used by these properties have been included in this handbook. In addition, a modern, systematic approach to the management of transit firms has been worked into the material as an improvement on the conventional practices of the transit industry. Extensive experience in providing local and statewide technical assistance in Indiana and conducting management performance audits of transit properties has provided IUT's staff with substantial insight into transit management.

The modern consumer-oriented approach to business is strongly emphasized in this handbook. The consumer-oriented approach is the major concept of business that has been pursued through the technique of marketing management by American business firms since the end of World War II. By adopting this powerful, strategic concept, this handbook is very much a marketing-oriented document. The justifications for this approach seem compelling because in general the transit industry admittedly suffers from a lack of marketing expertise and effort. Today, the transit industry still is primarily operations-oriented. However, in many parts of the United States transit properties of all sizes are becoming more marketing-oriented.

The handbook is divided into four sections. Part I: Goals, Support, and Finance (chapters 1-3) includes the important matters of establishing goals and objectives, understanding the consumer, gaining public support and public action for transit, institutionalizing transit as an integral part of the community, and financing transit. Part II: Management and Control (chapters 4 and 5) focuses on management itself and the control and information devices needed for effective management. Part III: Operations (chapters 6-10) covers important areas of day-to-day operation, coordinated as the product element in the marketing mix. Part IV: Marketing (chapters 11-14) deals with the marketing program and promotional activities.

Because this handbook is intended to serve as a reference work, not a textbook, care has been taken to produce chapters that are complete in and of themselves, which can be used independently. Some repetition is inevitable when using this technique, but every effort has been made to eliminate duplication as much as possible by cross-referencing and through providing a detailed table of contents. Appendixes are included with some chapters to give more detail on certain subjects without interrupting the flow of the text. A short but relevant bibliography is provided at the end of each chapter. A general bibliography is included at the end of the handbook.

Early in this handbook, the need to establish goals and objectives is stressed. Indeed, the concept of management by objectives (MBO) is treated in some detail. MBO recommendations are given for policy-making bodies as well as management. A detailed explanation of how to use MBO for transit management is provided.

The critical concept of consumer orientation through marketing is reflected throughout the handbook, but perhaps most strongly in Chapter 1 and Chapter 11. Chapter 1 is a discussion of the goals and objectives of a transit enterprise. It covers consumer behavior as it may be applied to mass transportation and a recommendation for the development of a general marketing-management strategy for transit management. In Chapter 11, the marketing program suggested for the small transit property is developed fully. The relationship of all parts of the transit enterprise is built around a marketing-oriented firm. The marketing mix--product, price, and promotion--is the concept that shapes managerial action in meeting consumer needs. MBO is the means by which results can be attained reasonably.

Throughout this handbook, careful attention has been paid to the consumer and to gearing management thought and the service provided by the transit firm to meet the desires and needs of consumers. Service quality is a key factor--not a minimum of service at the lowest possible

cost, concocted mainly to meet the needs of the transit firm, but service that meets consumer needs and desires at a cost carefully calculated and controlled. This seems a wise course for transit managers; publicly owned transit firms--of which the number is increasing rapidly--generally focus on service as their main reason for operation. Even privately owned transit firms cannot hope to generate long-run profits without providing good service to their clientele.

In addition to covering broad strategic concepts of management and matters of systematic, day-to-day operation, this handbook deals with critical factors including public support, finance, and various forms of public ownership. A fair proportion of the contents, therefore, is directed not only toward transit managers, but also toward public-spirited citizens and public officials who wish to inaugurate or improve transit services through public action.

This handbook should be considered a draft, as was the first edition. It combines the tried-and-true methods--where these appeared to be the best possible practices--with innovation, in the application of modern business techniques to transit. Thus, this handbook ventures onto untested ground. In a world of managerial as well as technical innovation, it would be surprising indeed if no major changes in modern business thinking and in transit occur in the course of 3 to 5 years. What is contained here may be subject to fairly rapid obsolescence.

We sincerely hope that by using this handbook managers of existing smaller transit properties will find many good ideas and suggestions that they may adopt easily. For the transit operation starting from scratch, this handbook provides as complete and usable a program as currently is available in published form. To be completely realistic, existing transit properties will be able to adopt the complete strategy and the major concepts suggested here only with some difficulty, because of vested interests, agreements, and other factors difficult or impossible to modify in a short time.

PART III

OPERATIONS

A key idea of modern business management introduced in this handbook is the concept of the marketing mix--product, price, and promotion--as an adjustable package that management may modify to reach different segments of the market. The service provided is the transit firm's product. The chapters in this section deal with the elements involved in providing that service. The various operational functions of personnel, maintenance, equipment selection, routing and scheduling, and communications and control are treated as parts of a whole. They are interrelated, not individual, unrelated pieces. All of these functions are oriented toward serving consumers--the goal of the transit enterprise.

If all this seems more complicated than just running buses around town, it is. However, the marketing concept is not difficult and it is a rational approach. The aim is not to optimize maintenance or equipment or any one aspect of operations, but to optimize the entire package of service-related functions.

CHAPTER 6

PERSONNEL AND LABOR RELATIONS

Introduction

Those involved in transit management must recognize the value of human resources. A qualified driver is more than just a pair of arms and legs. The driver is a valuable part of the product package that transit has to offer the public. The manager of the transit enterprise does not have daily contact with riders; the drivers and office personnel do. Inconsiderate drivers or inattentive office personnel can erase any attractive image that the transit agency may have created through new equipment, advertising, or public relations. Slipshod work by maintenance personnel will result in equipment breakdowns or dirty, unreliable equipment.

A major problem confronting transit management is recruiting, selecting, and training qualified personnel. A personnel program is a way of finding and selecting the best persons available, and of molding a team of workers geared to fit the goals of the transit undertaking. Viewed in this manner, personnel is not an expense, but an investment that becomes an integral part of both the transit agency's product and image.

Labor is a key factor in mass transit. Transit is a labor-intensive industry, with labor expenses making up the bulk of operating costs. Despite the importance of labor, many jobs in transit appear to have no future. This has been true during the long decline of the industry and particularly during the 1950s and early 1960s. The outlook is much more promising today, although there still is a tendency for employees to think, "Once a bus driver, always a bus driver." The paths toward promotion and better opportunities often are unclear.

A great deal of responsibility is thrust upon operating employees by the nature of their work. Passengers' safety is their responsibility, along with the responsibility of operating a large, expensive vehicle on crowded streets.

Supervision of operating personnel is difficult. Supervisors simply cannot be present at all times to provide the help operators need, nor can they monitor performance continually.

In recent years, the pay for transit employees has been relatively high, especially when compared with pay in the 1950s and early 1960s. Operator productivity, however, has been falling, in terms of the number of passengers moved annually per employee. This falling productivity was for many years the result of declining patronage. In recent years, however, patronage has begun to rise, but service expansion has required additional employees. The new increases in ridership have not overcome productivity declines.

The transit industry is highly unionized; the Amalgamated Transit Union represents most transit employees. Some employees are represented by the Transport Workers Union, the Teamsters, or the United Transportation Union. Under section 13c--the labor protection clause--of the Urban Mass Transportation Act of 1964, as amended, agreements must be reached between management and labor before UMTA can approve federal capital or operating grants.

Federal laws concerning equal opportunity require that all jobs be open to all persons, regardless of sex, race, creed, national origin, or age. Management must be sure that the laws are obeyed to the letter or face the likelihood of lawsuits and fines.

Personnel management in a transit system includes:

1. Personnel planning.
2. Recruitment, selection, orientation, and training.
3. Career development.
4. Personnel evaluation.
5. Employee compensation.
6. Administration of equal employment opportunity and affirmative action programs.
7. Administration of health and safety programs.
8. Labor relations.

Personnel Planning

Assessing Personnel Needs

Before a transit system can recruit, select, or train its employees, it must have some idea of its personnel needs. Personnel planning begins with job analyses and ends with calculation of personnel needs. It provides the basis for all the actions in this area (see Appendix 6A).

Job analyses are systematic studies of the characteristics, duties, and responsibilities attached to specific jobs. These analyses are used to prepare a job description for each job or class of jobs. The job description outlines the duties, responsibilities, and conditions that characterize a particular job. A job description does not attempt to describe the individual worker, but rather the task performed.

Managers can identify the standards for performance necessary for successful work in some jobs. These standards are measures of output desired for each job. In addition to providing criteria against which to measure employees' performances, these standards allow the system to look for certain characteristics in applicants for particular jobs. Such job specifications help the system to search effectively for individuals who have the desired skills most closely related to success on the job.

Job analyses, descriptions, criteria, and specifications are also useful to the transit system because (1) they clarify relationships among different jobs (e.g., drivers working under the direction of road supervisors), (2) they maintain an equitable salary structure, and (3) they define future lines of promotion.

Assessing Personnel Resources

Before the transit system looks outside for people to fill its positions, it should analyze its current personnel resources. The best way to do this is for the system to maintain skills inventories of its workers. A skills inventory is a list of the names, characteristics, and skills of people working for the transit system. The data kept in these inventories can become unmanageable rapidly. Therefore, the inventory must be tailored to the needs of an individual organization. With this information, the system not only knows what skills each position demands, but who in the organization can or will be able to fill each job.

A transit system's goals and objectives place demands on all of its resources, especially its human resources. Therefore, if personnel management is to fulfill these needs, it must be informed of these goals and objectives.

Personnel management also must be able to work with management and the other functional areas to translate this information into preliminary personnel requirements. In general, these preliminary figures are compared with the skills inventories of the system for each job or class of jobs. When personnel management finds it is unable to fill all positions with current employees, it can begin to recruit new employees.

Filling Personnel Needs

After compiling information on the types of jobs that will be available, management is ready to begin filling the personnel needs of the transit system. The steps in this process may be subdivided into four areas.

1. Recruitment
2. Selection
    a. Application
    b. Interview
    c. Reference check
    d. Test
    e. Physical examination
3. Orientation
4. Training
    a. New driver training programs
    b. On-going training programs
    c. Reviewing progress

Recruitment

When a vacancy is forecast or known to exist, the manager needs to ask the following questions:

1. What are the specific job requirements for the job?
2. What kind of employee or applicant has these qualifications?
3. Where can we find the employee or applicant with these qualifications?

Personnel planning provides management with most of the answers to these questions. Job specifications enable management to assess the qualifications necessary for

successful performance of the task. Skills inventories give management information about current employees who have the necessary qualifications. Personnel planning also provides the manager with an idea of the outside sources that should be tapped for each position to be filled.

In the recruitment of new transit employees, vacancies can be filled from many sources, such as walk-in applicants (a common source of drivers); employee referrals; trade publications and mail applications (management personnel); high schools, trade and vocational schools (apprentice mechanics); newspaper advertising (the best source of drivers); and employment agencies (office personnel). Obviously, the more a transit system knows about the labor markets from which it draws, the better it is able to recruit from these markets.

Aside from being the best source of drivers, newspaper advertising often can be used to sell the system. Transit management should recognize that it is not merely advertising a job, but it is selling the company as well as the career opportunities that are available. Many transit firms use attractive advertising copy that stresses good fringe benefits, pleasant working conditions, and generally paints a picture of the company as a progressive employer and a nice place to work.

Most personnel advertising in the print media (newspapers and magazines) is of two types: "blind ads" and advertisements that identify the company. Proponents of the blind ad claim that it offers some definite advantages; because the advertiser is not named, paperwork is reduced (all inquiries do not have to be answered). When job openings are limited and many applicants inquire, the company is saved the embarrassment of turning away many qualified applicants. If the firm has a high labor turnover rate, the company can use blind ads to hide this factor while attempting to rectify the situation.

Advocates of identification-type advertising claim that attractive ads enjoy better response and allow the company to use its name effectively in public. The ad has more credibility and eliminates the embarrassing circumstances that occur when an employee accidentally applies for a job with the company by which he or she is already employed.

Selection

Application. After applicants have been attracted to the transit system, the application form should be completed. The application form has two primary purposes: (1) it becomes part of the employee's permanent record, and (2) it can be used to validate the employee's education, employment, and training.

A good application form should be factual and concise. In particular, the application: (1) should conform to legal standards, laws, and regulations on national, state, and local levels; (2) should not be unduly personal; and (3) should be worded to aid in candidate evaluation. A sample transit application form is shown in Figure 6.1.

Interview. The next step is the interview. The interview provides an opportunity for in-depth discussions on many matters and a chance to evaluate an applicant. Some personnel experts claim that the interview may help predict the success a candidate may have in a particular job, but this contention is difficult to prove. To be effective, the manager should know the requirements for the job so that he will be able to evaluate the candidate objectively. The manager should have a knowledge of the minimum physical, intellectual, and attitudinal requirements for the job.

To make the task of interviewing manageable and to preserve objectivity, a few factors critical to success or failure on the job and in the company must be chosen from the job description. These factors should be determined by examining what the employee must have:

1. The kinds of skills required--communications, mechanical, technical, analytical, social, and so forth.
2. The capabilities that the job requires--physical, mental, special aptitudes, and so forth.
3. The attitudes that are necessary to handle the job--compliance with company rules, self-confidence, self-respect, relations with superiors and others. and so forth.

The exact number of critical factors depends on the particular job. The important points to remember in choosing the critical factors are: (1) choose factors that are related both to success and failure and (2) attempt to limit the total number of factors to preserve objectivity.

To increase the objectivity of the interview further, two other areas must be controlled: (1) the interviewer's attitude toward the interview and the candidate and (2) the interviewer's manner with the candidate and method of obtaining the necessary information.

The interviewer should attempt to follow these guidelines to maximize the objectivity of the interview:

HOMETOWN TRANSIT COMPANY APPLICATION BLANK

Name: _____ Date of birth: _____
first last middle

Address: _____
street city state zip

Phone: _____ Education: Circle last year completed

High School	1	2	3	4
College	1	2	3	4

Name and address of schools attended:	Grades	Yrs. Attended
1.		
2.		
3.		

Former employers: (List last three employers, starting with last one first.)

Date	Name & Address of Employer	Salary	Position	Reason for Leaving
From				
To				
From				
To				
From				
To				

References: Give below the names of three persons not related to you whom you have known at least one year.

Name	Address	Occupation	Yrs. Acquainted
1.			
2.			
3.			

Have you fulfilled your military obligations? _____
Branch _____ Rank _____
Are you presently a member in the National Guard or Reserves? _____

Activities other than religious in which you participate (civic, athletic, fraternal, etc.) _____
EXCLUDE ORGANIZATIONS, THE NAME OR CHARACTER OF WHICH INDICATES THE RACE, CREED, COLOR OR NATIONAL ORIGIN OF ITS MEMBERS.

FIGURE 6.1 Transit job application form.

Were you ever seriously physically injured?_____Give details_____
_____
Have you any defects in Hearing?_____Vision?_____Speech?_____
List any other physical infirmities or defects_____
_____
IN CASE OF EMERGENCY NOTIFY (Please give name, address and phone number.)
_____

Remarks for applicants use only:_____
_____
_____
_____
_____

Remarks for company use only:_____
_____
_____
_____
_____
_____
_____

Do you pledge yourself if employed, and during your employement, to comply with the companies rules and regulations now in existence, or which may hereafter be established?_____ _____

Do you grant the company permission to investigate any references you have given?_____

Do you agree that if you are employed by the company, the company shall thereafter at anytime and from time to time have the right to require a medical examination by a company physician of your physical and mental condition, to include (but not be limited to) X-ray examination and laboratory tests, and that it shall further be a condition of your employment that you be mentally and physically qualified (as determined by medical examination) to perform the designed duties of your position?_____
_____

In part consideration for my employment, I agree to return upon demand, on or demand, or on severing my connection with this company, all company property then in my possession, and whenever requested, to make and verify an affadavit containing a full and truthful statement of any and all accidents, ejections, assaults, etc., of which I may have knowledge.

FIGURE 6.1 continued.

I agree to at once provide myself with a standard uniform in accordance with the rules and regulations of the company.

If given an opportunity, I agree to work on a trial basis for the probationary period designated by the company and, if retained at the end thereof, to work faithfully thereafter and give my best efforts in the interest of the company. I agree to operate any type of coach which the company may request me to operate.

Operators must provide themselves with a standard watch before entering upon employment with the company.

I hereby warrant that the foregoing answers are true in every particular, and I further agree to resign immediately from the employ of this company should any one of my statements or answers on this application blank be found untrue, or should my past record, upon examination by the company, prove unsatisfactory.

Date_____ Signed_____

(Applicant will not write below this line)

I have personally questioned the above applicant and believe him mentally and physically fitted for the position herein applied for.

Date_____ Department Head_____

Referred to Dr._____at_____

for examination.

FIGURE 6.1 Continued.

1. Treat everything that is said in context.

2. Do not treat everything that is said as fact or even of equal importance.

3. Listen to everything the candidate says and notice what the candidate does not say.

4. Remember that the interview is a social situation, which in itself influences what is said.

5. Do not display any kind of authority.

6. Do not give advice or criticism.

7. Do not argue with the candidate.

8. Speak only to help the candidate talk, relax the candidate, or guide the conversation.

With the aid of the interview guidelines and a tolerable number of critical requirements, the manager should be equipped with the tools, background, format, and attitude to evaluate the candidate objectively.

While the interview is widely used as a selection tool in transit and many other industries, the manager should be aware that the interview process has limited reliability and validity. An interview should not be the only selection tool used by the transit system.

Reference check. More information is needed to supplement the information obtained from the application form and interview. Obtaining additional information about the applicant and verifying the data supplied make the selection process more objective. Caution must be exercised, however, because in many states the applicant's references can be verified only after permission is given in writing.

Former employers are among the best sources of information about the applicant's characteristics and qualifications. They may be contacted by letter, telephone, and/or personal visit. In general, the telephone or a personal visit is the best method to use. Often an employer is reluctant to put detrimental remarks about a former employee in writing. Oral evaluations usually produce frank comments and allow the company to evaluate the attitudes of the applicant's previous employer. Telephoning is better than a personal visit, because personal visits are time-consuming, expensive, and are generally beyond the resources of the small transit enterprise. An example of a telephone questionnaire used by one transit property is shown in Figure 6.2.

TELEPHONE INFORMATION DATA

Made by_____
Date_____

Name of Applicant_____

Company Where Applicant Worked_____ Telephone Number_____

Former Supervisor_____ Title_____

1. Mr. (name) has applied for employment with us. I would like to verify some of the information given us. When did he work for your company?

   From_____19_____ To_____19_____

2. What was his job when he started to work for you? When he left?

   _____

3. What did you think of him? (Quality and quantity of work, attendance, how he got along with others, etc.)

   _____
   _____
   _____

4. He says his earnings were $_____ per_____is that correct?

   _____

5. What accidents has he had?

   _____
   _____

6. Why did he leave your company?

   _____
   _____

7. Would you re-employ him?

   Yes_____No (If not, why not?)_____
   _____

Additional comments _____
_____
_____

FIGURE 6.2 Personnel information: telephone questionnaire.

The company also should undertake a complete investigation into the applicant's personal history. Many transit operators fingerprint all applicants. State and local police departments, as well as motor vehicle departments, are excellent sources of accident and moving violation records.

A complete credit check on the applicant should be conducted to detect a poor credit rating and/or judgments or garnishments levied against the applicant. Garnishments levied against an applicant should not cause a system to drop a candidate from further consideration. In at least one Supreme Court decision, an employer has not been allowed to terminate an employee because his wages have been garnished. Dropping applicants from consideration merely because their wages have been garnished is a questionable selection practice.

Personal references generally have little value except when the applicant has little or no prior working experience.

Tests. Many types of tests have been used effectively in a wide variety of job situations. Solutions to most, but not all, selection problems can be supplemented by one of the basic test types: (1) capacity or aptitude tests, (2) proficiency or achievement tests, or (3) personality and interest tests.

The capacity or aptitude tests are better known as intelligence tests. They are designed to measure general mental ability and are a valuable aid in predicting job success for the inexperienced applicant. Also in the category of capacity or aptitude tests are multi-aptitude tests, which measure the pattern of a person's abilities and the level of understanding in certain basic areas.

Proficiency or achievement tests are designed to measure certain skills of the applicant. Among the more common tests are clerical aptitude tests, which measure accuracy in perceiving verbal and numerical similarities and differences; mechanical aptitude tests, which measure mechanical abilities and understanding; and manual dexterity tests, which measure the person's ability to work with his hands by measuring both gross and fine dexterity.

Personality and interest tests measure the applicant's interests and preferences and provide some insight into how the person will behave with other people. These tests aid in establishing an interest inventory, a list of the person's likes and dislikes.

Most transit systems that use some form of testing have found them only moderately helpful in the selection process.

Most tests do not provide precise measurements of an individual's potential, but are general in both their nature and the feedback they provide. Therefore, the typical testing program is useful only as a supplement to interviewing and references. A great deal depends on the particular employer, the job, and the situation.

Transit systems must be careful in testing to avoid discrimination. It is claimed that some tests used in the past in the transit industry discriminated against minorities. In the early 1970s, several new tests were devised and evaluated to ensure that they were nondiscriminatory.

Physical examination. The selection process for a transit company would not be complete without a rigorous physical examination. The purpose of the examination is to determine whether the applicant has any impairments that would make him unable to do the job. In the selection of drivers, a transit manager should pay particular attention to such things as previous heart or back ailments, high blood pressure, color perception, and depth perception.

Once again, management must take care in using tests in the selection of new employees. This warning applies to all selection tools. That is, physical requirements such as height and weight must not discriminate against women and/or minorities, unless such requirements are related directly to successful job performance.

Orientation

After passing the hurdles of the selection process successfully, the applicant is ready to become an employee. The attitudes and skills learned by the new employee during the early period of employment are crucial and lasting. Consequently, most business firms have established some form of orientation or indoctrination program (see Appendix 6B). Managers have come to realize that many new employees leave the organization because of adjustment problems. The new employee must be introduced to the organization and to his membership role. He must receive all the necessary information needed to assume a position and its responsibilities, together with the confidence and attitudes that will make the employee a useful member of the organization. For these reasons, the orientation acts as the planned and guided adjustment of the employee to both the employer and job.

The manager should establish a set of goals for the indoctrination process and then bolster it with a set of guidelines. Among the goals that have been frequently found in training programs are:

1. The transit agency must be sold to the employee so as to establish a set of favorable attitudes about the agency and its work.

2. New employees must be made to feel that they belong in the organization, and must be made to feel that they are valuable and contributing members of the firm.

3. New employees must be given the necessary assurance and confidence to be relaxed and ready to accept the organization and the training material. Removing the common fears and uncertainties that usually accompany new employees will aid the learning and adjustment process.

Included among other, more specific goals of an adequate orientation program are (1) to reduce turnover and help cut costs associated with the selection process, and (2) to give a thorough and proper explanation of fundamentals that can later reduce grievances.

Training

After the new employee has completed the orientation program, he is ready for any formal training that might be required before he becomes an active member of the organization. Although the primary purposes of training are to impart skills and develop proper attitudes, many other benefits may result from an organized training program, such as:

1. Reduced waste.

2. Lower absenteeism and turnover costs.

3. Greater personal involvement of the employees.

4. Reduced supervisory costs.

5. Lower overtime costs.

6. Lower maintenance expenditures.

7. Fewer personal injuries.

Training must not be regarded as a cure-all for the organization's problems. Training will probably prove to be a poor investment if it is used to:

1. Make up for poor planning or organization.

2. Serve as a substitute for low hiring standards.

3. Make up for inadequate employee compensation or aging equipment.

4. Force employees to learn. Training only provides the means for learning. Unless the employee is properly motivated, he will not learn anything.

A formal training program should be considered only when one of the following situations exists:

1. The existing performance standards could be surpassed by improving employee's skills, attitudes, or work methods.

2. A future shortage of skills is foreseen because of an increase in service and/or a loss of experienced employees.

3. New equipment or technology is introduced that will require adaptation or new skills and methods.

If the manager decides upon a formal training program, he must determine how the training is to be performed (see Appendix 6B). For new operators, the following must be considered:

1. Direct training.

2. Delegated training within the organization.

3. Delegated training outside of the organization.

The following guidelines should be used in determining which training procedure will be used:

1. The manager should choose the procedure that will optimize the training objectives of the company.

2. Outside help always is a consideration, but it should be tailored to fit the needs of the organization and should appeal to the person(s) with the highest potential within the trainee group. Any decision to use the training resources should depend upon the comparative costs and efficiencies of internal versus external programs.

3. The instructor should be given maximum freedom to present the material to the trainees.

New driver training programs. If management decides to train the driver within the company, a training policy should be established to decide (1) who will do the training, (2) what resources will be allocated to the program, and (3) what instruction method will be used. The choice of the particular instruction method used will be determined largely by:

1. The amount and complexity of the new material to be learned.
2. The effectiveness of active or passive learning at each stage in the training program.
3. The need for imitation or repetition to facilitate the learning of new and important material.
4. The number of trainers.
5. The way in which the training program is organized.

The program should be structured logically and the material presented in each sequence should not be ambiguous or confusing to the trainee. A vivid presentation, combining new material with material already familiar to the trainee, is recommended.

Regardless of the instruction method used, the following steps are the best way to present new material to the trainee:

1. Prepare the trainee; put the person at ease.
2. Present the job or task stressing the key points, being careful not to overload the trainee with new material.
3. Give the trainee a chance to see how well he can perform.
4. Review what has been learned.
5. Gradually decrease the amount of instruction as the trainee's performance and attitude improve.

In most transit enterprises, an experienced driver does most of the training of operators. Because the instructor has a crucial part in shaping new employees' attitudes and performance, the instructor should know what the trainees already have been told, what they need to be told, and what the instructor's duties are. When experienced drivers are used to train new members, they should be allowed to participate in setting up the training program because these employees know the most about the driver's job. By participating in planning the training program, instructors become personally involved and are more likely to have a better understanding and acceptance of the program.

On-going training programs. Situations often arise where experienced employees, particularly drivers, may require additional skills or training. Training is an on-going process that does not end after the initial indoctrination-training program, but must be supplemented for a variety of reasons. Additional skills may be needed because of changes in equipment. Long-time employees may require additional training because of inadequacies in the previous training program. Some of the employees may have developed poor attitudes, work habits, or skills that need correction. When these problems arise, the company may want to retrain or upgrade some of its operators. Retraining is valuable especially in the areas of safety and customer relations.

Safety training is a challenging area because safety is not a skill but a state of mind. The safe driver is one who has a proper attitude as well as mental alertness. To promote safety, many transit companies use a form of training that uses visual aids, contests, and periodic observation of the employees. When an employee has repeated difficulty with regard to safety procedures, he is visited by his superior. The superior usually will discuss the employee's problems with him and may assign him to one or two days of retraining with an appropriate instructor.

Customer relations is another important area that must be evaluated continually. Many complaints about a particular driver may call for a conference with his superior. Many transit companies have periodic "charm schools," in which a competent instructor reviews the importance of courtesy to the customer. Usually, some attention is devoted to the "problem passenger," because these people can spoil a driver's trip and affect his attitude toward the other passengers.

Reviewing progress. The concepts of measurement and feedback are central to the entire training program because they motivate the employee and provide an objective basis for self-review of performance. Recognizing this, the

instructor should review the trainee's progress periodically at various stages of the training program.

The appraisals should be conducted objectively by the instructor. To maximize objectivity, the company may want to use readily available tests such as the "Road Test Check List" available from the American Automobile Association (AAA), or it may design a test of its own. In either case, the test should reflect the materials presented in the training program. An example of a "Road Test Check List" is provided in Figure 6.3.

To achieve the maximum benefit of any evaluation, the results need to be conveyed to the trainee. Accordingly, review sessions between each trainee and the instructor should be held to discuss:

1. The trainee's performance.
2. Any problems encountered.
3. The test results and their significance.
4. The trainee's strengths.
5. Areas in which improvement is needed.

While the testing procedure evaluates the trainee, the review sessions should be perceived as counseling or helping him. If the review sessions are threatening, they will not help the trainee but will merely waste time. To achieve any benefit from the review session, then, they should be conducted in a frank and open manner. At the close of the session, the trainer should summarize the discussion briefly and emphasize the progress that the trainee has made since the last conversation.

At the close of the formal training program, each trainee should be made aware that training is continuous, and that good drivers are not made in weeks but in years. Recognizing this fact, most transit agencies have established a 90-day minimum probationary period for the new driver. During this period, the new employee can be dismissed if references were falsified or if there have been serious problems in adjusting to the job.

Career Development[1]

While the orientation and training of new employees is important, transit systems should not limit their investment in personnel to these programs alone. For the system to maximize the return on its personnel investment, it also

STUDENT OPERATOR BREAK-IN REPORT

Operator _____ Line _____
Date _____ On _____ Off _____

Student _____ is breaking in as an operator.
Please cooperate by checking off the steps as he progresses.

BE SURE YOU KNOW THAT HE KNOWS:

Check one of the following:	Good	Fair	Poor	Remarks
Driving ability				
Handling Equipment				
Safety and handling passengers				
Route				
Stops				
Time points				
Transfers				
Transfer points				
Fare box				
Copies schedules correctly				

IS FAMILIAR WITH:

Check one of the following:	Good	Fair	Poor	Remarks
Pull out and pull in instructions				
Location of schedule information				
Bulletin boards				

Attitude _____
Student drove coach _____ Hrs. _____ Min.

Additional information regarding student: _____

FIGURE 6.3 Road test checklist.

should be concerned with the development of these resources over time. By providing career development, the organization can (1) attain its goals and help employees reach individual goals, (2) reduce employee turnover and thus costs, and (3) reduce the hoarding of high-caliber personnel.

Individual and Organizational Goal Attainment

For many people, work is very important to the development of a full identity. To the extent that the transit system provides career opportunities and the means to help the employees attain their career objectives, the system will be helping the employees reach very important individual goals. The transit system benefits both parties because its employees are motivated to achieve career objectives for their own fulfillment; the career opportunities themselves are designed to give the organization the highest return possible on its human assets.

Reduced Turnover and Costs

When potential employees know what possible career paths the transit system offers, they are better able to decide whether to pursue employment opportunities with the system. This benefits the organization in two ways. First, new employees will tend to stay with the system, thus reducing costs from increased recruitment, selection, orientation and training expenses, inefficient operations, low morale, and so forth. Second, the system reduces the opportunity costs involved with hiring the wrong person and not hiring the right person.

Hoarding High-caliber Personnel

Supervisors will tend to retain good employees in their areas after they are ready for advancement, unless both the employees and the organization have developed career plans for them. This hoarding of high-caliber employees does not grow out of supervisors' malice toward them or the organization; supervisors merely want to keep their best subordinates. However, to avoid having employees stagnate in their current positions and lose their abilities in another position, the organization must provide a mechanism to move the employee forward.

Basis of Career Development

Tc provide for the fullest development of its employees, a transit system should prepare career paths, with a listing of the requirements for progressing along these paths. The transit system should be able to provide the necessary training and counseling from supervisors.

Career paths. The development of career paths is based on the existence of useful job descriptions. For each group of employees--maintenance workers, drivers, and so forth--the relevant set of job descriptions will provide information concerning which positions are available in the area and the relationships among them. In the maintenance area, for example, the positions may range from apprentice mechanic through maintenance supervisor. This set of job descriptions implicitly states the career paths available in this area. When the transit system has stated all such career paths explicitly, it can begin listing the requirements for advancement.

Job specifications can be written from these requirements for advancement. For example, a first-level mechanic may have to be able to rebuild transmissions. For the apprentice mechanic, this implies that he must be given the training, either on-the-job or outside, to fix transmissions so he can advance to first-line mechanic.

Training. When these requirements are listed for each career path, the transit system will not only be able to plan the career development of employees to help its overall personnel planning processes, but it will have relatively detailed information about the training capacities it will need to develop internally or obtain from outside sources.

A skills inventory will give both the employee and the system an idea of how prepared he is for advancement at any one time. Also, when used in conjunction with the job specifications and the training required for any position an inventory will give the employee and the system a good estimate of the remaining training needed for advancement.

Counseling. While career development places demands on the entire transit system in terms of personnel planning requirements, the most crucial variable is the actual superior/subordinate relationship. This is true for two major reasons. First, unless employees think they have a substantial input into this process, they will not be as motivated to take advantage of the opportunities offered than they would otherwise. Thus, many of the potential benefits of career planning will be lost. The most logical point for this employee input is in the individual's relationship with his supervisor (with the aid of personnel management supervision).

In addition, the employee will need ongoing counseling throughout his career development. Again, the best place for this is through his relationship with a superior. The supervisor, in turn, must be knowledgeable about the career opportunities available to subordinates, their current degree of readiness for advancement, and what training they still need.

It should be noted that their participation in the career development of subordinates places additional demands upon supervisors. To ensure that they will give career development the emphasis it deserves, supervisors should be evaluated based on the advancement of their subordinates over time. This criterion, of course, must be used in light of the system's needs for these people to advance, not merely in terms of raw numbers of employees ready for advancement without regard to whether the system can better use them in other positions.

Personnel Evaluation

Personnel evaluation is much like checking a map while driving. A map is checked to find out where you are, compared to where you should be, where you want to go, and how you can get there. When the transit system evaluates its employees, it needs to know what they have done, compared to what they should have done, what it wants them to do, and how they can do what is wanted. Properly designed, a set of personnel review procedures will allow the system to evaluate its employees' past performances and identify their future needs.

The system can use evaluations to improve its procedures for achieving goals and objectives and as inputs into the promotion and salary review processes. The information flowing from personnel evaluations serves as feedback for the career development process discussed above.

The basics of personnel evaluation are to identify (1) who will be evaluated, (2) who will be the evaluators, (3) the criteria the evaluators will use, and (4) the techniques the evaluators will use.

The Evaluatees

While it is desirable to evaluate all employees, different jobs present different problems in their evaluation. For example, the evaluation of union members may be limited by the transit system's labor contract. This contract may not allow these employees to be evaluated by some performance measures, if these evaluations may affect their compensation. However, this does not imply that such evaluations cannot be done and used informally by both the system and union in assigning additional responsibilities.

For other employees, it may be difficult to develop criteria with which to evaluate their performances. For example, it is not obvious which criteria or measures would be useful in evaluating the employee responsible for the system's community relations program.

Finally, evaluating employees costs money. Therefore, while it may be desirable to evaluate all employees, the transit system may be able to afford to evaluate only managerial personnel formally.

The Evaluators

As with most other decision-making processes, the more information available, the better the chances are of making a proper decision. This implies that the more evaluators, the better the evaluation process. For almost any position in a transit system, potential evaluators include the individual's peers, subordinates, and superiors. However, as with the value of incremental information in general, there is a cost factor to be taken into account. That is, how much the system is willing to spend to increase the quality and quantity of personnel evaluations, in light of the other financial needs it faces. For most smaller transit systems, evaluations of employees can be done by their immediate superiors. This probably is the best trade-off between the relevant benefits and costs, given the financial realities faced by most of these systems.

The Criteria

Problems arise when the measures used to evaluate an employee's performance do not cover every aspect of what is involved in performing the specific job. If the criteria chosen to measure an employee's performance do not relate to the job, the evaluation will be useless. For example, evaluating a driver on his ability to overhaul a transmission has nothing to do with whether he is able to drive a bus properly.

With these limitations in mind, managers should choose the criteria used to evaluate employees carefully. Drawing on the practices of personnel planning, the proper measures are the relevant job success criteria and the objectives for which each employee is responsible. For a driver, if one of his department's objectives is 98% on-time service, one of the measures of his performance will be his own on-time performance. For the supervisor of maintenance, if one of his objectives was to maintain maintenance costs at or below a certain level per vehicle mile, one of the measures of his performance will be the extent to which he maintained this level of costs.

The Techniques

Where relatively obvious measures of performance are used, as in the above examples, the evaluation technique to use is merely to compare actual performance to planned performance. Supervisors should investigate discrepencies by asking their subordinates for explanations and tell these

employees when they were successful and where improvement is required.

If the aspect of the employee's performance that is being measured is relatively subjective (e.g., initiative), the range of possible evaluation techniques expands. While it is not the purpose of this section to present descriptions or discussions of the possible evaluation techniques, one thought should be kept in mind. Usually, any personnel review technique will be strong in either the personnel evaluation or development area. Therefore, a transit system should probably use at least two review techniques to yield the performance evaluation and career development information it needs.

Employee Compensation

Employee compensation includes both the direct and indirect compensation that transit systems provide for their employees. Direct compensation is the set of financial rewards that systems offer their employees; indirect compensation consists of the other benefits and services (including pensions) the systems offer. While employees may receive intrinsic rewards in addition to these compensation schemes from their employers, for most employees these direct and indirect compensation schemes represent the most important set of rewards for their labor.

Direct Compensation

The set of financial rewards a transit system will provide to an employee depends on the job or task; some positions require greater rewards than others. The nature of the employee also is important; some employees deserve greater rewards than others. Labor market conditions also affect the type of financial rewards offered. Where the demand for labor is high relative to supply, direct compensation must be greater than it would be if the supply were greater than the demand. Another important factor is the system's financial situation; some systems are limited severely in the amount of direct compensation they can offer.

In addition, as public entities, the direct compensation many systems can offer is affected by governmental regulations. The government also affects the direct compensation a system may offer in other ways, for example, by policies such as CETA, minimum wage, overtime, and equal pay provisions. Finally, unions can have a large effect on the direct compensation a system offers. The stronger the union, relative to the bargaining power of the system, the greater its effectiveness will be in this area.

There are two major methods of direct compensation: (1) those based on time worked and (2) those based on the efficiency of the work done. Before either method can be used, the transit system must make certain preparations.

Preparations. The direct compensation level for each position must be adequate to attract and retrain employees, and the differences between the levels for different positions must be large enough to provide some motivation for employees to perform better and advance. The direct compensation for a position usually is set by comparing it to other positions; either to other positions inside the system or to similar positions outside the system.

While there are many formal procedures that can be followed in preparing the direct compensation requirements of each position, the other factors affecting the levels of compensation make setting the levels more of an art than a science.

Methods. Direct compensation schemes based on time are the most widely used types of systems, especially in transit. Generally, these involve setting a rate per basic time period--for example, $X per hour--and compensating employees according to the number of such time periods worked. Federal regulations require that workers receive 150% of this rate for work done in overtime (beyond 40 hours per week). Usually, labor agreements in transit also provide for wage rates for workers on split-time, extraboard, and so forth.

For direct compensation schemes based on employee efficiency to be workable, output must be easily identifiable and measurable. Both the employer and the worker (and/or union) must agree to such a scheme. In transit, where, until recently, workers' output could not be identified or measured, such schemes were not used. Also, most labor unions will not accept such schemes officially.

Indirect Compensation

Indirect compensation, the set of other benefits and services a transit system may offer its employee, can be classified as follows:

1. Legally required benefits--social security, unemployment compensation, and workmen's compensation.
2. Pensions and retirement programs.
3. Pay for time not worked--holidays, leaves, and vacations.

4. Insurance--accident, health, and life.

5. Services--including counseling, education, and recreation.

The factors affecting the levels of indirect compensation a system will offer are similar to those affecting its levels of direct compensation.

There are three major purposes for such a program of benefits and services, besides governmental requirements. First, an organization has a better chance of attracting and retaining good employees. Second, such rewards increase employee satisfaction and, hopefully, employment. (Compensation as a motivator will be discussed in more detail below.) Finally, some organizations hope to preempt the appearance of unions by offering a large enough benefits and service package.

Compensation as a Motivator

For most employees, compensation is a motivator to the extent that pay and other benefits and services are means to attain other goals (e.g. financial security). They will perform to levels required to receive their compensation. However, when any organization wants to increase either the quality or quantity of their employees' performances, most compensation systems are not very helpful. This is because they are based on time worked and/or tenure in a position, neither of which are necessarily related to the quality or quantity of work.

Although compensation differentials among positions should provide some motivation for employees to perform better and advance, the effectiveness of these differentials is limited in two major ways. First, there is a limited number of positions to which any employee can hope to advance, and, of these positions, even fewer will be open at any one time. In short, the chance of any one employee advancing in the foreseeable future is relatively small. Therefore, possible advancement cannot act as a major motivating force for employees. Also, compensation differentials among positions have no effect on performance of employees who will occupy a single position--for example, drivers--for the foreseeable future.

It is only when a transit system can introduce effectiveness, efficiency, or productivity criteria into direct and indirect compensation systems that they can act as motivators for improved performance. However, there is an area of compensation that does offer some hope in motivating improved performance that has not been discussed.

The employee compensation schemes discussed above are based on offering employees extrinsic rewards, rewards that affect the employees outside of their work for the transit system. Compensation schemes can be constructed to offer employees intrinsic rewards, rewards which apply solely to their work for the system. Besides being directly tied to an employee's performance, these schemes are very inexpensive. Some examples of these schemes include periodic rewards for driver courtesy, on-time performance and safety recognition given to maintenance personnel for performing periodic vehicle inspections on time and under budget, and so forth. Besides giving employees positive feedback, which enhances their self-esteem, such schemes can improve overall system morale. However, while these types of compensation can be useful, they can not be substituted for an adequate set of direct and indirect compensation.

Administering Equal Employment Opportunity and Affirmative Action Programs

To assure that employees are not discriminated against on the basis of their creed, race, religion, or sex, the federal government has passed a series of legislation. Starting with the Civil Rights Act of 1964, the federal government has set up administrative machinery to provide for equal employment opportunity. In addition, through executive orders, the federal government requires many organizations to take affirmative action to avoid discrimination in the future, often in effect demanding action to compensate protected classes of citizens for the results of past discrimination.

While it is not within the scope of this handbook to describe these programs in detail, one of the tasks of the personnel function is to administer them. Therefore, each transit system must know the applicable federal, state, and local legislation and regulations and provide for their compliance. One of the first organizations to contact in this regard is the federal Equal Employment Opportunity Commission (EEOC).

Administering Health and Safety Programs

Just as there has been increased federal, state, and local interest in equal employment opportunity and affirmative action, employee health and safety have become the subjects of governmental attention recently. Again, the administration of such governmental programs is the responsibility of the personnel function. Therefore, the system again must know the relevant legislation and regulations and provide for their compliance. One of the first organizations to contact in this regard is the federal Occupational Safety and Health Administration (OSHA).

Note for Chapter 6

[1]Much of this section is from William F. Glueck's Personnel: A Diagnostic Approach, Dallas, Texas Business Publications, 1974, pp. 259-79. This particular passage is from page 264.

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The numbers in parentheses are NTIS order numbers.

APPENDIX 6A

PERSONNEL PLANNING: AN EXAMPLE

Four categories of information are necessary for an accurate job analysis. The first three categories are used to determine the nature and scope of the work, while the fourth measures the level of difficulty of the task and the skills required to complete the task. The four categories are: (1) what the worker does, (2) how he does it, (3) why he does it, and (4) what skill is involved in performing the task.

Some of the items that might be included in the job analysis for a driver are:

1. Amount and type of supervision required.
2. Extent of responsibility.
3. Use of initiative.
4. Mental alertness.
5. Judgment.
6. Dexterity.
7. Accuracy.
8. Tools and equipment.
9. Working conditions.
10. Social environment.
11. Knowledge.
12. Experience.
13. Physical demands.
14. Amount and type of training required.

Needed information can be acquired by observing the job and by interviewing both the employee and his supervisor.

By observing the job, management is able to nave a first-hand look at the job being studied and is able to see the working conditions. The interviewing stage is used to supplement and confirm the information obtained by observation. Observation should be used as much as possible to minimize the time and expense associated with interviewing.

Preparing Job Descriptions

After the data has been gathered, management must decide which data are useful, accurate, and necessary in the preparation of the job description. Particular care and attention should be taken to make statements in the job description clear and concise.

Management must have cooperation and understanding from employees during the job analysis. Every effort should be made to communicate to the employees that it is the job and not the person that is being evaluated. Often, employees will need to be reassured that the analysis will not reduce their pay or result in any harmful consequences to anyone.

Like any standard, a job description must be reviewed periodically. Changes in the job analysis and job description will occur as new equipment and technology are introduced. Once job descriptions are written, managers must review them periodically, so they will remain reasonably accurate and up to date.

In preparing a job description or conducting a job analysis, care should be taken to ensure that the information collected is used properly. The future use of a job description or analysis often determines, in part, how it will be researched and formulated. Finally, a job description that is not clear is worthless. It must be clear, and it should not contain so much information that it is overly rigid. An example of a job description for drivers is shown in Figure 6A.1.

Forecasting Personnel Needs

For the following driver manpower forecasting exercise, assume that the system has 50 employees who are or will be drivers at the start of the planning period. Also there is a 5% loss rate for drivers per year from deaths, promotions, terminations, and transfers. Other drivers will retire during this period, but these figures can be gotten directly from the employee files each year. Finally, we are assuming that every vacant position will be filled, in addition to any new position that may be necessary.

HOMETOWN TRANSIT COMPANY--Job Description

1. Job Title: Intra-city bus driver

2. Sex: Male or female, no restrictions

3. Age Range: Minimum eighteen years, maximum thirty-five years

4. Physical Requirements:

   a. Height: Minimum 5'7", maximum 6'4"
   b. Weight: Must be in proportion to height. Minimum 140 pounds, maximum 250 pounds.
   c. Average physical activity
   d. Average manual dexterity with hands and feet
   e. Vision: Correctable to 20/20--maximum incorrectable 20/400
   f. No prior history of back injuries

5. Education: High school diploma or recognized equivalency

6. Ability:

   a. General Intelligence: Must attain a minimum of 75% on the following written tests: AAA Traffic Test, New York University Knowledge Test, Siebrect Attitude Scale
   b. Special Aptitudes: Must be able to memorize or be thoroughly familiar with routes, schedules, and fares

7. Interests: Must be interested in being a salesman of the transit service, route, and the particular bus

8. Personality Requirements: The important personality traits are:

   a. Cooperation
   b. Loyalty
   c. Dependability
   d. Safety-minded
   e. Politeness--absolutely essential for customer relations
   f. Attitude--must not regard himself as the "captain of the bus" but must be cooperative and, as situations require, humble

9. Satisfactions: Should enjoy serving people of all ages and racial backgrounds

10. Problems: Must be willing to work split shifts, weekends, and holidays. Night work is required.

11. General:

    a. Appearance: Must exhibit good grooming
    b. Grammar: Should be well-spoken and pleasant sounding

FIGURE 6A.1 Hometown Transit Company: Job description.

To forecast how many drivers a system needs, one must know what variables most closely affect the number of drivers necessary. In general, revenue vehicle hours plus a judgment factor of about 20% for check-in and check-out time, miss outs, vacations, and so forth are the variables to use. For example, if a system foresees 800 revenue vehicle hours per week, and wants to minimize overtime payments, it will forecast its driver manpower needs by adding the 20% judgment factor to its revenue vehicle hours and dividing by 40 hours per week per driver: 800 + 20% = 960/40 = 24. Therefore, the system will need approximately 24 drivers to operate at its desired level of service for the year.

To put the planning procedures for driver manpower forecasts together for this example, the transit system needs to forecast future levels of service to be offered. Assume the rate of growth will be 10% per year over the next 3 years. The total number of new driver positions necessary and the total number of new drivers needed then can be calculated (see Table 6A.1).

TABLE 6A.1 Hometown Transit Company--Driver Personnel Planning

	19X1	19X2	19X3	19X4
Employees				
Current[a]	50	52	55	58
Losses				
Death	3	3	3	....
Retirement	2	4	6	....
TOTAL	5	7	9	....
New positions[b]	2	3	3	....
Total number of new drivers needed[c]	7	10	12	....

[a]As of beginning of fiscal or calendar year.
[b]New positions = addition of revenue vehicle miles per week + additional judgment factors per week, per 40-hour week.
[c]Total number of drivers needed from 19X1 to 19X3 = 29.

Table 6A.1 is useful to the transit system in several ways. First, it forces management to review the need for drivers in terms of replacing drivers and creating new positions that will need to be filled. That is, while the system's growth will require only 8 new positions over the next 3 years, the system will also need to obtain 21 new drivers to replace those it will lose through attrition during this period.

Second, the system can get an idea of how many drivers it will need to hire and when it will need them. For example, over the next 3 years perhaps 5 of its current employees in other areas can be expected to become drivers. Then the system would only need to hire 24 drivers from outside. Finally, looking at the increases in losses because of retirements, it may be the case that many of the system's current drivers are approaching retirement. If this is the case, increased pressures will have to be applied to the system's future recruitment, selection, orientation, and training capabilities.

APPENDIX 6B

ORIENTATION AND TRAINING: AN EXAMPLE

Orientation Program

The driver training program begins with the orientation period. During this stage, the following subjects must be thoroughly explained:

1. The history and operation of the company.
2. The chain of command within the company.
3. The union contract.
4. The probationary period.
5. The company benefit program.
6. The compensation program including wages, deductions and percentages, vacation procedure, and off days.
7. Extraboard drivers.
8. The goals of the formal training program.

A conference should be held among the trainee and management and union representatives to be sure that the trainee is thoroughly aware of his rights and responsibilities under the contract. Also the trainee should know how much he will be paid during the orientation and training programs.

Training Program

After the driver has gone through the orientation program successfully, some formal training will be necessary, regardless of previous training and experience. A driver training program should be designed to mold an expert salesman and a professional bus operator, as well as to instill proper attitudes. The driver training program

will be divided into oral instruction and behind-the-wheel training.

Training Instructor

For a small property, the instructor often is an experienced operator who fulfills a dual role of driver and safety supervisor. Generally, the instructor receives a differential rate of pay for training new operators. The driving instructor should have:

1. Experience, and should be well-known and respected by other drivers.
2. Excellent driving skills, with a good driving record (perfection is not necessary).
3. The attitude, appearance, and personality that the company is trying to impress on the trainees.
4. An interest in people and a desire to train new employees to be good drivers.
5. Extensive knowledge of all phases of driving and the routes, with an ability to convey this knowledge to others.
6. An understanding of the trainee's situation.

Oral Instruction

Oral instruction should prepare the employee for behind-the-wheel training. The oral instruction should include three areas.

1. Familiarization with equipment
   a. Dimensions of the bus
   b. Locations and functions of the controls
   c. Operation of doors and door-brake interlock mechanism
   d. Seat adjustment
   e. Mirrors
   f. Location and operation of emergency exit
   g Running repairs
   h. Air-conditioning
2. Safety
   a. A complete explanation of the crucial importance of safety

b. Safety literature--audiovisual aids, handbooks and leaflets
c. Passenger safety
d. Emergencies such as robberies, sudden illness and accidents
e. General precautions, such as assisting the elderly and handicapped

3. Public relations

a. Appearance
b. Manners
c. Importance of the driver
d. Service (the product of the transit agency)
e. Knowledge of routes, schedules, and fares
f. Public speaking

Oral instruction, while intended to prepare the driver-trainee for behind-the-wheel training, does not end at the outset of road training. It must be emphasized continually throughout the entire training program.

Behind-the-wheel Instruction

The goals of behind-the-wheel training are:

1. To reemphasize the material presented orally.

2. To present the fundamental skills of driving to the trainee.

3. To mold a professional driver who is skillful, safe, familiar with the equipment, and aware of the importance of good public relations.

Yard driving. The initial phase of behind-the-wheel training should be conducted on the property or in a sparsely populated area. The emphasis should be upon putting the trainee behind the wheel to allow him to get the feel of driving. No attempt should be made to have the trainee perform skillful maneuvers or turns at the outset. Use of equipment, safety, and public relations should be reemphasized.

The next step in yard driving should be designed to mold a safe and skillful driver. Accordingly, skills and rules of the road are presented to the trainee after the feel of driving has been developed. The topics to be covered include nine areas.

1. Downtown driving
2. Suburban driving
3. Highway driving
4. Boarding customers (trainees may act as passengers)
   a. Approaching the stop
   b. Pulling into a stop after negotiating a right or left turn
   c. Positioning the bus
   d. Leaving the stop
5. Fare receipts
   a. Accepting fares
   b. Giving change
   c. Transfers
   d. Passes
   e. Special fares (if applicable), park 'n' ride, reduced fares for senior citizens, special promotions
6. Changing lanes
7. Turns
8. Interval between vehicles
9. Accidents
   a. Frequent causes
   b. Prevention
   c. Procedure in case of an accident
      --passengers
      --property

Downtown driving. After the trainee has acquired the basic driving skills, the next phase of behind-the-wheel training is to operate the vehicle in downtown areas, suburbs, and on highways. The objectives of city driving are to allow the trainee to practice and demonstrate the skills acquired in yard driving.

This phase of the training program should be conducted in two stages:

1. Nonrevenue service, where city driving is merely an extended form of off-street training; this would include following routes.

2. Revenue service with instructions and experienced operators.

   a. Observing the experienced operator driving and dealing with the public.
   b. Practice under the instructor.

CHAPTER 7

THE MAINTENANCE PROGRAM

Introduction

For most transit properties, especially those of small and medium size, maintenance consists simply of upkeep of plant and equipment. In the best properties, regardless of size, a more formalized maintenance program is used as a technique to reduce expenses. It has been found that the number of breakdowns can be reduced by scheduling certain types of routine maintenance. This type of maintenance is known generally as preventive maintenance. (Maintenance performed upon failure is referred to as breakdown maintenance.) A preventive maintenance program is implemented because it costs a firm less than breakdown maintenance.

The goal of maintenance in the transit industry is to preserve a systematic pattern of transit operation that is as free from interruption as possible. This effort is critical in the transit business because schedules for personnel and equipment have been set up to run on a strict timetable to meet the needs of the public. Breakdowns in equipment mean either failure to live up to this timetable or a considerable oversupply of equipment on hand to handle contingencies. The result is either a lack of dependability in serving the public or an investment in underused equipment. The chances of wasting driver time also are increased when equipment maintenance is of low standard and reliability. For this reason, it is very important that schedules are met and that the amount of equipment and personnel time wasted is minimized.

To put it another way, when a coach breaks down on a scheduled route, it is likely to cause the following problems:

1. Delayed and missed schedules, which in turn cause poor customer appeal and, eventually, lost patronage.

2. Extra maintenance costs because of damage to parts and equipment.

3. Extra driver or personnel costs to switch equipment.

4. Disruption of maintenance program routine.

5. Lost revenue and future revenue losses.

6. Investment in extra equipment, which then may be underused.

7. Increased insurance cost, if the breakdown causes an accident resulting in personal injury or property damage.

A Preventive Maintenance Program

Simply put, preventive maintenance means averting trouble before it happens. Clearly, however, an understanding of what really constitutes preventive maintenance is necessary. Many people think preventive maintenance is merely the replacement of parts and equipment at a predetermined time. Behind this reasoning is the belief that one can pick out a time in the future when a particular part (such as a generator) should be replaced. Beyond this replacement process, however, preventive maintenance also is concerned with carefully planned inspections aimed at providing safe, reliable operation. In any case, subsequent references to preventive maintenance in this handbook will involve any type of maintenance other than that required simply to keep the transit vehicles operating. Some of the following activities fall under preventive maintenance:

** Checking steering gear for excessive play.

** Checking fuel pump pressure to idle properly.

** Checking seats and seat frames.

** Checking exterior and interior lights.

** Checking angle drive oil level.

** Cleaning battery terminals and taking cell readings.

** Washing batteries with water.

** Tightening rear spring U-bolt nuts.

** Checking exhaust system and mufflers for leaks.

** Checking for loose nuts and bolts.

** Checking for dents.

** Checking for tears in flooring.

** Checking for correct shifting speeds.

Costs

What does maintenance cost the transit industry? Financial statements contain a section under operating expenses titled maintenance costs. This category is supposed to give a complete picture of maintenance costs, but probably it does not. Parts and labor constitute the major portion of maintenance costs. However, the loss of revenue, number of dissatisfied customers, and the disruption of service from coach breakdowns also are costs attributable to maintenance. Putting dollar figures on these indirect maintenance costs is a tricky business at best, but the unhappy customer and the disruption in service surely do not gain a company anything, and they are factors that must be reckoned with constantly.

Within industry in general, a quality control or reliability function usually is determined by the production department. This activity, through a variety of techniques, seeks to ensure that the finished product has a certain minimum level of acceptable quality. If a piece of machinery is turning out substandard products consistently, the quality control activity takes that machine off the line until it is repaired or replaced. Firms act this way because engaging in quality control costs less than having unhappy customers. Firms seek to increase the reliability of their products or services because reliability attracts and keeps customers and clients. Preventive maintenance is not merely an expense, but an investment that can help retain present patrons and help attract new patrons.

Added to the actual repair expense is the cost of completing the contracted charter. These costs might involve motel expenses, the cost of sending an additional bus, and the possible cost of unhappy customers.

In public transit, the customers depend upon buses' adherence to schedule. The extra cost of sending a new bus to the breakdown scene probably is outweighed by the loss of revenue incurred when regular passengers eventually change to another mode of travel because of breakdowns and low reliability.

The general field of carriage-for-hire is particularly sensitive to breakdowns. This sensitivity is because of the quality control and reliability aspects of the service. In the transit industry, breakdowns have an immediate effect on expenses; but, more importantly, they have an immediate effect on revenues. For example, one of the federal mass transportation demonstration projects cited that: "Dependability (reliability) of service was ... (an) important factor. While the express service trips were operated on schedule over 99% of the time, the daily riding statistics indicate that those passengers who were occasionally inconvenienced quickly found alternative travel means."[1]

Transit firms use preventive maintenance techniques as the least costly method of insuring quality control and reliability, two factors which probably have a more immediate effect on demand in the transit industry than for industry in general. Because of its impact on the quality of service, preventive maintenance programs should be thought of as marketing variables controlled by the firm.

Goals and Objectives

The maintenance program for small-scale mass transit enterprises described here is based on findings from visits to a number of small- and medium-sized properties and the experience of close association with small transit properties over a number of years.

In setting up a maintenance program, it is important for the firm to decide what type of program it wishes to use. First, the goals and objectives of the program must be established. This probably would be put in terms of so many breakdowns or serious failures for every 10,000 miles of revenue service offered. Another method would be to use breakdowns per day, week, or month, without regard to the amount of service offered. For an operating transit property, there might be an existing breakdown level of perhaps three breakdowns or service failures per 10,000 miles. An objective of no more than one service failure per 10,000 miles of revenue might be established. The causes of breakdowns then would be analyzed to determine the major

reasons for failure, and steps would be taken to prevent those failures in the future. Crucial to the program would be the definition of service failure. An actual breakdown of equipment so that it cannot function at all, such as engine failure, transmission failure, or a flat tire, is one definition. Stricter definitions include factors such as air-conditioning failure, broken windows, water leaks, or interior lighting failures, depending upon the operative standards set. Some well-managed transit agencies with high standards may pull a vehicle out of service for as small a problem as graffiti on an interior advertisement. The definition of equipment failure is closely related to the overall objectives for service quality established by the transit agency.

In light of the above discussion, what should be the goals and objectives of the maintenance program? The discussion that follows is presented in terms of cost minimization. However, the reader should remember that included in these costs are opportunity costs of lost ridership significant in the public transit industry. In other words, if the firm minimizes the costs of the maintenance program while the opportunity costs associated with lost ridership increase, then the firm has not really minimized costs at all (see Figure 7.1).

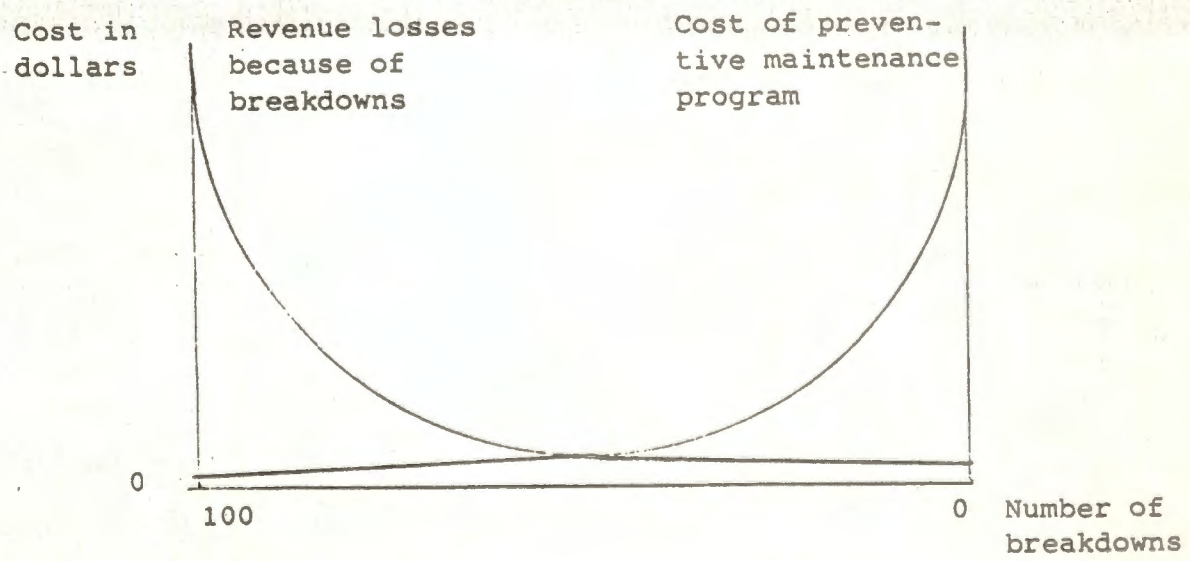

FIGURE 7.1 Cost of preventive maintenance program.

The ideal preventive maintenance program would prevent any breakdown whatsoever. However, the expenses involved in such a program, as shown in Figure 7.1, would be prohibitive. If zero-breakdowns is not a goal, then the optimal number of breakdowns cannot be specified. In a small transit agency, one breakdown per day would be too many, and in a very large transit firm a rate that low probably could not be achieved. Transit properties should aim for a range in breakdowns-per-time-period that does not cost them ridership or force them to invest in additional equipment and/or excess operator expense. In most cases, ridership will be affected first.

Safety is a paramount goal of any maintenance program. At a minimum, the preventive maintenance program should ensure that all vehicles be able to pass a rigid safety inspection at any time, by any agency--management or regulatory. (Indeed, this goal should be made part of the program with surprise inspections by management as a quality check.)

From a marketing standpoint, the objectives should be set so that the passenger can at least expect to ride on a clean vehicle, with an interior that is not an eyesore. The seats should be in good repair. The windows should not be cracked. If the riders have grown to expect heat in the winter and air-conditioning in the summer, no vehicles should be dispatched or continue to operate beyond the end of any run if these components are not operating properly. Riders also should have a high expectation that service will not be delayed or interrupted because of equipment breakdowns.

Implementation

To ensure the service quality set by the transit agency, the maintenance department can use a variety of guidelines in its preventive maintenance program.

The defect card. The heart of any preventive maintenance program is the driver. The driver should report any and all defects in writing on the driver's defect report (see Appendix 7A). The importance of this report should be emphasized in driver training and retraining programs. Drivers should be encouraged in this endeavor by the management of the firm. The best encouragement is given by prompt attention to defects as they are reported. In addition, if for some reason defects cannot be repaired immediately, the driver should be notified and should be given an explanation for the delay. Too often maintenance people and drivers defeat this system with petty squabbling. The operators complain that the mechanics will not make the repairs, and the mechanics complain that the drivers are too picky. This situation indicates a lack of leadership on the

part of management. When a maintenance problem occurs that may lead to squabbling, top management must evaluate the situation, determine what is at fault, find a solution, and, most important, communicate to all parties--drivers and mechanics--the problem and the solution.

Management should stress that it is trying to build a preventive maintenance program for the future, not trying to blame individuals for problems. A preventive maintenance program will work only if it is taken seriously by everyone.

In some larger properties, rather than relying on defect cards, a representative of the maintenance department checks each vehicle in, asking the driver verbally for any defects or problems. This method is, perhaps, more costly, but it provides more information; it is far easier for a driver to explain a problem orally than to take the time to write it. The opportunity for dialogue may permit better diagnoses of problems.

Periodic road-testing by mechanics should not be overlooked in the search for defects. Because of the physical layout of some properties, a mechanic must drive a vehicle some distance from the parking area to the garage facilities. If the mechanic notices any defects that have been overlooked by the driver, he should note them on the defect card so they can be corrected. This step is added insurance for a good preventive maintenance program.

Daily fueling inspection. A second preventive maintenance tool is the daily fueling inspection. Buses must be fueled at least once a day, and each fueling takes at least 5 to 10 minutes. During that time, a very thorough vehicle inspection can be performed--tire pressures, oil levels, lights, windshield wipers, brakes, doors, windows, seats, and so forth, can be checked, and defects noted. The transit property thus has two checks per day that are essentially costless; one by the drivers who operate the buses and the other by the people who fuel them. These two checks are the keys to achieving the goal of uninterrupted service.

Mileage inspections. A third preventive maintenance tool is the vehicle mileage inspection form (see Appendix 7A). In general, three types of vehicle inspections are performed: (1) lubrication, (2) oil change, and (3) major inspection. These inspection forms are really lists of items to be checked by the mechanic who makes inspection, but maintenance personnel should not stop with the items listed. With a little extra time and effort, the inspector can check other items--wiring and hoses, for example. Good maintenance shop leadership encourages its mechanics to do this.

A careful review of the substance of these inspection forms will reveal that they all are in basic agreement on what is to be checked. In most cases, the only differences are in one or two areas.

When deciding which mileage intervals should be used, four basic factors must be kept in mind:

1. The type of coach.
2. The length of time it takes a coach to reach a particular inspection point.
3. The manufacturer's suggested procedure.
4. Climate and operating conditions.

Most inspections are made on a mileage basis, checked against time. Perhaps a better way would be time checked against mileage. The person who schedules the vehicle inspections can do the scheduling much faster by using the time elapsed since the last inspection as a basis, rather than computing elapsed miles for every vehicle through actual odometer readings or formula. Monthly inspection is a reasonable average for most bus fleets. Periodically, this time basis can be checked to avoid overinspecting the buses. However, overinspection is preferred to underinspection.

Battery maintenance. Battery maintenance is one of the least discussed areas of a preventive maintenance program. Maintenance procedures suggest that hydrometer readings be taken and terminals be cleaned, and some firms take voltage readings. Battery cells should be checked daily for proper electrolyte levels as part of the fueling inspection.

Records should be kept on various makes and models of batteries. The information collected should include date of purchase, date of installation, date of failure, and cause of failure. Road failure frequency can be collected from the road service call reports. Mileages should be recorded routinely.

This information collection will permit experiments with various battery programs. The best type and model of battery can be selected. Another possibility that can be investigated (if proper information is collected routinely) is the use of rebuilt batteries, which might represent a cost savings.

Tire maintenance. Most transit firms that use standard-size transit buses lease tires rather than purchase

them because a much better-wearing tire is available through lease. Companies such as Goodyear, Firestone, Uniroyal, and B.F. Goodrich will bid on the lease contract. The lowest bidder who meets specifications usually supplies the tires. In general, a tire will run a given number of miles. A particular mileage point is set, which usually is referred to as a "bogey." Anything past this "bogey" point is bonus mileage and does not cost the lessee as much to run, providing an incentive for a high level of tire care. Tire records are critical if a property is getting mileage past the bogey period. Hubodometers generally are used to collect accurate tire mileage information. Tire record forms usually are supplied by the rubber companies.

Actual tire maintenance may be performed by an employee of the local tire distributor using transit agency facilities. In general, all that is needed in the tire maintenance operation is a place to store tires and a device to remove rims and place them in the new tires. It also is important to use the new safety device--in effect a cage--that does away with the dangerous problem of exploding tires. Because of the high pressure these tires are under when inflated, they may be very dangerous.

Transit properties using small buses--not standard buses--must buy their tires. Such tires are standard truck tires. Careful maintenance still is required.

Inventory control. Transit firms must control two types of inventories: (1) fuel, lube oil, and grease; and (2) parts, special tools, tires, and batteries.

Quantity discounts generally make it mandatory for transit firms (large or small) to purchase fuel in transport (bulk) quantities. The cost reduction per gallon usually far outweighs the increased inventory-holding costs. Purchasing in transport quantities requires the installation of storage tanks with a minimum capacity of 8,000 gallons.

The firm that uses a bulk lube oil system can purchase lube oil in 2,000-gallon lots (delivered in tank trucks) and, with proper plumbing, the oil can be distributed from the supply tank to several locations. Metering nozzles are available to measure quantities delivered. Scale considerations determine whether a firm will use this system. If firms do not purchase in bulk, the standard unit of delivery is the 55-gallon drum.

Actual inventory control procedures for fuel are simple. Pump readings taken at the beginning and end of each day are checked against the fuel tickets for discrepancies. In addition, a dip stick reading of the tanks is taken weekly. When fuel delivery is made, the tanks are checked before and after delivery to make sure

that the gallonage in the tanks equals the gallonage on the delivery ticket. A similar procedure is followed for the bulk lube oil system. Grease generally is not controlled.

Parts inventories are extremely difficult to systematize because many different items with wide price variations are involved. Generally, firms set a lower part cost limit and control the inventory of parts that exceed this lower limit. Parts that cost less than the lower limit usually are not subject to rigorous controls.

Parts are kept in bins when possible, and the bin compartments are labeled with the part number and/or the part identification, the part cost, the reorder point, the number of units to order, and the supplier. This information allows the parts clerk to monitor much of the parts inventory daily as he supplies parts to the mechanics. This situation is true especially for the larger, frequently used parts. For the less frequently used parts, periodic, routine monitoring during slack periods will allow the parts clerk to make out requisitions for purchase.

Special tools, tires, and batteries can be monitored separately with procedures that fit individual circumstances. For example, special tools may be checked out to mechanics in a manner similar to library books.

A great deal of money can be tied up in obsolete parts inventory. One of the most important inventory procedures to implement is the periodic, routine campaign to eliminate obsolete parts. Most suppliers will buy back obsolete parts if they can be used by their other customers. Naturally, the part or its package must present a reasonably good appearance, and the part generally cannot be too old. The periodic obsolete part campaign should be undertaken often, perhaps quarterly.

Other Maintenance Programs

Outside Maintenance Contracts

An option to establishing an in-house repair facility is negotiating a contract with an outside party for vehicle maintenance and repair (see Appendix 7B). This option might be most attractive in cases where the number of vehicles is small, because it would avoid the substantial fixed investment of equipping a repair facility. Setting up an outside contract would involve negotiating a contract for performance of vehicle inspections and repairs with an automobile dealer, truck dealer, independent garage, or user of related equipment. Some disadvantages include:

1. Control over the quality of the inspections is lost.

2. Work scheduling is more difficult because of priority considerations.

3. The expenses incurred, while variable (rather than fixed and variable as with in-house work) may be higher.

4. Because much bus work is specialized, more than one contract may have to be negotiated resulting in a loss of quality control and increased scheduling difficulty.

5. The party performing the maintenance might be unwilling to stock the necessary parts, leading to lengthy periods when the vehicle is out of service.

This option is not desirable for any but the smallest firms and probably useful only for transit properties not operating standard transit vehicles.

Selective Outside Maintenance Contract

A more practical option would be selective outside contracting of specialized maintenance and repair work while the transit agency continues to perform the more routine tasks at its own facility. Many transit firms now follow this approach with their tires, but the concept might be extended to repair work on glass, bodies, seats, diesel engines, and so forth. In this case, the firm has the fixed investment of a facility, but it does not have a large fixed investment in specialized repair equipment and tools. The disadvantages previously discussed all pertain in this situation, but they are not as severe because the firm has some in-house capability.

Another approach is to contact several of the firms leasing trucks for a full-service leasing quotation. Under their standard plans, they furnish the vehicles plus a guaranteed maintenance program. In outlying locations, they would equip a repair facility that would serve the transit firm's operation exclusively. However, they would own the vehicles, and they might be unwilling to operate these vehicles for as long a period as the transit firm wished. This situation could well lead to higher operating costs than the transit firm would incur on its own. For any firm, public or private, that is starting up an operation, a quotation by a truck-leasing firm would serve as a ceiling on expenses. That is, because the leasing expense is a set contractual price, the fledgling transit firm could use these prices as maximum expenses.

Performing Maintenance on Other Vehicles

A third possibility to be considered is that of repairing other firms' vehicles. This could be done on an

open-shop basis or on a contractual basis. For planning and scheduling ease, the contractual basis is preferred.

Because parts for standard city transit buses are specialized and not widely distributed, it generally is considered infeasible for truck dealers or garages to perform preventive maintenance programs and repair work for buses. However, truck parts are widely distributed and easily obtained on short notice. Therefore, it is possible (indeed attractive) for transit firms to perform maintenance on trucks without a drastic increase in inventories, investment in additional equipment, or additional employees. For small transit firms in outlying locations, this service would represent an attractive method of spreading the repair facility overhead.

A natural customer for a publicly owned transit agency is local government. Maintenance may be provided for city trucks, fire engines, heavy equipment, and perhaps police cars. Work on heavy vehicles often is especially attractive because local government can avoid the costs of installing expensive special equipment similar to that already found at a transit property.

Out-of-house vehicle maintenance can be done selectively. For example, the transit firm could open its own facilities for diesel engine work. Perhaps it could contract solely for preventive maintenance inspections.

As far as charging for this work is concerned, the firm can easily determine competitive labor costs by investigating the rates charged by the local automobile dealers, independent garages, or truck dealers. Parts can be priced at cost, plus 15%. These are starting points. The final prices will be determined through negotiations.

The variations on this theme are endless. The important aspect is the spreading of the overhead. One or two sound maintenance contracts may spell the difference between a small city being able to afford a good transit system, a poor one, or none at all.

Maintenance Facilities

Most transit properties only have one maintenance facility (the very largest properties will have several storage and inspection facilities and, generally, one main maintenance location). A variety of tasks are performed at the maintenance facility including:

** Heavy repairs.

** Engine overhauls.

** Unit rebuilds.

** Major body repairs.

** Painting.

** Upholstery.

** Route sign preparation.

** Bus stop sign manufacture.

** Brake relining.

** Brake drum turning.

** Radiator repairs.

Within the facility there should be stalls in which to perform the repairs as well as support space. Support space includes such activities as a machine shop, a component rebuild area, a sheet metal shop, a welding shop, stockrooms, offices and all other spaces not designed to hold buses.

To do the job properly, there should be two or three heavy repair stalls for each 100 buses; paint and body stalls average two per 100 buses. A decently equipped heavy repair stall should have a hoist or a pit. If pits are generally provided, there should always be at least one hoist in a maintenance facility.

The average allocation of space per vehicle in the bus fleet should be about 60 square feet each. Ideally the stalls would be about 18 x 67 feet to 18 x 80 feet each; this includes clearance and passageways for equipment movement, work benches, and perhaps bus trafficways within the facility. About 20 square feet per bus should be allocated for machine shop and component rebuild area. For stockroom space, about 25 square feet is needed per bus. Shop areas require an average of 20 square feet per bus. Other activities, including such things as cleaning vats, battery storage, offices, locker rooms, air compressors, and lubricant storage, need about 25 square feet per bus.[2]

What are the needs of a typical transit property? More to the point, how do these needs compare with the facilities feasible for the small-scale mass transit firm? There are 14 basic needs in an all-around maintenance facility:

1. Fueling service area.

2. Wash area.
3. Grease pit or hoist, or combination of both.
4. Body shop.
5. Paint shop.
6. Machine shop.
7. Stockroom.
8. Storeroom (the stockroom and storeroom may be combined).
9. Maintenance superintendent's office.
10. Indoor or outdoor storage of coaches.
11. Fuel and lube oil storage tanks.
12. Cleaning and repair area.
13. Battery room.
14. Tire room.

These facilities cover the typical maintenance functions for a mass transit property. Managers may have some difficulty applying these functions to small-scale transit operations, particularly when they compare facility cost and need. Because all functions must be performed, some work might have to be farmed out if it cannot be done in-house.

Fueling Service Area

In addition to fueling the buses, the fueling service area is a place where checks on coolant levels, oil levels, and torque fluids are done. It also provides a place to conduct some minor inspections, pull the defect card, remove the fare box, check tires, and clean and wash the buses. Whether the fueling area needs to be connected directly to the maintenance facility depends upon personal preference, the amount of space available, and the section of the country.

The fueling area may be located completely away from the main garage building. In a warm climate, all that is needed is a roof. One advantage of keeping the fueling area separate from the main facility is that a coach may not need to use the washer and other facilities as often as it needs to be fueled and serviced. With this arrangement, the bus

would not have to run through connected facilities unnecessarily, and it would not hamper other operations.

The following major functions are performed at most service islands or inside service areas:

** Fuel refill.

** Oil check and refill.

** Recording of fuel and oil use.

** Tire check.

** Coolant level check.

** Cleaning of interior and exterior.

** Lights check.

** Torque fluid check.

** Fare box removal.

** Minor maintenance check.

** Brake check.

If the bus is to be cleaned as part of the fueling operation, cleaning personnel begin by using air hoses to loosen dust and trash inside the bus. Meanwhile, if an automatic bus vacuum is used, the bellows of that device are placed against the front door of the vehicle. The vacuum then sucks the trash and dust out of the bus. When the fueling and vacuuming are finished, the bus can be moved to the wash area. If an automatic washer is used, cleaning personnel simply drive the bus slowly through the machine. The bus may then be driven to the storage area unless it has been marked for work in the maintenance area.

Washing Area

Most modern fueling and washing area installations are located inside. The advantage of having them inside is that they can be kept cleaner. Also, it is easier to recycle washing materials. By enclosing the entire operation, bad weather does not interfere. Service personnel are more likely to do a better job if they are protected from the elements. In cold climates, it is wise to conduct the entire washing process indoors in a heated environment, with a place for the buses to drip dry. Otherwise there may be severe problems with the ice that forms from the water

dripping from the buses. Indoor facilities must include adequate drains so that water will not form large puddles.

The wash area is a necessity if equipment is to be kept attractive. On a very small property, the internal cleaning job may have to be done manually. If so, the bus would be cleaned in the storage area, rather than in the fueling area. Financial constraints will determine whether a mechanical washer can be used. The initial cost of a mechanical washing system is high. For a small transit property, it might be more practical and economical to hire a person to wash the buses by hand. However, the small property should not rule out the use of machinery simply because of the initial cost of the equipment. When deciding on the cost feasibility of mechanically cleaning and washing equipment, some factors must be kept in mind including:

1. Initial cost of equipment.
2. Length of time equipment can be used.
3. Lifetime operating cost of running the equipment.
4. Lifetime cost (relative to the expected life of mechanical devices) in labor expense for men to do the machine's job.
5. Number of coaches to be served by the equipment.
6. Possibility of renting the service provided by the equipment to other firms, such as other bus lines, motor carriers, or automobile agencies. (The main consideration is that the outside work should not in any way interfere with the effective operation of the transit enterprise.)
7. Possibility of transit firm contracting for washing service.
8. Cost constraints (inflation, rising wages, current value, and so forth).

Transit firms should evaluate the alternatives in any investment situation in terms of current value, to take into consideration the time value of money. As a simple example, if the choice is between investing $100,000 in equipment and paying an employee $4,000 each year for the next 25 years to do the same thing, it would appear that the alternatives are equal. However, one alternative requires an immediate outlay of $100,000, while the other requires outlays over a 25-year period. In the second alternative, $96,000 could be used in other ways for one year, $92,000 the next year,

$88,000 for the next, and so forth. In other words, the portion of the $100,000 that can be used in other ways might bring in new revenue not available under the first alternative. Therefore, before the second alternative is compared to the first, future outlays under the second alternative need to be discounted to the current time at a rate comparable to the rate of return that could be obtained by investing the excess funds.

Grease Pit or Hoist Area

The grease pit provides a simple means of daily undercarriage inspection. A mechanical hoist takes a little longer per vehicle to operate. However, a hoist is more useful for steam cleaning a bus' undercarriage, general engine work, tire changes, and brake work. The pit is excellent when used for preventive maintenance on brakes because it simplifies weekly adjustments that may take only 3 to 5 minutes.

In general, hoists are preferred over pits, although some maintenance people believe the hydraulic hoist requires costly maintenance. Another important advantage of the hoist is that, unlike the pit, people cannot fall into it, nor can a careless repairman drive a bus into it. The small-scale transit operation may not need both, but it appears that both are desirable for maximum maintenance efficiency. If an operation were to have just one facility, probably the pit would be the best choice. However, if hoists are available, two pits or one very large pit still might be needed to allow for simultaneous repair and inspection.

A steam cleaner should be located somewhere near the pit or hoist area. The steam cleaner is important for cleaning the dirt and grease that collects on the underside of the bus. Because the diesel engine located in the rear of the bus requires air intake on the side, dirt builds up underneath. Eventually, this area of the vehicle can become a fire hazard if it is not cleaned properly. Also, the steam cleaner can be used to clean the engine and engine parts before every preventive maintenance inspection. This enables the inspectors to see the parts clearly. If the parts cannot be observed closely, inspectors may miss heat spots and friction points that should be noted and repaired. The undercarriage also needs to be steam cleaned periodically.

Body Shop and Paint Shop

Both of these areas are found in all but the smallest properties, where these functions would be handled by outside contractors. Usually, if a company has between 40 and 100 buses, one bus will be in the body shop and another

in the paint shop each day. At one time, paint and body shops often were combined. However, recent federal regulations required that painting facilities be separated completely from the rest of the maintenance facility.

Machine Shop

For the very small mass transit property, a complete machine shop may not be very practical. Much of this work may be contracted out. But for properties with 10 buses or more, a machine shop with a lathe, valve grinder, and other small repair tools very definitely is needed.

Stockroom and Storeroom

The stockroom is a basic area for supply and inventory control. All parts are stored here, to be placed in service on the coaches at a later date. Each item is checked out through this room. Inventory counts and records are also kept here, and the stockroom also can be used for employee time cards, records, work reports, and so on as well.

The storeroom is used to store large items, such as rebuilt engines and transmissions. If the transit property is far from a supplier of this type of equipment, it is usually wise to keep a spare engine and transmission on hand to assure interruption-free service.

Maintenance Superintendent's Office

The maintenance superintendent's office is the center of the maintenance operation. It is the origin of work orders and the place where information is gathered for the maintenance records. The maintenance superintendent's office need not be large, but it should be located close to the site of maintenance work for purposes of close supervision of employees.

Indoor or Outdoor Storage

There are conflicting opinions on the question of indoor or outdoor storage. Many people think that storing buses indoors is too expensive and not worth the cost of construction and upkeep. Indeed, if it is combined with the typical masonry maintenance facility, the expense of such a building may be exorbitant compared to the benefits it provides. A less expensive framed or aluminum shelter of course, could be used as an alternative. In many areas of the country, indoor storage is an absolute necessity, particularly in sections with extremely cold winters. Diesel engines are usually very difficult to start when the temperature falls below 40 degrees.

In some areas transit managers feel that with the new technological advances in plug-in engine heating equipment, it is more practical to use these units and store the buses outside. The opposite view is that outdoor storage is harder on paint and other exterior parts, causes more wear and incurs expense arising from vandalism. Others who have older buses without oil-sealed axles, feel that lubricants do not serve their purpose and fail to keep friction at a minimum when buses are kept outside in the cold. This factor is particularly important for the first few miles each day.

Fuel and Lube oil Storage Tanks

The best method is to have the tanks underground, but this is not always done. Another question involves the advantages of storing fuel and oil in large tanks. Although such tanks are costly, scale advantages are apparent:

1. Have tanks large enough to allow buying at the best bulk discount.
2. With large tanks, it is possible to maintain a schedule that will enable fuel and lubricants to be obtained through competitive bidding.
3. If fuel use makes it necessary to have 12,000-gallon capacity, it is probably wise to have two 6,000-gallon tanks, to allow for possible tank breakdowns.

Another method of lowering overall costs is to have a tank located near the pit area. When the oil is changed, the old oil can be saved for reclaiming. A tank is needed because oil companies will not reclaim quantities as small as barrels. The particular facility that a transit firm requires depends on the following:

1. The type of maintenance program that is operated.
2. The number of buses.
3. The section of the country.
4. The topography of the land.
5. The cost constraints.

Notes for Chapter 7

[1]Final Report on Mass Demonstration Project MD-MTD-1, Metropolitan Transit Authority of Maryland, U.S. Department of Housing and Urban Development, and the McMahon Transportation Company, Inc., p. 28.

[2]The information on the space needed is from Virgil S. Thurlow, John A. Bachman, and C. Denver Lovett, Bus Maintenance Facilities: A Transit Management Handbook, Washington, D.C., MITRE Corporation, November 1975. This is an invaluable source of material and should be consulted by all persons concerned with the operation, construction, or refurbishment of transit maintenance facilities. It was prepared under a grant from the Urban Mass Transportation Administration as project VA-06-0004-75-05.

Bibliography for Chapter 7

[1] Bakr, M.M., and Rretschmer, S.L., Optional Scheduling of Bus Maintenance, Milwaukee, WI: Marquette University, Urban Transportation Program, March 1974.

[2] Cooling, W.C., Low-Cost Maintenance Control, New York, NY: AMACOM (a Division of American Management Associations, Inc.), 1973.

[3] Corder, A.S., Maintenance Management Techniques, New York, NY: McGraw-Hill, 1976.

[4] Mann, L. Maintenance Management, Lexington, MA: Lexington Books, 1976.

[5] Scott, R.L., SIMS Implementation Handbook, Washington D.C.: Dept. of Transit, Urban Mass Transportation Administration, 1974. (NTIS PB 245 610)

[6] Thurlow, V.S., et al., Service Inventory and Maintenance System Computer System Description, McLean, VA: The MITRE Corporation, Transportation Management Systems Group, December 1975. (NTIS Vol. I: PB 249 058; Vol. II: PB 249 059; Vol. III: PB 249 60)

[7] Thurlow, V.S., et al., Bus Maintenance Facilities: A Transit Management Handbook, McLean, VA: MITRE Corporation, November 1975. (NTIS PB 250 475)

The numbers in parenthese are NTIS order numbers.

APPENDIX 7A

EXAMPLES OF MAINTENANCE FORMS

Included in this appendix are a number of forms currently used by transit firms. In addition, some recommended forms are included, which are generally made up of two or more other forms combined for simplification.

Most of the forms are self-explanatory; some are reviewed in the accounting section of the handbook at some length.

Figure 7A.1: Bus Defect Report

The bus defect report is self-explanatory. The emphasis should be placed on the drivers' completing this form on a daily (or shift) basis. The form should be filled out routinely, even when there are no defects. A place should be explicitly provided on the form for the no-defects entry.

Figures 7A.2, 7A.3: Daily Inspection Forms--A, B

These forms are simply a guide for use by the people performing the inspections. A form should be completed for each bus every day it is in service.

Figures 7A.4-7A.15: Mileage Inspection Forms--A, B, C

These are examples of mileage inspection forms currently in use. They should be attached to repair orders by the maintenance superintendent or foreman whenever such an inspection is to be made.

Figures 7A.16, 7A.17: Air-Conditioning Inspection Forms--A,B

More and more buses are being equipped with air-conditioning units. Air-conditioning in the summer is a must for passenger comfort and helps to serve as a builder of revenue. However, preventive maintenance of and repairs to these units are specialized. Air-conditioning units should be separated from the general vehicle preventive

maintenance and repair operations. Separate inspection reports are shown here for preventive maintenance and repair.

Figure 7A.18: Foreman's Inspection Form AA

Nothing sharpens and tightens a preventive maintenance program as much as random inspections by a member of the management team. This system gives concrete evidence that management is serious about the quality of the maintenance work and is paying attention to it.

Management should use this inspection practice as a means of rewarding the outstanding performers in the maintenance and repair area. It can be a means of upgrading low-quality performance when placed on an instructional basis rather than to censure individuals. Mechanics, like all other people, have their own pecking order. Their desire to be the best mechanic can be used as an instrument to raise the quality of the whole system. A system of quarterly dinner meetings, where individuals are specifically cited and rewarded (wallets, pins, and so forth) before their peers, is a prime means of eliciting high-quality job performance from these people. Outstanding examples of high-quality foremen's investigation should be made part of the employee's permanent record file.

Figure 7A.19: Battery Report Form

This form serves to trace the history of each battery from date of purchase to date of final disposition.

Figures 7A.20, 7A.21: Tire Forms--A, B

These tire forms are used by the United States Rubber Company, now Uniroyal Incorporated, for its leased tire operation.

Figure 7A.22: Vehicle History Form

Each vehicle should have its own maintenance file, which should include a copy of every repair order, mileage inspection form, and vehicle record. All major component repairs should be listed on the coach record, together with the date of this repair and the mileage. This system provides management with a quick history of individual component's performance as well as a history of each bus.

Figures 7A.23-7A.26: Inventory Control Forms--A, B, C, D

These forms and their use are discussed in Chapter 6.

Figure 7A.27: Repair Order

The repair order form is the basic unit of the operations information system. Each time the vehicle is inspected or repaired, the labor time and parts charges are added on this form. One copy of this multi-copy form should be placed in the maintenance file of each vehicle.

Company Name_____

BUS DEFECT REPORT

Bus #_____ Date / /

MOTOR	OPR. NO.	MECH.	BODY	OPR. NO.	MECH.
No Power			Dest. Signs		
Misses			Wiper		
Heats			Mirrors		
Knocks			Heaters		
Idle Motor			Windows		
Fan			Windshield		
Water Leak			Seats		
Oil Leak			OTHER DEFECTS		
Fuel Leak			Lights		
Accelerator			Wheels		
Starter			Doors		
INSTRUMENTS					
Oil Gauge					
Air Pressure					
Temperature					
Ammeter					
TRANSMISSION					
Noisy					
Shift Lever					
ELECTRICAL					
Battery					
Str. Switch					
Buzzer					
Horn					
FOOT BRAKES					
Loose					
Tight					
Stick					
HAND BRAKES					
Loose					
Tight					
CLUTCH					
Slips					
Grabs					
STEERING					
Stiff					
Rough					
REAR END					
Noisy					
Bumps					

IF THERE ARE NO DEFECTS, INDICATE HERE _____

REMARKS

Foreman_____

FIGURE 7A.1 Bus defect report.

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Bus # _____ Date / /

DAILY INSPECTION

ITEMS TO BE CHECKED	CLOCK #	REMARKS
Wheel Nuts and Studs		
All Lights		
Windshield Wipers		
Horn		
Windshield Fans		
Service Brakes		
Hand Brake		
Fan and Generator Belts		
Steering		
Generator Charging		
Shifting		
Drain Air Tanks		
Oil Pressure (Gas & Diesel)		
Radiator and Water Hoses		
Oil Level		
Fuel		
Use Buck Cyclone Cleaner		

Inspector _____

FIGURE 7A.2 Daily inspection form--A.

DAILY GARAGE REPORT

Company_____ Shift_____ Date_____

BUS NUMBER	DRAINED AIR LINES	WATER CHK'D	OIL CHK'D	BATTERIES CHK'D	TIRES CHK'D	FARE BOX VAULT RMV'D	WINDSHIELD CLEANED	FLOORS SWEPT	FLOORS SCRUBBED	WASHED INTERIOR	WASHED EXTERIOR	TIRES CHANGED	WINDOWS CLEANED

REPAIRS MADE_____

BUSES CHANGED OFF_____

OPERATORS LATE_____

Signed_____

FIGURE 7A.3 Daily inspection form--B.

Bus #_____ Company_____
Inspection #_____
Date_____ "A" INSPECTION

Mechanic's instructions: Items inspected and found OK shall be marked "✓". Items adjusted or repaired shall be marked "X". Items requiring additional repairs or adjustments shall be marked "O". Mechanics shall either initial or insert their number beside each item inspected.

	INSIDE COACH
	Hand brake for grip spring & adjust five notches
	Compressor for cut-in pressure (minimum 80 lbs) & cut-out (100-105 lbs. range)
	W/s wiper for operation and speed
	Blow horn-must be audible 300 feet
	Oil pressure & temperature gauge operation
	Defroster, floor heater & blower operation
	Check steering wheel free play
	Mirrors for clear view & condition of adjustment
	All danger signals & lites for burning
	Inside lights for burned out bulbs & shade condition (Do Not remove fluorescent tubes while turned on. Power unit may be damaged)
	Head lamps for focus & tilt switch operation
	Doors for operation, leading air open & closed & step light switch action
	Buzzer and cord condition
	Seats for cuts, stanchions for tightness
	Flags & flares in place

	OUTSIDE COACH
	Marker, tail, diredtional signals & stop lights for shade & burned out bulbs
	Wheels, axle cap and axle flange nuts for tightness
	Window Glass & body for condition
	Inflate tires to correct pressure
	Wiper blades & arms for tightness and blade condition
	Battery for gravity reading and electrolyte level. Batteries with reading below 1.200 or 25 points or more variation between cells should be changed. Inspect battery cables & & clean terminals Battery No. _____&_____

	ENGINE COMPARTMENT
	Radiator shutter operation
	Hoses & water, oil & fluid leaks
	Fan Hub condition
	Fluid fan - leaks & operation
	Engine oil for level & condition
	Clutch operating air cylinder for air leaks
	Throttle knockdown cylinder for air leaks
	Torque fluid level (added ___ qts)
	Angle Drive oil level & condition
	90-91 transmission governor oil level
	Engine for unusual noise & idle
	Brake lining-5/16" min. at center of shoe. Adjust to 3/4" push rod stroke using "apply-bar" at each cylinder.
	Brake cylinder & hose for air leaks
	Body springs for broken leafs. Air suspension for bellow, leveling valves leaks
	Drain air tanks and sumps
	Differential for leaks level-clean vent
	Clean heating filters (when used)
	Clean coach interior & steering

PERFORM THE FOLLOWING ONLY WHEN "X" IS PLACED IN SQUARE

☐ CHANGE OIL
☐ CHANGE OIL FILTER
☐ LUBRICATE CHASSIS

MAKE DETAILED REPORT OF ITEMS MARKED "O" ON REVERSE SIDE

FIGURE 7A.4 Mileage inspection form--A1.

Accumulated Miles_____ Coach Number_____

Date_____ GM HYDRAMATIC COACH "A" INSPECTION REPORT Inspection Number_____

Type of operation to be performed: "✓" if OK, "X" adjusted; "O" repairs needed.
Make detail report of items marked "O" on reverse side.

MECH. NO.	SYM.		MECH. NO.	SYM.	
		Steering gear for excessive play			Ck. brake lining 5/16" at center of shoe. Adjust to 3/4" stroke by applying bar at each cylinder.
		Starting Motor Operation			
		Oil Pressure at idle is _____ #			Build up air pressure. Ck. for air leaks at diaphragms & hoses
		Interior dome & headlights			Differential housing & pinion seal for leaks
		Fare box & step lights			Fill differential to proper level. Added _____ #.
		Passenger signal & cord			Clean differential vent
		Horn for tone			Tighten Trans./Angle drive bolts
		Ammeter for generator charge			Inflate all tires
		Air compressor cuts out at _____ lbs.			Tighten air comp. belts
		Air compressor cuts in at _____ lbs.			Ck. idler pulley bearing play
		Dash, stop, rear door signal, low oil and temperature signal lights			Fan blades-W/pump for excess play
		Windshield wiper operation			Gas lines & connections
		Front & rear doors for proper operation. Adjust when necessary.			Choke operation
		Defroster motors-heaters			All hose & clamps for leaks
		Adjust hand brake to hold			Repair or report oil leaks
		Seats for cuts-seat frames			Ck. angle drive level. Added ____ qts.
		Tighten grab rails & modesty panels			Ck. trans. level with engine running & shift lever in drive. Added ____ qts.
		Emergency door latch			Wash battery with water-dry
		Glass & sash for condition			Fill battery to proper level. If water level is low, ck. for improper volt setting
		All exterior lights-stop light			Road test. Ck. shift pattern & repair rattles. Clean steering wheel & seats
		Damages to body. Report on other side.			
		Horn wire conn. at steering column			
		Front springs for breaks			
		Lube control links to accel. & hand brake			
		Drain air tanks			
		Ck. drive line & U joints. Tighten flange nuts.	Road tested by _____		

PERFORM THE FOLLOWING ONLY IF "X" IS PLACED IN SQUARE

☐ CHANGE OIL ☐ LUBRICATE CHASSIS ☐ CHANGE FILTER

FIGURE 7A.5 Mileage inspection form--A2.

Accumulated Miles_____ Coach No._____

Date_____ FLXIBLE COACH 3000/6000 MILE INSPECTION REPORT Inspection No._____

Type of operation to be performed: "✓" if OK; "X" adjusted; "O" repairs needed.
Make detail report of items marked "O" on reverse side.
Items marked * are to be performed on Inspections No. 4, 8, 12, 16, and 20 ONLY.

MECH. NO.	SYM.		MECH. NO.	SYM.	
		Steering gear for excessive play			Raise front wheels, ck bearings. Adjust kingpins for wear.
		Starting motor operation			
		Oil pressure at idle is #			Adjust front brakes. Report them when worn to 5/16" at centers
		Interior dome & head lights			
		Step lights			Tie rod ends and Pitman arm
		Passenger signal & cord			Shocks and linkage for wear
		Horn for tone			Horn wire connection at steering column
		Ammeter for generator charge			Front springs for breakage
		Air compressor cuts out at _____ lbs.			*Front spring bushing wear
		Air compressor cuts in at _____ lbs.			*Tighten front spring U bolt nuts
		Dash, stop, rear door signal, low oil & temperature signal lights			Lube control links to accel. & hand brake. Replace worn pins
		Windshield wiper operation			Drain air tanks and ck mountings
		Front door for proper operation. Adjust when necessary			Raise rear wheels, ck bearing adjustments and tighten flange nuts.
		Defroster motors--heaters			Adjust rear linings. Report when worn to 5/16" at centers
		Adjust hand brake to hold			
		Seats for cuts--seat frames			Ck drive line & U joints, tighten flange nuts & lubricate joints
		Emergency door latch			
		Glass & sash for condition			*Rear spring bushing wear
		Floor covering wear and damage			*Tighten rear spring U bolt nuts
		Step nosing wear & looseness			Build up air pressure. Ck all diaphragms hose & connections under pressure
		Ck clutch pedal clearance			
		All exterior lights--stop lights			
		Damages to body. Report on other side			Differential housing & pinion seal
					*Exhaust & muffler for leaks

FIGURE 7A.6 Mileage inspection form--A3.

MECH. NO.	SYM.		MECH. NO.	SYM.	
		Frame for cracks			Hose and clamps for leaks
		Fill differential to proper level			Engine compartment wiring condition
		Clean differential vent			Repair or report oil leaks
		Check each fuel pump separately			*Drain sump & oil shutter cylinder. Ck shutter operation.
		Lubricate chassis, oil pins if ck'd			*Change oil & filter cartridge if ck'd
		Tighten transmission bolts			Check transmission oil level
		Inflate all tires			Wash off battery with water
		*Service air cleaner, ck hose conn to carburetor and to air box			Clean terminals and take cell readings from positive to negative. Cell 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____ . If cell readings are below 1225, remove regulator cover and raise voltage 1/10. If over 1250, lower 1/10 volt. Write voltage setting in cover with pencil.
		Service crankcase air cleaner			
		*Generator brushes & springs for wear			
		*Starter brushes & springs for wear			
		Tighten air compressor bolts			
		Fan blades--pump bearing for wear			
		Water pump belts for cracks. Adjust.			
		Ck generator brackets			Voltage set by
		Generator drive belt for cracks. Adjust.			Fill battery cells to proper level
		*Service spark plugs. Adjust.			Battery No. is
		*Clean distributor cap. Inspect.			
		*Spark plug wires & ends for condition			Baggage compartment condition
		*Ck points. Adjust.			Road test: Check transmission shifting. Repair unnecessary rattles. Clean steering wheel & seats.
		*Lubricate distributor cam & point arm			
		*Tighten manifold nuts			
		*Engine supports for condition	MAKE DETAIL REPORT HERE		
		*Condition of clutch clevis, pins & crank at rear of engine. Make needed repairs.			
		Adjust clutch if necessary			
		*Set ignition time with light			
		*Adjust carburetor			
		*Engine governor RPM			
		Gas lines and connections	Road tested at ____		
		Choke operation			

FIGURE 7A.6 continued.

Coach #_____ Assigned to_____

Date__/__/__ LUBRICATION

Type of inspection: 2,500 Mi. ( ) 5,000 Mi. ( ) 25,000 Mi. ( )

(✓) OK (X) Adjustments Made (O) Repairs Needed (/) Repairs Made

1000's of Mi.			ITEMS TO INSPECT
2.5	5	25	
			Brake application valve
			Door engine linkage
			Accelerator pedal
			Destination signs
			Accelerator bell crank
			Control linkage
			Steering controls (L&R)
			Front springs (L&R)
			Front brake assembly (L&R)
			Front door hinge pin
			Rear door hinge pin
			Front shift & accelerator bell crank
			Hand brake cable
			Rear springs (L&R)
			Rear brake assembly (L&R)
			Differential housing
			Hand brake mechanism
			Rear shift & accelerator bell crank
			Propeller shaft
			Control bell cranks
			Engine oil (refill)
			Shutter air cylinder
			Shutter thermostat
			Starter
			Generator
			Shift & clutch control lever
			Transmission turbine bearing

FIGURE 7A.7 Mileage inspection form A4.

6,000 MILE SERVICE INSPECTION
ALL COACHES EQUIPPED WITH DIESEL HYDRAULIC

Coach No._____ Inspection Miles_____ Date_____

Symbol Definitions: "✓" OK; "X" Adjusted: "O" Repairs Needed*

REFER TO MANUFACTURER'S MAINTENANCE MANUALS FOR DETAILS OF INSPECTION PROCEDURES

OPERATIONS TO BE PERFORMED

COACH INTERIOR INSPECTION

MECH NO | SYM

Check Steering Wheel Free Play.
Check Brake & Accelerator Pedal Operation.
Check Horn for Sound & Button Operation.
Check Air, Oil & Generator Gauges for Correct Reading and Operation.
Check Temperature Gauge for Operation.
Check Shift Tower & Lever Operation.
Check Hand Brake Lever Operation.
Check Windshield Wiper Switch & Operation.
Check Rear View Mirrors.
Check Head Lights & Dimmer Switches.
Check Dome, Dash & Stepwell Lights.
Check Turn Signal Operation Lights.
Check Passenger Buzzer Sound & Operation.
Check Destination Sign Operation & Lights.
Check Front & Rear Door Operation.
Check Instrument Panel Switches.
Check Start & Stop Switches.
Check Heater & Blower Operation.
Check Driver's Seat & Operation.
Check Windows, Latches & Operation.
Check Stanchion & Grab Rails for Defects.
Check Seals, Frames & Covering for Defects.
Check Buzzer Cord.
Check Emergency Door Lever & Operation.
Check General Interior Condition, Paint Panels, Etc.
Check Fire Extinguisher.
Check Door Engines for Air Leaks, Etc.
Check Floor Covering for Lonsness and Defects.
Check Stepwells for Loose Covering and Defects.
Check Safety Door Edges, Treadles, Etc.
Check First Aid Kits & Seal.

COACH UNDER CHASSIS-PIT INSP.

MECH NO | SYM

Check All Air Bellows for Leaks etc.
Check Drag Link & Tie Rod for Wear and Adjustment.
Check Pedal Shifter, Accelerator and Hand Brake Rods for Wear.
Check Front Springs for Broken Leaves, Center Bolts, Loose Shackles and U Bolts.
Check and Drain Air Tanks - Mountings.
Check Expello Valves.
Check Fuel Tanks for Leaks, Etc.
Check Rear Spring for Broken Leaves, Center Bolts, Loose Shackles and U Bolts.
Check Hand Brake Linkage and Adjustment of Shoes.
Check Drive Shaft & U Joints for Lonsness, Etc.
Check Differential Pinion Seals and Housing for Leaks.
Check Brake Diaphragms for Leaks (Brakes Applied).
Check Cam Travel & Position (Brakes Applied).
Check Brake Release Operation & Adjust Brakes.
Check Brake Shoe Return Spring Operation.
Check Wheel Seals for Oil or Grease Leaks.
Check Entire Under Chassis of Coach for Defects.
Check Differential Oil Level.
Check DDA Operation (Energy Brake).
Complete Chassis Lubrication & Per Manufacturer's Specifications.

COACH EXTERIOR INSPECTION

Check Marker & Clearance, Stop & Tail Lights.
Check Door and Fender Rubbers.
Check General Body and Paint Conditions.
Check & Tighten Wheel & Axle Flange Nuts.
Check Visually Tires for Uneven Wear, Cuts and Etc.
Check and Service Batteries.

VOLTAGE	BATTERY NO.	HYDROMETER
	BATTERY NO.	

COACH ENG. COMPARTMENT INSP.

Check All Wiring for Broken Insulation, Loose Terminals, Etc.
Check Engine Compartment Switches, Engine Stops, Rear Starter, Etc.
Check Engine Alarmostat.
Check All Oil Lines & Brackets.
Check All Air Lines & Brackets.
Check All Fuel Lines & Brackets.
Check All Water Lines & All Water Hoses and Hose Clamps.
Check Transmission Output Seal For Leaks.
Check Neutral Stop Adjustments and Operation.
Check Clutch Adjustment.
Check Generator Brushes & Springs (Blow Out Dust).
Check Engine Insulators.
Check Air Compressor Unloader Valve Lash.
Check Starter Operation, Starter Brushes and Springs.
Check Blower Box Drains for Obstructions.
Check Engine Governor Linkage, Etc.

ANY REPAIRS NEEDED WHICH CANNOT BE MADE AT THE TIME OF THE INSPECTION SHOULD BE LISTED UNDER REMARKS (ON REVERSE) AND CALLED TO THE ATTENTION OF THE SHOP SUPERINTENDENT OR FOREMAN.

FIGURE 7A.8 Mileage inspection form--B1.

COACH ENG. COMP. INSP. (CONT)

MECH	S/M

Check Front Engine Support.
Check Fan and Hub.
Check Fan Shroud for Looseness, Cracks, Etc.
Check Radiator & Surge Tank for Leaks and Mountings for Looseness.
Check and Blow Out Radiator Fins From Inside.
Check Radiator Filler Cap and Gasket.
Check Radiator Shutter Operation.
Check Tail Pipe and Mountings.
Check Bulkhead Bellcranks, Rods and Clevises
Check Air Compressor Supercharger Tube.
Check Muffler and Exhaust Pipe.
Check Water Manifold for Leaks.

Check & Air Tires.

COACH ENG. COMP. LUBRICATION

MECH	S/M

Shutter Air Cylinder (Kysor Fluid).
Shutter Air Filter (Kysor Fluid).
Clutch Air Cylinder (Oil).
Throttle Air Cylinder (Oil).
Starter (Oil).
Generator (Grease).
Change Air Compressor Oil (Wagner Compressor).
Transmission Governor (Oil if Necessary).
Clutch Release Bearing (Grease).
Hydraulic Transmission Bearing Caps (Grease).
Clutch Release Shaft - Upper and Lower (Grease).
Shutter Linkage and Blade Bearings (Oil).
Clean Air Compressor Air Cleaner if Equipped.
Clean Generator Air Strainer if Equipped.
Clean Engine Air Cleaners and Check Intake System.
Clean Engine Oil Strainers, if Equipped.
Change Engine Oil Filter Element.
Change Engine Lube Oil.
Check Transmission Oil Level.
Check Torque Fluid Level, if Equipped.

REMARKS

SIGNATURE OF SUPERINTENDENT OR FOREMAN

FIGURE 7A.8 continued.

Accumulated Miles_____ Coach Number_____

Date_____ GM HYDRAMATIC COACH "B" INSPECTION REPORT Inspection Number_____

Type of operation to be performed: "√" if OK; "X" adjusted; "O" repairs needed.
Make detailed report of items marked "O" on reverse side.

MECH. NO.	SYM.		MECH. NO.	SYM.	
		Steering gear for excessive play			Adjust front brakes, report them when worn to 5/16" at centers
		Starting motor operation			
		Oil pressure at idle is #			Tie rod ends and Pitman arm
		Interior dome & headlights			Tighten kingpin draw keys
		Fare box & step lights			Shocks and linkage for wear
		Passenger signal & cord			Horn wire connection at steering column
		Horn for tone			
		Ammeter for generator charge			Front springs for breakage
		Air compressor cuts out at lbs.			Front spring bushing wear
		Air compressor cuts in at lbs.			Tighten front spring U bolt nuts
		Dash, stop, rear door signal, low oil and temperature signal lights			Lube control links to accel. & hand brake--replace worn pins.
		Windshield wiper operation			Drain air tanks and check mountings
		Front & rear doors for proper operation--adjust when necessary			Raise rear wheels, check bearing adjustment & tighten flange nuts
		Defroster motors--heaters			Adjust rear linings--report when worn to 5/16" at centers
		Adjust hand brake to hold			
		Seats for cuts--seat frames			Check drive line & U joints, tighten flange nuts & lubricate joints
		Tighten grab rails & modesty panels			
		Emergency door latch			Rear spring bushing wear
		Glass & sash for condition			Tighten rear spring U bolt nuts
		Floor covering wear and damage			Build up air pressure--check all diaphragms, hose & connections under pressure
		Step nosing wear & looseness			
		Lube door engines & linkage			
		All exterior lights--stop light			Differential housing & pinion seal for leaks
		Damages to body--report on other side			
		Raise front wheels, check bearings, adjust kingpins for wear			Exhaust & muffler for leaks
					Frame for cracks

FIGURE 7A.9 Mileage inspection form--B2.

MECH. NO.	SYM.		MECH. NO.	SYM.	
		Fill differential to proper level			Repair or report oil leaks
		Clean differential vent			Drain sump & oil shutter cylinder, check shutter operation
		Check each fuel pump separately			
		Lubricate chassis, oil pins			Change oil & filter cartridge
		Tighten trans./angle drive bolts			Check angle drive oil level
		Inflate all tires			Ck trans. oil level with engine running & shift level in Drive
		Service air cleaner, ck hose connection to carburetor and to air box			Wash off battery with water
		Service crankcase air cleaner			Clean terminals and take cell readings from positive to negative. Cell No. 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____ (If cell readings are below 1225, remove regulator cover and raise voltage 1/10 volt. If over 1250, lower 1/10 volt. Write voltage setting in cover with pencil.)
		Generator brushes & springs for wear			
		Starter brushes & springs for wear			
		Tighten air compressor bolts			
		Idler pulley bearing play			
		Fan blades--pump bearing for wear			
		Water pump belts for cracks--adjust			
		Generator drive belt for cracks--adj.			
		Service spark plugs--adjust			Voltage set by
		Clean distributor cap--inspect			
		Spark plug wires & ends for condition			Fill battery cells to proper level
		Ck points--adjust to .022 (31° angle)			Battery No is:
		Lubricate distributor cam & point arm bushing			Road test: Ck trans. shifting. Repair unnecessary rattles. Clean steering wheel and seats
		Adjust valves--.012 intake--.020 exhaust			
		Rocker arm lubrication			Road tested by
		Tighten manifold nuts			
		Engine supports for condition			Make detailed report here
		Set ignition time with light			
		Adjust carburetor with analyzer			
		Engine governor not over 3200			
		Gas lines and connections			
		Choke operation			
		Hose & clamps for leaks			
		Engine compartment wiring condition			

FIGURE 7A.9 continued.

Coach # _____ Assigned to _____
Date ___/___/___

COACH DIESEL ENGINE AND HYDRAULIC TRANSMISSION

Type of inspection: 5,000 Mi. ( ) 25,000 Mi. ( )
(✓) OK (X) Adjustments Made (O) Repairs Needed (/) Repairs Made

1000's of Mi.		
5	25	ITEMS TO INSPECT
		Fuel oil filter, primary
		Fan
		Fuel oil filter, secondary
		Air intake system
		Tailpipe
		Fuel pump
		Accelerator linkage
		Engine overhead
		Exhaust valves
		Injector timing
		Injector controls
		Air compressor
		Shutter air filter
		Blower air cleaners
		Shifting units
		Neutral stop solenoid
		Air box
		Exhaust system
		Accelerator stop piston
		Low air pressure switch
		Oil door hinge pins
		Valves adjusted - 25,000

FIGURE 7A.10 Mileage inspection form--B3.

Coach #_____ Assigned to_____
Date__/__/__ ELECTRICAL SYSTEM

Type of inspection: 5,000 Mi. ( ) 25,000 Mi. ( )
(✓) OK (X) Adjustments Made (O) Repairs Needed (/) Repairs Made

1000's of Mi.		
5	25	ITEMS TO INSPECT
		Battery
		Instrument panel
		Fuse panel
		Ventilator motors
		Ventilator blowers
		Heater motors
		Door control equipment
		Engine compartment panel
		Engine shut-off
		Overheating alarmostat
		Emergency stop solenoid
		Starter and control unit
		Generator
		Generator regulator
		Hydraulic transmission
		Buzzer--clean and check cord
		Operators fan
		Signal lights
		Marker lights
		Stop lights
		Sign lights
		Dome lights
		Step lights
		Heaters--switches & motors
		Brake interlock--release
		Windshield wipers--blades
		Ventilators--oil hinges
		Brake pedal rollers--oil
		Air strainers--to panel
		Brake interlock magnetic valve

FIGURE 7A.11 Mileage inspection form--B4.

Coach #_____ Assigned to_____

Date__/__/__ CHASSIS AND BRAKE

Type of inspection: 5,000 Mi. ( ) 25,000 Mi. ( )

(√) OK (X) Adjustments Made (O) Repairs Needed (/) Repairs Made

1000's of Mi.		ITEMS TO INSPECT
5	25	
		Brake application valve
		Hand brake lnkg. (front)
		Front brake lining (L&R)
		Front brake drums (L&R)
		Front brake chamber diaphragms (L&R)
		Anchor pin locks (L&R)
		Shock absorbers (L&R)
		Steering knuckles (L&R)
		Front wheel studs & nuts (L&R)
		Wheel alignment
		Air tanks
		Fuel tank screen
		Air exhaust silencers
		Relay valve
		Pinion shaft bearing
		Hand brake
		Differential bearing cup locating bushings
		Rear brake drums (L&R)
		Rear brake chamber diaphragms (L&R)
		Rear brake lining (L&R)
		Rear wheel studs & nuts (L&R)
		Axle flange studs & nuts (L&R)
		Hand brake linkage (rear)
		Propeller shaft & "U" joints
		Tire wear
		Leveling valves & links
		Heater hose
		Sludge valve

FIGURE 7A.12 Mileage inspection form--B5.

ATC-104-M

10,000 MILE INSPECTION

Inspection No. _____

COACH NO. _____ COMPANY _____ DATE _____

Mechanic Instructions: Items inspected and found O. K. shall be marked ' '. Items that were adjusted or repaired shall be marked 'X'. Items requiring additional repairs or adjustments shall be marked 'O'. Mechanics shall either initial or insert their number beside each item inspected.

Wash Engine-Batteries-Wheels- Radiator fins from inside/out

INSIDE COACH

1. Hand brake for grip spring and adjust 5 notches Air park brake for operation and release
2. Gear selector for proper adjustment
3. Compressor for cut-in pressure (minimum 100 lbs.) and cut-out pressure (115 to 120 lb. range)
4. w/s wipers for operation & speed (wet w/s)
5. Bloc horn - must be audible 300 ft.
6. Oil pressure and temperature signal operation
7. Defroster, floor heater and blower operation
8. Check steering wheel for excessive free play (adj.)
9. All mirrors for clear view and condition of adjustment
10. All danger dash signals and lights for burning
11. Fluorescent tubes for lighting - do not remove tubes while power is on as power unit may be damaged
12. Headlights for focus and tilt switch operation
13. Doors for operation, locking air open & closed and stop light switch action
14. Step and floor condition
15. Buzzer and cord condition
16. Seats for cuts and looseness - stanchions for tightness
17. Window latch condition and ease of opening & closing windows ck ICC window clips
18. Tighten screws interior panels
19. Emergency door for ease of opening and open signal
20. Diversion valve/heat pump for operations and leaks
21. Clean/check graduotat
22. Fire extinguisher for condition and fill
23. Flags and flares in place (3 each)

OUTSIDE COACH

24. Check tail, directional signals, stop lights and marker lights
25. Check emergency flasher (ICC)
26. Wheels, axle cap & axle flange nuts for tightness
27. Inflate tires to proper pressure _____ lbs.
28. Condition of window glass and body panels Ck condition of Permit No.
29. Wiper blades & arms for condition and tightness.
30. Remove batteries - take gravity readings - check level (batteries with readings below 1.200 or 25 points or more variation between cells must be changed). Clean batteries, carrier and slides, lube .lines and carrier. Inspect battery cables, clean & inspect terminals.
31. Check radiator shutter operation. Add 2 squirts hyser fluid in filter & 1 squirt castor oil in air motor.
32. Drain engine and alternator oils.
33. Replace oil filters.
34. Check condition of oil line to alternator - clean fitting and orifice in end cover.
35. Clean main air line check valve.
36. Check oil filler cap condition - replace drain plugs.
37. Fill engine with _____ qts. oil.
38. Drain water filter sump. Indicate if filter is changed. ☐
39. Check speedometer & drive.
40. Remove air cleaners, wash out mesh - drain thoroughly, check all gaskets and seals for air leaks. Replace cleaner oil.
41. Clean engine air intake screens.
42. Service oil fuel filters.
43. Check blower base condition, screen and rotor for cleanliness. Open drain tubes.
44. Check operation of emergency stop solenoid, check condition of latch for full opening of air shut off valve.
45. Check fan assembly for looseness - defects.
46. Check condition of all water and oil hoses - clamps.
47. Check surge tank for tightness and bleeder condition - check alignment with radiator elbow.
48. Starting motor brushes and commutator condition - lube - check operation and linkage.
49. Check battery voltage under load (8½ volts ok)
    a. Generator - remove commutator end and hand pack bearing. Use special lube
    b. Generator brush and commutator condition.
50. Operate engine and check following:
    a. All water connections for leaks
    b. All oil hose connectors for leaks
    c. Engine for oil leaks
    d. Torque converter for leaks
    e. Fluid fan for oil leaks & control valve for operation
    f. Alternator & regulator output 13.6 min.-13.8 max.
    g. Fuel pump pressure-idle _____ lbs. _____ lbs. at 1400 R.P.M.
51. Engine for unusual noise and idle adjustment adj. to 450 R.P.M. (on A/C equipped - 490 R.P.M.) check engine governor - set to 2150 R.P.M. max.
52. Check clutch operating mechanism for proper operation.
53. • Torque Fluid level. Added _____ qts.
54. Check torque converter pressures - see specs.
55. Bench test trans. governor for operation and adjustment

FIGURE 7A.13 Mileage inspection form--C1.

10,000 MILE INSPECTION

(In addition to the other side)

COACH NO. _____ DATE _____ Inspection No. _____

54. Adjust engine exhaust valves to .13(4 valve) .009(2 valve)

57. With brakes fully applied, check all brake chambers, air hoses and relays for air leaks.

58. Check air suspension bellows, leveling valves and general condition of suspension.

59. Drain air tanks.

60. Check Espelio valve.

61. ∞ Differential for leaks & level, clean vent, added _____ lbs.

62. Rear axle housing for cracks and leaks.

63. Service heater/A.C. filters. Clean evaporator coil.

64. Check blower motors for cleanliness - brush wear.

65. Check A/C blower motors current draw 86-88 amps.

66. Drain Pressure Regulator to Graduated.

67. Clean oil drain hoses & tubes.

68. Lubricate chassis & check following:
   a. King pins for excessive wear
   b. Tie rod ends for wear/adj.
   c. Drag link for wear/adj.
   d. Shock absorber linkage for tightness
   e. Lube brake anchor pins with hand gun sparingly.
   f. Lube A/C drive shaft U joints & clutch shafts.

69. Adjust brakes to 3/4" push rod stroke. Report lining worn down to 5/16" at center.

70. Check lateral rod bushings.

71. Replace Engine Fans.

72. Low air pressure buzzer switch.

73. Bumper braces & channel support pads for cracks & breaks.

74. Seats straps in place and condition (where used)

75. Tighten connections on driver control panel.

76. Road test for rattles, smooth shifting and trans. governor operation.

77. Clean steering wheel and operator compartment.

78. Spray for roaches.

79. Wipe seats to remove spray - sweep out coach.

FACTORY AIR CONDITIONED COACHES

COMPRESSOR

80. Check tightness of mounting bolts.

81. Check oil level. Added _____ pts.

82. Check suction and discharge valves mounting bolts & valve caps for tightness.

LIQUID RECEIVER TANK

83. Refrigerant level. Added _____ lbs.

84. Mounting bolts for tightness

CONDENSOR

85. Clean coils.

86. Fan fluid oil level. Added _____ qts. fluid.

87. Fan speed - 1800 ± 25 R.P.M.

88. Pump drive belts for tightness

89. Hi-lo pressure switch adjustment

90. General condition of hoses & lines - look for chaffing & wear where lines are fastened.

ITEMS TO BE PERFORMED ON #6 INSPECTION (30,000 MILES)

91. Reset Injector timing and high, low speed spring gap.

92. Engine blower pressure _____ lbs. (Normal 5½ lbs. @ 2100 R.P.M.)

93. Replace all worn pins and clevises.

94. Hand brake shoe adjustment equalized

95. Inspect/repair wiring in engine compartment.

96. Inspect/repair water, air and fuel line insulation.

97. ∞ Change Differential lube.

98. General tightening of nuts, bolts and screws throughout coach

99. Torque all air suspension bolts as per specs.
   a. • Change Torque Converter Oil.
   b. Change Torque Converter filters - clean screens.

100. Change water filter cartridge.

• Item 53 ∞ Item 61

Defects Noted And Not Corrected:	Date Corrected:

Approved: _____

FIGURE 7A.13 continued.

20,000 MILE SERVICE INSPECTION

ALL COACHES EQUIPPED WITH DIESEL - HYDRAULIC

PROPERTY: _____

COACH NO. _____ INSPECTION MILES _____ DATE _____

SYMBOL DEFINITION: ✓ O.K. — X ADJUSTED — O REPAIRS NEEDED

NOTE: REFER TO MANUFACTURER'S MAINTENANCE MANUALS FOR DETAILS OF INSPECTION PROCEDURES

COACH INTERIOR INSPECTION

CHECK THE FOLLOWING:

MECH. NO.	SYMBOL	
		FREE-PLAY in STEERING WHEEL
		BRAKES, ACCELERATOR-PEDAL OPERATION
		HORN for SOUND & BUTTON OPERATION
		AIR, OIL & GENERATOR, GAUGES FOR PROPER READING & OPERATION
		TEMPERATURE-GAUGE OPERAT'N.
		SHIFT-TOWER & LEVER OPERATION
		HAND-BRAKE-LEVER OPERATION
		WINDSHIELD-WIPER, SWITCHES & OPERATION
		REAR-VIEW MIRRORS
		HEAD-LIGHTS & DIMMER-SWITCHES
		DOME, DASH & STEPWELL LIGHTS
		TURN-SIGNAL OPERATION & LIGHTS
		PASSENGER-BUZZER for SOUND & OPERATION
		DESTINATION-SIGN FOR OPERATION & LIGHTS
		FRONT & REAR-DOOR OPERATION
		INSTRUMENT-PANEL SWITCHES
		STOP & START-SWITCHES
		HEATER & BLOWER OPERATIONS (BLOW OUT CORES)
		DRIVER'S-SEAT & OPERATION
		WINDOWS, LATCHES, OPERATION & GLASS
		STANCHION & GRAB-RAILS FOR DEFECTS
		SEAT-FRAMES & COVERING FOR DEFECTS
		BUZZER-CORD
		EMERGENCY-DOOR, LEVER & OPERATION
		GENERAL INTERIOR CONDIT'N., PAINT, PANELS & ETC.
		DOOR-ENGINES For AIR-LEAKS, ETC.
		FIRE-EXTINGUISHERS
		FLOOR-COVERING For LOOSENESS & DEFECTS
		SAFETY-DOOR EDGES, TREADLES, ETC.

COACH EXTERIOR INSPECTION

MECH. NO.	SYMBOL	
		MARKER, CLEARANCE, STOP & TAIL-LIGHTS
		DOOR & FENDER-RUBBERS
		GENERAL BODY & PAINT CONDITIONS
		TIGHTEN WHEEL & AXLE-FLANGE-NUTS
		VISUALLY, TIRES For UNEVEN WEAR, CUTS & ETC.
		ADJUSTMENT ON WHEEL-BEARINGS (RAISED WHEELS)
		KING-PIN WEAR (RAISED WHEELS)
		CHECK AND SET TOE IN
		CHECK AND SERVICE BATTERIES

COACH EXTERIOR INSPECTION - CONTINUED

FILL IN THE FOLLOWING:

VOLTAGE	BATTERY NO.	HYDROMETER

BATTERY NO.

CHECK VOLTAGE - REGULATOR (IF NECESSARY)

COACH UNDER CHASSIS - PIT INSPECTION

MECH. NO.	SYMBOL	
		DRAG-LINK & TIE-ROD For WEAR & ADJUSTMENT
		PEDAL, SHIFTER, ACCELERATOR & HAND BRAKE-RODS FOR WEAR.
		FRONT SPRINGS For BROKEN LEAVES, CENTER BOLTS, LOOSE SHACKLES & "U" BOLTS.
		SHOCK-ABSORBERS FOR FLUID & LINKAGE ADJUSTM'T.
		AIR-TANKS, MOUNTING, "DRAIN TANKS"
		FUEL-TANKS FOR LEAKS, ETC.
		REAR-SPRINGS For BROKEN LEAVES, CENTER BOLTS, LOOSE SHACKLES & "U" BOLTS.
		HAND-BRAKE LINKAGE & ADJUSTMENT OF SHOES.
		DRIVE-SHAFT & "U" - JOINTS For LOOSENESS, ETC.
		DIFFERENTIAL-PINION-BEARING FOR EXCESSIVE LASH.
		DIFFERENTIAL-PINION-OIL-SEAL For LEAKS.
		BRAKE-DIAPHRAGMS FOR LEAKS (BRAKES APPLIED).
		BRAKE-CAM TRAVEL & POSITION (BRAKES APPLIED).
		RELEASE-ACTION & ADJUST BRAKES.
		BRAKE-SHOE-SPRING OPERATION
		WHEEL-SEALS FOR OIL OR GREASE LEAKS.
		ENTIRE UNDER-CHASSIS OF COACH For DEFECTS
		MUD-SPLASH FLAPS
		COMPLETE CHASSIS LUBRICATION as per MFGR'S. SPECF.
		DIFFERENTIAL-OIL LEVEL

NOTE. Any Repairs needed which cannot be made at the time of the inspection should be listed under Remarks (On Reverse) & called to Att'n. of Shop-Supt. or Foreman.

FIGURE 7A.14 Mileage inspection form--C2.

PAGE - 2

20,000 MILE SERVICE INSPECTION

PROPERTY: _____

SYMBOL DEFINITION ☑ O. K.
☒ ADJUSTED
⊖ REPAIRS NEEDED

COACH ENG. COMPARTMENT INSP. (CONT.)

MECH. NO.	SYMBOL	CHECK THE FOLLOWING:
		CHECK STARTER OPERATION, BRUSHES & SPRINGS
		BLOWER-BOX-DRAINS FOR OBSTRUCTIONS
		ENGINE GOVERNOR LINKAGE, ETC.
		FRONT ENGINE SUPPORT
		FAN and FAN-HUB
		FAN-SHROUD FOR LOOSENESS, CRACKS, ETC.
		RADIATOR & SURGE-TANKS For LEAKS, and
		MOUNTINGS For LOOSENESS
		BLOW OUT RADIATOR-FINS FROM INNER SIDE
		RADIATOR FILLER-CAP and GASKET
		RADIATOR SHUTTER OPERATION
		TAIL-PIPE, MOUNTINGS
		BULKHEAD BELLCRANKS, RODS, & CLEVISES
		AIR-COMPRESSOR SUPERCHARGER TUBE
		MUFFLER & EXHAUST-PIPE
		WATER-MANIFOLD For LEAKS
		VALVE LASH - HOT ENGINE
		INJECTORS & INJECTOR FLUID LINES For LEAKS
		STALL TEST: TUNE ENGINE, IF NECESSARY
		CHECK & AIR TIRES
		ALL WIRING FOR BROKEN INSULATION, LOOSE TERMINALS, ETC.
		ENGINE COMPARTMENT SWITCHES
		ENGINE STOP, REAR STARTER, ETC.
		ENGINE ALARMSTAT
		ALL OIL, FUEL, AIR & WATER LINES FOR LEAKS & DEFECTS
		ALL WATER HOSE & CLAMPS
		TRANSMISSION OUTPUT-BEARING FOR EXCESSIVE LASH
		TRANSMISSION OUTPUT-SEAL For LEAKAGE
		NEUTRAL STOP ADJUSTMENT AND OPERATION
		CLUTCH ADJUSTMENT
		GENERATOR BRUSHES & SPRINGS (BLOW OUT DUST)
		ENGINE INSULATORS
		AIR-COMPRESSOR-UNLOADER - VALVE - LASH
		ASPIRATOR, IF SO EQUIPPED
		FLUID-PUMP, IF SO EQUIPPED

COACH ENG. COMPARTMENT LUBRICATION

MECH. NO.	SYM.	CHECK THE FOLLOWING:
		SHUTTER AIR CYLINDER (KYSOR FLUID)
		SHUTTER AIR FILTER (KYSOR FLUID)
		CLUTCH AIR CYLINDER (OIL)
		THROTTLE AIR CYLINDER (OIL)
		OIL - STARTER
		GREASE - GENERATOR
		CHANGE AIR-COMPRESSOR OIL (WAGNER COMP.)
		TRANSMISSION-GOVERNOR (OIL, IF NECESSARY)
		CLUTCH RELEASE-BEARINGS (GREASE)
		HYDRAULIC TRANS. BEARING-CAPS (GREASE)
		CLUTCH RELEASE SHAFT, - UPPER & LOWER (GREASE)
		SHUTTER-LINKAGE & BLADE-BEARINGS (OIL)
		CLEAN AIR-COMPRESSOR AIR CLEANER, IF EQUIPPED
		CLEAN GENERATOR AIR-STRAINERS, IF EQUIPPED
		CLEAN ENGINE AIR-CLEANERS & CHECK INTAKE SYSTEM
		CLEAN ENGINE OIL STRAINER
		CHANGE ENGINE OIL-FILTER ELEMENT
		CHANGE ENGINE LUBE OIL
		CLEAN FUEL OIL STRAINERS
		CHANGE FUEL OIL FILTER-ELEMENT
		CHANGE TRANS. FLUID & CLEAN STRAINER
		CHANGE ANGLE-DRIVE OIL

REMARKS:

_____

SIGNATURE OF SUPERINTENDENT OR FOREMAN

FIGURE 7A.14 continued. 106<

Bus No._____ Date_____
Mileage_____ Foreman_____

MILE INSPECTION AND UNIT CHANGE

Type of inspection: 60,000 Mi. ( ) 120,000 Mi. ( )

1000's of Mi. 60	1000's of Mi. 120	ITEMS TO CHANGE	MECH
		All water hose	
		Low air pressure switch	
		Fuel pump	
		Air governor	
		Stop light switch	
		Starter	
		Brake chamber	
		Air strainers	
		Shutter thermostat	
		Engine governor RPM	
		Brake interlock	
		Generator	
		Air compressor	
		Brake relay valve	
		Brake application valve	
		Nozzles	
		Door engine-front	
		Door engine-exit	
		Water pump	

ITEMS TO INSPECT	MECH
All air lines & hose	
Brake chamber hose	
Tie rod ends	
Drag link	
Spring shackles, pins & bushing	
Shock absorbers & linkage	
Rear axle assembly	
Front axle assembly	

REMARKS

Foreman_____

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FIGURE 7A.15 Mileage inspection form--C3.

Coach #_____ Date_____

"A" & "B" AIR CONDITIONING SYSTEM INSPECTION

"A" - 100 Hr. Inspection "B" - 200 Hr Inspection
*-Denotes this item on 200 Hour Inspection ONLY
Items #5 and #6 should also be performed on regular coach inspections.

CAUTION: Disconnect starter wire at Air Conditioner so that the Engine cannot be started from inside the coach.

_____1. Drain oil while engine is warm, refill with correct quantity and type.
_____2. Inspect oil filler gasket.
_____3. Drain, clean and refill air cleaner with SAE 30 oil .
_____4. Clean and inspect crankcase breather.
_____5. Inspect belts for wear and adjust to proper tension.
_____6. Lube fan shaft bearings with #3 high temperature grease.
_____7. Check compressor pulley for tightness.
_____8. *Check engine pulley set screws for tightness.
_____9. *Check fan bolts for tightness.
_____10. Clean air filter screen in evaporator housing. Do not oil.
_____11. *Check carburetor and choke adjustments.
_____12. *Clean, inspect and adjust ignition points. Lube felt.
_____13. *Clean, inspect and regap spark plugs.
_____14. *Check engine RPM @ low speed _____ @ high speed _____.
_____15. Clean, inspect entire unit for leaks, damage and tightness of screws, bolts and nuts.
_____16. Check coach interior temperature control setting.
_____17. Check engine oil pressure tell-tale light for functioning.
_____18. *Check operation of fuel pump and clean screens in filter and in bottom of pump.
_____19. Lubricate all linkage

SPECIFICATIONS:	Thermo-king	Flxible	4104's	3751's
Oil capacity	7 pints	4 quarts	4 quarts	6 quarts
Dist. cam angle	30-40 degrees	Magneto	Magneto	
Dist. point gap	.022	Magneto	.015	.018
Spark plug gap	.025	.030	.025	.025
Low engine RPM	1400	1000		
High engine RPM	2350	1800	2000	2000

Today's clock reading_____
Last clock reading_____
Added hours_____
Accumulated on 200 Hour Service_____

Inspector and number_____

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FIGURE 7A.16 Air-conditioning inspection form--A.

GM AIR CONDITIONER PM INSPECTION
(Perform on Regular Coach Inspection)

Coach No._____ Date_____

	MECH
COMPRESSOR	
Check tightness of mounting bolts	
Lube propellor shaft - 3 fittings	
Check oil level. Added _____pts.	
Check suction and discharge valves, mounting bolts & valve caps for tightness	
LIQUID RECEIVER TANK	
Refrigerant level. Added _____lbs.	
Mounting bolts for tightness	
CONDENSOR	
Clean coils	
Fan fluid drive oil level. Added _____qts.	
Fan speed - 1800 ± 25 RPM	
Pump drive belts for tightness	
Clean & re-oil underfloor filters	
Clean evaporator coil	
BLOWER MOTORS	
Check brush wear	
Check current draw (54-58 amps)	
Check mounting & electrical connections	
Hi-lo pressure switch adjustment	
General condition of hoses & lines - Look for chaffing & wear where lines are fastened	
Grad-U-Stat for cleanliness	
Tighten connection on driver control panels	

Remarks_____

NOTE: Replace dehydrator strainer cartridge whenever system has been opened. See page 498 - Manual X6215 for details on specifications of oil, fluid and refrigerant.

FIGURE 7A.17 Air-conditioning inspection form--B.

FOREMAN'S INVESTIGATION REPORT OF INSPECTION

(To be made after every third 10,000 mile inspection on Diesel Coaches and every 5th 6,000 mile inspection on Gasoline Coaches.)

Coach No._____ Date_____

ITEMS TO BE PERFORMED AND INVESTIGATED	
1.	Torque converter/turbine oil changed
2.	Torque converter oil screens & filter changed
3.	Fuel filter & screens cleaned
4.	Engine cooling system filter sump cleaned & filter changed
5.	All hoses changed when necessary
6.	Reset injector timing. Reset high and low speed spring gap
7.	Engine blower pressure lbs. Normal 5½ @ 2100 RPM
8.	Compressor oil filter changed (when used)
9.	Replace all linkage, worn pins & clevises
10.	Hand brake shoe adjustment equalized
11.	Inspect/repair wiring in engine compartment, starter, battery cables and terminals
12.	Inspect/repair water, air & fuel line insulation
13.	General tightening of nuts, bolts & screws throughout entire coach

THE FOLLOWING ITEMS ARE TO BE PERFORMED AT LEAST ONCE PER YEAR. PLACE X IN BOX IF TO BE PERFORMED ON THIS INSPECTION.

☐ Transmission oil changed ☐ Differential oil changed

☐ Angle drive oil changed ☐ Front wheel bearings packed

☐ Rear wheel bearings packed

CHANGE THE FOLLOWING UNITS:

All the above SERVICE has been performed and inspected

Signed _____
(Foreman)

FIGURE 7A.18 Foreman's inspection form.

BATTERY MILEAGE RECORD

Battery No. _____ Make _____

Invoice _____ Date _____

Form 392 JCC

Bus	Date Installed	Bus Mileage	Date Removed	Bus Mileage	Reason for Removing	Disposition	Mileage Battery Oper.

FIGURE 7A.19 Battery report form.

UNITED STATES RUBBER COMPANY
Report of Vehicle Miles Operated

Month of _____ 19____

Submitted by _____
(Name and Address of Operator)

MAIL TO: United States Rubber Company, 154 Grove Street, Chicopee Falls, Massachusetts.

TIRE EQUIPMENT				TIRE EQUIPMENT				TIRE EQUIPMENT			
FRONT	REAR	S D		FRONT	REAR	S D		FRONT	REAR	S D	
VEHICLE #	MILES RUN			VEHICLE #	MILES RUN			VEHICLE #	MILES RUN		

FIGURE 7A.20 Tire form--A.

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UNITED STATES RUBBER COMPANY
RECAPITULATION
REPORT OF VEHICLE MILES OPERATED

Month of _____ 19____

Invoice To _____
(Name and complete address of operator)

Mail To: U. S. Rubber Co., Tire Mileage, PO Box 778 G.P.O., Detroit, Mich.

Tire Equipment Front	Rear	S/D	Total Miles Operated	Rate Effective To ____19__	Extension

For Supplier's Use Only		
Account	Amount	

FIGURE 7A.21 Tire form--B.

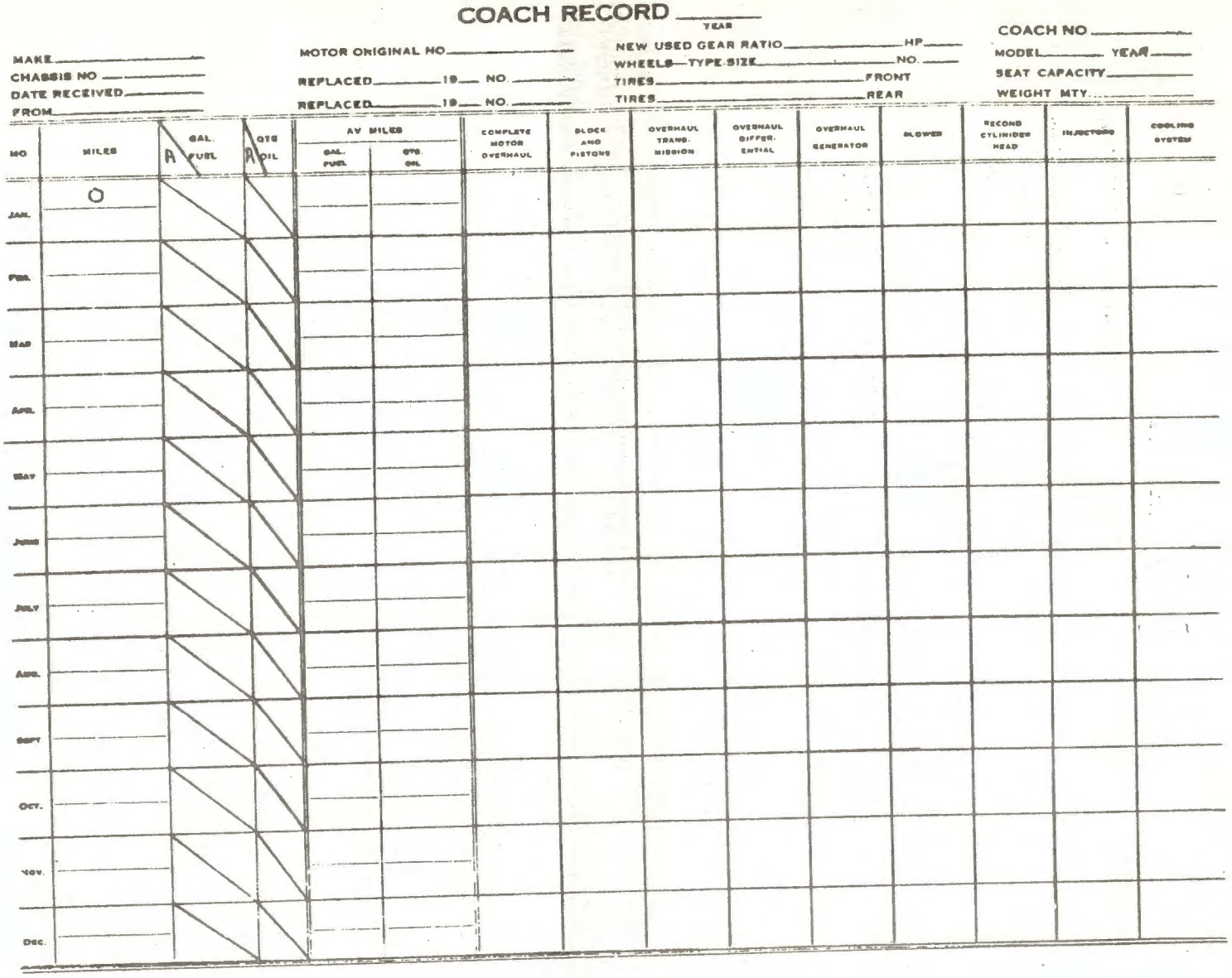

FIGURE 7A.22 Vehicle history form.

Coach No._____

STARTER AND BATTERY	REPLACE GEAR TRAIN & CAM SHAFT	CLUTCH	STEERING GEAR	AIR COMPRESSOR	FRONT AXLE	BRAKES AND DRUMS	DRIVE LINE AND UNIVERSAL	WHEEL BEARINGS	LIGHTS AND WIRING	SPRINGS	FUEL PUMP AND TANK	VOLTAGE REGULATOR	BODY PAINT	OTHER	MO.
															JAN.
															FEB.
															MAR.
															APR.
															MAY
															JUNE
															JULY
															AUG.
															SEPT.
															OCT
															NOV.
															DEC

FIGURE 7A.22 continued.

DESCRIPTION											PART NO.				
Ordered		Purch	Received			Delivered-Received				Bal	Delivered-Received				Bal
Date	Quan	Order	Date	Quan	Unit C	Date	Reg No	In	Out		Date	Reg No	In	Out	
Vendor			Terms			Vendor's Pt #		List		Disc	FET	St Tax	Net		
Location				Bin No		Acct No		Model Coach					Unit Ouan		
Year	Jan	Feb	Mar	Apr	May	June	July		Aug	Sept	Oct	Nov	Dec	Total	Max	Min
Form 690																

This form may be used front and back.

FIGURE 7A.23 Inventory control form--A.

Parts and Material Inventory_____ Date_____

PART NO.	DESCRIPTION	Quan.	Unit Price		AMOUNT		Make or Model	Surplus	Obsolete

FIGURE 7A.24 Inventory control form--B.

DAILY GARAGE SERVICE REPORT LOCATION _____

Signed _____	SHIFT	FROM		A.M. P.M.	DATE	
		TO		A.M. P.M.		

Stock Received			Summary	Bus Fuel (Gallons)		Bus Oil (Qts)
Reference	Product	Quant		Gasoline	Diesel Fuel	
			Opening Inventory			
			Total Receipts			
			Total			
			Disbursed			
			Balance			
			Closing Inventory			
			Over			
			Short			

Pump Number	Gasoline	Gasoline	Diesel Fuel	Diesel Fuel	303 Oil	
Closing Meter Reading						
Opening Meter Reading						
Disbursed						

INVENTORY OF GASOLINE

Date _____

Stick Reading Ft._____ Ins._____ Gals.____

Truck Meter Reading

After Unload _____

Before Unload _____

Difference _____

SAE 30 Oil in Gallons _____

FIGURE 7A.25 Inventory control form--C.

MONTHLY MILEAGE, FUEL, AND OIL DATA

Company________________________________ Month of______________ 19___

Motor Coach		Miles Operated	Miles Per Gal. Fuel	Miles Per Quart Oil (Added Only)	Fuel Consumption		Oil Used	
Type	No.				Gas	Diesel	Total	Added Only

NOTE: When listing coaches above, segregate them by coaches owned and by coaches leased. Prepare summary section at bottom of last page: One summary by types of coaches owned; second summary, if required, of coaches leased.

On typed form, for summaries by types, show all data. For individual coaches, show data through "Miles Per Quart Oil" only.

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FIGURE 7A.26 Inventory control form--D.

Inspection Type _____ REPAIR ORDER # _____

Repair Type _____ Vehicle No. _____

Mechanic _____ Mileage _____

Date _____

PARTS					LABOR	
Part No.	Quantity	Description	Each	Total	Remarks	Time
					TOTAL TIME	
					LABOR RATE	
		Grease			LABOR COST	
		Oil			PARTS COST	
			Total		TOTAL COST	

Posted to inventory by _____

FIGURE 7A.27 Repair order.

APPENDIX 7B

CONTRACTUAL PURCHASE OF SUPPLIES

Certain items (fuel, oil, tires and equipment, for instance) are purchased on a contract basis. Usually, the maintenance superintendent either purchases these goods himself or acts in concert with others in the firm. If the purchase decision is a group decision, the maintenance superintendent usually collects the information upon which the decision will be made.

Because these purchases represent long-term commitments by the firm, they are very important decisions. Furthermore, price plays an extremely important part in determining which supplier gets the contract in these arms-length transactions. As a result, each supplier will quote his price based upon furnishing his lowest-cost merchandise. Thus, it is up to the individual transit firm to specify the minimum quality of the commodity that is acceptable.

Determination of minimum quality is a very important task, especially in the purchase of fuel and oil. The quality level has both cost implications to the firm and also consequences for equipment. Low-grade fuel will have maintenance cost implications, especially on diesel equipment (with low-quality fuel, injectors are apt to gum up and will have to be worked on more often, etc.). Equipment warranties are often voided if fuel and oil of specific grades are not used. Equipment manufacturers specify these grades, but the information is generally to be found only in their maintenance literature. The transit agency must dig for the proper information. Furthermore, some firms follow up fuel contracts by having their fuel tested routinely by an independent testing laboratory as often as monthly to ensure that they receive the proper grade or quality of fuel.

Many information sources are available. Other transit firms are quite helpful in most cases. The American Public Transit Association will help members in various areas of operation. Suppliers will furnish an abundance of literature, and their salesmen are an excellent source of

information. Supplying firms will often extend technical assistance in various forms--on-site technical representatives, training schools, and so forth. In short, abundant information is available, but the firm must seek it actively.

The transit firm should not be a passive party in these transactions. Information that bears on the particular decision should be sought from all possible sources. The terms, conditions and levels of quality on all contractual purchases should be specified on the basis of the information gathered. If the firm specifies equipment components, supplier services, or contractual obligations in its invitations to bid, supplier representatives will quickly advise the transit firm that its requirements are too stringent or not in line with the customary methods of conducting these transactions. Such situations can often occur in any industry. If overly stringent supplier obligations are written into a contract to purchase, the various supplying firms' legal departments will take exception. In these ways, a new transit operation learns the rules of the game--the firm learns what it can insist upon and what it cannot. A small transit property does not have much bargaining power in comparison with the giant firms that are often its suppliers, but the property is still a prospective customer, and it should exercise to the utmost the rights accrued to customers everywhere.

It may be advantageous for a number of small transit properties within a state or region to form a purchasing consortium for commonly used parts or supplies. Fuel, oil, grease, certain parts, stationery and office supplies would probably lend themselves well to such an arrangement. By pooling their purchasing power, small properties should be able to get more favorable prices than by purchasing independently.

CHAPTER 8

EQUIPMENT SELECTION

Introduction

Passenger-carrying equipment is not a standardized element in a transit service that can be "plugged into" service without careful consideration. The kind of equipment, the uses for which it is intended, and the quality of service it offers are very important factors in the product portion of the marketing mix. Because of the interrelated and interdependent nature of elements in a transit operation, the buses must fit into the whole service package. The role played by equipment, therefore, is creative, not passive.

The Creative Role of Equipment in the Marketing Mix

Creating an Image

The quality of service--a complex bundle of factors that includes service frequency, scope of service, ease of accessibility to the service, and hours of operation--is probably the most critical factor in winning transit riders. Closely allied, however, are factors that might be termed amenities, in that they affect all of the nonservice factors associated with a transit ride. Such factors may not be the initial reasons a passenger takes a trip (the bus coming along at the right time and going to the right place within the right time span probably was responsible for that), but they may be the reasons a consumer continues to use transit or supports the service more happily.

In the area of transit amenities, the fact that the bus is air-conditioned--and that the air-conditioning works--is apt to help keep a passenger during the warm days of the year. Attractive decor inside the vehicle is not likely to get a passenger to ride in the first place, but it may help keep passengers riding if the interiors are cheerful and clean. Again, shelters may not cause a rider to take the bus, but when the weather is poor it may help to keep the rider as a steady, fare-paying customer. The appearance and comfort of the equipment is an intangible comfort factor,

but it is nevertheless critical to the success of a transit operation.

The rolling stock of a transit agency is the largest outward image of the firm; whether or not a member of the public uses the bus service, he most certainly notices the bus. Regardless of the efforts of advertising, promotion, and public relations, the equipment will, in large part, set at least the initial image of the transit agency in the minds of the public. Great care must be taken in acquiring equipment that will maintain the desired image, not only when it is new, but over the years of its useful economic life.

A bus, indeed, is not the whole trip--routes, schedules, and fares also are a vital part of the trip package. But it is too easy for management to regard equipment as a given fact, even though great pains are taken and great creativity exercised in all the other elements of the marketing mix.

Meeting the Service Requirement

In providing a mix of services to various segments of the market, equipment must be geared to meet the particular needs that arise from the differentiation of service.

Regular route service. Equipment should provide an interior layout that makes boarding and leaving the bus fast and easy. Also it should provide reasonable seat comfort and sufficient room for passengers to stand uncrowded. Because in a smaller city most patrons on regular routes will not ride for long distances, there may be no need to provide extraordinary levels of comfort either in the seating or suspension of the vehicle. However, if streets are rough or poorly cared for as a rule, it may be wise to opt for equipment providing the smoothest possible ride under the conditions.

Under federal rules and regulations, transit services supported with federal funds must provide service that is accessible to elderly and handicapped riders. Indeed, federal rules now require that all new buses be equipped with wheelchair lifts. There still is some debate on whether it is best to make all transit vehicles accessible through the installation of ramps or lifts for wheelchairs or to provide specialized services with a separate fleet of equipment for the elderly and handicapped.

Specialized service. The particular needs of the service will determine key features of the buses used. For example, in gearing service to make travel easy for the handicapped, special equipment may be necessary on buses. To meet the needs of those who have difficulty in moving up

or down steps, a minimum number of steps of low height are needed, along with additional handrails. Persons traveling in wheelchairs may have considerable difficulty in passing down bus aisles. Because a large portion of potential customers may be elderly, consideration must be given toward providing vehicles geared to meet the needs of this group as well.

The buses used in conjunction with demand-activated special services (dial-a-ride) should be highly maneuverable to enable them to reach any place to which they may be called quickly and easily.

Where subscription bus service is offered, the ideal equipment used should not be so large or costly that filling it to profitable levels sacrifices the potential time advantages of the service. Maneuverability of the vehicle also is a factor here, and in any service that attempts to offer door-to-door service.

Charter service. In this case, patrons often must travel a considerable distance to reach their destinations. In such instances, equipment should be selected carefully and designed to provide maximum comfort. Restrooms, air suspension, high-back seats, a public address system, tables, ice water, snack bar, and perhaps taped music are all part of the mix of quality that may be included in such a vehicle.

In recent years, federal laws and regulations have cut back the charter work that a publicly owned transit system may operate in the face of competition from privately owned bus companies. Before purchasing equipment for charter use, management must make sure that it can be used as intended.

Using Equipment as Promotion

The revenues that may be earned from using transit vehicles as an advertising medium can be attractive. However, management must consider advertising's implications for transit's image. A maximum degree of managerial control should be exercised in cases where equipment is used to carry advertising messages on its exterior. Interior ads are less jarring, but again the question of the overall image sought must be weighed against the possible revenue, to determine whether ads should be carried. A transit firm trying to build a champagne image with its equipment will be hard-pressed to do so if its vehicles are plastered with ads for beer and cold cuts.

The bus itself as a symbol of transit--even though not always a pleasant symbol--can be used as a promotional device. Delivery of a vehicle--particularly if there is something new and interesting about it--offers an

opportunity for good advertising and community relations work. Transit is news, and because local newspapers usually are hungry for local news features that lend themselves to photographs, the delivery of new equipment can be the source of free newspaper and television publicity.

Symbolism is very important in promotional work, a fact illustrated by the pains large business firms take to develop a distinctive trademark or logo that is instantly recognizable. When the symbol is attached in the public's mind to a quality product, the symbol becomes a complete advertising message each time it is seen.

Some distinctive feature connected with the buses can be used as a symbol, not only for the transit system but perhaps for the city itself. London is as much symbolized by its famed red, double-decker buses as it is by the clock tower of the Palace of Westminster. The cable cars are as much a symbol of San Francisco as the Golden Gate Bridge. Great care should be taken in selecting decor and other features of the vehicles because they may have a direct bearing on the ability of the promotion and public relations people to symbolize the transit service easily and effectively. The use of a distinctive type of horn, or perhaps a chime similar to that used on some British police and emergency vehicles, might provide an interesting audible logo for the transit service.

The name used to identify transit service usually is displayed prominently on the equipment. Again, the service can be promoted through use of the name. For example, the word "Metro" has replaced the familiar American term "subway" on the underground railways in Montreal and Washington, D.C. In all honesty, subway has dank, dark, unpleasant connotations that Metro does not stir up. In many places "transit" may also be a term to be avoided. Some other name, such as "Extra Car"--used in Los Angeles' promotional and advertising work--"Metrobus," "Transporter," "Transpo," or "Metropolitan Transport" may be desirable. In other cases, plain facts have carried the day, and the transit system is dubbed simply, "The Bus Company."

Transit should, if possible, take advantage of the symbolism a city has or is trying to create for itself. There is a potential for tie-ins and the opportunity for city promotion to help advertise transit in an indirect fashion.

Important Specifications for Equipment Selection

In deciding which equipment to buy, management should start with broad, largely nontechnical specifications based on the service functions the equipment is to perform. These considerations will form the basis of the transit agency's

guidelines for technical specifications. These technical specifications will be used to make valid mechanical and operating comparisons between different makes and types of equipment.

Some features important to many operators would be items such as the type of engine and/or transmission necessary to meet power requirements; the rate of acceleration, where tight schedules must be maintained; and the turning radius, which is a fair indication of the maneuverability of the vehicle. Where comfort is to be the major part of the product element of the marketing mix, the type of suspension and air conditioning is important also.

The outer dimensions of the buses and the weight on the axles are important factors if the equipment is to be used both in city service and on state and county roads. For example, a 102-inch wide city transit bus provides a service quality advantage, giving standees six inches more aisle room or seated passengers wider seat room than the standard 96-inch wide bus. However, wide buses cannot be operated on most state and federal highways. Similarly, an air-conditioned, 53-passenger transit bus offers the advantages of both air-cooled comfort and high passenger capacity. However, the 40-foot frame of the bus and additional weight of the air-conditioning unit, along with a diesel engine large enough to propel the bus and operate the air conditioner, will place too much weight on the rear axle to fit within many state axle-loading limits. A smaller or lighter bus may have to be found to run inter-city charters. Because of conflicting needs, management should consider very carefully whether to buy one or more buses exclusively for charter work, if they can operate such services legally.

In any case, the list of specification factors is provided to help transit managers make equipment decisions. A number of firms provide transit equipment, and it is not the province of this handbook to name specific makes or models that are "ideal" in one way or another. However, some guidelines for selection are offered, with the hope that managers will find them useful in laying down particular specifications to meet the needs of their marketing mix and operating conditions. The various manufacturers can then indicate what their wares have to offer.

The transit properties to whom this handbook is directed will be interested in vehicles ranging from small vans, for small city operations and special types of service, up to the largest capacity standard transit buses. In all cases, public officials involved in new transit undertakings should consult with others in the industry to learn about their experiences with various types of equipment and perhaps for aid in writing specifications.

Agencies seeking buses that carry fewer than 30 passengers will have the most difficult job in finding good, substantial, long-lasting, reliable equipment. There are many manufacturers that have sought to find a place in this segment of the market for buses; but few have lasted very long, and the quality of their products often has been poor. The operator of small buses simply may have to be reconciled to purchasing the best equipment available and replacing it frequently. The standard transit bus has an economic life of 12 to 15 years; the small bus, particularly those with gasoline engines, may have an economic life of no more than 3 to 5 years.

Guidelines for Selection

These guidelines are set forth to ensure that management considers all possibilities related to equipment, keeping in mind the interrelated nature of transit service. These guidelines form the background issues and ideas from which a listing of both broad and precise specifications for equipment may be developed. From this listing will come the decisions that will influence the final choice.

1. Body structure
    a. Chassis body or integral
    b. Riveted or welded
    c. Length
    d. Width
    e. Standard number of seats (and seat configurations available)
    f. Height, from ground to first step
    g. Number of steps
    h. Height, from ground to floor (at front axle)
    i. Flat floor (transit only)
    j. Headroom
    k. Approximate unloaded weight
    l. Weight on front axle
    m. Weight on rear axle
2. Suspension
    a. Wheelbase
    b. Track--front
    c. Track--rear
    d. Turning radius over outside
    e. Turning radius of body (at front corner)
    f. Type of suspension (air, spring, and so forth)
    g. Steering manufacturer and model
    h. Rear axle manufacturer and model
3. Engine (recommended for given specs)

a. Location
b. Inline or transverse
c. Manufacturer
d. Gas or diesel
e. Configuration (6, V-6, V-8, and so forth)
f. Displacement
g. Peak hprpm
h. Peak torquerpm
i. Estimated engine life before major overhaul

4. Brakes

a. Type
b. Total area
c. Estimated life

5. Transmission

a. Manufacturer
b. Model
c. Type (torque, conv., 3-speed, and so forth)

6. Performance

a. Acceleration speed
--0-20 mph
--0-30 mph
--0-40 mph
b. Maximum grade
c. Braking

7. Ventilation and lighting

a. Heat type (recirculating or fresh air)
b. Air-conditioning capacity
c. Air-conditioning type (integral w/heat or other)
d. Candle-power at reading plane

8. Other specifications

a. Seat spacing
b. Aisle width
c. Fuel tank capacity
d. Standard tire size
e. Front axle capacity
f. Rear axle capacity
g. Estimated fuel mileage

9. Price (typical price for the coach, rounded to the nearest $1,000)

10. Other items usually considered optional equipment

Demand Characteristics

In selecting a vehicle or type of vehicle, the characteristics of the demand for service must be considered carefully. This task requires far more than mere calculation of the total passenger volume a vehicle may have to carry; qualitative aspects of the demand also are involved. For example, on a smaller transit property where excess equipment is an expensive luxury, a vehicle must be versatile enough in capacity and design to be used in a variety of service. A bus that meets the standards--high standards, it is hoped--of regular route service may be unsuitable for use in special service or in charters.

A vehicle offering the widest variety of services should be flexible enough in design and construction to meet not only changes in the magnitude of demand but also changes in its nature. It should have a seating arrangement that can be changed easily. Indeed, for those transit operators considering small buses or vans, it may be possible to have the seats of the bus palletized for easy movement. With seats removed entirely during off-peak hours, the vehicle can be used for the movement of freight, mail, or parcels.

Equipment that meets the general demand charactistics must fit the expected volume of traffic at any one time. As a rule of thumb, if numerous trips per day with a large volume of customers are likely, it makes sense to have relatively large vehicles so that customers can be handled as quickly, comfortably, and conveniently as possible. However, if regular route service calls for the handling of relatively large numbers only once or twice a day, it would be unwise to acquire a bus with large seating capacity only to haul around empty seats most of the time. Indeed, if the peak hour load is 50 patrons twice a day, and its passenger loading never rises above 30 patrons at any other time, it is foolish to pay a high price for the extra seats--which may mean buying a bus that costs up to twice as much--merely to meet demand 10 times per week. In this case, comments from the community are apt to be critical. Careful scheduling and the use of smaller buses could alleviate the standee problem. However, the use of high-capacity vehicles for some other services, such as lucrative weekend charters, may make large vehicles a wise choice.

Operating Conditions

In setting specifications and in selecting equipment careful attention must be paid to the operating conditions under which it will be used. The width and clearance of roads and streets over which service may be operated are, of course, among the first decision factors to be considered along with the sharpness of curves and corners.

The local topography, particularly hills and valleys, is another important factor. Sufficient engine power must be provided to meet schedules. A combination of steep hills, narrow streets, and tight corners calls for a bus with a high degree of maneuverability and power. Hills also call for extra braking power. The combination of power and maneuverability necessary to meet operating characteristics probably is the key factor under such conditions.

Another important decision arises in areas where temperatures demand air-conditioning. The bus power plant must be strong enough to propel the vehicle at scheduled speeds, up and down hills, and to operate the air-conditioning unit. Vehicles operating under such conditions probably would have to be equipped with diesel engines, although gasoline-powered engines may be suitable where few hills are encountered and stops are spaced far apart.

Regardless of the terrain, vehicle maneuverability imposes limitations on the quality of service that may be provided. It may be impossible to take very large vehicles, such as the standard 35- to 40-foot transit bus, into certain areas with restricted clearances that are common in residential areas. Yet, offering a fine-grained service that penetrates the entire city may be very critical to a transit operation.[1] If streets are relatively narrow and curves are sharp, a highly maneuverable vehicle with a relatively short wheelbase probably is needed.

Noise is a sensitive factor, especially in fine-grained operations. The hustle and bustle of traffic on busy streets tends to cover the operating noise of the bus. In quieter residential neighborhoods, however, excessive bus noise will stand out annoyingly, as will the pounding and vibration caused by heavy vehicles. Transit must be a good neighbor when extending its reach into residential areas. It may be difficult to make very large and heavy vehicles "friends" to those who live along the routes.

Comfort and Quality Needs

The comfort and quality characteristics of a vehicle are critical decision factors in vehicle specification and selection. As an example, the suspension of the vehicle--whether it be metal springs, torsion bars, or some sort of air bag system--is important in assuring overall vehicle riding comfort. Beyond that, air-conditioning, heating, and ventilating systems must be given serious thought. As a rule of thumb, in any part of the country where restaurants, motion picture theaters, supermarkets, beauty parlors, and other businesses are air-conditioned, transit vehicles also should be air-conditioned. In very cold climates, heavy-duty heating systems should be installed.

Another important factor is the feeling of spaciousness in the vehicle. Because buses use public highways, their width is limited necessarily. Therefore, the treatment of the interior space in terms of window size and location, decor, and the colors used on seating and floors is important. Firms should avoid a cramped appearance.

Bus seating leaves much to be desired in many cases, not so much because the seats themselves are uncomfortable, but because they are placed so close together that taller passengers have difficulty fitting their legs into the small space available. Maximizing the number of seats and at the same time maximizing discomfort for many potential patrons appears to be poor economy. Some thought should be given to having the buses fitted with fewer than the maximum number of seats usually installed. The use of diagonal seats or single row seating down one or both sides of a bus should be considered seriously. This choice can be difficult if there are large peak loads, because patrons do not like to stand.

The lighting is another part of the transit sales package. One of the advantages of public transit is the opportunity afforded passengers to read a book or magazine, work a puzzle, or do some office or school work, rather than worry about driving. The lighting should be adequate to ensure ease of reading during darker times of the day. Also, care must be taken so that there is no undue glare on the inside of the windshield during night driving hours.

The modern appearance of buses and their cleanliness are very important items in passenger appeal. Exterior and interior designs should be selected carefully so that a fresh, cheerful, and modern appearance can be maintained easily. The paint chosen for the exterior should be durable and easy to maintain. Colors or paints that fade easily should be avoided.

Perhaps the vehicle should be selected with the thought in mind that redecoration inside or out could be accomplished easily by means of quick-change panels or paint. It would be quite sensible to plan for a relatively complete change in decor at least three times during the 12- to 15-year vehicle life of a standard transit bus, provided the change could be made easily and inexpensively.

The headsigns (sometimes called destination curtains or blinds) that indicate route number, name, and destination are an aid to patrons in the use of the transit service. Within space limits, the main headsign on the front of the bus should give as much information about the route as possible. In addition to the destination, it should include information about the major streets used and principal points served. Other clearly visible signs should indicate the fare, where to enter, and so forth. In addition to the

large headsign, a smaller curtain should be mounted on the right side of the bus so that passengers approaching from the side can see the route number and destination easily. Ideally, signs also should be placed at the rear and left side of the bus to show at least the route number and preferably the route name. Another possibility is to have each route identified by a colored metal flag or similar device that could be mounted on the roof just above the front door so that it is visible from all directions. Regardless of the direction from which a patron approaches, it should be possible to know what route the bus serves.

Drivers' Needs

Vehicle specifications and selection must take the drivers' needs into consideration. A bus driver must be able to do his job under conditions that minimize fatigue. Otherwise, he is likely to grow careless, which may lead to an accident, or he may become grumpy, which is bound to result in surly treatment of patrons. Both situations must be avoided.

The vehicle must be easy to drive and, except perhaps for vehicles used in over-the-road charter service, should include an automatic transmission. The instruments and control devices in all buses should be located so that they are within convenient sight and reach of the driver. The driver's seat should be comfortable and designed to help reduce fatigue.

The quality of the buses themselves can be a factor that helps to maintain a high level of driver morale. Equipment that looks good and is neat to begin with and that is well-maintained and comfortable can help to instill a strong sense of pride in all employees. This will help provide better service for the public.

Maintenance Needs

Without question, the vehicle must be easy to maintain. Ease of maintenance involves not only the upkeep of mechanical devices, but cleaning as well.

As many of the mechanical components of a bus as possible should be provided in a modular form, so that the entire air conditioner, engine, generator, or whatever may be pulled out or replaced quickly and easily without putting the vehicle out of service for long periods of time. The modular approach should apply to any components likely to cause trouble. If extra initial cost is involved in purchasing buses with modular components, it must be weighed against the cost of a breakdown in service, as well as the cost of owning extra buses to serve mainly as stand-by equipment.

For purposes of housekeeping maintenance, the interior of the bus should be designed and constructed to avoid as many dirt-trapping surfaces or obstacles as possible. Seats cantilevered from the bus wall, without the pedestals that can trap papers and other debris, may be a wise choice where automatic vacuums are used to clean bus interiors. The exterior of the bus should be as free as possible from protrusions, so that it may be washed easily and quickly. The continually rising cost of labor will make it more and more expensive to maintain high maintenance standards if cleaning is done by hand. Mechanical means of cleaning should be adopted for all but very small bus fleets. The mechanical devices that are on the market at the current time should be evaluated carefully.

Other Considerations

Standardization. One of the most obvious features in many U.S. transit systems is the high degree of equipment standardization. Usually it is believed that the savings possible make standardization a considerable advantage and, indeed, it may be. But it is probably unwise to standardize strictly for the sake of standardization, particularly if a variety of different vehicle makes and styles could better perform the different types of service needed by various market segments. The cost savings at one point--standardization usually helps to cut maintenance costs--may be costly or lead to ineffective service elsewhere.

With the many possible types of service needs and the small likelihood that any one type of vehicle can satisfy all those needs, acquisition of several types of equipment may be the wisest course of action. This approach does not mean acquiring the largest variety of different sizes, shapes, and makes of buses possible. It does mean making sure that the equipment fits properly into the marketing mix and is consistent with the firm's objectives and policies with regard to cost and revenue.

Small buses. Small buses often suggested for use in smaller cities may be a wise purchase. However, some transit managers are reluctant to buy smaller vehicles, pointing out that the major operating cost is drivers' pay, which does not vary according to the size of the vehicle operated. The important thing to consider, however, is not the hourly wages of a driver or operating costs divided by the number of seats in the bus, but whether the vehicle itself is part of a package of services that certain parts of the public need and are willing to buy. If the small bus--or, indeed, a horsecar or rickshaw--fits the market or an important market segment, then it is the proper vehicle.

Cost. In addition to the sheer capacity of the vehicle, the cost of ownership should be calculated in light of the flexibility with which the bus, as a unit of passenger capacity, may be used. It may be better to own two smaller buses than one large one. The larger number of vehicles of smaller size adds to the variety, number, and flexibility of services that may be offered. Unless the total demand per trip is high, it appears unwise to have chunks of unused seating capacity tied up in a given vehicle and thereby locked to a given route at a given time.

Many smaller transit firms may consider the use of school-type buses for their service. As a general rule, school buses are much less expensive to buy than are buses built primarily for transit service. The reason is simple: a school bus body usually is placed on a mass-produced truck chassis equipped with a mass-produced engine. Even though the economies seem attractive at first, the use of such vehicles in transit service might not make much marketing sense. The persons in most market segments probably would not be very happy about riding in something that looks like a school bus. The image is simply not that of a progressive transit operation, especially if the vehicle has the engine obviously located in the front. A squared-off, more bus-like appearance might overcome this potential objection. Some truck producers manufacture rear-engined school bus chassis, and the bodies fitted to them appear much like a standard bus. If such vehicles offer advantages sufficient to outweigh the possible disadvantages, then they should be considered seriously. In any case if school buses are used, transit management must recognize that such vehicles will have to be replaced every 3 to 5 years.

School bus body manufacturers can be important in another way, however. Where specialized needs in small city transit operations cannot be met by regular transit type vehicles, it may be practical to arrange with a school bus body manufacturer to build bodies to meet custom specifications. Special equipment for the elderly and handicapped is a case in point.

Leasing buses. Transit managers should weigh carefully the question of leasing buses or of buying used buses. Economies may be possible. However, not only should the cost in dollars and cents be measured, but also whether the equipment so acquired fits into the marketing mix. With capital improvement money available from UMTA for new equipment, leasing is primarily a short-term option so that service can be provided while waiting for new equipment to be delivered under a federal grant.

New or used buses. One important consideration, especially for a transit firm starting from scratch, is

pacing the replacement of equipment through purchase of a mixture of new and used equipment. If, at the start, similar equipment is acquired all at one time, it will tend to wear out at about the same time. Unless a transit enterprise foresees a steady enlargement of service over its first four or five years of operation, so that several new buses will be added each year, both new and used equipment probably should be included in the initial fleet. Older buses should be kept for a year or two and should then be replaced by new equipment.

New buses. Ideally, the transit firm should add some new vehicles each year. This practice will help keep the average age of the fleet low. It will also rule out the need for very large capital expenditures every 8 or 10 years. The constant influx of new equipment should help maintain a good image for the service and is, of course, grist for the public relations mill.

The Need For Other Equipment

Other Vehicles

In addition to the rolling stock for carrying passengers, a transit operation needs other vehicles. A tow truck large enough to handle any job is one piece of equipment that may be well worth having. The question is whether it is worth tying up the capital in a tow truck or better to rent the service when it is needed. In a firm with very few buses, it may be best to enter into an agreement with a local operator of trucks or a truck service agency to use its towing equipment.

A service wagon might be a useful investment. This would be a relatively small truck or van used to make light, running maintenance on the buses to help cut down on the need to take the bus off its route for very simple repairs. The service wagon might also include a fuel tank and pump so that buses could be fueled at terminal points, rather than returning to the garage. (The fuel tanks on small buses and vans may not be large enough to cover a whole day's operation.) Depending on cost and availability, it may be wise to purchase a general purpose truck large enough to perform towing chores and able to handle other needed service jobs as well.

Street supervisors, who usually make their rounds in ordinary automobiles, should perhaps be equipped with small bus-type vans. Vans possess the maneuverability of a car, but may be useful in helping to transport drivers to and from relief points and, in a pinch, may be pressed into use to move passengers if a regular bus breaks down. The decision on this idea will depend on the route configuration and company policy, as well as cost considerations.

Snowplows may be required in some areas to clear the area around the maintenance facility. Depending on the size of the job, the snowplow may be no more than a jeep or a tow truck equipped with a plow blade. Unless snowfall is regular and heavy, a vehicle especially equipped for snow service only is not needed. Another option would be to contract for plowing service with a local construction company, the city street department, or a local snow removal company.

Passenger Facilities

High-quality rolling stock can do much to make public transportation an attractive means of travel. Passenger facilities that complement the equipment complete the package of high-quality service. No matter how attractive equipment may be or how pleasant it is to use, passengers who have to stand on a cold or wet street corner waiting for a bus are bound to be somewhat less than enchanted with the total package of service provided for them.

Shelters. Shelters should be provided at all principal stops and at as many lesser stops as is economically feasible. The shelters may range from simple fiberglass or metal canopies erected on steel pipes, to small, completely enclosed structures. The transit firm may wish to construct its own structures or purchase some of the prefabricated shelters now on the market. Because these facilities are likely to be costly, agreements may be made with firms who will supply shelters or benches in return for advertising privileges on the structures. The decision to advertise on or in the shelter depends upon the image that the transit firm is seeking.

Terminals. Wherever a number of routes share a common terminal point station, facilities should be more elaborate, depending upon the expected passenger traffic. The facility should be made comfortable and attractive and should probably be air-conditioned and/or heated if extremes in temperature are common.

If the system has a major downtown focus, a terminal facility of ample size should be provided. In addition to waiting space and shelter for passengers, it should contain restroom accommodations for both the public and for drivers and other staff personnel. The central controller or supervisor and the telephone information personnel also should be located here. The facilities should be completely air-conditioned and heated.

Architecturally, the transfer house--which may be a separate structure or built into an existing structure--should be as attractive as possible. It has advertising and promotional value as part of the image that

the transit firm must establish. The outer part of the structure should include the logo of the system, and perhaps a time and temperature sign. The latter feature is to ensure that the transfer house attracts the attention of those who do not intend to patronize the service. It never hurts to be in the public eye under favorable circumstances.

Locating shelters. The location of shelters can be determined by means of passenger boarding counts or by interviews with drivers; the places where most passengers board are the first priority locations for shelters. Often it is more difficult to secure permission to erect a shelter than it is to determine where it should be located. City ordinances may restrict the construction of passenger shelters because they may partially block the sidewalk. It may be necessary to have the ordinances changed. Furthermore, adjacent property owners or businesses may object to the placement of shelters. If a shelter is placed on private property permission must, of course, be granted. Purchase of a small parcel of land may be necessary.

Parking. Parking lots for park-and-ride services are an increasingly common part of transit service. The location of parking lots should be along major corridors leading to central core areas or major destinations where parking is difficult. The precise location may depend upon the land that is available. UMTA funds can be used for the purchase and construction costs of transit parking facilities. It is not necessary to buy and clear land in all cases; there may be parking lots already in existence that can be used for the transit service. Shopping centers are often willing to let part of their parking lot be used for park-and-ride bus service in the expectation that some of the passengers may become customers on their way home. Church parking lots and drive-in theaters are another source of space that is used to capacity only at times when the park-and-ride service would not be used.

If at all possible, the buses must enter the parking lot so that park-and-ride patrons need not walk an inconvenient distance. Passenger shelters should be made a part of the lot, along with proper signs and information.

Note for Chapter 8

[1]Fine-grained operations are those in which routes are placed close together. They typically penetrate residential areas more deeply than routes confined to principal thoroughfares.

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CHAPTER 9

ROUTING AND SCHEDULING

Introduction

To increase and maintain ridership and to serve a community better, one of transit management's principal objectives is to minimize the consumer's costs in time, energy, and money, making transit an attractive means for making a particular trip. Two of the transit manager's prime tools in this area are routing and scheduling. Through careful route layout and proper scheduling technique, the transit manager can minimize the consumer's time, energy, and money costs and reduce the transit enterprise's opportunity costs in terms of foregone passenger revenue and lost sales penalty costs.

Although the opportunity and lost-sales costs do not appear on the income statement, they are real costs, and their effects last over extended periods of time. Consumers and, therefore, sales revenues are very sensitive to routing and scheduling variables on the downside, but much less sensitive to routing and scheduling on the upside. In other words, poor routing and scheduling will decrease ridership rapidly, but excellent routing and scheduling probably will increase ridership slowly. Therefore, great care and patience are necessary in this area.

On the production side, the transit firm's ability to manipulate routing and scheduling variables is extremely limited because of scale considerations. The addition of a new route and/or more frequent service through cuts in the length of headways may require additional capital investments in equipment. For example, a property regularly operating seven buses on seven routes at 30-minute headways will need 14 buses to maintain 15-minute headways on the same route structure.

It is in the routing and scheduling function, then, that the services and costs of transit are built and controlled. Careful thought must be devoted to this area, with constant sensitivity to viewpoints of the consumer and potential consumer of mass transportation services. The

factors that are important to consumers in terms of various service attributes and applicable variables include:

Service Attributes	Variables
1. Travel time	--walking to and from stops --waiting --riding --transferring
2. Convenience	--frequency of service --hours of service --number of transfers --fare collection system
3. Comfort	--crowding or standing --vehicle characteristics --shelter at stops
4. Reliability	--schedule adherence --delays on route
5. Cost	--fares

Many of the variables are closely related to routing and scheduling processes. For example, placing routes close together will cut down on the average walk of patrons to and from transit stops. Through-routes connecting major origin and destination points will reduce the need of passengers to transfer between routes and vehicles. Likewise, schedules written realistically to reflect the traffic conditions and patronage level will make it easier to offer reliable service.

Forecasting Demand for Transit Service

The starting point for all routing calculations is the forecast of demand. A new transit firm must estimate demand from scratch. The transit firm that is already in operation can begin with the current ridership. However, if the service is poor, with badly planned routes, poor frequency, hard-to-obtain information, unreliable service, and/or poor equipment, potential demand will be seriously understated. Because one or more of these negative elements is found generally in most small-scale operations, it is probably advisable to forecast demand as if the route did not exist previously.

The forecast starts with a street map of the total area to be served. All major traffic generators should be identified on the map including: (1) residential areas, (2) shopping places, (3) industrial areas, (4) commercial areas,

(5) hospitals, (6) schools, and (7) recreation areas. Obviously, the route layout should serve these traffic-generating points so that origins and destinations are joined together. Further, every effort should be made to link these points directly. Forcing passengers to transfer only increases their time and energy costs and places transit at a relative disadvantage to the private automobile.

Employers, schools, merchants, hospitals and, most importantly, the riders themselves must be questioned to make even a simple forecast of how many people will be traveling to and from these points. Answers to these questions will provide a good estimate of which areas should be linked and what the potential ridership would be on these links. (See Chapter 11 for more detailed information on researching the market for transit.)

By identifying traffic generators, a transit firm can determine where large numbers of people arrive and depart each day. Yet these people have not been enticed to take advantage of the service being offered. The firm does not know what their behavior will be with respect to purchasing transit service, and this is precisely the information that the transit firm desires for the forecast. To make a responsible demand estimate, the total figure must be reduced to the number that reasonably can be expected to avail themselves of the service. Salesmen, employees who live out of town, and people who simply will not ride a bus are examples of groups that cannot be expected to use transit.

Market Segmentation

Socioeconomic Data

Historically, transit firms have segmented their total "people-market" according to various socioeconomic variables such as age, income, education, occupation, sex, and the presence or absence of physical handicaps. Transit firms typically have selected from this breakdown the elderly, the economically disadvantaged, schoolchildren, blue-collar workers, women, and the handicapped as the market for transit (see Chapter 11). Very cursory market research--a tour of part of the city or a few days of traffic observation--will indicate the relative number of elderly people, poor people, factory workers, and white-collar workers, who drive. The number of women who drive can be ascertained roughly by a survey of one good-sized shopping center.

This method of market segmentation is not the best. The chief recommendation for using this kind of information is low cost and availability. (Much of the information can

be obtained easily from census data.) Transit firms have used this information to derive implied needs for transit service and have inferred consumer desires from these needs. Plainly, these inferences are invalid; they simply do not predict ridership (see Chapter 11).

Census Data

Census data are facts gathered from the published decenniel census data. The census records information from personal interviews with major employers in an area and from personal interviews with a cross section of the public.

These are ways to improve predictions of the corridors of demand and the travel desires of the public. It still is difficult to predict the impact of various marketing and promotional schemes on transit. However when it is accomplished, determination of where to offer the service and what points to connect is an obvious beginning to the routing procedures.

For the remainder of this chapter it will be assumed that a reasonable and proper forecast has been made. It is very important that data be collected regularly on the composition of the ridership and its origin and destination points, as a part of the research for routing and scheduling work.

Routing

There are two general patterns of routing--radial and grid.

Radial Routing

The most commonly used form of routing is radial routing, in which the routes fan out from one or more central points--usually the central business district (CBD)--like the spokes of a wheel. The precise pattern will depend upon the street layout of a given city, but the major thrust is to a central focus (see Figure 9.1). Even in the radial-route pattern there may be some crosstown routes that connect several of the basic radial routes or key activity centers, but these will not be serious deviations from the overall pattern.

Grid Routing

The grid pattern applies generally to large cities (see Figure 9.2). Here, a network of routes blanket the bulk of the urban area; many of them do not touch the CBD. The successful grid system means that with no more than one transfer, any point in the urban area may be reached.

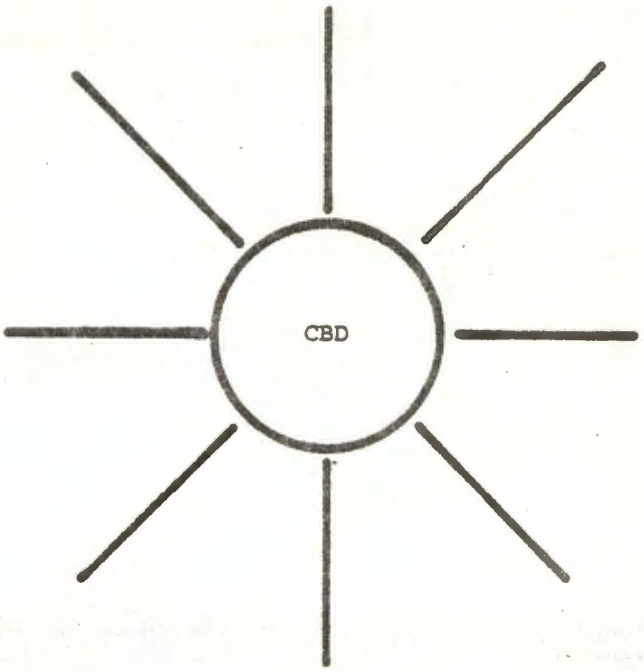

FIGURE 9.1 Radial routing.

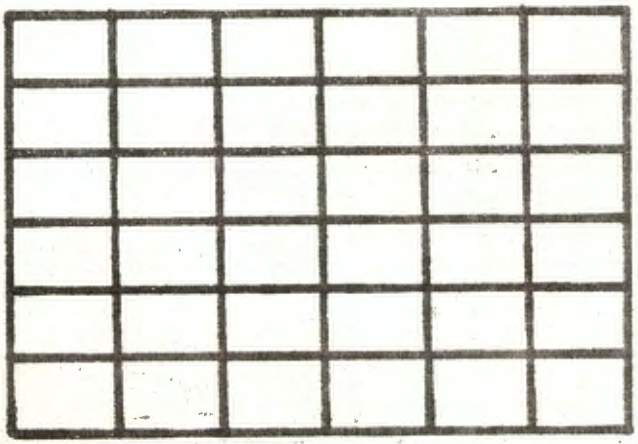

FIGURE 9.2 Grid routing.

The success of the grid depends upon frequent service on all lines. Ensuring close interface with each route when vehicles operate on infrequent schedules is practically impossible. Creating a schedule in which all transit vehicles reach junction joints at the same time is virtually impossible as well. in large cities, such as Chicago (a claassic example), Philadelphia, New York, and Toronto, are generally the only places where the grid is workable. In such places the large population and relatively high population density can justify closely spaced routes and frequent schedules. Even if the grid is the general pattern, there may be some radial routes, particularly if the street pattern permits it. In the case of Chicago, the basic system pattern is that of the grid, but there are major radial bus routes. The rapid transit lines also act as radial members of the route structure.

Other Routing Patterns

Beyond the major routing patterns, routing is of two types: through routing and cycle routing. Both are most applicable to radial route patterns.

Through routing. Through routing simply is routing the vehicles from one side of town to the other--generally through the CBD (see Figure 9.3). The route name and number may or may not be changed as the bus passes through the downtown area.

Through routing will minimize the number of passengers who must transfer at the CBD to complete their trips. However, if service is interrupted, two lines will be affected rather than one.

Cycle routing. Cycle routing is the practice of running the buses into the CBD and routing them back out over the same line, usually at a fixed interval (see Figure 9.4). It works particularly well with radial routing patterns. Both through routing and cycle routing allow arrivals at the CBD to be scheduled for convenient transfers to other lines.

Cycle routing simplifies scheduling somewhat, but it forces more pasengers to transfer from one line to another. If through-passenger traffic is heavy, through routing is preferable, because it minimizes the time and effort costs of the passenger.

Reverse routing. In some areas, a type of routing called reverse routing or loop routing is used (see Figure 9.5). This technique involves shunting an outbound run to an adjacent line for the inbound run. The ordinary routing plan, of course, is to provide service both outbound and inbound over the same streets. The reverse routing plan has

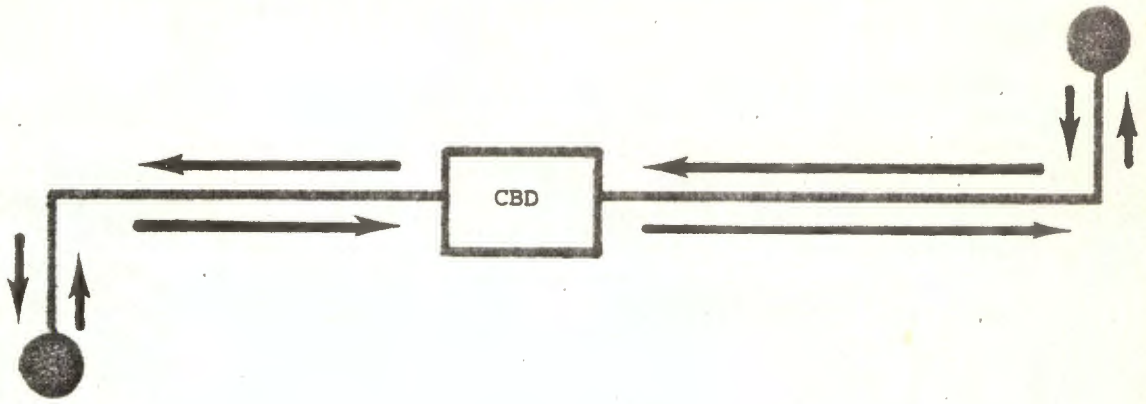

FIGURE 9.3 Through routing.

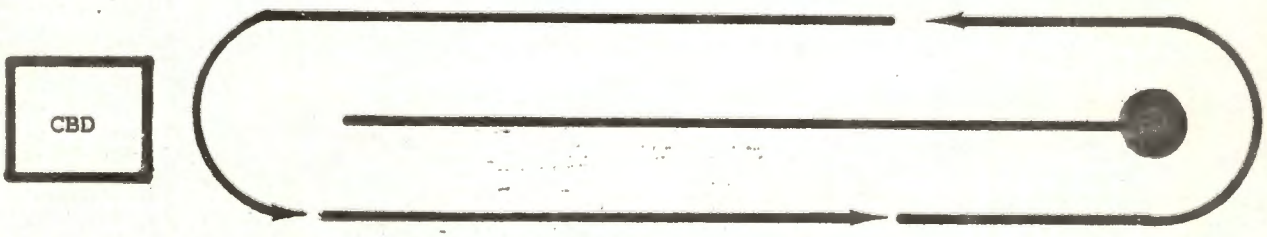

FIGURE 9.4 Cycle routing.

the advantage of reducing bus miles operated, because one bus seems to do the work of two. However, only half the work really is being performed on each route. Obviously, this use of routing is not designed to increase ridership. A passenger on the outbound portion of the route who wishes to go to the CBD is forced to board the outbound bus, ride it to the end of the outbound line, ride the loop, and then ride in to the center of town. This has the effect of increasing the passenger's time and effort costs and his general inconvenience. The cost savings of reverse routing, then, may be offset by revenue loss, as riders find alternate means of making trips.

Reverse routing is a tool that should be used sparingly because of the inconvenience and extra distance to ride that it imposes on the public. Moreover, loops should never have layovers at the end of the outbound runs, and they should in every case have short running times over the loop portion of the trip.

Balloon routing. Balloon routing is a useful tool for outlying areas (see Appendix 9A). This type of routing is used at the outlying end as a line to serve residential areas (see Figure 9.6).

Figure 9.6 shows how more than one residential area can be served by this routing technique. The use of balloon routing results in "fine-grained" service in the area served. That is, routes lie close enough to each other that riders walk only a short distance to the nearest bus stop. In fact, if the residential areas are reasonably small subdivisions, the balloon routing technique can be regarded almost as door-to-door service. Balloon routing is a very consumer-oriented technique and should be used wherever it can provide a superior service. Note that the balloon loops are relatively small, covering a limited area, as opposed to reverse routing, which covers a large area.

Access to Transit Service

The best plan for a particular route is the one that minimizes the time, effort, and money costs of access activity on the part of the consumer.

Fine-grained service. Routing is concerned essentially with access, a service characterstic that may take different forms. Fine-grained service keeps the consumer in mind. It tailors routes to the consumer's need for convenience--savings in time and effort. For one group of riders, it may involve door-to-door service. At the other end of the spectrum, it might involve parking facilities for riders so they may provide their own pick-up-and-delivery service. These, and the range of service between these two extremes, fall within the fine-grained service concept. The essential

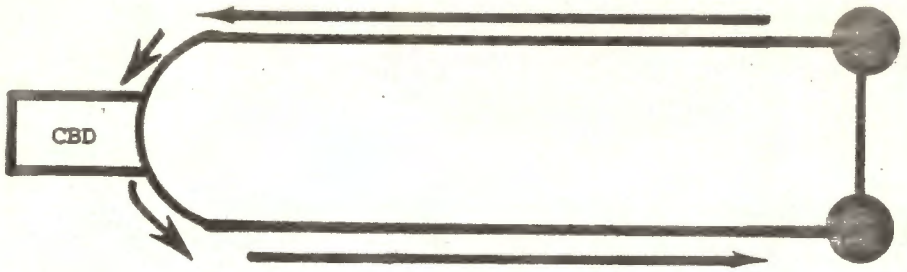

FIGURE 9.5 Reverse routing.

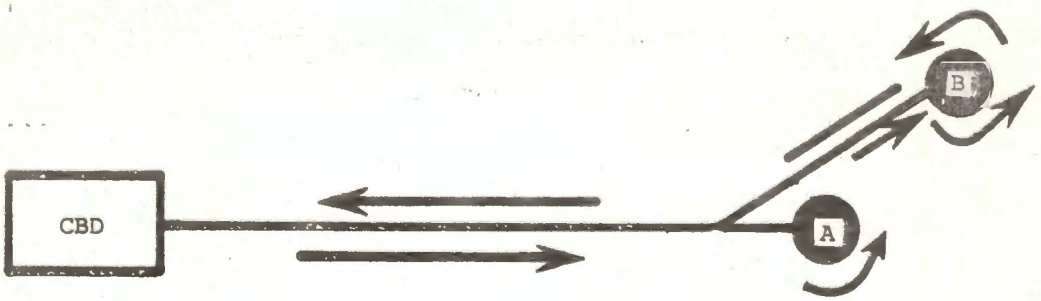

FIGURE 9.6 Balloon routing.

feature of these types of service is that they explicitly make the consumer part of the transit system.

Loose-grained service. Another possibility is loose-grained routing, in which the transit routes are located relatively far apart (about one-half mile). This pattern is adopted usually as a money-saving effort; it is not a practice that is attractive to the consumer because it increases the average walking distance to the routes. Several independent demonstration projects have shown that ridership falls off sharply beyond the first block, because of the personal effort costs required. Loose-grained routing should be avoided if possible. Routes should be close together to provide the most convenient access to the traveling public.

Commuter-contractual service. Several demonstration projects have investigated a new kind of service--commuter-contractual service. This is a door-to-door, home-to-work, work-to-home service, with a contract period of 1 month. In effect, transit riders subscribe for a month of service. The routing and scheduling for this service is extremely flexible. A new customer can start the service immediately if he is on an established route. If serving a customer requires a route change, he is required to wait for service until the Monday following his application. Thus, a complete reevaluation of each route is made every week, and changes are implemented every Monday. (The service also could be operated on a monthly basis, with the changes occurring each month.) Scheduling problems are solved by building slack time into each route from the start, with the arrival and departure times governed by the starting and quitting times of the destination (work place). In some cases, scheduling considerations lead to the initiation of new routes. Obviously, the subscription bus concept is highly consumer-oriented.

Transit Speed

Because passengers' time and energy costs play a major role in influencing transit ridership, improvement of transit speed should be a high-priority goal in the design of a firm's route network. Transit speed can be stepped up by selecting routes that have proper physical characteristics and by implementing traffic control.

Common sense dictates that narrow streets with long, steep grades and unrestricted parking should not be selected for routes if they can be avoided. Most cities have special streets (that often are not main streets) for peak-hour travel. The traffic lights on these streets are coordinated so that traffic maintaining the proper speed can make the entire trip without having to stop for traffic lights. Parking is forbidden on these streets, making it easier for

buses to pull into bus stops and decreasing the time required to load and unload passengers. Because parking is forbidden on these streets, the bus operator never finds a car parked in the bus-stop zone. Such streets are prime candidates for bus routes. The number of stops on these routes should be limited to major traffic generators and/or major transfer points to provide a semi-express service. A general rule is that private automobile drivers usually select routes that minimize travel time, and these routes should be considered for bus routes.

Steps taken to improve the movement of transit vehicles fall under the Transportation System Management (TSM) policy and UMTA regulations. TSM regulations require that urbanized areas develop plans and programs for low capital cost projects that can help use existing facilities to improve the flow of traffic (see Chapter 3). UMTA or FHWA funds then can be used to carry out the various plans to improve transit and other vehicular flow. Routes with bottlenecks can be improved and upgraded as part of TSM.

Marketing Effects of Routing

Implicit in the previous discussion has been the marketing effect of routing. The selection of the route network pattern and type determines the geographical markets the transit firm can serve. To provide quality service, the geographical area covered by a single route should be considered individually. By focusing on one geographical area, a planner is forced to examine the access to the route, and to regard passengers as part of the transit system. Routing, considered carefully and purposefully, in conjunction with other marketing tools is one of the major factors in attracting riders.

The route network chosen by the transit firm should never be considered permanent. Because it is a marketing variable under the control of management, the route layout should be audited at regular intervals, (annually at least, more often if conditions require it). Perhaps the best plan is to divide this audit into quarterly reviews, making the audit an ongoing activity of the transit agency, rather than a disruptive, unpopular, year-end activity. The audit would be a marketing audit--not a determination of whether the route is profitable. What is desired is an idea of marketing effectiveness, not cost effectiveness. In some cases, the approval of a regulatory agency is required for route shifting.

Guidelines for Routing

Certain guidelines for routing should be observed, such as:

** Using direct routing where possible.

** Choosing through routing over cycle routing.

** Using reverse routing or balloon routing very sparingly.

** Making the access character of routing (fine-grained service in route spacing, parking facilities, door-to-door service, and so forth) part of routing analysis. The consumer and his interests in route planning should be considered.

** Exploiting the physical characteristics of the various possible routes (factors that affect trip speed, such as traffic flow, and so forth). These should be used to the transit agency's advantage in providing lowest time and effort costs to consumers.

** Avoiding duplication of routes; it is better to run three routes on three separate streets than to run three routes on one street, assuming that the street layout permits such route spacing. Naturally the routes will tend to converge at the CBD.

** Routes should--if possible--begin and end at traffic generators (see Figure 9.7).

** Routes should attempt to touch as many traffic generators as possible. If a route becomes too circuitous--as measured by distance or running time--then another route may be needed to cover the territory (see Figure 9.8).

** Where several routes focus on a subcenter (such as a shopping center), service beyond this subcenter may require separate routing analysis with the subcenter considered as the hub (see Figure 9.9).

** Buses should, if possible, enter a shopping center, apartment complex, recreation area, factory complex, or other traffic generator (see Figure 9.10).

** At a major downtown or shopping center terminus, the buses should pull up next to one another to make transfers more convenient. Passengers should never have to dash across a street to transfer. A transfer house should be almost mandatory at downtown sites, even if it means working with public officials for some change in street patterns (see Figure 9.11).

The route should be considered as a flexible marketing instrument, and its review (in conjunction with the other marketing variables) should be a regular activity of the transit agency.

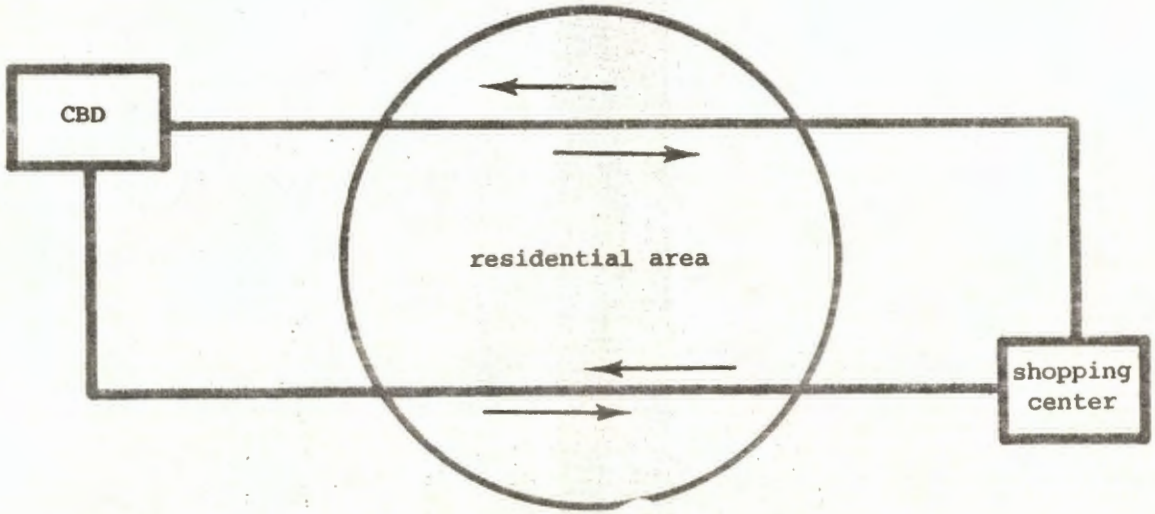

FIGURE 9.7 Routes between major traffic generators.

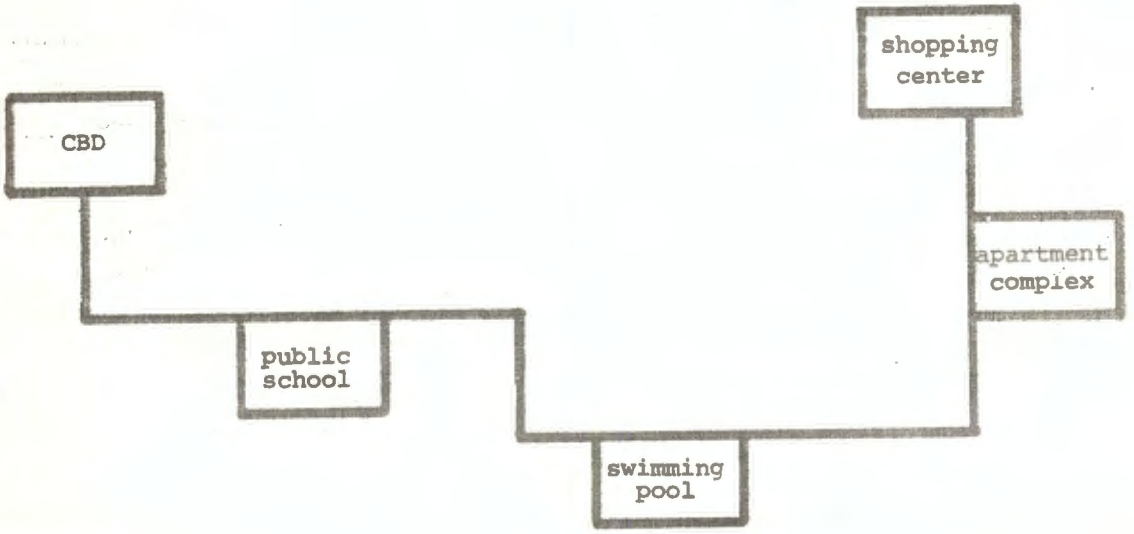

FIGURE 9.8 Inclusion of traffic generators in route design.

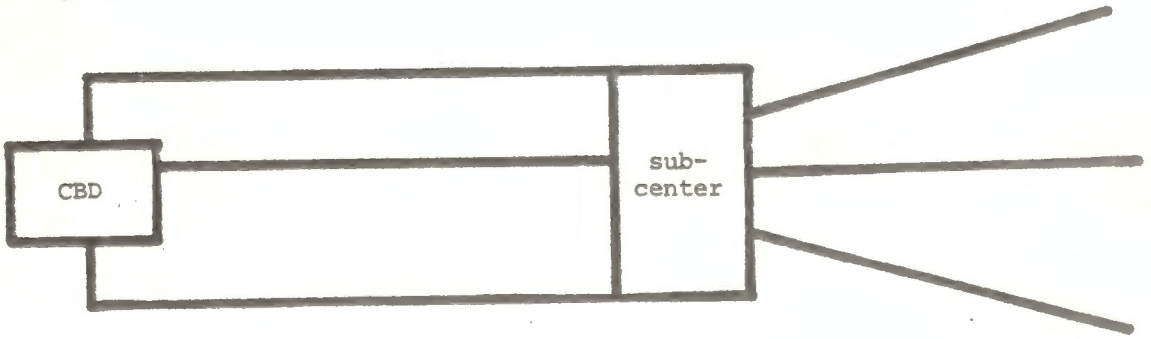

FIGURE 9.9 The subcenter in route design.

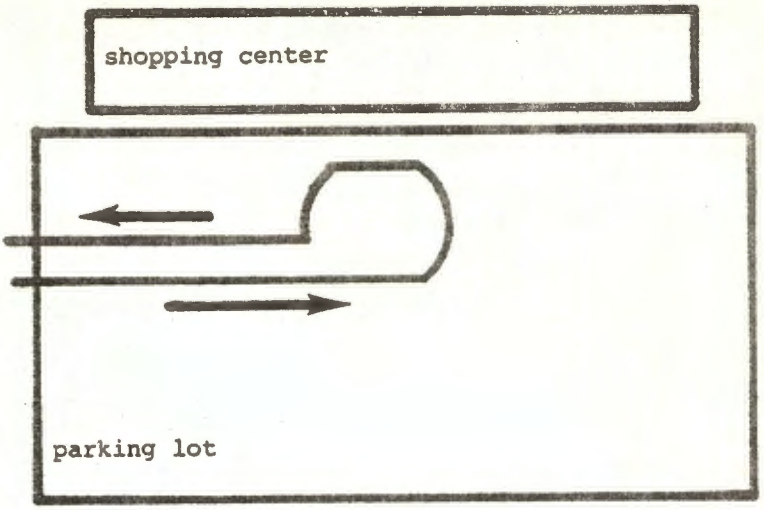

FIGURE 9.10 Loading within major traffic generators.

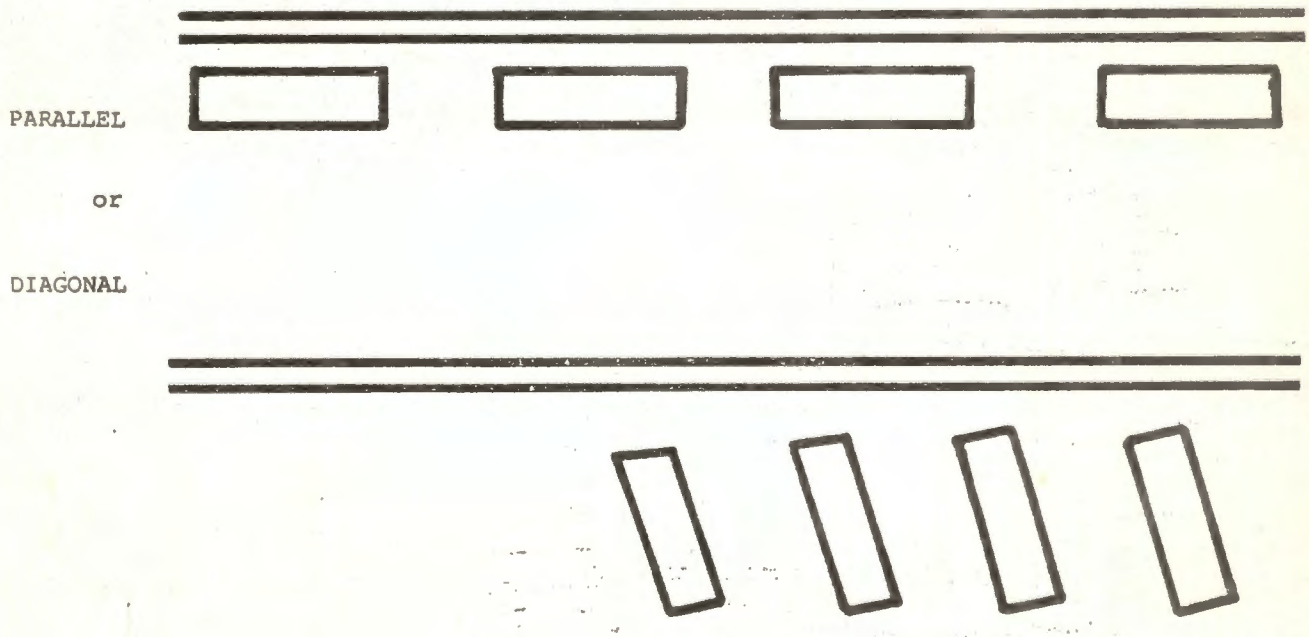

FIGURE 9.11 Parking to permit transfers between buses.

Evaluating Existing Routes

The first step in the evaluation of existing transit routes is to gather useful information.

On-line riding checks. This involves riding each route and checking the number of passengers and where they board and alight. (This information also may be gathered for scheduling purposes; the process will be detailed in the discussion of scheduling.) The essential information to obtain is the number of passengers per platform hour (a scheduled hour of revenue service) and the number of passengers per trip. Ideally, route and trip data should be collected as a routine matter. Unfortunately, this is not often the case in transit, although recent UMTA regulations will make better data collection a regular practice in the future.

Trail checking. In this method, buses are trailed by automobile, and the boarding and alighting passengers are counted. Again, the major information sought is the number of passengers per platform hour and the number of passengers per trip.

Transfer analysis. By checking transfers, it is possible to determine the transfer patterns of riders. This is done by using transfers that show the name or number of route of origin to be collected and kept by the driver on the bus in which the trip is completed. This makes it possible to understand the links that passengers make on their trips. On the basis of this information, linkages between routes can be made. For example, if large numbers of passengers are transferring from route No. 8 to route No. 9, it would make sense to join the two routes into one through route, thus eliminating the need to transfer. The through route will be more convenient for the passengers.

"Tell Us Where to Go" campaign. Riders and potential riders can be encouraged to tell the transit agency literally what it should do and which services it should operate. Forms may be printed and run as ads in newspapers, or there may be handouts on the buses to be dropped into a box on the bus or mailed in. This is a relatively inexpensive way to find out what the public wants.

Land use changes. It also is necessary to review land use in the city on a regular basis. Transit planners should be particularly aware of new land use patterns for apartment developments, industry, shopping centers, or other places of activity that promise to be traffic generators for transit. This can and should be done on a formal basis, by developing contacts with planning agencies so that the transit agency is informed regularly of changes in land use. It also can be carried out informally by means of "windshield

surveys"--simply by driving around town and observing what changes are happening.

In conducting this survey, answers should be sought for the following questions:

1. Does the existing route provide effective and efficient service? (Effective service means doing the right things; efficient service means doing things right.)
2. Are there additional places that should be served?
3. Should service be withdrawn from certain areas?
4. Does transfer analysis point to linking routes for through routing?

The criteria for route scheduling is discussed in detail below. The essential idea is that route evaluation must be carried out regularly and necessary changes made.

Scheduling

Scheduling is the inventory or assortment of finished goods offered to the consumer by the retailing transit firm. The finished goods inventory of transit service is a very perishable commodity. It is put on the shelf as the bus approaches a stop and it is destroyed when the bus leaves that stop. Even though it is destroyed, the costs of its production are incurred. Thus, the scheduling variable is extremely important to the transit agency.

There are two categories of scheduling: (1) demand-based and (2) policy-based. Demand-based scheduling is the more complicated because it attempts to match the amount of service to the demand for transit. Such scheduling is practiced mainly in large cities where peak demand is substantial; indeed, in very large cities there is a significant difference between the amount of transit service provided at peak times and during off-peak periods.

Demand-based Scheduling

Demand-based scheduling is geared to the actual passenger demand imposed upon a system. Data is necessary to do such scheduling. In the following material, it is assumed that service already exists. Where no service exists, estimates may be used to construct a schedule until a service is operated for a sufficient length of time to permit careful data collection based upon real conditions. Schedules can then be developed more accurately.

Passenger data. The number of passengers using the service must be determined. This is carried out by means of on/off riding checks. This is done most accurately by checkers who ride each trip and gather the needed data. The following information must be accumulated:

1. Route name or number, trip identification (either by time or by an assigned trip number), the number of the vehicle, and the direction of travel.

2. A list of stops in the order of their sequence.

3. A record of passengers getting on and off at each stop and the number of passengers on board--the passenger load--when departing each stop.

4. The actual time at check points.

5. Weather conditions.

Figure 9.12 shows a form that can be used to record the needed data. It is best to have such a form prepared in advance for each route, with all the stops listed. An alternative is to prepare a printed blank form with room for the checker to write in ahead of time all the stops on the route from a master list of stops for each route. The section at the top marked "unit number" is a means of identifying a given run. In larger, more complex transit systems, a number of vehicles will be needed to operate each route during the course of a day; each of these is identified by a unit number (some transit systems use the term "block number" to refer to the same thing).

The on/off checks provide information on the patterns of use of the transit service and give a complete picture of the passenger loadings and the maintenance of schedules under varying passenger loads. The continuing passenger count that is possible by counting each boarding passenger on each trip can provide a much more complete picture of transit use over a long period of time. The information can be used in scheduling and in equipment assignment; it will also provide a means of determining the pattern of demand change over a period of time or in response to some innovation in service.

Conducting a comprehensive riding analysis in a short time period requires a great number of checkers if the transit system is a large one. A less accurate means of gathering the data is to station a checker at one point--usually the assumed maximum load point--who boards each bus to make a quick count. Such information is then entered on a form similar to the one shown in Figure 9.13.

Route No. 1 Day and Date Tues. 11/2/71

Vehicle No. 100 Unit No. 3

Direction Inbound Weather Fair

Stop	On	Off	Load
14th and Main	6		6
(Actual Time 7:00AM)			
12th and Main	7		13
11th and "	1		14
10th and "	10	2	22
8th and "	6	3	25
(Actual Time 7:16AM)			
6th and Main	8		33
5th and "	7		40
3rd and "	2	3	39
2nd and "	1	11	29
1st and "		29	-
(Actual Time 7:30AM)			
Total	48	48	

FIGURE 9.12 On/off riding check form.

SERVICE REPORT

FORM 810-7711

POINT CHECKED 5th & Main

DAY AND DATE Mon 11/1/71 TIME 6A-10A

WEATHER CONDITIONS Fair

	INBOUND					OUTBOUND		
SEQ #	TOWN NO.	VEHICLE NUMBER	NUMBER PASSENGERS	ACTUAL TIME		NUMBER PASSENGERS	ACTUAL TIME	
1	4	277	9	6:00		1	6:25	
	1	100	23	30		5	56	
	4	277	28	700		3	7:26	
	6	318	31	15		2	40	
	1	100	42	30		6	55	
	2	166	47	40		7	8:05	
	3	425	48	51				
	4	277	51	802		5	28	
	5	320	42	10				
	6	318	40	21				
	1	100	42	30		3	55	
	2	166	33	46				
	4	277	27	9:01		2	9:27	
	1	100	23	30		1	55	
	4	277	18	10:00				

SIGNED _____

FIGURE 9.13 Single point maximum load check form.

The whole process of data collection can be aided greatly if, as a matter of daily routine, drivers count passengers on each trip. An inexpensive counter can be mounted on the dashboard of each bus. The driver then counts each passenger by merely pressing a button on the counter. At the end of each trip the total number of passengers is entered on a suitable form; the counter is cleared to 0, and the process is repeated on the next trip.

Maximum load. The maximum load is calculated from passenger data. The maximum load is critical because it provides the basis for determining the number of trips for each route for each period of the day. A maximum load summary is shown in Figure 9.14. In the example shown, the day is divided into 15-minute periods during peak hours, and 60-minute periods for off-peak hours. The number of passengers using the route in each time segment is shown. Figure 9.14 shows the gradual buildup to and subsequent decline of the morning peak.

Service determination. In determining the level of service to provide, the first consideration must be given to the load standard--the number of passengers, compared to the seating capacity of the vehicles. This capacity usually is not more than 150% of the seating capacity of the vehicle used. That is, a bus with 40 seats would be at capacity with 40 seated passengers and 20 standees. If the ratio of standees to seated pasengers is relatively high, more vehicles must be operated on more frequent headways. Adjusting the standard can have a major effect on headways. The comfort of the passenger (always an important factor) must be weighed against the cost and feasibility of providing more service.

There are other important parameters for scheduling that have to be considered. The following list shows examples of the more common ones:

1. Service shall begin at 6 a.m.
2. Peak-load standard will be 100% (one passenger for each vehicle seat).
3. Headways between 6 a.m. and 9 p.m. shall not exceed 30 minutes.
4. Service shall end at midnight.
5. Vehicles with at least 50 passenger seats shall be used.

Average Maximum Load Route 1--Main Street
Average Checks of: 10/12/71; 10/14/71; 10/20/71 and 10/22/71

Time Period (Estimated for Inner Terminal)	Total Load
6:00 - 6:15 A.M.	25
6:15 - 6:30 "	25
6:30 - 6:45 "	50
6:45 - 7:00 "	50
7:00 - 7:15 "	50
7:15 - 7:30 "	100
7:30 - 7:45 "	100
7:45 - 8:00 "	100
8:00 - 8:15 "	100
8:15 - 8:30 "	100
8:30 - 8:45 "	50
8:45 - 9:00 "	50
9:00 - 9:15 "	25
9:15 - 9:30 "	25
9:30 - 9:45 "	25
9:45 - 10:00 "	25
10:00 - 11:00 "	50
11:00 - 12:00 A.M.	50
12:00 - 1:00 P.M.	50
1:00 - 2:00 "	50
2:00 - 3:00 "	50

FIGURE 9.14 Summary of total maximum loads by time period.

Policy-based Scheduling

In small transit operations there may be no need to schedule service to meet widely shifting demand. In the smallest urban places, service may simply be based on a combination of policy and what the transit agency believes it can afford, mixed in with some marketing considerations. Generally this means that, regardless of the time of day, the service will be offered on a standard, policy headway, such as every 30 minutes.

The entire system may use the same headway, or there may be different headways for different routes. Those routes which have a higher level of demand, may operate every 30 minutes; other routes may operate only every 60 minutes. It must be noted that even in transit systems that use demand-based scheduling for peak-hour service, the off-peak base period of moderate to light demand generally is handled on the basis of policy headways.

There are two basic types of policy scheduling: (1) cycle schedules, and (2) noncycle schedules.

Cycle schedules. Under a cycle schedule, all buses leave the CBD at the same time. They travel their routes and return to the CBD at the same time--usually within 30-minute roundtrips. This means the buses depart from the CBD (or other terminus) at the same time and return at the same time each hour. Thus the headway repeats itself each hour. For example, at a given point on a route a bus will pass at 22 minutes after the hour and at 52 minutes after the hour. The schedules are easy for the public to remember. It implies that there is basically one bus per line and that each line or route is the same length (in terms of roundtrip time). Where routes are long, there may be more than one bus assigned per route. The essential point is that one of them will pass a given point on a regular basis and that they will gather in the CBD central transfer point at the same time.

Once the routes have been selected and their roundtrip time made uniform, only the departure times from the CBD need to be established to determine the rest of the schedules. The advantages of this system are obvious, as are its disadvantages. The chief disadvantage is inflexibility. Lengthening or shortening one route means putting all the other routes out of phase: the temptation to maintain the status quo is almost irresistible under these circumstances.

Noncycle scheduling. Under a noncycle schedule, each route is scheduled individually. Noncycle scheduling is much more complex than cycle scheduling, because good noncycle scheduling demands coordination between routes, or

at least certain routes for which there is substantial transferring. Noncycle scheduling, with its attendant flexibility, offers more opportunity for scheduling to be used as a marketing tool.

Schedule Time Periods

Both policy-based and demand-based scheduling will need to pay attention to different schedule time periods. In each there may be significant differences in the amount of service that should be scheduled. Systems that adhere to demand-based scheduling will be particularly interested in these periods:

Time Period	Type of Scheduling
Pre-morning peak	Policy
Morning peak	Demand
Base	Policy
Evening peak	Demand
Night base	Policy
Owl service	Policy
Saturday	Policy
Sunday/holiday	Policy

Even a small transit system that does not use demand-based scheduling may need to modify its service during the peak times if there is serious overcrowding on its vehicles. If the bus fleet contains one or more larger vehicles, one of the larger units may be operated during particularly busy runs to avoid serious overcrowding. Another possibility is an extra bus, operated a few minutes before or after the regularly scheduled bus, on the standard headway; this would help to soak up the excess demand at busy periods and ensure greater passenger comfort.

Transit agencies that rely strictly upon policy-based schedules--and that would include most services for smaller cities--should reconsider their headways regularly. The maximum headway that should be operated under the name of transit service is 60 minutes. Even small cities should aim to have service offered at least every 30 minutes. If patronage develops well along certain routes, serious consideration should be given to reducing headways to every

20 or 15 minutes, should passenger loadings justify the expense. There is no need to adhere to a uniform headway on each route if patronage suggests otherwise, as long as the headways mesh at a central transfer point for the convenience of transferring passengers.

Cutting the schedule. The first step is to determine the time each trip will leave one of the terminals on a route. This is based on the standards developed. The number of trips is then fitted to meet the passenger load and the standards developed for the ratio of seated to standing passengers. Based on the running time needed, the schedule time at the other terminal of the route is determined. Then, time points are established between the terminals for the aid of both passengers and drivers.

Building the headway. Three facts must be known to construct the actual headways in minutes: (1) the coach capacity based on the adopted standards, (2) the time period under consideration (in this case, the peak hour) in minutes, and (3) the total number of passengers expected. To arrive at the headway the following formula is used.

$$\text{Headway} = \frac{\text{coach capacity x time (minutes)}}{\text{total passengers}}$$

Assuming that the coach capacity is 50, that the time period is 60 minutes, and that the total number of passengers is 1,000, the headways would be 3 minutes.

$$3 = \frac{50 \times 60}{1{,}000}$$

To determine the number of vehicles that will be required to operate the service, the roundtrip running time including built-in recovery time (which may be a part of the union contract) and the headway are needed.

$$\text{Coaches required} = \frac{\text{roundtrip running time}}{\text{headway}}$$

If the roundtrip running time is 60 minutes and headway is 3 minutes, 20 vehicles will be needed to operate the service.

$$20 = \frac{60}{3}$$

Figure 9.15 shows a headway table. Please note that units 1 and 2 maintain the basic 30-minute headway of the route throughout the day. Additional units are added to the schedule as demand begins to build. Unit 3 covers the 6:18, 7:18, and 8:18 a.m. runs from the outer terminal; unit 4 covers the 6:48 and 7:48 a.m. runs; unit 5 covers only the 6:55 and 7:55 a.m. runs. Units 6, 7, and 8 each handle only one morning peak run.

Figure 9.16 shows the entire unit schedule for a weekday. Each unit number is listed on a separate line with the time of arrival at each terminal. At the bottom of the figure is a vehicle/hour summary. The eight units scheduled for this service operate a total of 49 hours and 36 minutes per day. Units 1 and 2 operate for the greatest number of hours in the day. The other units assigned operate for fewer hours. It is a general practice in the transit industry to assign the newest or lowest operating-cost vehicles to the more lengthy runs throughout the day. Vehicles that are older or more expensive to maintain and operate are assigned to the shorter running periods. The unit operating schedule is also useful to the maintenance department in planning its maintenance activities.

Run cutting. From the unit schedule shown in Figure 9.16, the driver assignment, or run cutting, is determined. The process must be completed within the provisions of the labor contract between the transit agency and the union representing its employees. The following parameters usually are contained in a labor agreement:

1. The number of working hours before overtime.
2. The minimum daily guarantee. This is usually 8 hours of pay for the employee reporting for regularly scheduled duty.
3. The maximum hours of continuous duty without a break.
4. The maximum hours of spread. Because of the peaked nature of the demand for transit service, many drivers work a split shift. This provision limits the total number of hours worked from the time the driver starts working until the end of the final run. Working time beyond the maximum spread is paid on an overtime basis.
5. Absolute prohibition of work in excess of total spread.
6. No more than one unpaid break.

Based on the above limitations, the work of driving is divided into runs. The straight runs, those approximately 8

Unit Number	Leave Outer Terminal	Time at Inner Terminal	Arrive Outer Terminal
1	5:33 A.M.	6:00 A.M.	6:27 A.M.
2	6:03	6:30	6:57
3	6:18	6:45	7:12
1	6:33	7:00	7:27
4	6:48	7:15	7:42
5	6:55	7:22	7:49
2	7:03	7:30	7:57
6	7:10	7:37	8:04
3	7:18	7:45	8:12
7	7:25	7:52	8:19
1	7:33	8:00	8:27
8	7:40	8:07	8:34
4	7:48	8:15	8:42
5	7:55	8:22	8:49
2	8:03	8:30	8:57
3	8:18	8:45	9:12
1	8:33	9:00	9:27
2	9:03	9:30	9:57
1	9:33	10:00	10:27
2	10:03	10:30	10:57
1	10:33	11:00	11:27
2	11:03	11:30	11:57
1	11:33	12:00 NOON	12:27 P.M.
2	12:03 P.M.	12:30 P.M.	12:57
1	12:33	1:00	1:27
2	1:03	1:30	1:57
1	1:33	2:00	2:27
2	2:03	2:30	2:57
1	2:33	3:00	3:27

FIGURE 9.15 Headway table.

				SCHEDULE DEPARTMENT TIMETABLE				DIVISION Centre / SCHEDULE 21				ROUTE 1 - Main Street / EFFECTIVE 11/2/71										SUPERSEDED 20			SHEET 1 OF 1						
Unit Number	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	Outer Term	Inner Term	
2			9/603	630	703	730	803	830	5/903	930	1003	1030	1103	1130	1203	1230	9/103	130	203	230	303	330	403	430	503	530	557		
6					5/710	737	804																5/410	437	510	537	604		
3			6/615	645	718	745	818	845	912												7/318	345	418	445	518	545	612		
7					3/725	752	819																3/425	452	519				
1	2/533	600	633	700	733	800	833	900	933	1000	1033	1100	1133	1200	1233	100	3/133	200	1/233	300	333	400	433	500	533	600	633	700	cont
8					4/740	807	834														4/340	407	440	507	534				
4			7/648	715	748	815	842														6/348	415	448	515	542				
5			8/655	722	755	822	849														8/355	422	455	522	549				
1	cont	700	733	800	833	900	933	1000	1027																				

Vehicle Hour Summary

Unit No.	AM Peak	PM Peak	Total
1	-	-	16:54
2	-	-	11:54
3	2:54	2:54	5:48
4	1:54	1:54	3:48
5	1:54	1:54	3:48
6	:54	1:54	2:48
7	:54	:54	1:48
8	:54	1:54	2:48
Total			49:36

FIGURE 9.16 Unit operating schedule.

hours long, are cut first, then the other runs are fitted in. This is illustrated in Figure 9.16. The run numbers are written in, over the time of departure from a terminal in Figure 9.16. Note that run 1 starts at 2:33 p.m. and ends at 10:27 p.m., for a total of 7 hours and 54 minutes. Run 2 starts at 5:33 a.m. and ends at 1:33 p.m., for a total of 8 hours. The other runs are shorter.

All of the runs are summarized in Figure 9.17. The other runs are all less than the platform hours worked on run 1 or 2. In some cases--runs 6,7,8, and 9--although the hours worked may be far less than other runs, there is premium pay because the amount of allowable maximum spread time has been exceeded.

Run No.	Time On	Time Off	Platform Hours	Spread Premium	Total Pay Hours
1	2:33 P	10:27 P	7:54	-	8:00
2	5:33 A	1:33 P	8:00	-	8:00
3	7:24 A	8:19 A			
	1:33 P	2:33 P			
	4:25 P	5:19 P	2:48	-	8:00
4	7:40 A	8:34 A			
	3:40 P	5:34 P	2:48	-	8:00
5	7:10 A	8:04 A			
	9:03 A	1:03 P			
	4:10 P	6:04 P	6:48	:27	8:27
6	6:18 A	9:12 A			
	3:48 P	5:42 P	4:48	:51	8:51
7	6:48 A	8:42 A			
	3:18 P	6:12 P	4:48	:51	8:51
8	6:55 A	8:49 A			
	3:55 P	5:49 P	3:48	:27	8:27
9	6:03 A	9:03 A			
	1:03 P	5:57 P	7:54	:57	8:57
		Total	49:36	3:33	75:33

FIGURE 9.17 Summary of runs.

Clearly, the objective is to get total pay hours as close to platform hours as possible. In the example shown in Figure 9.17, 49 hours and 36 minutes is the actual number of platform hours. However, the total pay hours equals 75 hours and 35 minutes, because of spread premium and minimum pay provisions.

Service Standards

Regardless of whether policy- or demand-based headways are used, serious consideration must be given to the standards of service that will apply. The major factors to consider are: (1) headways, (2) vehicle occupancy, (3) area coverage, and (4) reliability.

Headways. The standard may be set loosely; that is, the maximum headway should be no more than 60 or 30 minutes, or whatever is determined reasonable. The headways should be timed so that the service always passes the same point on the same route at the same number of minutes past the hour.

Vehicle occupancy. Vehicles should not be loaded beyond a certain point. That point may be limited to the seating capacity of the vehicle used, or it may be some percentage greater than that. For example, if the vehicle occupancy standard is set at 150%, a bus with 45 seats should not carry more than a seated load plus 23 standees on a regular basis. Probably an ideal vehicle occupancy factor is no more than 125%.

Area coverage. This service standard may be set to provide coverage for all areas within the civic city limits in such a way that no point is more than 3 blocks (or some other number of blocks) from a transit route. The standard also may be set on the basis of population density: service will be provided in any area with a population density greater than some number of persons per square mile. Whatever is chosen as a basis will guide the routing and the scheduling of service. The latter element comes into play when the standard is cast into terms of service frequencies, based either on population density or on distance from some given point. For example, service shall be provided every 30 minutes to portions of the city with a population density of 3,000 per square mile; places of lesser population density would receive service every 60 minutes.

Reliability. This is a critical service standard because patronage will suffer greatly if service is not reliable. Typically, reliability is cast into the form of a statement such as: 95% of the service shall operate no more than 2 minutes behind schedule; no buses shall run ahead of schedule. If schedules cannot be maintained on a reasonable basis, for whatever reason, either schedules should be rewritten or other steps taken to maintain the reliability of the schedules.

Scheduling Questions

Whether the scheduling practice used is policy-oriented or demand-oriented, there are some basic questions which must be answered:

1. How long is the route?
2. How far is the garage from the route?
3. How long does it take to complete one roundtrip?
4. How long are headways?
5. What is the maximum peak-hour ridership?
6. What is the capacity of the coach to be used?
7. What are the time points?
8. What is the gas mileage of buses?
9. How many buses are required?
10. How many drivers are necessary?

Marketing Effects of Scheduling

From the standpoint of marketing considerations, the firm should use the scheduling variable as a means to attract and hold customers who have been obtained by the firm's other marketing efforts. Consumers must be enticed to ride the bus before the firm can appeal to them through its comfort, convenience, reliability, and scheduling. In all cases the schedules should be easy for the rider to understand. Schedules should, when possible, repeat throughout the day. In other words, "Buses stop at Atwater and Magnolia at 5 minutes past the hour throughout the day." Buses whose schedules are designed to serve a specific traffic generator should not have arrival and/or departure times that are inconvenient to the patrons they are attempting to serve. Some transferring is bound to occur, but proper routing should minimize the passengers' needs to transfer. Scheduling should be coordinated so as to make all transfers as convenient as possible.

Schedules should be reviewed frequently. Flexibility is a keystone of good scheduling, but scheduling is a marketing variable, and any change has an effect upon the consumers as well as cost implications to the transit agency. Capricious, frequent schedule changes tend to confuse patrons and reduce ridership. Therefore, while schedules should be reviewed continually, actual changes should be evaluated carefully. Changes that have favorable consumer implications (service increases, for instance) can be made immediately. Changes adversely affecting riders (service cutbacks, for instance) should be made only at fixed, stated intervals. Naturally, all schedules and schedule changes should be thoroughly publicized.

Guidelines for Scheduling

There are nine adjectives which should apply in practice to any transit schedule.

Marketable. Scheduling is a most important marketing variable. In the firm's marketing strategy, it is designed, in conjunction with other marketing tools, to hold customers who have been enticed to use the service.

Simple. Schedules should be simple and easy to remember. The passengers are not scheduling experts. Simplicity also is helpful to the operating employees, drivers and dispatchers alike. For a small transit property, scheduling should require neither highly skilled people nor a computer, in keeping with the restrictions on available funds.

Adequate. For cities of fewer than 100,000 in population, maximum headways of 30 minutes should meet the needs, although headways should be evaluated carefully for each and every route.

Prompt. From a financial standpoint, it probably is impossible to have very frequent headways (i.e., in the 5-minute range). Therefore, careful drawing and scrupulous maintenance of schedules is extremely important.

Convenient. Schedules should be coordinated so that transferring is made as convenient to the rider as possible. Waiting time at transfer points should be minimized.

Practical. Schedules attempting to appeal to certain riders should be made in such a way that these riders actually are being served. Buses that make work-related trips cannot be scheduled to arrive at the work place 5 minutes after the starting time.

Reliable. Schedules should be checked often to assure that they are being kept.

Available. Schedules and schedule changes should be well publicized.

Up-to-date. Schedules should be reviewed continually as an ongoing activity. All changes should be evaluated in terms of their marketing implications.

Resource Allocation

Transit firms are the same as any other economic endeavor. They are attempting to produce revenues through investment in and allocation of scarce resources.

Routing and scheduling have a direct effect on the allocation of a transit agency's limited resources. Routing determines the number of markets the firm will serve, and scheduling allocates the buses among the various markets or routes. Because the selection of a route implies the scheduling or allocation of at least one bus, the transit property, especially one just starting up, must avoid the pitfall of selecting too many routes to serve. That mistake could cause certain undesirable results. First of all, the transit agency, because of its limited resources, might be forced to schedule infrequently on some or all of its routes. This infrequent scheduling could fall below the reasonable level of service needed to attract the best possible patronage. Second, money needed for promotional effort might be used up in the purchase of equipment. Either of these conditions would lead to disappointing results.

The resource allocation aspect of the routing and scheduling activities points out their extreme importance in the planning of the organization. Thus, routing and scheduling are matters of concern to the entire enterprise, and no planning, budgeting, or new investment should be undertaken until these two activities receive explicit attention in the analysis.

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APPENDIX 9A

ROUTING/SCHEDULING EXAMPLE

The following hypothetical routing and scheduling example is designed to illustrate some of the concepts discussed in Chapter 9.

In a mythical small city in the United States, a transit agency's market research has indicated a possible extension of service, in the form of a new route to three outlying residential areas. This market research had taken the form of a series of meetings between the transit agency's representatives and the several neighborhood associations (originally formed, perhaps, for purposes of zoning protection). At these meetings, the transit agency and the neighborhood associations had agreed upon a rough notion of route and schedule parameters. It remained only for the transit management to make final the details of the route and schedule.

This transit agency had recently begun service, and it was operating all its routes according to several guidelines:

1. All services run from 6 a.m. to 7 p.m. daily, except Sundays.

2. All routes are basically radial, CBD-oriented cycle routes, because this type of routing was considered simpler at the time operations began. It was thought that certain lines would become through routes as experience dictated.

3. All existing routes are scheduled to arrive at the central business district at the same time, for the convenience of passengers who desire to transfer between them.

4. Scheduled arrival times at the CBD are 15 and 45 minutes after the hour. This scheduling allows a sufficient time for working passengers to arrive at their work place on time.

The transit agency was interested in a new route, the Lake Central Flyer, because it would complement two other existing routes nicely. The proposed layout of the route of the Lake Central Flyer is shown in Figure 9A.1.

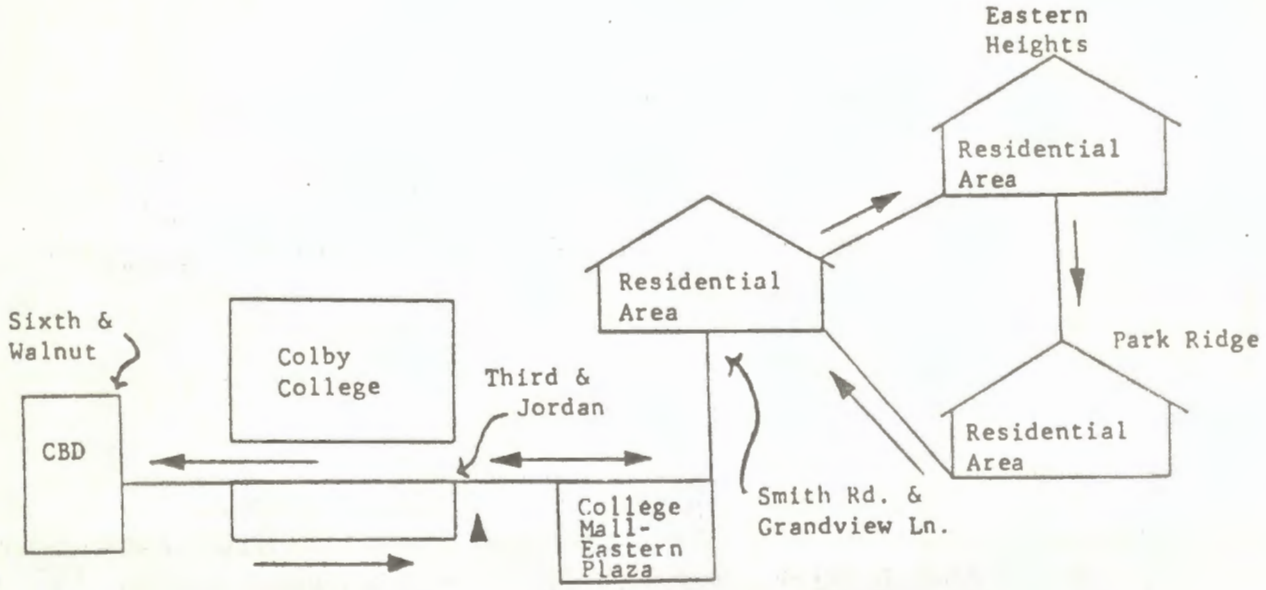

FIGURE 9A.1 Proposed layout: Lake Central Flyer.

Many of the work-related trips of the patrons of the Lake Central Flyer involved Colby College. Colby College is quite spread out. It is determined that three routes are necessary to make transit service sufficiently convenient to attract riders. Two routes already were in service, and Lake Central Flyer would be the third.

The three routes converged at an outlying shopping center. There, the college passengers could transfer free to the most convenient line to their destination. Parking for riders coming from outlying points was available, as was a sheltered terminal for the comfort of the riders. The scheduling of the three routes was arranged so that the buses arrived at the shopping center within 3 minutes of each other and departed together.

The following information was gathered concerning the Lake Central Flyer route:

Length of route	7.1 miles
Distance from garage to route	3.2 miles
Running time per roundtrip	50 minutes
Headway (determined by policy)	30 minutes
Maximum rush hour traffic	41 riders
Capacity of each	53 riders

The length of the route was determined by hubodometer mileage of a simulated trip. The running time for one roundtrip was determined by simulating the trip by bus during the morning peak. Headway was determined by the overall policy of arrival times at the CBD. The maximum rush hour passenger load was determined by discounting the ridership intentions expressed at the neighborhood association by 50%. The capacity of the coach was determined by the coaches available. Two capacities were available: 33- and 53-passenger. The 53-passenger coach was selected to avoid a standee problem.

Time points were selected as departure times from the various traffic generators. The morning peak inbound schedule is shown in Figure 9A.2. As indicated, the one-way running time is 25 minutes. Allowing a 2-minute layover at the CBD and a 3-minute layover/recovery time at Smith Road and Grandview Lane provide for a 30-minute headway.

From the twin shopping centers inbound, the route used the main automobile route to the CBD. This route was a one-way street inbound. Outbound used a one-way street one block south. This situation made transit service on this route comparable in time with the private automobile as far as possible, while still preserving a high level of passenger convenience.

In the three residential areas, the service was fine-grained; that is, it was laid out so that bus service was no more than one block from any house anywhere on the route. This arrangement made the route somewhat circuitous; but, since each subdivision was relatively small, the time lost was more than made up by the convenience gained. In addition, the transit agency agreed to stop anywhere on the part of the route that ran through the residential areas. At the same time, it appealed to the prospective riders to group themselves into convenient groups--as school children do--to minimize the number of stops and thus minimize total trip time.

Obviously, much of the uncertainty involved in laying out and scheduling the route has been removed by system policy considerations--arrival times at the central business district and the shopping center subterminal, for instance--and by desire of the transit agency to flesh out its network with a route operating on a specific street. All decisions

	Smith Rd. and Grandview Ln.	Eastern Heights	Park Ridge	Smith Rd. and Grandview Ln.	College Mall-Eastern Plaza	Third and Jordan	Sixth and Walnut
Distance between points	-	1.9 mi.	1.2 mi.	1.0 mi.	.5 mi.	.9 mi.	1.1 mi.
Time between points	-	3 min.	3 min.	3 min.	3 min.	4 min.	4 min.
Schedule time (after the hour)	:20	:23	:26	:29	AR LV :32 :37	:41	:45

FIGURE 9A.2 Sample inbound schedule.

were made with the passengers' time and energy costs mimimized. In terms of resource allocation, a highly desirable route was added to the transit network--one that will add revenue to other routes as well--with the additional allocation of one bus. In short, the transit firm has made a highly consumer-oriented decision with a reasonable expenditure of scarce resources.

CHAPTER 10

COMMUNICATIONS AND CONTROL

SUPERVISION OF OPERATIONS

Introduction

Supervision of transportation employees is difficult because the employees usually are spread out over a large area. Despite this difficulty, supervision is critical in transit because of the nature of the service. For example, it is necessary for buses to arrive at transfer points at about the same time for passengers to transfer from one route to another. The service must be reliable. This depends in large part on the performance of transit employees. Unless the agency pays meticulous attention to maintaining the published schedules, the public soon will become disenchanted with the transit service provided.

Personal supervision of employees in mass transit is difficult, costly, and at times inefficient. Nonetheless, the personal supervision provided by road supervisors can be very effective. In past years, of course, all transit supervision was of a personal nature. Today, however, communications devices can help provide high quality supervision at a reasonable cost and offer control over day-to-day transit operations. A communications system can link transit vehicles together to form a unified package of service.

Supervision

The Main Tasks

The five main tasks of supervision are:

1. Monitoring performance. Supervision helps to monitor the overall, on-time performance of transit service.

2. Solving problems. When problems arise, such as flat tires or mechanical breakdowns, supervisors can make sure replacement vehicles arrive at the scene without

delay. When traffic jams occur or problems arise because of fires or street maintenance work, supervisory control can help route transit vehicles around the blocked spot.

3. Ensuring safety. Supervisors can observe operating practices of drivers and, where unsafe conditions exist, can take steps to remedy problems.

4. Collecting data. It is possible for supervisors to collect information on schedule maintenance and ridership as part of their duties.

5. Providing feedback. Supervisors can observe the general functioning of the system and provide feedback to management in its planning work. Observations gathered by the supervisory force also can be used in decisions concerning routing and scheduling (see Chapter 9).

Location of Supervisory Personnel

If supervisory personnel are used, they may be located at any of a number of places. Supervisors may use an automobile with or without a two-way radio. If the vehicle is not equipped with a radio, the supervisor must call transit headquarters on a regular basis to find out if there is trouble. Based on their experience, supervisors also can use the vehicle to travel to places where they know difficulties are likely to arise.

Supervisors also may be stationed on foot at places on the street where they can observe the operation of the transit system and take only necessary corrective action. Supervisors on foot may or may not be equipped with radios. However, supervisory personnel without two-way radios must call headquarters or rely on messages given to them by bus drivers to stay aware of the situation. Hand-carried two-way radios are available and can be used to extend the supervisory range of supervisors on foot.

Another option is for supervisors to remain at some central location--such as a downtown terminal and transfer point or at the main offices of the transit agency--with or without a two-way radio. A supervisor at a major downtown terminal can monitor the schedule performance of the routes and may take actions when a bus does not arrive within a reasonable time of its schedule. A supervisor with a radio at a central location can be in contact with the buses and the maintenance garage and can act quickly to remedy problems.

Sometimes supervisors are located only at key transit traffic points. In general, they are on the street or in a

car at these points to help put buses in the proper order for arrival at the terminal, to turn buses back that are running off schedule, or to take other actions to ensure reliable operation.

The supervisors' ability to cover the field and to act quickly when problems arise is extremely limited without two-way radio equipment. A supervisor located out on the street without a radio is probably of value only when there is a great deal of transit traffic, for example, at rush hour. A supervisor at a downtown terminal may be extremely useful. In the long run, however, all supervisory personnel should be equipped with two-way radios, whether in the car, at a fixed location, or on foot.

Communication Systems

Communication is as much a part of the marketing mix as are the routes, schedules, equipment, and so forth. Therefore, buses equipped with two-way radios or other, more exotic communications systems are not a luxury but a necessity. They enable the firm to meet its objectives of flexible and dependable transit service for various segments of the transit market (see Appendix 10A).

The use of communication systems, particularly those oriented around two-way radios, can provide significant supervisory aid and play an important role in ensuring on-time service and overall dependability of transit operations. With communication systems, an active transit operations control system is possible. The location of vehicles can be found and service monitored. Problems associated with breakdowns can be corrected quickly. It is also possible that information on traffic and safety can be relayed and action taken before there is a serious problem with the quality or reliability of service. Finally, communication systems can make it possible for bus drivers to communicate with one another to coordinate transfers of passengers between routes.

Communication also is critical if the transit firm offers all or some of its service in the form of a demand-controlled, consumer-activated system, often called dial-a-ride.

Every effort should be made to use the communications system--whatever its mode--in an active role as a complete and continuing control device. This approach is the most sensible way to help maximize the quality of service in line with organizational goods and make most efficient and effective use of personnel.

Methods of Communication

Supervision and control can be carried out in a number of ways. All of these methods involve communications of one sort or another.

A transit firm may choose to do without any supervisory personnel or communications system of its own, relying instead on customer complaints to detect undependable service. Such a system will be costly in terms of company image and community relations. Although it affords low costs in communication, such a method only leads to falling ridership. This method has no place in a service-oriented, market-sensitive transit undertaking.

Telephone check-ins. As a kind of halfway point between personal supervision and some form of radio or instrumented control on each vehicle, drivers may check in at route ends and at certain places along the route, by means of telephone boxes. While this method is better than no communication at all or communication through supervisors alone, its effectiveness is limited by the location of the telephone boxes. Moreover, it may involve considerable inconvenience for the driver as well as the possibility of delay.

Two-way radios. Two-way radios, especially the greatly improved mobile types that have come on the market in recent years, offer considerable flexibility. They also provide high degree of control without excessive expense. Many large properties already have equipped all or part of their fleets with radios. With two-way radios, information can be transmitted instantly between vehicles and the base station. Communication delays may be virtually eliminated.

For the small-scale transit enterprise, probably the best bet in communication devices is the two-way radio. Several manufacturers produce a relatively wide variety of this equipment. In selection, installation, and operation, prime needs are ruggedness, durability, and a sufficient range, so that all vehicles can maintain contact with the supervisor at the radio base station.

Collecting certain types of data is possible with two-way radios. The drivers on given routes or runs can report the number of passengers boarding and alighting at each stop. This information can be recorded at the base station, either by hand or by a tape recorder. Spot checks on passenger traffic thus can be gathered easily and quickly.

Simple demand-activated systems, which may be necessary to serve certain segments of the market, can use two-way radios. Potential riders merely call a controlling

supervisor and request that a bus operating in a certain sector pick them up. This information then would be radioed to the driver.

Telephone handsets. Two-way radios are fairly common in taxicab operations. However, the radio communications systems used in taxi service can be a great annoyance both to passengers and drivers because of its constant chatter. The ideal type of radio system for transit is one in which a centrally located supervisor may call all the buses or any one of them selectively. The drivers may call in at any time. Some of the hardware used in large city transit even enables drivers to call other buses or road supervisors. The receiving and sending equipment on the vehicles usually is similar in design to a telephone handset.

For convenience, the drivers could be equipped with lightweight headsets that combine an earphone and a small microphone. The headset would leave the drivers' hands free at all times. A foot control would enable the driver to initiate a call or to respond quickly and easily to a call from the central controller.

Electronic vehicle monitoring systems. Another possibility for control is electronic vehicle monitoring systems used with two-way radios. Several of these systems currently are being developed and tested. In some systems, the vehicle emits a radio signal that is picked up by lineside detecting devices and transmitted to a central control station. By means of computerized map displays, it is possible to locate any bus on the portion of the transit system so equipped. The bus or the entire fleet can be traced in its movements along routes.

More complicated versions of electronic vehicle monitoring systems will show only buses that are either running late or running ahead of schedule. Others will flash an emergency signal automatically in the case of robbery or some other problem. It is possible with some systems to count the number of passengers boarding and alighting from the buses. Some monitoring systems under development even go so far as to report on the mechanical condition of the bus while it is operating its route. For example, engine temperature may be rising too high; the transmission may be showing symptoms of failure, or the air compressor may not be doing its job properly. This type of data can be relayed automatically by radio or other means of transmission and stored in a computer; a signal is flashed if any defect becomes serious. Computer printout tells the nature of the problem.

Currently, the only drawback of such electronic systems is the cost, which may make them uneconomical for small-scale transit use. However, expected improvements and

cost reductions may make it possible for even the smallest transit firm to use simple, inexpensive electronic vehicle monitoring systems in the future.

Closed-circuit television. In recent years, the development of small, rugged, and relatively inexpensive closed-circuit television cameras has made visual contact at key locations possible. Monitoring entire routes visually probably would be too costly, but television seems to be an excellent means of monitoring multiple route subterminals or congested intersections. Combined with two-way radios, closed-circuit television would enable the communication system to have mechanical eyes and ears. For the small firm, cost is the major drawback--particularly the cost of linking remote locations to the supervisory control center by cable, if channels in the video spectrum are unavailable locally.

System Selection

Some guidelines for the selection of communication equipment follow:

1. The system should allow constant and immediate contact with all buses in regular route and special service operation to: (1) meet supervisory and dispatching needs, (2) meet data-collection needs, and (3) meet information and emergency needs.

2. The quality of the system should provide high range and coverage, clarity and precision in transmission and reception, and reliability in operation. There also should be no interference with driver and customer comfort or with community radio, television, and telephone systems.

3. The equipment in the bus should require little space.

Central Control Concept

Because dependability is the critical factor in marketing a successful transportation package, a two-way radio communication system should be regarded as much more than a mere device for reporting emergencies or making casual checks on drivers.

At the very least, the communications system can be used for the integration of services; for example, to dovetail the transfers between lines. Nothing is more frustrating to a passenger who must transfer from one route to another than to discover he has just missed his connection. This annoyance often is unavoidable if a bus is

running late and the driver has no way to signal to another driver that he has a transfer passenger. A communication system would eliminate this problem, by tying the vehicles together through a central control point.

A controller at a central point in the transit system--probably the center-city terminal--can be even more useful as a monitor and control agent for the entire operation. His main function would be to ensure the dependable, scheduled operation of the transit service, through regular contact with each route. In this case, the exact location of each bus at a given time could be learned easily. The advantages of electronic vehicle-monitoring systems could be enjoyed, without the need for the installation of costly computers and automatic detection devices.

The central controller also should be used as a dramatic promotional device. For maximum impact on the public and as a visual dramatization of the importance given to dependability and flexibility of operations, the central controller should be located at some highly visible spot, probably the major downtown transit terminal. Using simple, electrically controlled map displays or the movement of markers on a map of the system, the central controller can plot the location of each vehicle in the system. Such overt concern for dependable operation of regular service can be a real contribution to the image-building process.

Bibiography for Chapter 10

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The numbers in parentheses are NTIS order numbers.

APPENDIX 10A

COMMUNICATION SYSTEMS

The communications system for transit operations is a field that has drawn attention only recently. Many transit systems only use supervisors for control and coordination. Others simply have the driver call the dispatcher on the telephone when he reaches the end of the line. The most common and most effective system, however, uses a mobile radio system.

System Acquisition

Suitability and Price

The initial step in obtaining a mobile radio system is to contact sales representatives or distributors dealing in mobile communication who can give information on price range. The price range varies widely with the type of equipment obtained. General Electric, Motorola, and RCA are among the leading manufacturers of equipment, but other sources are available, both domestic and foreign. The company representative first will attempt to find out what the user wants his radio system to do. Thus, the user should have a fairly definite idea of what range he desires, how much the communication system will be used, what equipment would fit his needs best, and other relevant information. The representative will investigate the physical characteristics of the area, the related radio systems operating in the vicinity, and related items. Putting all of these data together, he will recommend a system for the transit agency that he believes will suit its needs best. Because systems designed by different representatives will vary, the transit system must pick the one it thinks most suitable and best for the estimated price.

After picking a system, specifications should be written for the equipment needed so bids can be let (usually required for public operations). After the low bid is accepted, plans can be made for getting the equipment, installing it, and training the employees in its correct use.

FCC Compliance

All radio operations in the United States are under the supervision of the Federal Communications Commission (FCC). To build and operate a radio system, a construction permit and operating license must be secured from the FCC in Washington, D.C. The representative of the equipment supplier usually will be very willing to help the buyer in dealings with the FCC. While regulations and procedures sometimes change, usually it is necessary to apply at least 2 months in advance of the proposed starting date. This is a reasonable allowance, as it will take the manufacturer a major portion of this time to produce the order after the sale. When the equipment is installed, notification must be given to the FCC before testing and regular operation begin. Forms and assistance may be obtained from the FCC or any of its regional offices.

Usually, licenses must be renewed every 5 years. The license covers a specific base station and specific number of mobile units. To move the base station, increase the number of mobile units, change power output, or make other changes requires modification of the license, although the original application can be written to include more mobile units than needed for current operation, to provide for expansion. The manufacturer also will assist the applicant in choosing a broadcasting frequency, as they are not arbitrarily assigned by the FCC. Several frequencies in each band have been allocated to Motor Carrier Radio Service. Probably these will be the most likely frequency for transit use. In choosing a frequency, the applicant will try to obtain one not already authorized for other use so that he will have exclusive operation.

In addition to the rules governing the establishment of a system, the FCC has rules for operation. The license, for example, must be displayed prominently. When using the communications system, proper user identification must be made during the transmission. Facilities must be open for inspection by the FCC at any time during regular operating hours. These and many other rules can be found in the FCC Rules and Regulations Manual or can be explained by the manufacturer.

Radio Equipment

Voice radio systems currently are allowed by the FCC for commercial use in three bands--low VHF (25-50 MHz), high VHF (150-173 MHz), and UHF (450-470 MHz). In general, as the megahertz increase, the range diminishes but the voice quality improves (less interference). Because only limited numbers of frequencies are available, frequency selection is a problem. In large cities it may be necessary to use UHF equipment (prices are slightly higher than with the other

two VHF bands) to get a clear channel and avoid sharing the frequency with someone else. In smaller cities it may be possible to secure a low or high VHF band frequency that no one else is using. The range on this type of equipment usually has a 15- to 25-mile radius from the antenna.

Mobile component. The mobile component will be the largest portion of the initial purchase expense. This unit is installed in the vehicle, usually mounted under or in back of the driver's seat with the microphone within reach of the driver. Various modifications such as a telephone handset or footswitch are available, to fit the needs of the operator. Various ranges of power output and solid state options are available.

Antenna. The antenna is important to the performance of the system. The height of the antenna is significant and will be determined by the range desired, the power of the units used, and the topography of the area. Naturally, the location most central to the bus routes needs the smallest antenna. The antenna often can be located on an existing tower or tall building, thus cutting the cost of installation. In some cases, the most central location may be in a valley; therefore, a nearby hill might be best. If the antenna is not at the dispatch site, it will be necessary to locate the base station at the antenna site and use it by remote control at the dispatch office, via a leased phone line. Antennas are relatively inexpensive, but towers for mounting them can become very expensive if great height is necessary.

Base station. The base station is the control point for the system. Small models may be of desk-top size, while larger and more sophisticated ones may take up space similar to a filing cabinet in addition to a desk panel. A desk or boom microphone may be used by the dispatcher. As noted before, the station may be located at the antenna site, with only a control panel at the operating location.

The mobile component, the antenna, and the base station are essential to all systems. A basic rule in radio work is that the more simple the system is, the better it is. Increased complexity greatly increases initial cost, maintenance cost, and down time. However, additional items may be added where needed, such as squelch controls, to weed out others on the same frequency, or various other means of selectivity whereby the dispatcher can call a particular bus or group of buses. These items may increase the price of each mobile unit from 10% to 40%.

Most radio operations currently in use are covered by a maintenance contract with the manufacturer's authorized service agent. This way of operating usually is the cheapest and most effective. The contract usually will be

set up to provide continuous coverage on the base station at the user's premises and pick-up service on mobile units. The service agent will visit the garage, pick up broken units that have been pulled from buses, fix them in his own shop, and drop them off again. With proper maintenance, good line equipment can be expected to last 10 years or more.

Other Systems

Other communication systems are possible, but few are practical at the current time. These systems have evolved into two basic types--a route-monitoring system, in which the bus is registered automatically as it travels its route; and a triangulation system, in which the bus is located by the direction of its signal from different receiving points. This pinpoint degree of control is probably unnecessary in small operations.

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