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Train Crew Reduction for Increased Productivity of Rail Transit

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Train Crew Reduction for Increased Productivity of Rail Transit

Abstract

With the increases in wages since the 1950s, labor costs have become the dominant portion of operating costs for transit agencies. Efforts to increase productivity of operating labor have been particularly successful on rail transit systems. For example, development of high-capacity articulated cars, provision of separated rights-of-way and introduction of self-service fare collection have resulted in an approximately 20-fold increase in productivity of light rail transit systems.

The report shows that while the modern rail transit systems (e.g. Lindenwold Line, San Francisco BART, Atlanta's MARTA) have one-person train crews and thus very high productivity, most older streetcar, rapid transit and regional rail systems still have obsolete, inefficient labor practices.

A systematic analysis of alternative ways of performing different duties shows that on many existing transit systems productivity of operating labor can be substantially increased through rather modest efforts. This has been illustrated in two actual cases. The greatest potential benefits from introduction of modern operating methods exist on regional rail systems. Existing rapid transit is another mode on which labor productivity can be substantially increased. Cooperation of labor unions should be obtained by retaining jobs through increased service frequency, or by passing on a portion of the savings to the operating employees in form of increased wages for increased duties.

Keywords

Light rail operations, Rail transit operating costs, Rapid transit train crews, Regional (commuter) rail train crews, Train crew, Labor productivity

Disciplines

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UNIVERSITY of PENNSYLVANIA

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FOR
INCREASED PRODUCTIVITY OF RAIL TRANSIT

9.14

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with Research Fellows:
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1. INTRODUCTION

1.1 Productivity in the Transit Industry

One of the basic measures of efficient operations of transit systems is their productivity. The concept of productivity is broad and it can be measured by several different indicators. Generally, productivity is defined as quantity of output divided by quantity of input, i.e., the amount of output produced through utilization of a unit of resource.

In passenger transportation the "product" or output can be measured by such units as seat-, space-, vehicle- or train-kilometers (offered service), or passenger-kilometers (utilized service). The "resource" or input can be manpower, energy, total or operating costs, etc.

The higher the productivity, the lower the unit cost of transit system operation. Thus high productivity means either low costs for a given volume of transit service, or a large volume of service provided for a given cost. This is always a desirable goal, but in recent years, with the sharpening financial difficulties in the transit industry (as well as many other branches of transportation, for that matter) the importance of increasing productivity has become even greater. Since labor wages have been increasing at a faster rate than most other costs, labor productivity has become one of the particularly important issues in transit.

Since operating personnel in transit usually represent a substantial, sometimes dominant portion of its labor force, productivity of operating personnel is the major determinant of overall labor productivity in transit agencies. This study focuses on labor productivity in operations of rail transit systems. The focus is on rail systems since rail modes have a considerable potential to achieve an extremely high level of labor productivity through utilization of modern operating practices which have not yet been introduced in many cities.

Transit vehicles which are operated as single units have, in most cases, already achieved the maximum degree of labor productivity which such modes can ever achieve: one person (driver) represents the absolutely minimum crew size which can be used on buses, trolleybuses (and all other highway vehicles), and on single streetcar vehicles.

The high labor productivity on rail transit systems is caused by the very large size of rail vehicles, the ability to operate in trains, their high performance due to electric traction, and high speed on semiprivate or private rights-of-way which most rail transit systems have.

The most practical unit for measuring operating crew productivity is space- (or seat-) kilometers "produced" per one crew member per hour. This unit of productivity of offered service is directly related to the productivity of utilized service.

The space-kilometers produced by one person-hour depend on three factors: capacity of the transit unit (TU - vehicle or train) operated, the crew size, and operating speed. This study focuses on vehicle capacity and crew size, i.e. the number of spaces per crew person. Operating speed is, of course, of great importance, but it is somewhat independent of the problem analyzed here and it is therefore not included.

1.2 Present Rail Transit Operations

With respect to TU crews on rail systems, there are presently a great variety of practices. In streetcar/light rail mode, the operating practices range from one operator per standard 4-axle car (thus a 3-person crew for a 3-car train) to one person per two 8-axle or three 6-axle cars. In regional rail, crews vary from two to seven persons.

Generally, in countries with high labor wages crew sizes have been reduced drastically to lower operating costs, while in developing countries large crews can still be found. The U.S. has not quite followed this path, since in this country one can find a wide range of practices from one-person crew per 10-car rapid transit train (BART) to 3-person crew on 3-car trains of short streetcars, or, until recently, of 4-car rapid transit trains (both in Boston). It is thus obvious that a number of our systems require further modernization to increase productivity of operating personnel. Further modernization is feasible, and highly desirable for economic reasons.

1.3 Purpose and Scope of Study

There has been traditionally a strong resistance in many transit agencies to change operating practices with respect to TU crew sizes. A typical explanation is that the "European practices" cannot be used in this country. In recent years however, newly opened rapid transit systems and several light rail transit systems in North America have shown that European practices are directly applicable and usable here, and that they can drastically increase efficiency of our transit systems.

It should be mentioned that at least one of our rapid transit systems (the Lindenwold Line) has been considered (both in the United States and throughout the world) as being in the forefront of high operating personnel productivity.

The purpose of this study is therefore to systematically review the issues in determining crew sizes in rail transit, to review the current practices in different cities, and to examine the possibilities of reduction of train crews, particularly on existing transit systems. Several closely related issues, such as the function of station personnel and productivity in terms of the product of capacity and speed, as well as several others, are mentioned, but not covered here in detail. The scope of this study has thus been generally limited to the sizes of TU crews in rail transit.

2. RAIL TRANSIT MODES AND THEIR CREW DUTIES

The inherently different methods of operation of streetcars/light rail, rapid transit and regional rail modes make the duties of their TU crews also different in character. Moreover, within each mode there are different crew sizes and, consequently, different operating practices. For the purposes of analysis of TU crews and their duties, all rail transit systems will be classified in the following section into seven categories on the basis of their crew sizes: two streetcar/light rail (LRT), two rail rapid transit (RRT), and three regional rail (RGR).

2.1 Mode Categories Defined by TU Crew Sizes

Each of the three basic rail transit modes is first described; then its different categories on the basis of crew size are defined.

2.1.1 Light Rail Transit. This mode is electric rail transit consisting of 1- to 3-car TUs operating on partially or fully separated rights-of-way, (and exceptionally also on streets). Stations are unattended except for some high volume stations in the CBD which have attendants and barriers for fare collection. Only manual driving is possible because of grade crossings or street running.

LRT-1: One crew member (the driver) per TU.
Driver supervises fare collection, checks "flash" tickets, or allows free entry (self-service system). Alternatively, the driver may sell tickets to those passengers without prepaid ones.

Driver controls doors and supervises passenger boarding. He also announces stations.

Vehicles may be large (articulated cars), and in some cases TUs may consist of two to four cars.

LRT-2: There are two types of systems in this category:

1. Driver plus conductor: the driver has no other duty except driving; the conductor controls fare collection, operates rear doors, supervises passenger boarding, etc. There are no North American operations of this type.
2. MU operation: the driver is in the lead car and an attendant is in each trailing car. The attendants perform all duties for their cars that the driver does for the lead car except driving.

Such systems normally operate MU for part of the day and as LRT-1 for the rest of the day.

2.1.2 Rail Rapid Transit. This mode includes rail transit systems with fully controlled R/W (category A) and stations; therefore fully automated driving is theoretically possible. TUs consist of up to 6 or 8 cars (exceptionally 4 or 10). All stations are either attended or have automatic fare collection. Fares are collected in stations before the passengers enter platforms. On board fare collection is uncommon (e.g. at night on some systems). Platforms are high-level.

RRT-1: The driver is the only crew member. In addition to driving, he controls the doors and announces stations via a public address system. On a few systems (Cleveland, Skokie in Chicago) he also collects fares.

RRT-1 systems are often, but not always, equipped with automatic train control.

RRT-2: Crew consists of the driver plus one or more other persons whose main duty is to control the doors.

The extra crew member(s) may also collect fares at low volume stations or during off-peak periods.

2.1.3 Regional Rail. Often called "commuter railroads," this mode consists of electric or diesel trains, usually with MU operation, running on railroad rights-of-way. Stations are generally placed much farther apart than those of rapid transit (running time greater than 2 minutes between stations is normal). Stations can be attended or unattended, but there is usually free access to the platforms (no barriers). Platform heights may be either all low, all high, or mixed (some low and others high-level).

RGR-1: In a low-volume operation the driver may be required to collect tickets in addition to controlling the doors and driving. This category is extremely rare; there are no examples in North America.

RGR-2 One driver plus another crew member who may primarily control doors, collect tickets, or both.

Most modern RGR systems operate with 2-man crews. Some operate as RGR-2 during off-peak periods when 1-car trains are used; at other times (with MU operation) more crew members may be required.

RGR-3: In the United States, such systems operate under class I railroad rules.

Doors are often manual and may have traps to enable operation at both low- and high-level platforms.

Tickets are sold either at stations or by conductors. Every passenger is checked for his fare payment by a conductor.

In summary, rail transit systems are classified for the purposes of crew size analysis into the modes listed in Table 2.1.

Table 2.1 Designations of rail transit categories by crew size

Basic mode	Crew size	Category designation
1. Light Rail Transit	1	LRT-1
2. Light Rail Transit	<u>>2</u>	LRT-2
3. Rapid Transit	1	RRT-1
4. Rapid Transit	<u>>2</u>	RRT-2
5. Regional Rail	1	RGR-1
6. Regional Rail	2	RGR-2
7. Regional Rail	<u>>3</u>	RGR-3

2.2 Definitions of Crew Duties

A detailed examination of operating practices on most rail transit systems, including all rail modes, has shown that all activities which crew members must perform can be classified into 17 duties. Naturally, most duties must be performed on each mode (e.g. driving, fare collection), but some of them are required only on one of the modes (e.g. raising or lowering door traps and changing directions of seats are performed on RGR systems only).

The 17 duties are defined here.

1. Driving - The control of all train movements between stations, terminals, yards, etc., with or without the help of automatic controls.

2. Train Inspection - The verification of brakes, at the beginning of the run to insure that the train can be operated safely; also, anything needing repair discovered during the course of the run is reported to maintenance personnel.

3. Reporting at Terminal - Reporting the train arrival after its run is completed. Performed on a few systems only.

4. Coupling/Uncoupling Cars - Moving the train sections into proper position, and coupling/uncoupling the section.

5. Communications with Control Center - Communications involving train operation, normally using radio equipment in driver's cab; can also include written train orders handled by line side (or station) personnel.

6. Announcements - Giving passengers information such as the name of the next station, using the train's public address (PA) system or calling out in each car.

7. Opening Doors - Opening all doors at once, automatically; or each door individually, manually.

8. Door Supervision - Checking to see that all passengers are clear of doors before closing them; may also make warning announcement ("Watch the doors").

9. Closing Doors - Manual or automatic, allied with door supervision.

10. Moving Traps - Covering or uncovering steps to allow passengers' boarding and alighting at either low or high platform stations (Philadelphia, New Jersey and Chicago - South Shore).

11. Signalling Departure - Letting the driver know that the doors are closed and the train is ready to depart.

12. Changing Seats - Adjusting seats to face forward, when train direction changes. A decreasing number of cars have this feature.

13. Passenger Information - Answering questions for passengers and perhaps volunteering useful information to individuals (e.g. "Change at Jamaica").

14. Fare Collection - Either collecting money from entering passengers, or selling and collecting tickets on board.

15. Fare Control - Checking to see that passengers have paid proper fare. May be done at random by roving inspectors, or regularly by train crew at boarding, during train travel or prior to alighting.

16. Security, Safety - Controlling order and dealing with unruly passengers. Warning passengers if they are doing something unsafe.

17. Emergencies - Interventions in irregular events (train breakdown, power failure, obstacles on tracks, sick passengers, etc.) through appropriate actions, such as repair, removal of problem, communication with control center, informing passengers about the interruption, etc.

Table 2.2 presents a list of the 17 duties with designations of applicability of each duty to the three rail modes. Sequence numbers of individual duties from the table will be used in later tables.

Table 2.2 Duties of rail transit crew members by modes

Sequence number	Duty	SCR/LRT*	RRT	RGR
1	Driving	x	x	x
2	Train inspection			x
3	Reporting at terminal			(x)
4	Coupling/uncoupling	x	x	x
5	Communications with control center	(x)	x	x
6	Announcements	x	x	x
7	Opening doors	x	x	x
8	Supervising doors	x	x	x
9	Closing doors	x	x	x
10	Moving traps	x		x
11	Signaling departure	x	x	x
12	Changing seats			x
13	Passenger information	x	x	x
14	Fare collection	x		x
15	Fare control	x	x	x
16	Safety and security	x	x	x
17	Emergencies	x	x	x

*SCR = streetcar

(x) = Few applications.

2.3 Alternative Methods of Performing Crew Duties

In order to analyze operations on the existing rail transit systems and examine possibilities for crew reductions on some of them, a systematic review of all practically possible alternative methods for performing each duty has been developed. The alternatives are described and examples of their uses are given for the less common ones.

1. Driving. The movement of the rail TU can be controlled in one of three ways:

a. Driver, located in the front of the first car, manually controls the movements of the TU. He can either drive on visibility only, or have various assisting or controlling signal systems and devices.

b. Computer-assisted automated system controls the movement of the TU. A driver, however, is present in the cabin to supervise the operation, react to unexpected situations, and insure safety. This system requires higher investment than the manual, but it allows more efficient movement of trains. Since the automated control can be used only on private rights-of-way (category A), it can be applied only on RRT and RGR modes. Examples are Washington Metro, San Francisco BART and PATCO's Lindenwold Line.

c. Computer-controlled, automated system controls the TU alone. There is no crew member to oversee the operation, except from a centralized, remote control location. This system is presently in operation only on AGT modes. The only such mode in a real transit role is the Morgantown "people-mover" system.

2. Train Inspection. In most cases rail cars are tested in maintenance yards prior to entering service. The driver must normally always observe car performance and report if any problems arise. On some systems, however, the train crew is required to test brakes (sometimes a few other mechanisms) prior to each run. Thus the alternative ways of performing train inspection are:

- a. By maintenance personnel in the yards; and
- b. By train crew on the line, once per day or before every run.

3. Reporting at the Terminal. Recording of the train's arrival at a terminal can be done:

- a. In a logbook kept by a crew member;
- b. Reporting (by a voice or signal) by a crew member;
- c. Automatically through a system monitoring movements of TUs.

4. Coupling/Uncoupling Cars. This duty can be performed by:

a. An employee stationed in the yard or at other locations where this action is done;

- b. A crew member (not driver);
- c. Driver through an automatic push-button control in his cabin.

5. Communications with the Control Tower. This can be the responsibility of:

- a. Driver;
- b. Another crew member;
- c. Passengers who can use an emergency phone on board each car in TU.

6. Announcements. Passengers aboard transit systems often need information about station stops, other transit routes, delays, etc.

This information can be relayed to the riders in the following ways:

- a. Graphic information on board the trains and in stations can replace most on-board announcements and thus reduce the need for on-board personnel.
- b. Crew, either directly or using a public address (PA) system can inform the passengers.
- c. Driver can inform passengers via a PA system.
- d. Automated system announces station stops and/or announcements are made from a centralized location off the train.

7. Opening Doors. There can be two different types of doors on rail vehicles and each one is opened in a different way.

Manual doors must be opened by a crew member. These hinged doors are used on RGR only and they are frequently left open during train travel (e.g. Philadelphia, New York). The passenger compartment of the train usually has an additional door, which passengers can open to enter or exit.

Mechanical doors are controlled by an electric switch. This type of operation makes multiple door control from the single switch possible. The switch can be operated by different methods and with different people controlling the operation. The alternative operating methods are:

a. Passengers activate a treadle or open the doors by a button or by hand. This switch is only functional at the discretion of the driver or crew when it is certain that the vehicle is in a safe position to release passengers. Usually these controls are locked when a TU is in motion.

b. A crew member can open the doors with a key-activated switch or by a push-button at a location not accessible to the passengers. The key or the separation is necessary to insure that no door is opened when the vehicle is in motion.

c. Driver can open the doors from his cabin.

Each method requires the decision maker (driver or crew) to make sure that the vehicle is in a safe position for boarding or alighting.

8. Supervising Doors. Passenger boarding and alighting can be observed in the following ways:

a. A crew member stands on the platform or looks from a train window;

b. Driver looks from the window of his cabin;

c. Station attendant;

d. There is no supervision, but there is a warning for passengers that doors will close and all doors have sensitive edges to prevent "catching" a passenger.

These methods are adequate for all systems with high level platforms. LRT and RGR systems on which vehicles have high first steps require on-location supervision and assistance to insure safe boarding and alighting.

9. Closing Doors. Manually operated doors on transit (RGR) vehicles are usually not closed after every station. Automatic doors are closed from a single control point, or automatically. Closing from a central location comes usually from a driver's cab, either in the first or in some other car. Automatic closing comes after a predetermined standing time interval. In either case a voice warning or a buzzer warns passengers prior to door closing. Thus door closing can be done by:

- a. A crew member (non-driver);
- b. The driver;
- c. Automatic pretimed control.

10. Moving Traps. Traps that change the doors from low to high level use are moved in two ways:

- a. A crew member changes the entrance of the vehicle by lifting a metal plate that covers the steps, or lowers the plate for high-level boarding.

- b. Steps are mechanically transformed into a flat surface for high level boarding and back into steps for low platforms. This transformation can be controlled at the door by a crew member, by a crew member not at the door, or by the driver.

11. Signalling Train Departure. After the door closing, the person who supervised them must inform the driver that all doors are safely closed, so that the train can start. Another signal must also exist for emergency use: if something goes wrong after the signal for door closing was given, there must be another signal which cancels the preceding one and tells the driver not to start, or to stop if he has started.

Train departure signal and emergency stop signal can be given by:

- a. A crew member;
- b. A station attendant;
- c. Automatically after the doors have been closed;
- d. Nobody - the driver observes and controls the doors

throughout station standing period and departure.

12. Changing Seats. Rolling stock on some RGR and LRT systems has seats which can be turned in either direction. These seats are flipped so that passengers always face forward. This can be the duty of:

- a. Driver, at the end of the run;
- b. Other crew members;
- c. Employee stationed at the end of the run;
- d. Seat arrangement left to the discretion of the passengers.

Note: these types of seats are becoming obsolete and their use will decline as rolling stock is replaced.

13. Passenger Information. Route and schedule information, as well as other pertinent facts, can be given to the passengers by:

- a. Crew members, directly or using a PA system;
- b. Driver, using a PA system;
- c. Station attendant;
- d. Telephone. Either, a special phone within the transit system that is hooked into an information network; or, a phone number;
- e. Regular information disbursement means, such as: signs, route maps and schedules, information booths, etc.

14. Fare Collection. Cash from passengers can be collected by:

- a. Automatic machines that issue fare cards to be used for entrance or to be checked on board.
- b. Fare boxes/turnstiles;
- c. Cashiers;
- d. Crew members;
- e. Drivers;
- f. Prepaid tickets (monthly commuter tickets, passes, etc.)

15. Fare Control. Fare payment can be checked by:

- a. Automatic gates activated by coins, tokens, or fare card;
- b. Crew on a regular basis, usually during the travel;
- c. Driver during passenger boarding or alighting;
- d. Controllers on a spot check basis.

16. Safety and Security. The safety and security of the passengers can be provided by:

- a. Crew on the train;
- b. Driver;
- c. Station attendant(s);
- d. Transit police or regular police at stations and on board the vehicles;
- e. Closed circuit TV, usually combined with a PA system.

Note: other operations procedures could be undertaken in an effort to provide a sense of safety and security to the passengers. Shorter trains to compact passengers, more frequent services to

discourage crime in stations, and closing some stations during off-peak periods are some of these methods.

17. Emergencies. Emergency procedures can be handled by:

a. Crew members;

b. Driver over a PA system;

c. Supervisor or other system personnel not on board the train over the communications system*.

2.4 Train Crews and Station Personnel

Some of the duties defined in the preceding section can be performed either by a train crew member, or by station attendants. In reducing the number of operating personnel these alternatives are considered: keeping 2-person train crews (typical for older RRT systems) and eliminating station personnel (Cleveland uses this practice during off-peak hours), or retaining station personnel, but reducing train crews to one member (typical for several new RRT systems, such as BART and Washington Metro).

The basic factor of selecting between these two alternatives is the number of stations (and their design which may require more than one station attendant) and the number of trains in operation. If the former is greater than the latter, station attendants should be eliminated, and train crews should perform all duties; on the lines with few stations and high density of trains it is more economical to reduce train crews by giving some of the duties, such as door supervision, station announcements, fare collection or control, to station attendants. In most cases station attendants are not busy most of the time and they can perform these duties without serious problems.

Since the number of trains varies greatly during different periods of day, some transit systems (Cleveland is the best example) use station attendants during the peaks, while an additional crew member replaces the station attendants in collecting fares during off-peak periods.

*Communications from a TU can be: 1) Non-existent, 2) One-way emergency signal from train, 3) PA system into train, 4) Two-way communications between driver and control center, or 5) Two-way communications between the driver and passengers in other cars.

Most LRT systems have no station attendants. This is possible because their trains are relatively short and some of the duties are considerably simpler than with RRT and RGR modes. Under certain conditions, however, the RRT and RGR modes can also operate with one-person crews and no station attendants. This is possible only with careful planning of operations and station design which allow automatic fare collection, centralized station surveillance, simple train departure procedures, etc.

3. THE PURPOSES OF TRAIN CREW REDUCTIONS

Why was it possible several decades ago to operate small street-cars with 2-person crews and rapid transit trains with one person per car, while now most transit systems try to operate one-person train crews? The reasons are simple and well-known.

3.1 Reasons for Crew Reduction

Ever since the automobile competition to transit became severe, transit has been seriously neglected in urban transportation policies and in financing. This neglect caused deterioration of service, which in turn decreased transit usage, further reducing revenues of transit operators.

The need for labor cost reductions in transit has been further intensified by the fact that labor costs have generally been growing considerably faster than other costs. Thus the percent of total operating costs going to labor has steadily grown, and in most transit agencies it amounts to some 60-80% of total operating costs.

3.2 Past Responses of Transit Agencies

Transit operators in U.S. cities were among the first in the world in the 1930s to introduce one-person crews on all street single-vehicle transit systems: streetcars, trolleybuses and buses. This led to a significant increase in labor productivity and, consequently, decrease of labor costs. That was, however, the last innovation resulting in an increase of operating personnel productivity for several decades. Several other developments occurred in the meantime which actually decreased productivity in street transit modes. These were:

- Replacement of streetcars by buses with approximately 20% lower capacity;
- Loss of separate streetcar rights-of-way on many lines, resulting in lower operating speed of transit;
- Increasing street congestion, also decreasing operating speed.

A drastic increase in rail transit labor productivity occurred only when new RRT systems were built: the Lindenwold Line in Philadelphia and RRT systems in San Francisco, Washington and Atlanta introduced one-person train crews. But very few RRT and RGR systems opened before 1965 have changed their operations and labor practices since the 1930s (or earlier). They still operate with obsolete methods and these systems have a considerable underutilized potential for reducing operating costs through increased labor productivity.

3.3 Potential Crew Reductions and Benefits from It

Figure 3.1 shows transit operating personnel productivity as a function of crew size for the three modes, LRT, RRT and RGR. The productivity is expressed in space-kilometers per crew member-hours; spaces refer to total vehicle capacity, including seats and standing spaces. The numbers are computed on the basis of typical values for vehicle capacity and operating speed found for each mode. Different speed values would actually change the absolute numbers, but not the relationship of productivities for different crew sizes.

The diagram shows LRT mode with non-articulated and articulated rolling stock, and with TU crews from 3 down to 1. The increase in productivity is in both cases highly significant. RRT mode is shown for 2-, 6- and 10-car TUs and crew sizes again from 3 (Boston)* to 1 person (San Francisco). RGR mode is also plotted for 2-, 6- and 10-car TUs, but their crews vary between 8- and 2-persons. For both RRT and RGR modes, productivity increase accelerates as crew sizes decrease.

It is very important that reductions of crew sizes do not result in either lower safety/security, or in lower level of service. Security is a very critical element of transit services in our cities and it cannot be decreased; deterioration in level of service could also be self-defeating through losses of ridership it could cause.

*Only recently 3-person crews on Boston RRT have been changed into 2-person crews.

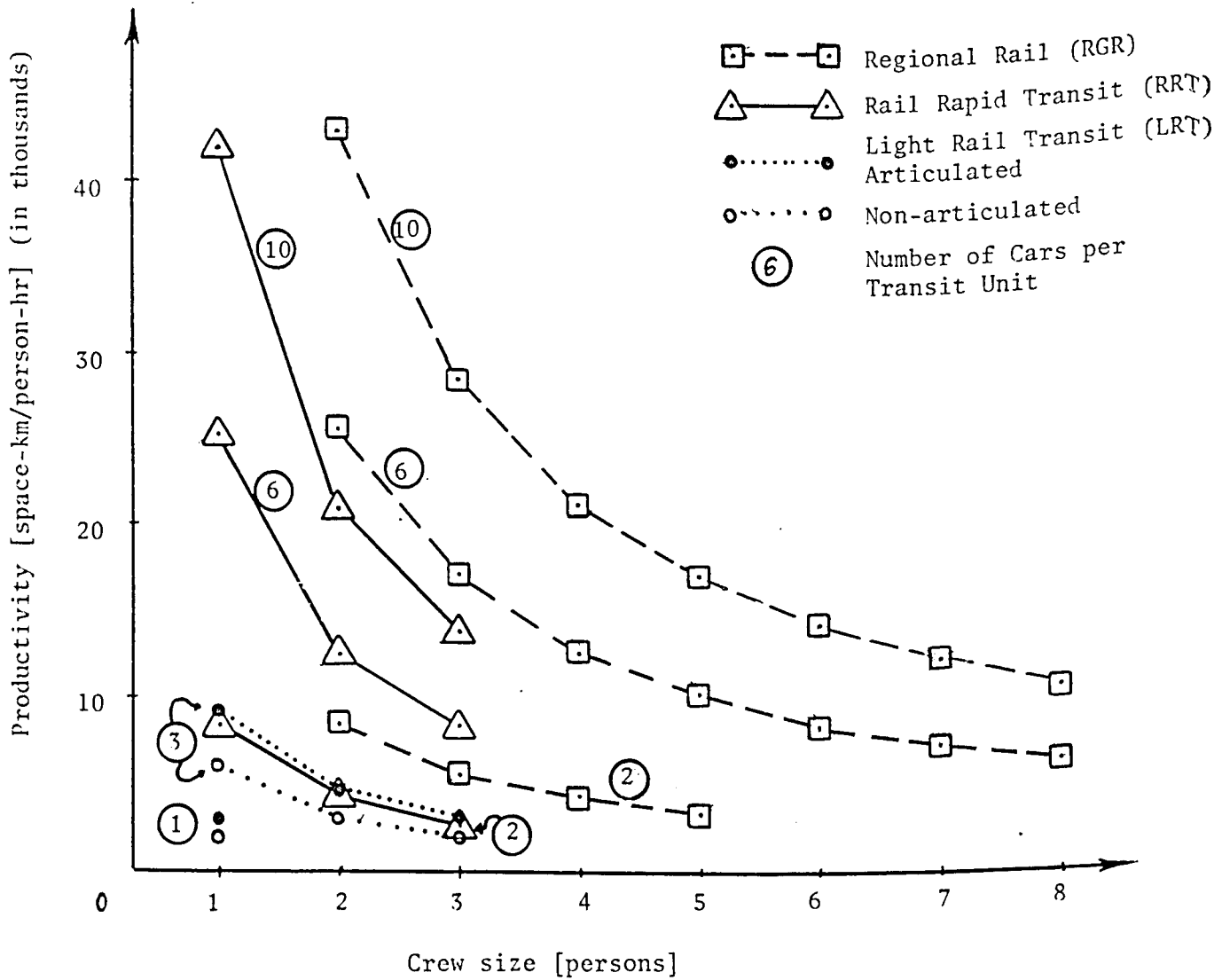


Figure 3.1 Operating personnel productivity as a function of crew size

Since some crew members have a role in maintaining passenger safety and security, special effort must be made to insure that the same or improved safety is provided through various automatic devices, control mechanisms, communications devices, etc.

Later sections of this report will show that maintaining the same level of service with smaller crews presents in most cases no problems. Actually, in many cases crew reduction may permit increased service frequency and thus improved level of service.

The benefits from reduced crew sizes are basically economical (reduced costs), but they can be translated into other forms. For example, a change in rapid transit operation from 2- to 1-person crews, described in Section 5 of this report, can be translated into the following benefits:

1. Reduce the number of operating personnel and maintain the same service. Benefits: reduced operating costs.

2. Retain the same operating personnel, but change the crew members released from duties into security officers. Benefits: increased security.

3. Retain the same operating personnel, but split trains into half-size units (e.g. one 8-car train into two 4-car trains) and provide service with double frequency at the same cost. Benefits: increased level of service.

In most cases a combination of two or three of these benefits is the best solution. For example, present service with 6-car trains operating with 8-min. headways would be replaced by a service with 3-car trains operating with 4-min. headways, so that both reduced operating cost (less personnel) and improved service (shorter headways) would be obtained.

4. CREW REDUCTION ON LRT SYSTEMS

Oversize crews and obsolete operating practices are not as serious a problem in LRT as they are on RRT and RGR systems. However, there are several LRT systems in the United States which could accrue certain benefits from reduction of LRT train crews through various modernization measures.

4.1 Labor Productivity Increase on LRT Systems in Recent Decades

No transit mode has made such remarkable progress in increasing labor productivity in a span of only approximately 25 years (between mid-1950s and late 1970s) as has been the case with streetcars/LRT. Actually, the changing operating practices resulting in increased productivity have been part of the transition of many systems from streetcars to light rail transit (LRT) mode. A review of LRT rolling stock and types of operation (characteristic for different stages of development) is presented in Figure 4.1. It should be mentioned that virtually all this progress took place in West European countries, since the practice of using longer TUs has had much longer tradition in those countries than in North America. It has been only in recent years that several cities in North America have adopted the latest advances in LRT system technology and operations from West European countries.

Major steps in this developing process, shown in Figure 4.1, were as follows. Many European cities have long kept the traditional operations of streetcar trains consisting of a motor car and two trailers, all of them 2-axle vehicles (case I in Fig. 4.1). During the 1950s, and in some cases even considerably later, one could see three 10 m-long cars running on streets. This 30 m-long TU had a total capacity of approximately 240 spaces and a crew consisting of a driver and one conductor for each car. As the table in Fig. 4.1 shows, this operation gave a productivity in terms of capacity per crew member of 60 spaces.

To obtain higher riding comfort, capacity and labor productivity, many cities began to introduce in the 1920s, and expand especially during the 1950s, the use of 4-axle vehicles, where one motor car tows one trailer (IIa). This TU had a 3-member crew, resulting in a productivity of some 73 spaces per crew member.

Years (approx.)	Cities	Length of T1[m]	Capacity [spaces]	Crew size	Capacity/crew mem.
1910-60	Hamburg, Vienna	3x10=30	240	4	60
1920-80	Belgrade, Cleveland	2x14=28	220	3	73
1940-80	Boston, Gothenburg	2x14=28	220	2	110
1960-80	Cologne, Düsseldorf	28	220	2	110
1965-80	Cologne, Düsseldorf	28	220	1	220
1975-80	Düsseldorf, Hannover	2x28=56	440	1	440
1975-80	Edmonton, Frankfurt, Calgary (1981)	3x23=69	570	1	570

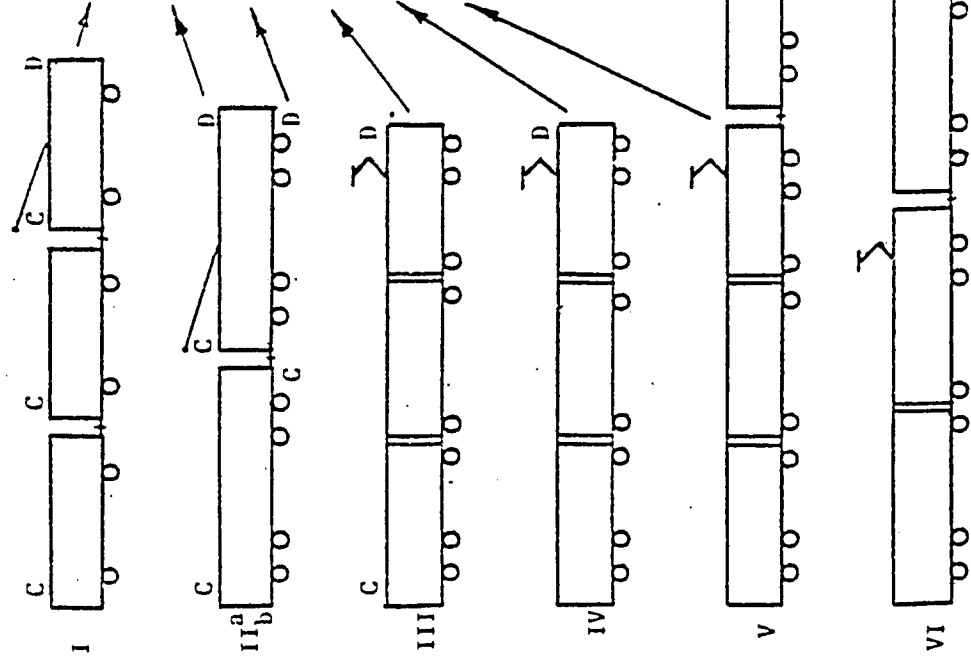


Figure 4.1 Increasing labor productivity on streetcars/LRT through rolling stock and operational innovations, 1950-1980

North American cities operating coupled cars (Boston, Cleveland, Philadelphia-Red Arrow, San Francisco and Toronto) operate the same kind of TUs, the only difference being that both vehicles are motor cars, and that the first car has only the driver, while the second car has a conductor. In this case, shown as IIb in the figure, the productivity increases to 110 spaces/crew member.

As a further step to increase productivity, the city of Düsseldorf (Germany) pioneered in 1957 the introduction of 8-axle doubled-articulated car which had a capacity approximately equivalent to that of a 2-car train, but which needed one driver and one conductor (III). Labor productivity on that car was the same as that in U.S. cities today.

A major breakthrough in the method of transit operation occurred in Europe in the mid-1960s: a full self-service fare collection system was introduced. This system allows simultaneous boarding and alighting through all doors, since passengers are not checked with respect to fares on a regular basis at one point, but only on a spot-check basis during the vehicle's travel. This type of operation, with extensive use of pre-paid tickets, allowed operation of an 8-axle vehicle by the driver only (IV), doubling the labor productivity in comparison to the preceding cases, IIb and III.

In the late 1970s the city of Hannover in Germany opened a new LRT line with carefully designed stations and vehicles and introduced TUs consisting of two 8-axle cars and operated by a single driver only (V). Similar operation is found in several other cities. Labor productivity in this 56 m-long TU jumped to 440 spaces.

A further small increase in productivity occurred when several cities began operation of TU's consisting of three 6-axle articulated cars with a total capacity of 570 spaces (actually, Frankfurt sometimes operates four such cars in a train, although under a regime more typical for RRT than LRT). Productivity of the crew member in this case reaches the extremely high value of 570 spaces (VI).

Reviewing the last column in Fig. 4.1, one can see that LRT labor productivity has increased by a factor of nearly 10 in a span of less than 30 years. The difference is actually even greater when speeds are taken into account. Cases I & II represent typical streetcar lines operating in mixed traffic at operation speeds of 10-12 km/h;

cases V & VI are LRT systems for which operating speeds typically fall in the range of 20-25 km/h. With twice higher speeds, labor productivity in terms of space-km/crew member-hour have actually increased approximately 20 times. No other transit mode has had a similar evolution during a relatively short period of technical and operational modernization.

4.2 Streetcar/LRT Systems in North America

During the long period of total neglect of streetcars in U.S. cities, from World War II until the early 1970s, there were no innovations in their operation. The majority of systems have operated single 4-axle vehicles with a driver.

Under UMTA's assistance the first 6-axle articulated LRT vehicles of modern design were introduced to this continent (Boston and San Francisco). The increase of vehicle capacity did result in increased labor productivity. However, in the cities where 2- and 3-car TUs are operated, the second and third cars still have conductors, i.e., employees who only supervise payments. This is a costly and obsolete practice since this employee does extremely little work and it would be easy to replace him by automated fare collection methods. The only reasons for his presence is a resistance of labor unions and, to some extent, lack of innovative initiative on the part of transit agency managements.

There is no doubt that streetcar/LRT systems in North American have suffered great losses from obsolete practices and reluctance to accept new ideas. Even at the present time Philadelphia and Toronto are purchasing new 4-axle vehicles which are generally considered as obsolete models for modern LRT systems. Virtually no other city in Western Europe and North America is purchasing new 4-axle vehicles for LRT systems.

4.3 Potential Improvements in Labor Productivity

Clearly all existing systems which clearly operate 4-axle cars as single vehicles cannot be made more labor-efficient. One driver on each such vehicle is the absolute minimum crew size that can ever be achieved. Thus no modernization can be used to exceed this level of labor productivity on existing LRT systems. During construction of new and renovation of existing systems, however, there are two methods by which labor productivity can be increased:

- Introduction of higher capacity cars, such as 6- and 8-axle articulated ones. Following the lead in this direction by Boston, Edmonton, San Francisco and Calgary, Cleveland (Shaker Heights) and San Diego will pursue the trend in the near future.

- Operation of the second and third cars in LRT trains without crews. This would be beneficial for new and existing systems which operate TUs with more than one car, such as Boston, Buffalo, Cleveland, Philadelphia, Pittsburgh and San Francisco.

This second operation, of a second car without a crew member, is discussed reluctantly by many transit agencies with the same skepticism which rapid transit authorities had before they eliminated crew members who used to be on each car of rapid transit trains. Now, for many years unmanned cars in rapid transit trains have operated satisfactorily, and there is no reason that one or two cars in LRT trains cannot be operated in the same way.

This innovation could not be introduced immediately on all lines with multiple unit operation, without any discretion. Supervision of doors, discipline of the public and prevention of vandalism would be among the serious problems which must be given full attention. However, the impact of crew decrease on labor productivity would be highly significant, as the diagram in Fig. 4.2 clearly shows.

Table 4.1 presents a review of distributions of duties on LRT systems in selected North American cities. Cologne has been added as representative of operation practices in West European cities.

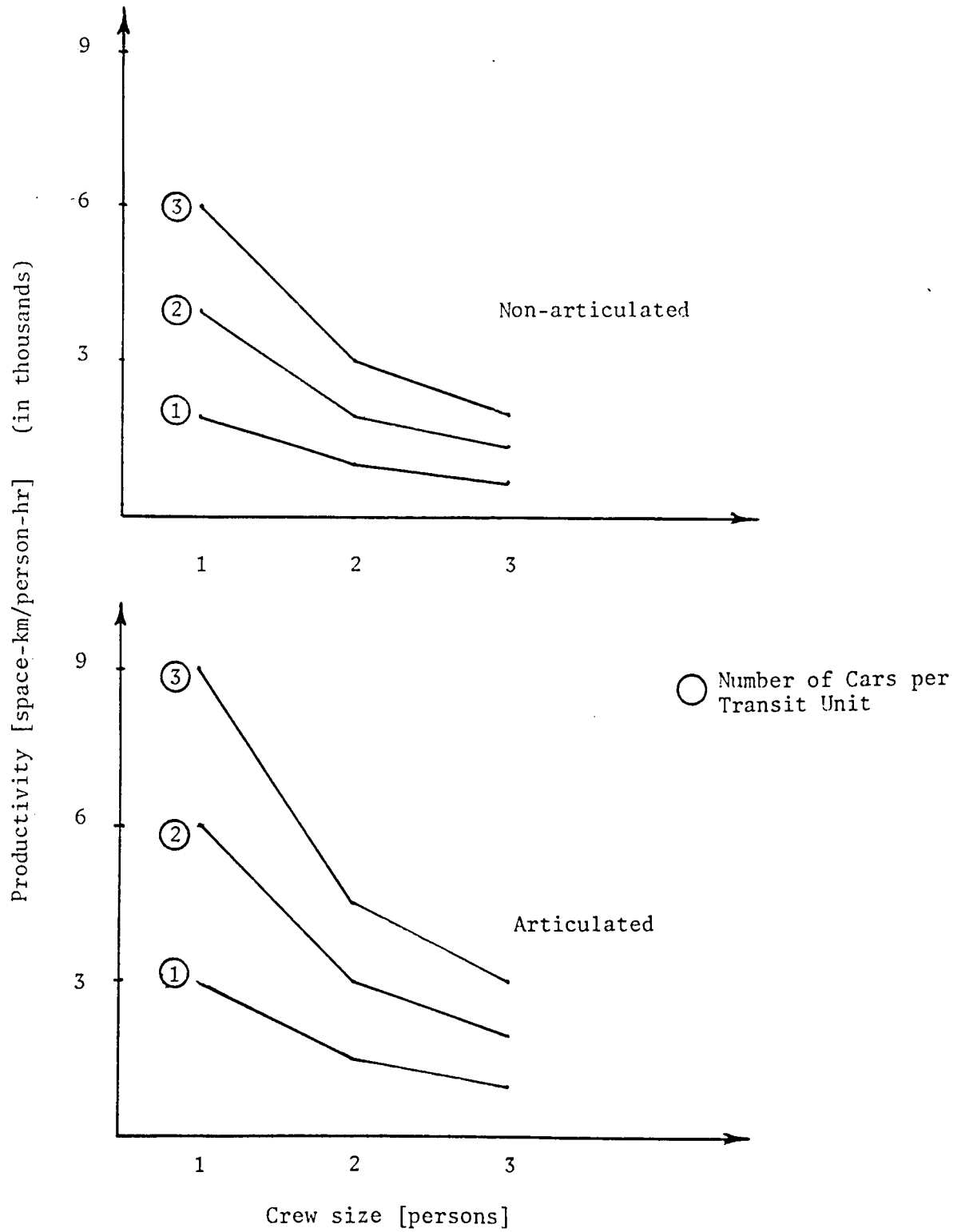


Figure 4.2 Impact of crew size on labor productivity of streetcar/LRT operations

Table 4.1 Crew Duties on LRT Systems

System	# Stn. Persnl	Driving	Inspection	Reporting	Couple/uncouple	Comm. w/ CC	Announcement	Open doors	Superv. doors	Close doors	Traps	Signal depart.	Change seats	Information	Fare collection	Fare control	Security	Emergency
Light Rail I Boston	0-1	D	D		1		D	D	D	A	-		-	D	D,F	-	D	D
Newark, Toronto, N. Orleans	0	D	D		1	-	D	D	D	A	-		D*	D	D,F	-	D	D
Philadelphia	1	D	D	-	1	-	D	D	D	A	-		-	D	D,F	-	D	D
Pittsburgh	0	D	D		1		D	D	D	A	-		-	D	D	-	D	D
San Diego	0	D	D		1	D	D	D	D	A	-		-	D	A,D	R	D	D
San Francisco	0-1	D	D		1	D	D	D	D		A		-	D	D,F	-	D	D
Calgary	0-1	D	D		1	D	D	D	D	A	-		-	D	A	R	D	D
Cologne	0	D	D	-	1	D	D	D	D	A	A		-	D	A,D	R	D	D
Edmonton	0-1	D	D		1	D	D	D	D	A	-		-	D	A,F	R	D	D
Light Rail II Boston (Grn. Line)	0-1	D	D		T		D-C	D-C	D-C	A	-		-	D-C	D,F	-	D-C	D-C
Cleveland (Shaker Hgt.)	0-1	D	D		T		D-C	D-C	D-C	A	-		-	D-C	D,F	-	D-C	D-C
San Francisco	0-1	D	D		D		D-C	D-C	D-C	A	-		-	D-C	D,F	-	D-C	D-C

Codes for personnel

- A = Automatic operation
- C = Conductor or other crew member
- D = Driver
- F = Fare cashier
- R = Roving inspector
- S = Station attendant
- T = Terminal or yard maintenance employee
- * = In New Orleans only
- = Not performed

5. CREW REDUCTIONS ON RRT SYSTEMS

As mentioned earlier, a major portion of the operating costs of transit systems goes to labor wages. Economics of transit operations is therefore heavily dependent on labor productivity. A reduction in the labor intensity of transit operations can accomplish one of two goals. Either, a transit system can maintain a consistent level of service at a lower overall cost, or an increased level of service can be provided with the same amount of operating funds.

The labor force involved in the daily operation of a rapid transit network consists of a variety of operating and support personnel. This study is concerned primarily with the train crews and the possible reductions of their sizes. Station employees are considered only where they have a direct bearing on crew sizes.

5.1 Present Practices on North American Rapid Transit Systems

The information about operating practices and crew duties on rapid transit systems in North America was collected from personal knowledge, through contacts with transit agency officials, and via a questionnaire that was mailed to a number of rail transit operators. This information has been systematized and it is presented in Table 5.1. The table defines which member of the crew, or station attendant, performs each one of the 17 duties (with the exception of those which do not apply to RRT).

With a few exceptions, there are two types of RRT systems in North America with respect to crew sizes. The systems which were in existence prior to 1969 have 2-person crews. One person is the driver, while the other person, the conductor, usually has few duties. Basically the conductor opens, controls and closes doors, then signals the departure to the driver, and has no duties during the travel of the train. This type of operation exists even on the modern Toronto and Montreal systems with only minor variations: in Montreal one person sits in the cabin in the front of the train, the other in the cabin at the end of the train; the one in the front is the driver, the one in the back is the door-controlling person. When the train reverses, the roles of these two persons reverse also.

Table 5.1 Crew duties on RRT systems

System	# Stn. persnl	Driving	Inspection	Reporting	Couple/uncouple	Commun. w/ CC	Announcement	Open doors	Superv. doors	Close doors	Move traps	Signal depart.	Change seats	Information	Fare collection	Fare control	Security	Emergency
<u>Rapid Transit I</u> Atlanta	0	D(A)	T	D	D,T	D	D	D	D	D	-	D	-	-	A	A	R	D
Philadelphia (Lindenwood)	0	D(A)	D	A	D	D	D	D	D	D	-	A	-	D	A,R	A	D,R	D,R
San Francisco, Washington D.C.	1-3	D(A)	T	-	D	D	D	A	A	A	-	D	-	S	A	A	D,R	D
Berlin	2-4	D-A*	D-T		T	D	D,S	D,P	S	D	-	S	-	D,S	R	A	R	D,S
Munich		D	D		T	D	D,A	D,P	D	D	-	D	-	D,A	R	A	R	D,S
<u>Rapid Transit II</u> Boston, Chicago, Philadelphia	1-3	D	D		T	D	-	C	C	C	-	C	-	F	F	F		D,C
Cleveland	0-1	D						D-C*	D-C*	D-C*	-	D-C*	-		D-C* -F*	D-C* -F*		D-C
New York (NYCTA)	1-3	D	D	D-C	D	D	C	C	C	C	-	C	-	F-C	F	F		D-C
New York (PATH)	0	D			T	D		C	C	C	-	C	-	C	A	A		D-C
Montreal		D						C	C	C	-	C	-					D-C
Toronto		D	T	D-C	T	D	D	C	C	C	-	C	-	D-C	F	F	D-C	D-C

Codes for personnel

- A = Automatic operation
- C = Conductor or other crew member
- D = Driver
- F = Fare cashier
- R = Roving inspector or police
- S = Station attendant
- T = Terminal or yard maintenance employee
- * = Performed on a partial or non-systemwide basis
- = Not performed
- P = Passenger

Two other systems have some special features. Boston rapid transit has one conductor for every two cars, so that its 4-car trains have 3-person crews, the largest rapid transit crews in the world. Needless to say, the duties of the crew cannot keep even one person busy, so that there is absolutely no justification for having two persons performing such limited duties. This antiquated operation is retained only because of obsolete labor contracts and regulations which cannot be justified by acceptable, rational reasons.

The Cleveland rapid transit system, opened in 1955, applies a great flexibility in crew employment. It operates with both 1- and 2-person crews, depending on the time of the day. During peak hours, stations have attendants and trains operate with 2-person crews, the conductor only controlling doors. During off-peak hours, most stations are not attended, with fares collected on trains. Two-car trains have 2-person crews, one-car trains have the driver only, who also collects fares.

The second group of RRT systems consists of those which started operations since 1969; Lindenwold Line in Philadelphia, San Francisco BART, Washington Metro and Atlanta MARTA. All these systems have "crews" which consist of one person - the driver - who performs all the duties: drives the train (which is in most cases automated), opens, supervises and closes doors, communicates with the control center, etc.

This second group of systems can be divided into the ones with station attendants, and those without station attendants. The former group includes BART and Washington Metro. The latter includes the Lindenwold Line and Atlanta.

Overall, practices with respect to crews and station attendants on North American rapid transit systems ranges from the most labor intensive and obsolete one in Boston with 2- and 3-persons crews and station attendants, to the Lindenwold Line and Atlanta with one-person train crews and no station attendants.

5.2 Potential for Crew Reduction and Its Implementation

In view of the fact that on all RRT systems with 2-person crews the second person has very few duties to perform, it should be a realistic goal to convert these operations to one-person crews. Exceptions may be found in such systems like New York, where passenger volume is very large, and presence of the second man may be needed for various other reasons. However, even in such cases considerable

benefits can be achieved by reorganizing the door control duty of the conductor (in most cases giving it to the driver) and thus freeing the conductor to perform more duties on the train than he presently does.

The potential increase in productivity which can be achieved through crew reductions on RRT can be seen from the diagram in Figure 5.1. Changing from 2- to one-person crews doubles the number of space-km per crew member, or it reduces labor costs by 50 percent. In order to reduce the size of the crew on a rapid transit unit, such a change must be acceptable to both the transit agency and the riding public. Therefore two aspects of the operation must be satisfied:

1. The overall safety of the system must not be adversely affected; and
2. The overall system performance (speed, reliability, etc.) must not be reduced.

To achieve these two requirements, all existing crew duties must be carefully examined and reassigned to the reduced crew. Since most duties of the second member are primarily related to safety, this aspect must be of primary concern.

The analysis of crew reduction must begin with an examination of typical crew responsibilities. If these responsibilities are performed satisfactorily in a one-person operation, all the safety and operating requirements will be satisfied.

In general, on a train with more than one crew member, the driver is responsible for driving only. All other duties are usually delegated to the remaining crew member(s). In order to reduce the size of the crew to one member, all these duties must be reorganized in one of the following ways:

- Assigned to the single crew member;
- Accomplished by an off-board person;
- Performed automatically; or,
- Deemed unnecessary and eliminated.

First, it is assumed, for the sake of completeness, that all of the duties are desirable; therefore none can be eliminated. Second, the category of personnel to be eliminated must be determined. Two types

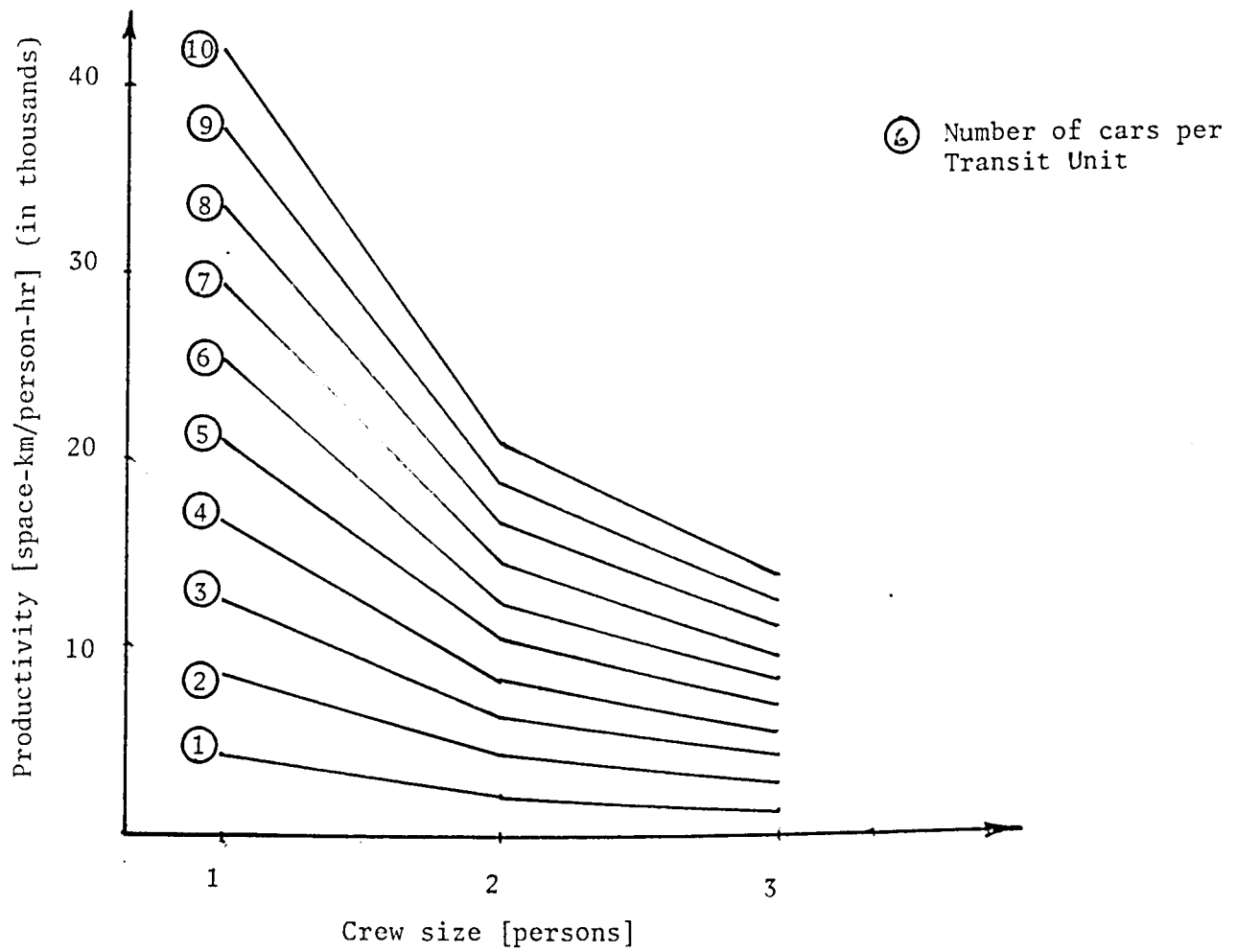


Figure 5.1 Impact of crew size on labor productivity of rapid transit operations

of personnel are on board the train: the driver and the crew member(s). If the number of crew is to be reduced to one, either of the two could be retained. If the driver is to be eliminated, an automated system must be installed to control the movement of the vehicle. If the driver is retained, all duties must become his/her responsibility.

The high cost and some technical problems of fully automatic operation indicate that only the second possibility is realistic at this time. All duties must be either the driver's responsibility, or they can be handled in other ways. Consequently, the driver, in addition to the traditional and obvious duty of driving, must be able to assume all new duties and still maintain the desired level of service and a high degree of passenger safety. A review of all his duties with such an operation follows here.

1. Driving - This duty would not change. The main concern is that the driver's assumption of additional duties does not interfere with driving proficiency.

2. Doors - The switch to open all doors can be placed in the driver's compartment. Opening the doors requires that the vehicle be in a safe position to release or accept passengers. The driver must do this also in a 2-person operation. Closing the doors requires the driver to know that all doors are clear. This can be done by direct observation by the driver, close-circuit TV, or a station attendant who signals the driver. A departure signal is not always given to the passengers, but it can be incorporated into a one-man operation.

3. Information for passengers - The driver is normally sitting in a separate compartment and by design is unable to answer passenger queries. On most systems however, other crew members are in similar conditions. The crew is not considered a source of information and this duty is usually handled by employees off of the train, or by available maps and schedules, wall graphics, and information booths. This aspect of service would therefore not be affected with the driver as the only crew member.

4. Announcements - The driver can easily announce stations, transfers, etc. over a public address (PA) system while operating the train. This duty is already performed by drivers in the newer systems (Washington and San Francisco) or by a crew member in the older systems (New York, Chicago, Boston).

5. Security - Crew members presently do not offer much security since they are frequently in isolated compartments and are present only in a few cars of a unit. Passengers, however, could perceive a reduction in safety if the crew is reduced to one member. Shorter trains, diverse security measures, and more frequent service (made possible by the reduced crew costs) could help to alleviate security problems and improve passenger perception of security.

6. Emergencies - Crew members are instructed to aid the passengers in the event of an emergency. In addition, posted emergency procedures are used. For one-person operation, the driver would be responsible for the passengers in the first car. Posted emergency procedures, or a PA system operated by the driver or by persons off of the vehicle, could provide assistance to the passengers at least equal to what they now have.

7. General inspection - The driver is responsible for the monitoring of the operation of the vehicle. Any mechanical problems or questions should be noted by the driver and reported to maintenance personnel. Frequent inspection of transit vehicles should be routine, regardless of the number of on-board employees.

The preceding analysis shows that one-man operation of rapid transit trains is also feasible on older systems. All duties can be accomplished by the driver with no decrease in either safety or level of service. The only major problems to be resolved on most systems are the door operation and perceived security.

Opening and closing of doors can be easily performed by the driver when he can observe the platform from his window (e.g. Lindenwold Line). He can do this when the platforms are on the side of his cabin (e.g. the cabin is on the right hand side and stations have side platforms), or at all platforms (side or middle), when his cabin extends across the car to both sides (BART, Washington Metro).

On rapid transit systems where the driver cannot see the platform directly, indirect observation of doors is necessary. The driver may use a specifically designed mirror. Alternatively, another employee can observe the platform directly, or via closed circuit TV, and signal the driver when he can close the doors. This type of operation has been in use in Hamburg since 1957. Initial supervision by an employee on the platform was later replaced by TV supervision performed remotely by a person who collects fares on the mezzanine. This employee activates a special signal (white cross) in front of the standing train which indicates to the driver that he can close the doors and start the train. In situations when after this signal was given, there is an emergency (e.g. a passenger is caught by a door), the supervising attendant can switch on an emergency signal (blinking red) instructing the driver to stop immediately. This type of operation in Hamburg has proved to be both efficient and safe.

On some RRT systems (Philadelphia) the second crew member, operating doors, contributes little to the general security, since he is often closed in a cabin rather than present in the passenger area. In such cases removal of this person does not affect actual level of security, but it may affect the perceived level of security. On the systems where the second crew member is with passengers (Chicago), both perceived and actual levels of security may be reduced. In any case it is desirable to increase security at the time a crew member is removed by such methods as roving personnel (transit police), TV surveillance of platforms, increased use of PA systems, etc.

Conditions for reduction of train crews vary with specific conditions on each RRT system. On some systems several major rearrangements in operations and/or introduction of new physical devices may be necessary. However, on most systems this change can be implemented with only minor changes, with much less difficulty and cost than is usually believed. The following example of an RRT line in Philadelphia shows that very clearly.

5.3 Case Study: Market-Frankford Subway-Elevated Line in Philadelphia

To illustrate the possibilities of reducing train crews on RRT systems, a specific RRT line has been selected for a case study. The Market-Frankford RRT line in Philadelphia (locally called "subway-elevated line" or MFSE) has many physical features and operating practices typical for most other older RRT systems. This line is described here and a plan for reduction of its crew size is presented. All the details were explored, checked on the line, and discussed with SEPTA's officials in charge of MFSE operation.

5.3.1 Physical Characteristics. The MFSE line is a conventional rail rapid transit line with broad-gauge track. The line traverses from the 69th Street terminal in Upper Darby, through West Philadelphia, the City Hall complex and the Central Business District, the neighborhoods of the lower Northeast section to the Bridge Street terminal in Frankford (Figure 5.2). The line operates on an elevated structure from 69th Street to 45th Street, then in a subway from that point through the CBD to Front Street. Utilizing median strip of Delaware Expressway for a mile, the tracks then rise to an elevated structure again and follow Front Street, Kensington and Frankford Avenues to the Bridge Street terminal.

Stations are located approximately every half mile along the route. Distances between stations in the CBD are shorter. The MFSE interfaces with a large number of surface routes (Figure 5.3).

The line is operated by the Southeastern Pennsylvania Transportation Authority (SEPTA), which owns half of its rolling stock. The City of Philadelphia, through its Department of Public Property, has the responsibility of overseeing transit facilities and formally owns the fixed facilities and the other half of the rolling stock of the line.

The rolling stock for the line consists of 267 vehicles built by Budd Company about 1960. Of this number, 221 units are married pairs and 46 are single units. Married pairs have a control compartment (driver's cabin) on each end of the pair and can only be operated together. Single cars have controls at each end and can be operated individually.

There are 28 stations on the line. Twenty-three have side platforms; three have center platforms; finally, the two terminal stations

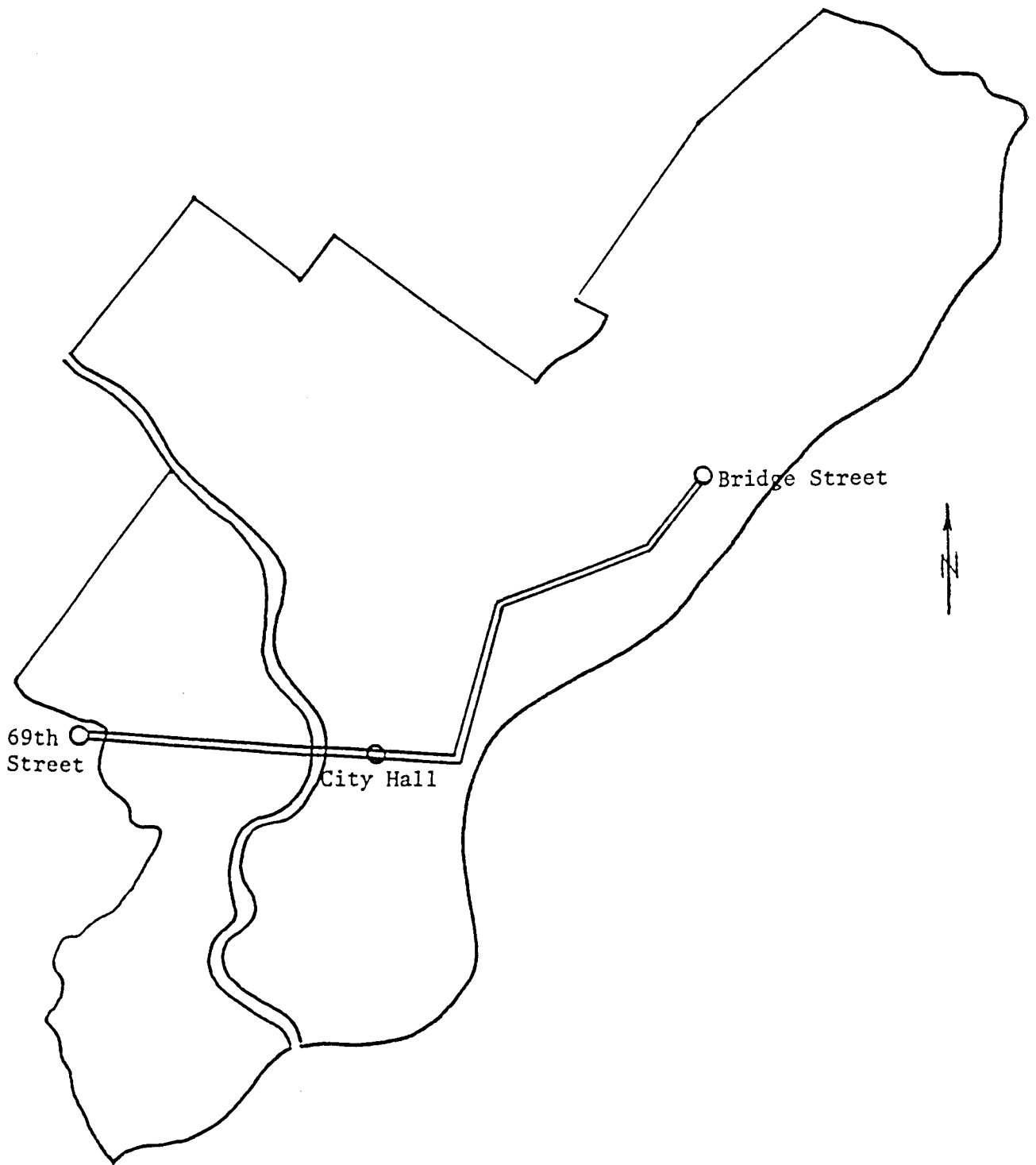


Figure 5.2 Route orientation of Market-Frankford Line

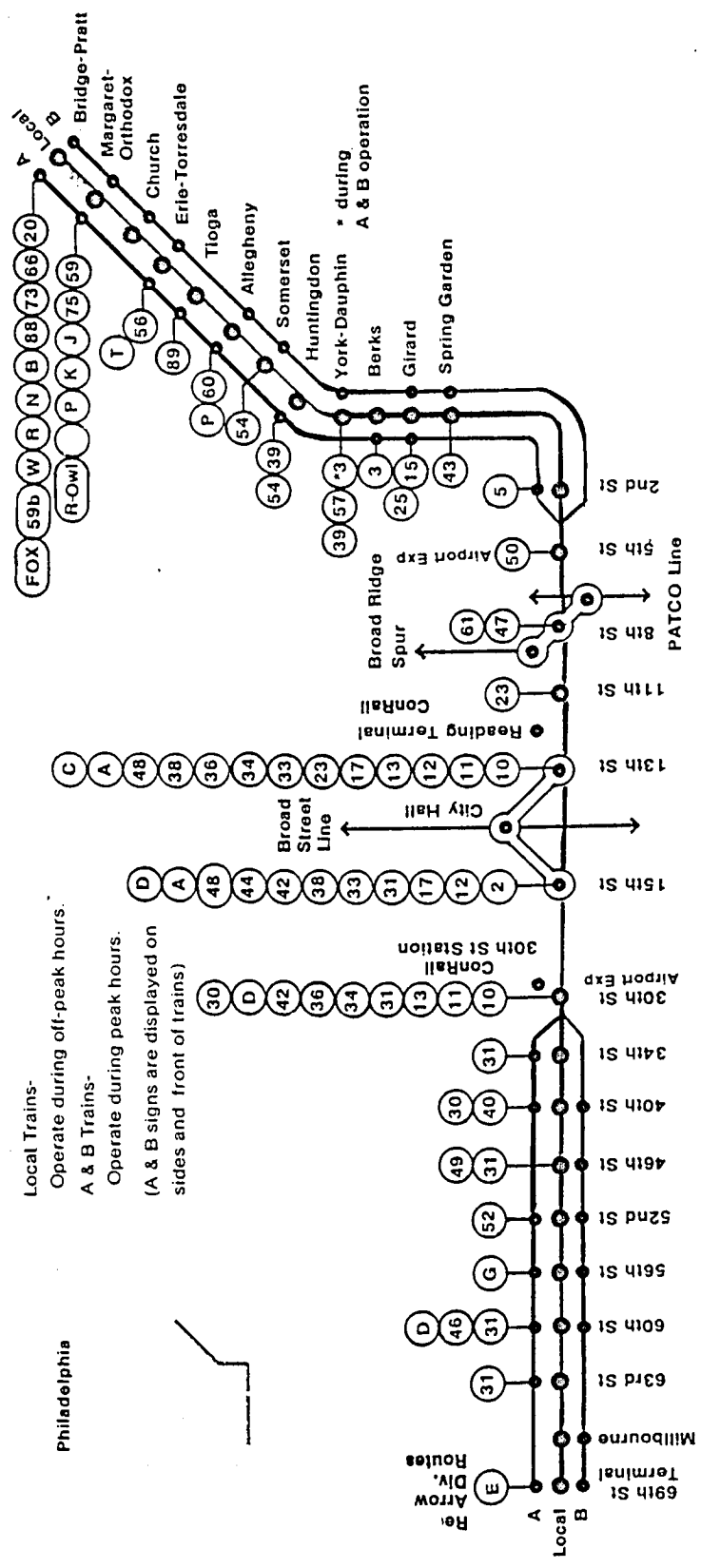


Figure 5.3 Route description of the Market-Frankford line

combine the two configurations, i.e., they have both side and center platforms. Figure 5.4 shows these platforms schematically.

5.3.2 Operational Characteristics. The line is operated with 33 6-car trains during the morning and evening peaks. At these times the headways are approximately two minutes. During the night, 3-car trains are operated with 30-min. headways. Four trains are required to provide the night service. The line operates 24 hours a day.

Passengers must have exact change to enter the system, except at certain major stations during business hours. Access to the platforms is controlled by cashiers, except during night hours, when only a few stations have attendants.

The trains currently operate with 2-person crews, a driver and a conductor. The driver is positioned in a cabin at the head of the train, on the right or outer side of the vehicle. The conductor is positioned in another cabin along the train. The train length and make-up, as well as the configuration of each stations, determine the exact position of the conductor (in a 6-car train he may be in the third, fourth or fifth car to supervise platform on the left or right side of the train).

5.3.3 Crew Duties. Eight of the defined 17 possible duties are assigned to train crews on the MFSE. The duties are the responsibility of the individual crewperson (driver or conductor), or they are shared:

- | | | |
|--|---|-----------|
| 1. Driving | } | DRIVER |
| 2. Train inspection | | |
| 3. Communications with
control center | | |
| 4. Opening doors | } | CONDUCTOR |
| 5. Supervising doors | | |
| 6. Closing doors | | |
| 7. Safety and security | } | SHARED |
| 8. Emergencies | | |

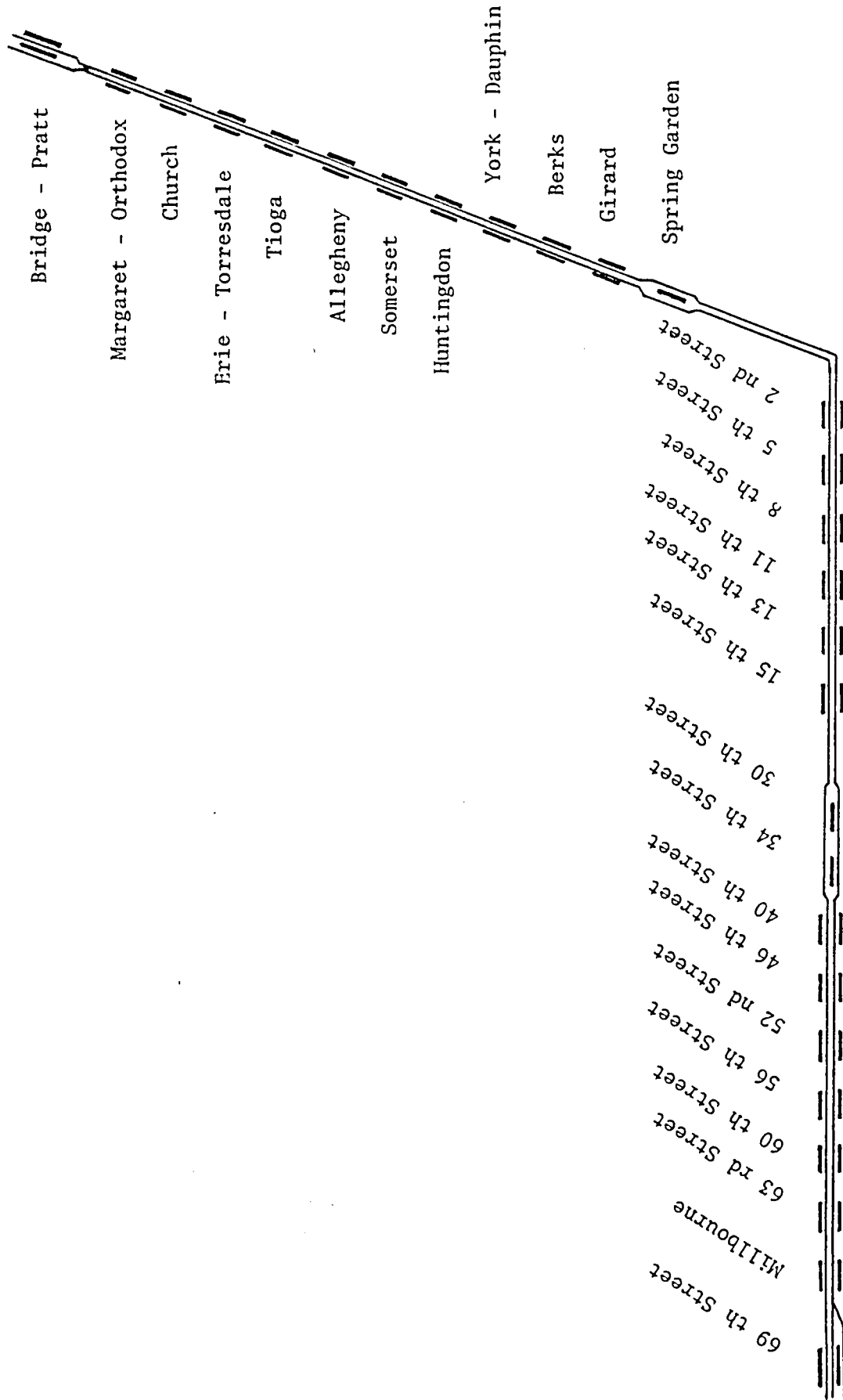


Figure 5.4 Station configurations on the Market-Frankford line

The titles, driver and conductor, are used only to identify the employee's job on the train. Actually, both persons are qualified to do either job and they are paid equally.

The majority of the stations have platforms which can accommodate 6-car trains and allow only a small margin of error. To insure that all car doors are along the platform length, the driver must center the train at each platform. The conductor observes a specific marker placed on each platform for the purpose of checking the position of the train prior to opening doors.

The conductor has an additional duty during night operations. Between midnight and 5 a.m., a number of cashier positions are closed, so that station access to the platform is not controlled. The conductor of each train collects fares and issues transfers through a control compartment window. The doors are opened after every boarding passenger has paid. The low levels of patronage make this operation possible.

Because of these duties, the positions of the two crew members are determined. The driver is, naturally, constrained to the front of the first car. The conductor, on the other hand, must change cabins between stations with side and center platforms to supervise and operate the respective sets of doors.

There are four different station designs along the MFSE. Each station and the corresponding operation will be discussed for 6-car train operation.

a. Stations with side platforms represent the most common type: 23 stations have them. Figure 5.5a shows the layout of a typical side-platform station and the locations of the two members on the train.

The driver and conductor are both positioned on the outer, right-hand side of the train. The driver is in the first car and the conductor is in the fourth car if it is a single unit, or in the fifth if it is a married pair. The driver stops the train at the platform and the conductor checks the position, then opens the doors. The conductor observes the boarding and alighting and closes the doors when all passengers are clear (no announcements or warnings). The doors of the cars

forward of the conductor are closed first, then the doors of the rear cars. He finally glances again at all doors, then signals the driver that the doors are closed. The train proceeds to the next station.

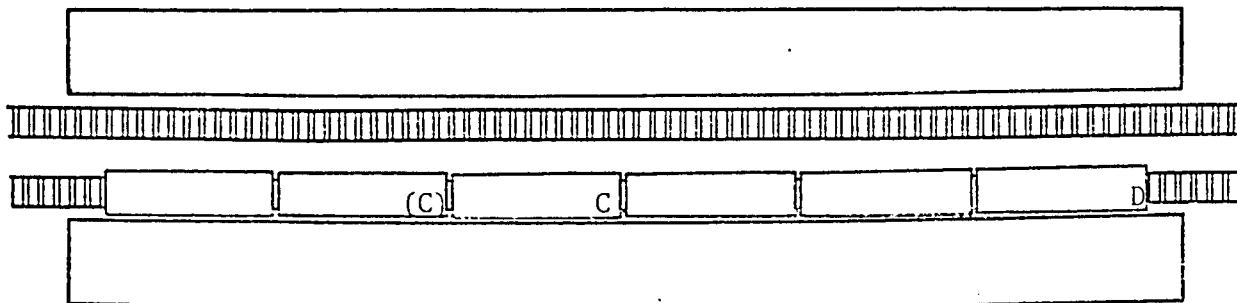
b. Center platforms are found at three stations: 34th Street, 30th Street, and Spring Garden. Figure 5.5b shows the design and positions of the crew members at these stations. The driver is again, of course, located on the right-hand side of the vehicle. The conductor, however, has moved to a cabin on the inner (left-hand) side. Train operation is the same as with side platforms: when the train stops, the conductor checks its position, opens and supervises the doors. After boarding, the conductor closes the doors, gives a signal to the driver, and the train departs.

c. 69th Street Terminal has a combination of side and center platforms, as Fig. 5.6a shows. Each incoming train stops at a side platform and discharges all passengers. The train then proceeds around a loop and enters the boarding section of the station, which has a center platform, with tracks for departing trains on both sides of it. The conductor supervises and operates the doors from a control compartment on the appropriate side of the train.

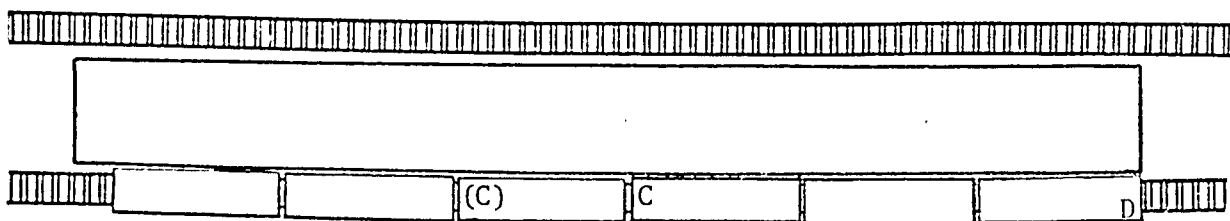
d. Bridge Street Terminal also has a combination of side and center platforms, but with only two tracks as Fig. 5.6b shows. The boarding and alighting operations are not separated.

During the A.M. peak period, the incoming trains come on the left incoming track, next to the center platform. After discharging passengers, they proceed around the loop, and enter on the track between the center and side platforms. Passengers board the train from either of the two platforms in order to speed up the operation. The doors next to the center platform are operated by the conductor and the doors next to the side platform are operated by a station attendant standing on the side platform, who reaches the controls through a cab window.

During the P.M. peak period, this operation is reversed. Trains coming in enter on the right incoming track, discharge the passengers onto both platforms and then make a loop in the opposite direction from their travel during A.M. peak. The train then enters on the other track and passengers board it from the center platform.



a. Station with side platforms



b. Station with center platform

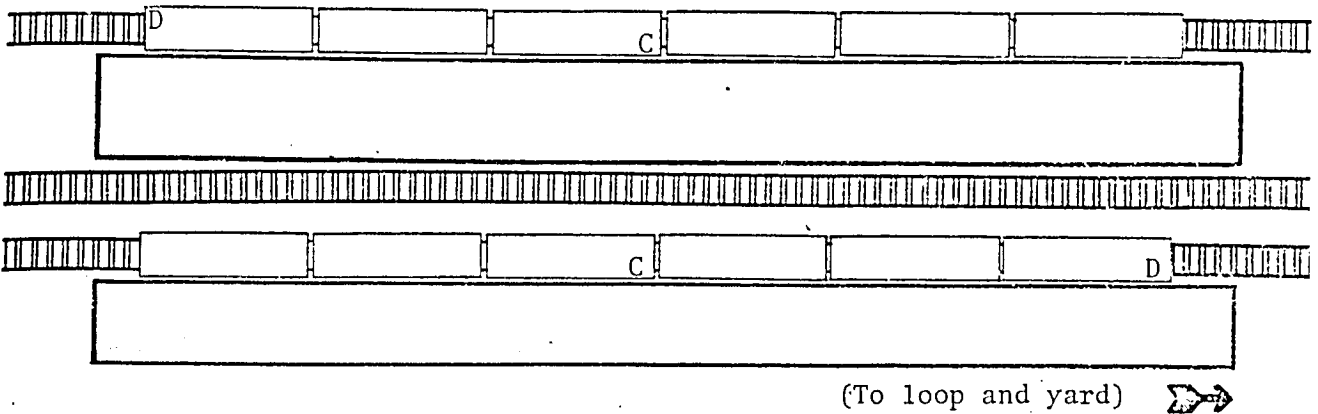
C - Conductor's location
for single unit cars

(C) - Conductor's location
for married pairs

D - Driver's location

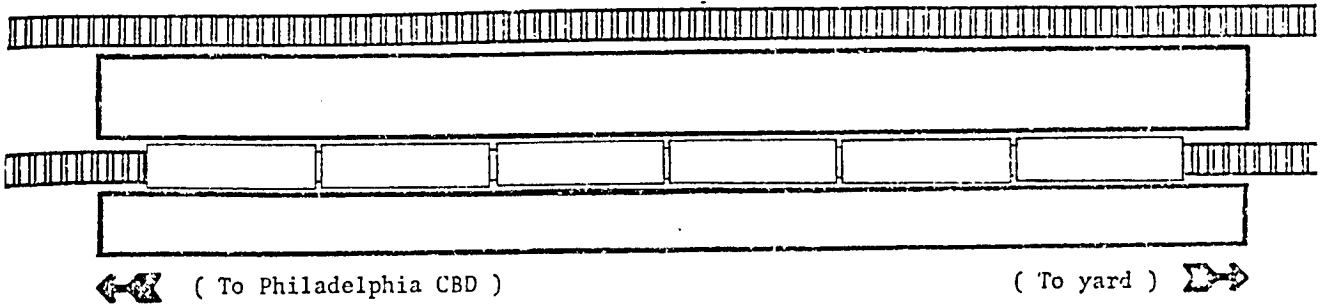
Figure 5.5 The two basic station configurations

← (To Philadelphia CBD)



a. 69th Street Terminal

(To loop and yard) →



b. Bridge Street Terminal

← (To Philadelphia CBD)

(To yard) →

Figure 5.6 Platform types at terminal stations

In operations during off-peak periods, trains do not make these loops. They reverse direction at the platform and the driver walks from one end of the train to the other. The side platform is not used during off-peak periods.

5.3.4 Operation With One-Person Crews. It is proposed that trains on the Market-Frankford line be operated with only one crew person, the driver, on board each train. He must then assume all on-board duties. At the same time a consistent level of service and equally safe operation as with 2-person crews must be insured.

Actually, since the second crew member presently has very limited duties, this reassignment is not difficult. A list of duties and their present and proposed assignments illustrates this.

The only totally new assignment of duties is that the driver must be responsible for the operation and supervision of the doors. Security, presently a partial and rather limited duty of both on-board crew members, can be supplemented by other personnel and equipment. In addition, the driver alone will be responsible for handling emergencies.

It is not difficult for the driver to assume door control because the time of driving is different from the time for operating the doors. During station stops the driver is idle. During moving operation the conductor is idle. Giving the driver both duties would combine these two work segments and produce a more efficient operation. Some technical adjustments must be made, however, to enable the driver to physically control the doors. A different type of door supervision (by the driver, by another person, or automatically) must be made possible.

Presently the line does not have an adequate level of security. The two train crew members are separated from the riding public and cannot offer an effective level of security and protection. Therefore, other methods of dealing with crime on transit lines have been developed and implemented. The Philadelphia Police, the newly formed and trained Transit Police, and the Guardian Angels patrol the rapid transit lines to provide security. In addition, emergency call boxes have been installed in many stations to provide protection. Better lighting and station improvements also provide safer conditions.

Another improvement which could provide security on the train would be the installation of emergency call boxes in each car. Passengers could use these boxes to communicate with the driver in times of distress.

The last duty to be reassigned is the responsibility to react during emergency conditions. Emergencies are rare, but when they occur, they require two actions to be taken. First, the emergency must be assessed and an immediate reaction must occur. Second, communication with outside assistance must be instituted if necessary. Both of these reactions can be done by a single crew person. The communication responsibility already now belongs to the driver.

Finally, one special duty has not been considered. During certain hours of operation the conductor collects fares at designated stations. This operation occurs at stations where the small number of passengers does not justify having a station fare collector. This can also become the duty of the driver in one-person operation, as is already practiced on the Evanston Service in Chicago.

This discussion shows that in order to make one-person crew operation technically feasible, the only aspect which must be addressed in great detail is the safe operation of the doors by the driver. If that can be achieved with an operationally feasible procedure, it can be concluded that one-person operation is possible.

5.3.5 Door Control and Operation. To enable the driver to operate the train doors, the restrictions of his location must be resolved. Unlike the conductor, the driver is located at a fixed place on the train, the outer front corner of the first car, and cannot move from that point. The physical problems that must be solved so that he can perform door control from that location are:

1. Adequate visibility for observation of boarding and alighting.
 - Along both sides of the train;
 - Up to the maximum length of the train.
2. Physical control of all doors from the cabin.

These requirements vary with station/platform designs, so that each type of station must be examined separately.

Stations with side platforms. At 23 of the 28 stations, the platforms are on the right side of the train, as shown in Fig. 5.5a. Since the driver's compartment is also on the right side of the vehicle, it is possible for the driver to open the doors, directly observe the boarding and alighting of passengers, close the doors, and ascertain if it is safe to start the train.

The driver could observe the doors in one of two ways. Either he can open the side window of his cabin and look back directly at the doors; or, mirrors could be installed outside each cabin and the driver could view the doors through that mirror. The direct method is preferred and more reliable, for long trains and busy periods, while the mirror could be used during off-peak periods. Prior to installing the mirrors side clearance should be checked and, if necessary, retractable mirrors can be used.

One concern is whether the driver is capable of observing the doors on a 6-car train. With 2-person operation, the conductor is located somewhere along the length of the train and does not have to observe its entire length. Usually he observes four cars in one direction and two in the other on a 6-car train. With only the driver, the entire length of the train would be the observation distance.

Each car on the Market-Frankford line is approximately 16 meters (55 feet) long. A 6-car train would require the driver to observe doors up to about 90 meters in distance. Detailed field observations have shown that the design of the stations allows direct vision of the entire train. The view is not blocked by any permanent structures in any of the stations. The lines of sight from the front of each train to all doors are clear.

Experience on systems in other cities suggests that it is reasonable to assume that a driver can observe the doors on 6-car trains. The PATCO High-Speed Line in Philadelphia operates trains consisting of six 20.6 m (67 ft) long cars and the doors are observed and controlled by the driver in the first car. In Washington, Metro drivers observe the boarding and alighting of passengers on up to 8-car trains. The trains on the Bay Area Rapid Transit (BART) system have up to 10 cars, and the driver

observes all the doors. Moreover, the Metro and BART cars are 8 meters (26 feet) longer than the Budd cars that are used on the MFSE. BART trains are thus up to 215 m long, while MFSE trains do not exceed 96 m.

Stations with center platforms. Three of the 28 stations, 34th Street, 30th Street and Spring Garden, have center platforms which serve station passengers for both directions. At these stations, the operation of one-person crews faces a problem. Some method of observation must be substituted for present direct observation by the conductor. The driver is on the opposite side of the train, so that he cannot see the doors on the left side of the train.

To resolve this problem, any one of the following alternative methods of door control, described in section 2.3, may be used:

a. Station attendant observes the doors and signals departure to the driver;

b. Fare collector or other stationary personnel observes the doors using a closed circuit TV screen;

c. Automatic closing of doors, supervision is not required.

5.3.6 Checking Train's Position. Presently the conductor checks the position of the train in the station prior to opening the doors. This function can be easily performed by the driver, since the plates along the track which show the stopping positions for all possible train lengths already exist and assist the driver to stop at predetermined locations. The problem is actually reduced since in the case of "overshooting" the platform, the driver can simply back up and then open the doors. Presently he can back up only after the conductor signals him, to avoid the possibility that the conductor opens the doors while the driver is backing up the train.

5.4 Conclusions

This analysis of labor practices on North American rapid transit systems shows that all systems opened since 1969 have one-person crews and operate successfully. Except for Cleveland, none of the older rapid transit systems (New York, Chicago, Philadelphia, Boston, Toronto and Montreal) have changed from 2- to one person crews, while several European systems have made such a change as early as 1958.

The systematic analysis of all crew duties and of alternative methods of performing them have shown that the non-driving crew member in most cases has very few things to do. The proposal to reduce train crews to one person was analyzed in great detail on the example of a rapid transit line in Philadelphia. This actual case has clearly shown that a crew reduction to one person is not only feasible, but it is rather easy to implement. Most of the required changes are operational, a few are physical (closed circuit TV and an additional signal at the stations with center platforms; control buttons for all doors in the driver's cab).

The results of the proposed crew reduction would be very significant; productivity of the personnel would double, as Fig. 5.7 shows for the Market-Frankford Line.

The operator/transit agency could make three different changes, or a combination of them, in order to take advantage of the crew reduction:

1. Reduce its labor force and thus lower its operating costs;
2. Increase level of service by operating half-size TUs at double frequency;
3. Employ the present conductors as security personnel.

In each of the alternatives the gains are considerable. In the example of the Market-Frankford Line, personnel can be reduced by approximately 50 during the peak hours.

Actually, in most cases the operator would select a combination of these alternatives. The first one is most applicable to peak hours, the second to off-peaks.

Indications are that, although conditions (station design, operating methods) vary among cities, most old systems presently operating with 2-person crews could eliminate the second person with rather modest changes. If the opposition of the labor union is strong, transit agencies should rely more on alternatives 2 and 3 rather than 1.

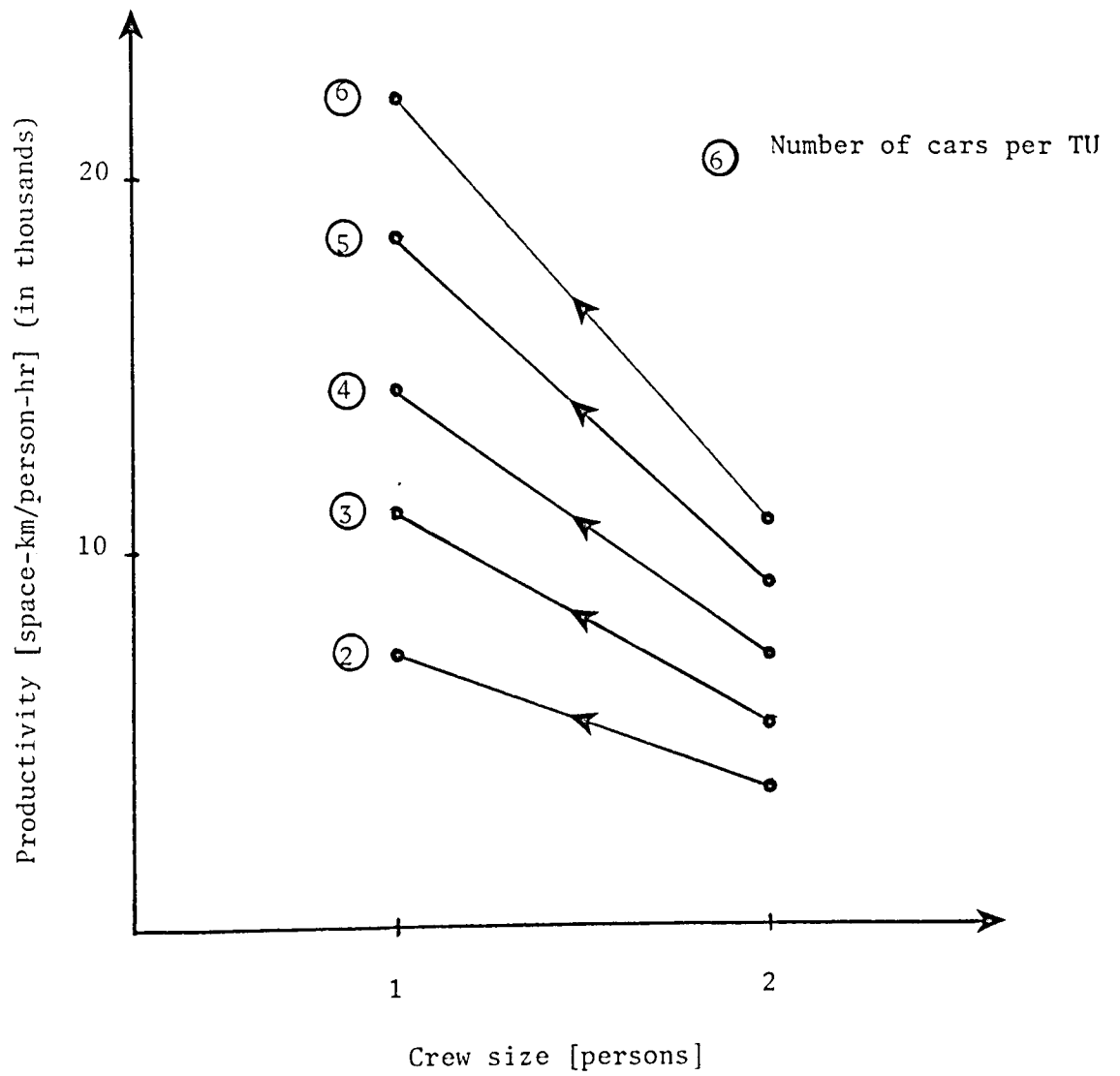


Figure 5.7 Labor productivity increase with one-person crews on Market-Frankford Line

6. TRAIN CREW REDUCTIONS ON REGIONAL RAIL SYSTEMS

Regional rail (RGR) systems started their operations as special services of long-distance railroads. In most cities they are still operated in that manner. Therefore, they have had a somewhat unique position in urban transportation, usually separated from regular transit services. For several reasons discussed below, the importance of regional rail services tends to be underestimated.

Railroad managements tend to consider RGR services as a separate duty which they, particularly in recent decades, do not want to have. Transit agencies, on the other hand, have little jurisdiction and little operating coordination with them. Since they are regional in character, RGR systems do not have a single government in the area they serve. Thus in many cases there are no distinct organizations or parties standing behind - or above - RGR operations.

Yet, in the last 20 to 30 years the role of RGR systems has greatly increased for two obvious reasons. First, they serve the suburban areas which have most of the population growth. Second, they offer high level of service (speed, reliability, comfort) so that they are more competitive with the automobile than any other urban public transport mode.

Finally in recent years, because of the mounting financial problems the railroads are experiencing, and because of the passenger demands for improved transit services, many cities have begun to give increasing attention to RGR systems.

6.1 Present Conditions

Because of the railroad origins and traditions, RGR systems in North American cities largely operate under obsolete, labor-intensive practices. The survey made in the course of this study discovered three types of serious problems related to labor practices on North American RGR systems.

1. Overstaffing. Train crews consist of 2 to as many as 7 (exceptionally even more) persons. In addition to the driver who, obviously, has a full job, there are usually a considerable number of other positions, many of which do not have any relationships between the title and the actual duty. Thus one finds a fireman on diesel locomotives, a position eliminated from freight trains many years ago. There is also

often a flagman and a brakeman, who have not had anything to do with flagging or braking trains for many decades, ever since modern automatic signal systems were introduced. Conductor and trainman have titles corresponding roughly to their work - which in most cases consists of fare (ticket) collection, door control, assistance to passengers on steps, and a few others. Since most RGR systems have obsolete methods of fare collection (mostly manual), these crew members are very busy on the heavily travelled line sections close to central cities, while they often have little to do on the outlying sections. Crew reductions commensurate with a decrease in crew duties as the train progresses outward is not practiced on any RGR system.

A summary of the present distribution of duties among different crew members on RGR systems in North American cities is presented in Table 6.1. For comparison, foreign systems (German S-Bahns) have been included. It should be noted that in several European countries, such as West Germany, Switzerland, Denmark and The Netherlands, RGR systems have been both operationally modernized and integrated with transit systems. Labor practices on these systems have been streamlined through a number of changes such as high-level platforms, self-service fare collection, closed-circuit TV supervision and others. Such innovations have been applied on this continent to a large extent only on Illinois Central in Chicago and, to varying degrees, on several New York railroads (LIRR, MTA).

2. Distribution of Duties. Each crew member has strictly defined duties and does not perform anything else. Very often two or more persons do jobs which are performed at different times. Hence, these jobs could be handled by only one person.

3. Excessive Wages. Labor on RGR systems receives much higher wages than transit workers on similar and often much more difficult jobs (e.g. driving buses through congested urban streets) because they usually belong to national railroad unions. Moreover, allowances for split shifts, overtime, etc. are often very high. Finally, there are a number of artificially imposed bonuses which have no rational basis. Examples of these are "daily mileage limit", where the crew member gets overtime if he has passed more than 150 miles per day, regardless of his working time; and, "lonesome pay" to compensate the diesel engine driver for

Table 6.1 Crew duties on RGR systems

System	# Stn. persnl	Driving	Inspection	Reporting	Couple/uncouple	Comm. w/ CC	Announcement	Open doors	Superv. doors	Close doors	Knove traps	Signal depart.	Charge seats	Information	Fare collection	Fare control	Security	Emergency
<u>Regional Rail I</u> S-Bahn (Germany - Munich, Hamburg, Frankfurt)		D	D		T	D	D, A	D, P	D*, C*, S*	D	-	D*, C*, S*	-	D, A	R	A	R	D, C*, S*
<u>Regional Rail II</u> Boston		D					C	C	C	C	C	C		C-S*	C	C-S*	C	D-C
Chicago (Illinois Cent)	O	D			T		C	C	C	C	-	C	C	C	A	A-C	C	D-C
Chicago (Other RTA), San Francisco	O-1	D			T		C	C	C	C	-	C-S*	C	C-S*	C	C-S*	C	D-C
New Jersey (NEC, E-L, CNJ)	O-1	D			C-T	D	C	C	C	C	C	C	T*	C-S*	C	C-S*	C	D-C
New York (MTA, ConnDOT)	O-1	D			T	D	C	C	C	C	C	C	-	C-S*	C	C-S*	C	D-C
Philadelphia	O-1	D	D, C, T	D, C	D, C, T	D, C	D, C	C	C	C	C	C	C*	C-S*	C	C, S	C, S	D, C
Montreal		D					C	C	C	C					C		C	D-C
Toronto		D	D, C, T	-	T	D, C	C	C	C	C	-	C	-	C, S	S	S	C, R	D, C

Codes for personnel

- A = Automatic operation
- C = Conductor or other crew member
- D = Driver
- F = Fare cashier
- R = Roving inspector or police

S = Station attendant

T = Terminal or yard maintenance employee

* = Performed on a partial or non-systemwide basis

- = Not performed

P = Passenger

being without a fireman, who had no duties anyway (this case exists on a line in Boston).

All of these three factors, naturally, contribute to the extremely high operating costs of this potentially most labor productive and efficient urban transit mode.

6.2 Potential for Crew Reductions

The preceding review of the current labor operating practices on RGR systems in North American cities clearly shows there is much potential improvement which can be achieved through modernization of RGR operations. RGR actually has by far the greatest potential gain from train crew reductions among all rail transit modes.

As a result of resistance of railroad labor unions to most modernization actions, lack of imagination and initiative of most railroad managements, and absence of a strong backing of RGR by governmental agencies, possibilities for train crew reductions have not even been examined and planned on most systems. Local conditions and needs vary among cities to some extent. To explore the possibilities for train crew reductions in this study, duties have been systematically defined and alternative methods for performing them have been presented and explained. A case study is presented to demonstrate how train crew reductions can be applied to modernize a RGR system. This case was selected because it exhibits some of the most complicated problems to be resolved. These include high- and low-level platforms, doors which are operated in part manually, in part automatically (traps and doors, respectively), open stations (no access control), and mixed passenger/freight operations on the line. This case study is presented in the following section.

6.3 An Example: Media Line in Philadelphia

For the analysis of the possibility of reducing train crew sizes on RGR systems, the Media-West Chester line between Philadelphia and its western suburbs has been chosen. As a representative system with many typical obsolete practices, this analysis is intended to show the overall feasibility and desirability of applying various innovations.

6.3.1 Line Description. The Media-West Chester line, one of 13 RGR lines serving the Philadelphia metropolitan area, extends from center city Philadelphia in the westward direction to West Chester. Figure 6.1

EXISTING COMMUTER LINES

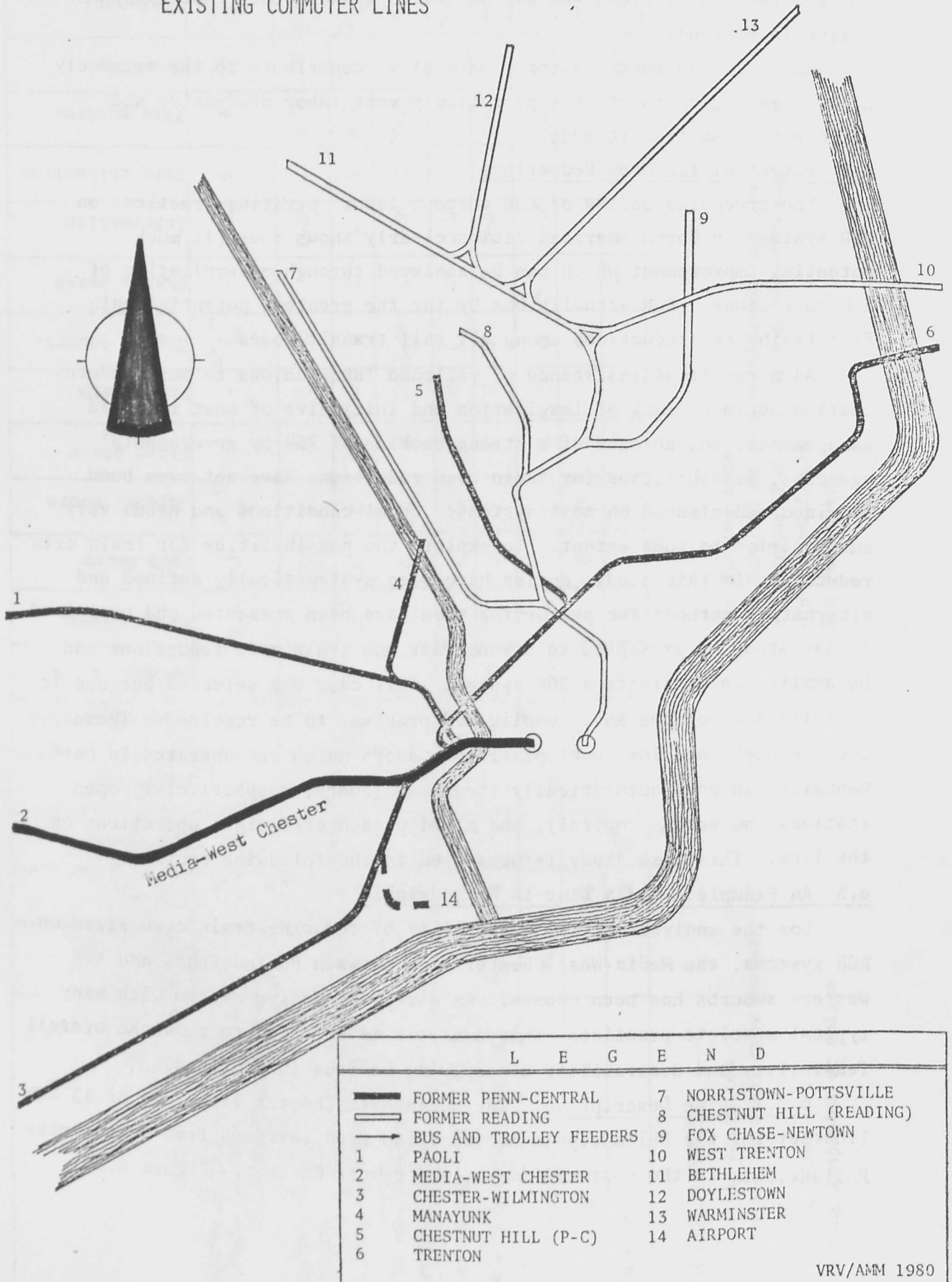


Figure 6.1 Route orientation of Media-West Chester line

VRV/AMM 1980

shows the route orientation.

This line is 27.5 miles long and has double track from Suburban Station in center city Philadelphia to Elwyn, and single track from Elwyn to West Chester (Figure 6.2). The right-of-way is separated, but there are about a dozen at-grade crossings, including the major ones at the Morton, Secane, and Primos stations. All crossings are controlled by automatic gates with signals. The line is electrified, with an 11,000-volt 25-cycle a.c. overhead catenary system.

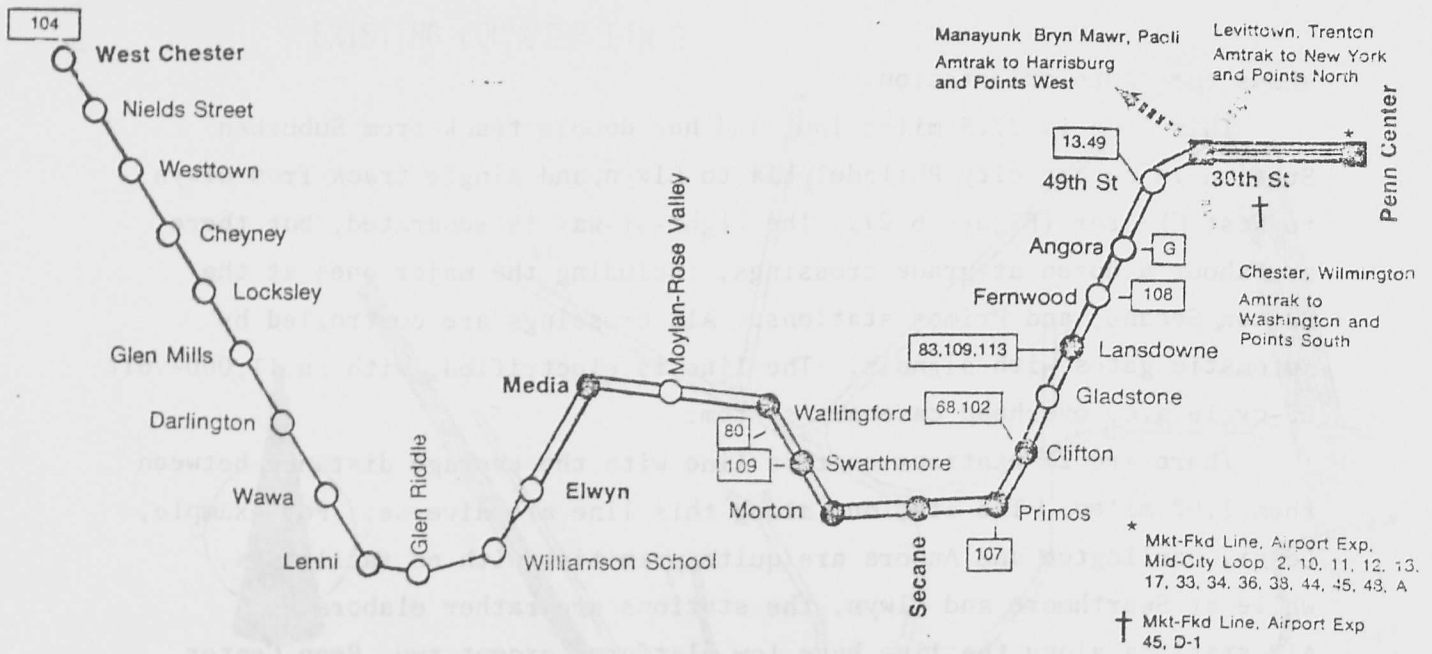
There are 27 stations on this line with the average distance between them 1.02 miles. The stations along this line are diverse. For example, Lenni, Darlington and Angora are quite primitive with no facilities, while at Swarthmore and Elwyn, the stations are rather elaborate. All stations along the line have low platforms except two, Penn Center and 30th Street Station (Figure 6.2). All station platforms are straight except at Media, Moylan and Swarthmore stations, which are curved.

The Secane and Primos stations have the problem that their platform lengths cannot accommodate peak hour trains. Moreover, they extend across major traffic arteries, so that some passengers board and alight on streets. This causes an inconvenience and can be somewhat dangerous.

Rolling stock used on this line includes Silverliners II, III, and IV, and a few old Reading cars. Most Silverliner IV's are married pairs, but some are single unit vehicles.

6.3.2 Present Operations. Outbound trains start at Penn Center ("Suburban") Station located in downtown Philadelphia, and travel in the westward direction. Some trains terminate their runs at Secane, most at Media, several at Elwyn and a few at West Chester. These stations are in Delaware and Chester Counties, PA. Likewise, the inbound trains commence their runs at West Chester, Elwyn, Media, or Secane. The number of departures from each of these stations for the different periods of the weekday is given in Table 6.2.

All trains stop at nearly all stations, except during the peak hours, when a kind of zonal operation is used. Generally, alternate peak trains skip stations on the inner and outer section of the line between center city and Media.



Stations with low level platforms:

● Manned ○ Unmanned

Stations with high level platforms:

■ Manned □ Unmanned

Figure 6.2 Media Line track and station characteristics

Table 6.2 Weekday departures from terminal stations - early 1981

Weekday departures from	A.M. peak	Midday	P.M. peak	Evening	Total
West Chester	3	4	1	3	11
Elwyn	4	4	2	3	13
Media	6	5	2	2	15
Secane	1	-	-	-	1
Totals	14	13	5	8	40*
Inbound boardings	6592	1603	216	257	8668
Percent	76%	18%	3%	3%	100%
Avg. train consists	4.4	1.1	2.0	2.4	2.6

* Thirty-eight trains arrive at Penn Center; the forty departures include two West Chester originating peak trains turned back at Media.

The boarding/alighting counts for each station are summarized in Figs. 6.3 and 6.4. For the inbound trains, daily boardings are sizable from Elwyn to Fernwood, with especially heavy boardings occurring at Media and Secane stations. Almost 98% of the alightings during the morning peak period occur at either 30th Street Station or the Suburban Station (Penn Center). For the outbound trains, this trend is reversed. That is, over 96.2% of the daily boardings occur at either the Suburban Station or the 30th Street Station, with the majority of the daily alightings occurring between Fernwood and Elwyn stations.

Thus there is a substantial imbalance between the line length and passenger volume of the inner and outer sections of the line. The inner section (from Suburban Station in center city to either Media or Elwyn) accounts for slightly over one half of the line length, but for over 90% of all passengers, as Table 6.3 shows.

The total number of stations, stops and the number of station stops during the peak periods for the inbound and outbound trains are summarized in Figures 6.5 and 6.6. These numbers also drop significantly between the Elwyn and West Chester stations.

The line presently operates with a minimum crew size of three (consisting of an engineer and two trainmen) for one-car trains, up to a maximum crew size of seven (one engineer and six trainmen) for 6-car peak hour trains. Crew size varies depending upon ticket collecting requirements, but in general, an additional trainmen is added for every additional two cars in the consist above the basic one-car/three-man operation. Figures 6.7a and 6.7b indicate the maximum crew size and the corresponding numbers of cars the crew operates for the different periods of the day, for both the inbound and outbound trains.

Table 6.3 Line section length and passenger boardings

	Track miles	Percent	Passenger boardings	Percent
Entire line	27.5	100	8,668	100
Elwyn - Center city	15.1	55	8,354	96
Media - Center city	14.0	51	8,078	93

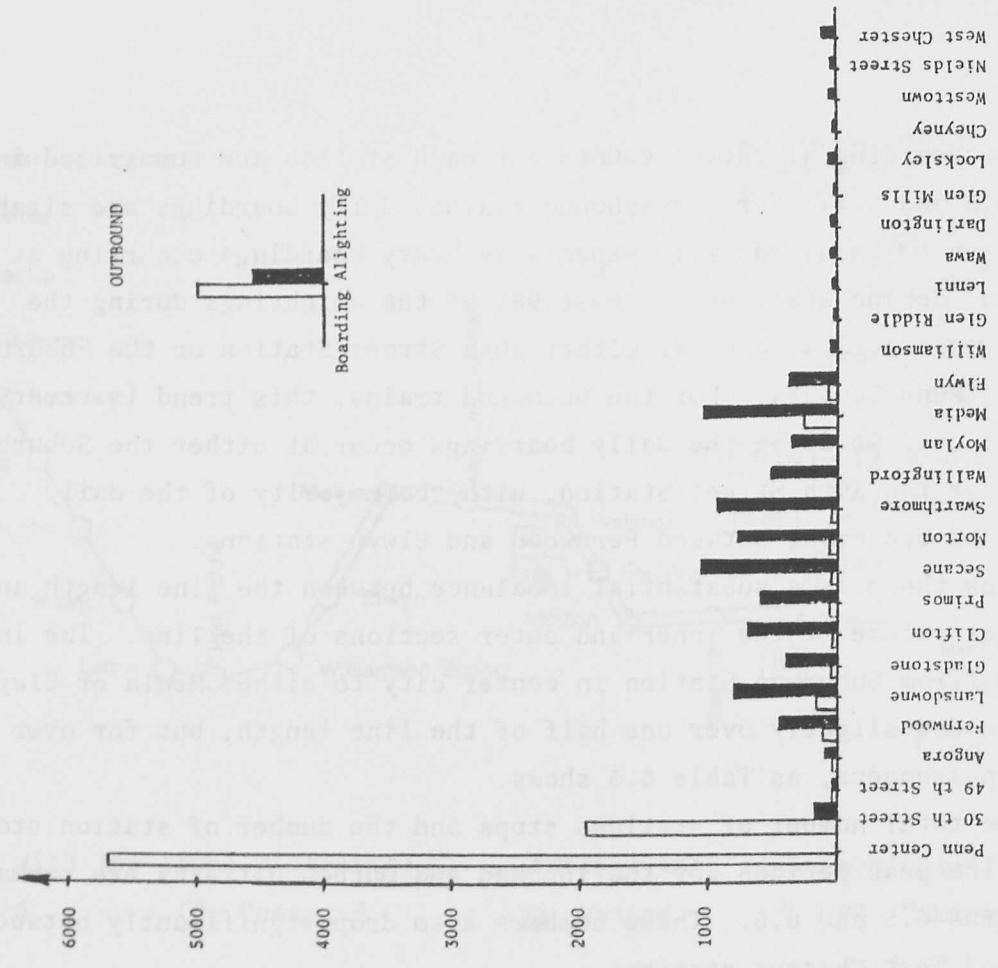


Figure 6.4 Outbound station boarding and alighting volumes

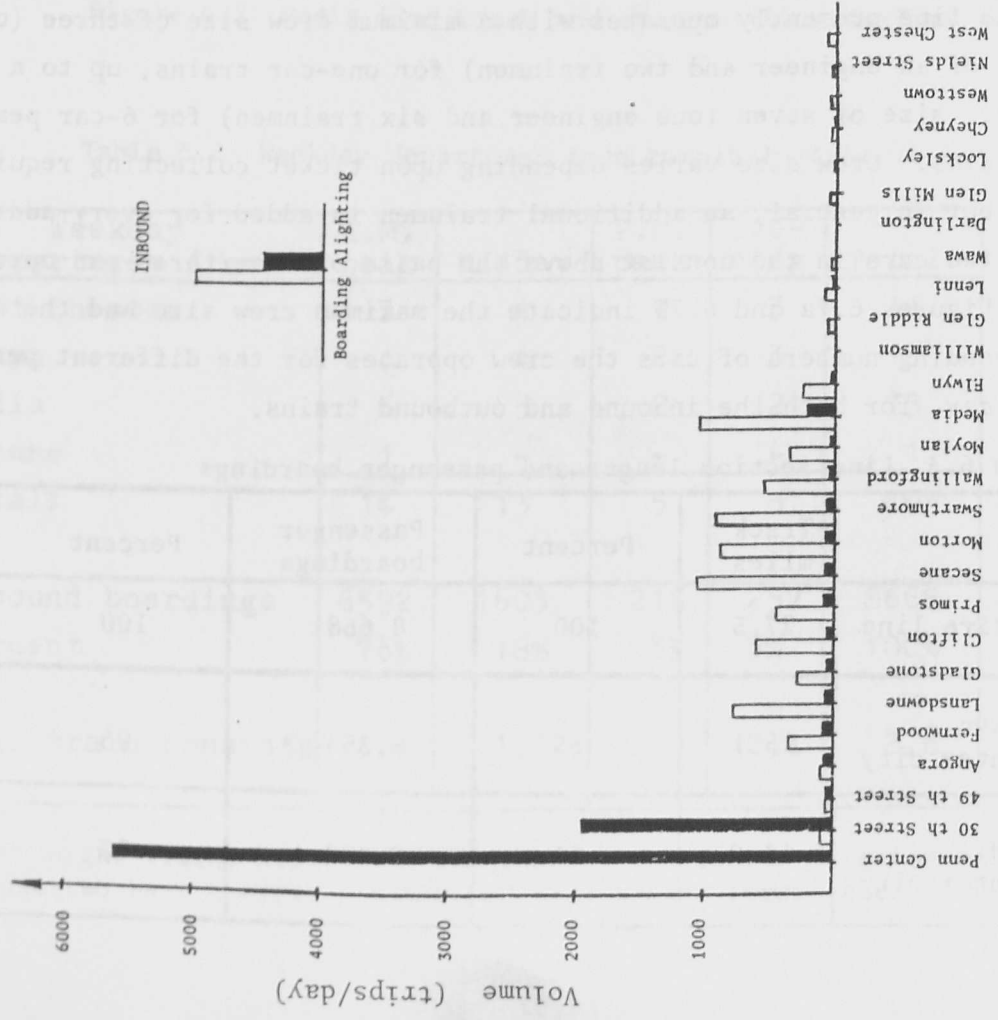


Figure 6.3 Inbound station boarding and alighting volumes

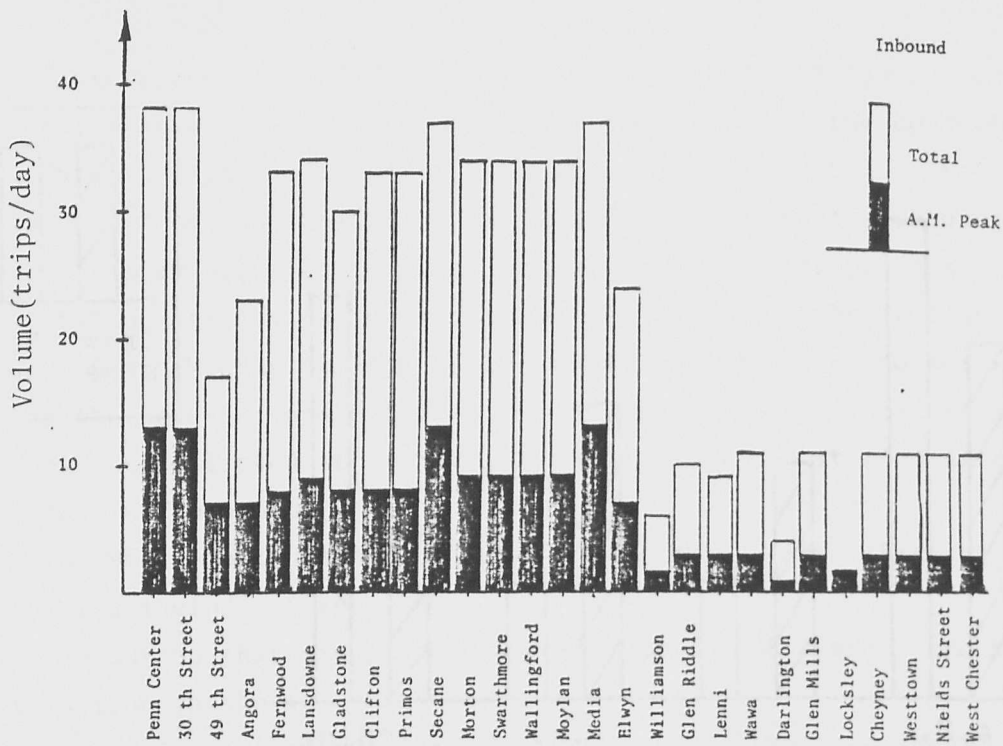


Figure 6.5 Number of inbound train-stoppings by station

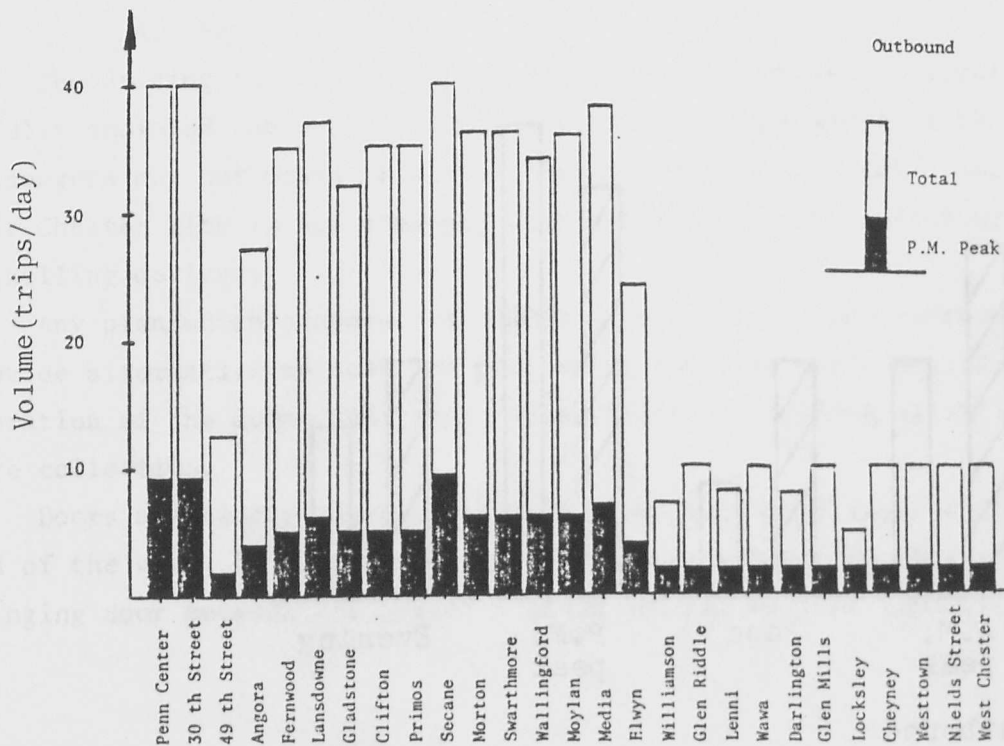
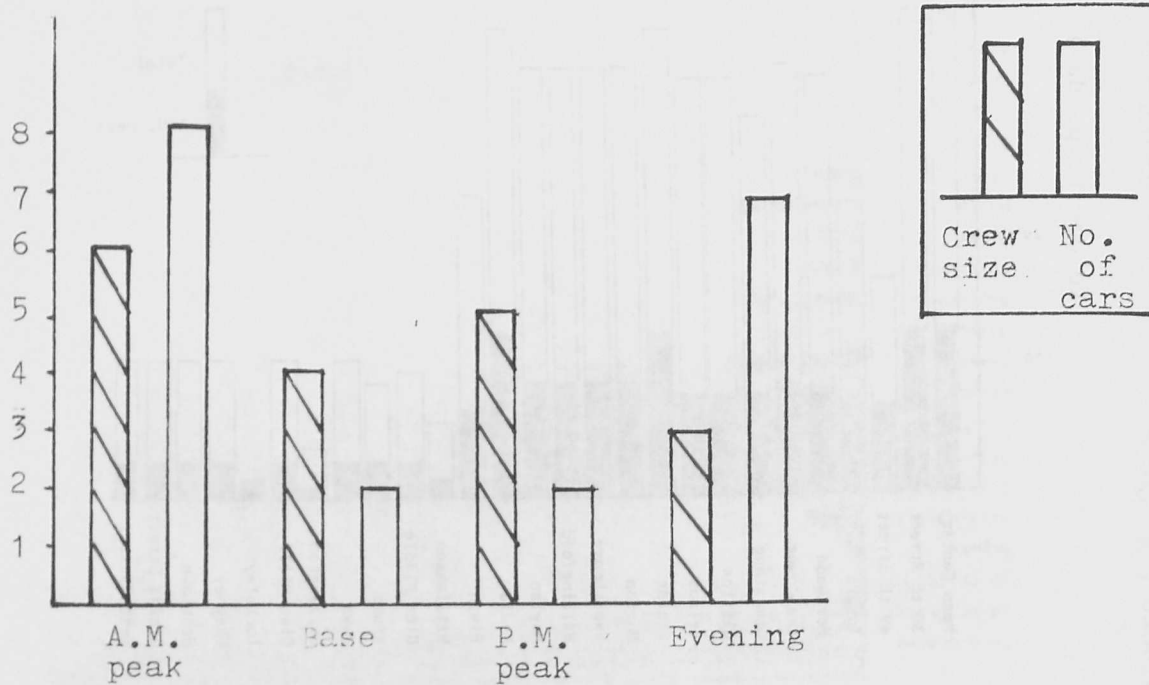
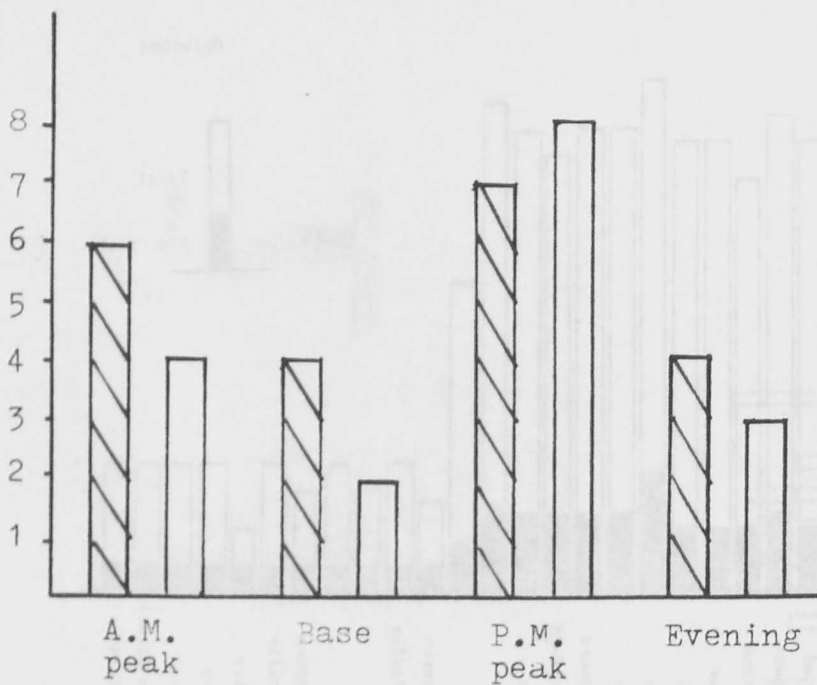


Figure 6.6 Number of outbound train-stoppings by station



a. Inbound



b. Outbound

Figure 6.7 Maximum crew sizes and corresponding number of cars per TU

Tickets are sold at the stations and/or on the trains. A comparison of total station agent ticket sales and revenues from the conductors' cash fares and the CBD sales outlets appears in Table 6.4. From this table, it is evident that both the station agents and the conductors presently play significant roles in the ticket selling process.

Station attendants are present at only a few of the stations for several hours Monday through Friday. Station attendants do not work during the weekends and holidays (Table 6.5). The total ticket sales and revenue collected at each of the stations by the station attendants is shown in Table 6.6.

The Media-West Chester line has a zone fare system (Figs. 6.8 and 6.9) which includes seven zones.

The duties that are typically performed on RGR systems are handled on thisline in the following ways.

Four major duties now performed by on-board train personnel are:

1. Driving
2. Opening/closing doors and moving traps
3. Supervision of the boarding/alighting process
4. Fare collection.

The driving function is performed by the driver who is located in a fully enclosed cab which extends across the entire width of the car. Passengers may not board or alight through the driver's cab. The Media-West Chester line is not equipped with automatic train control or cab signalling devices.

Any plan which proposes to reduce on-board crew requirements must provide alternative methods for performing the last three duties: operation of the doors and traps, supervision of boarding/alighting, and fare collection.

Doors are single-channel, sliding doors which are located at each end of the car. In addition to the sliding exterior door there is a swinging door between the driver's cabin and the body of the car.

Table 6.4 Media-West Chester ticket sales
November, 1980

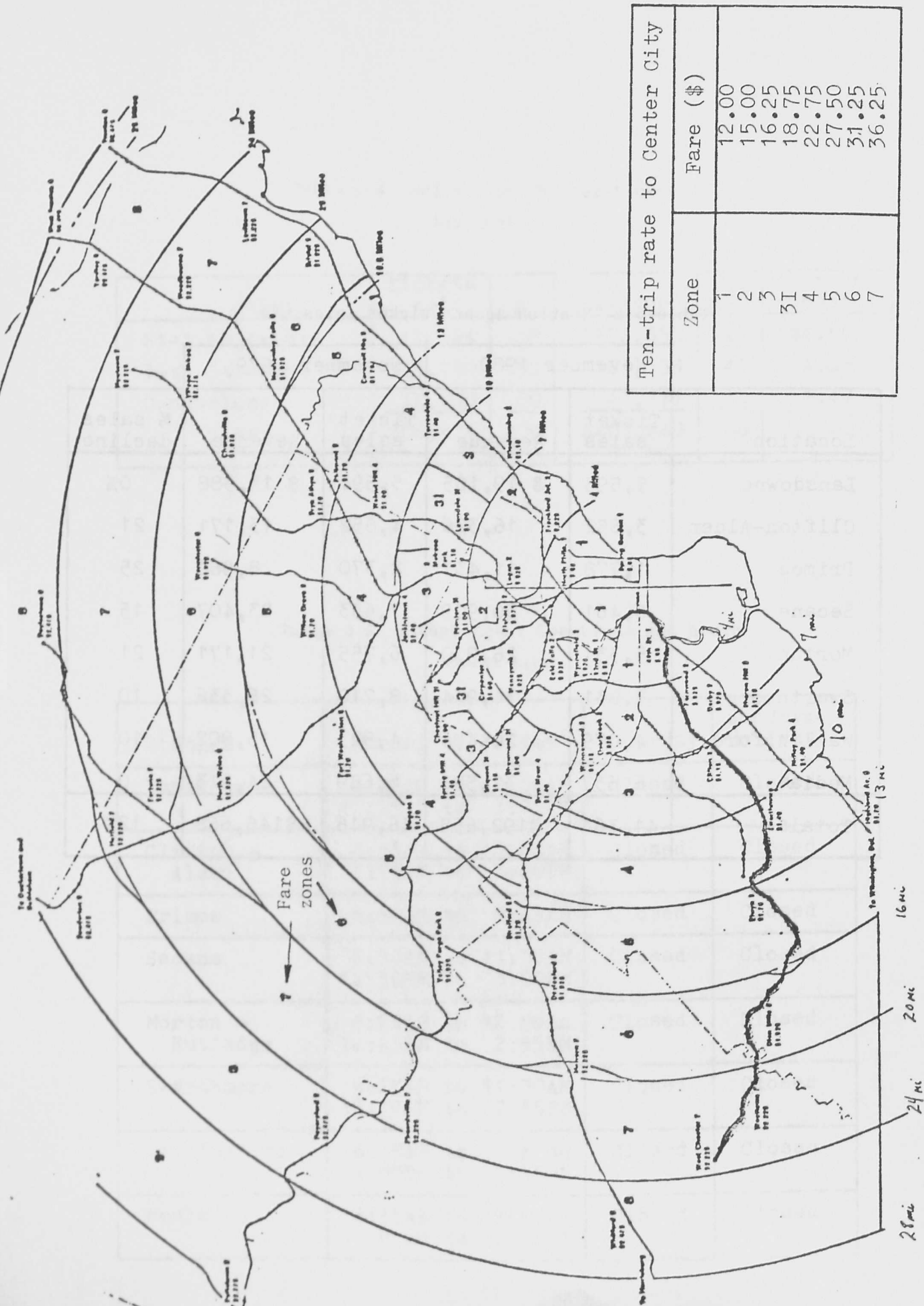
Outlet	Tickets sold	%	Revenue	%	Average sale
Station Agents	41,364	38	\$192,655	47	\$4.66
30th St./Penn Ctr	35,130	32	163,753	41	4.66
Conductors	<u>32,080</u>	<u>30</u>	<u>47,241</u>	<u>12</u>	1.47
Total	108,574	100	\$403,649	100	

Table 6.5 Ticket agent locations and hours
Media Line

Station	Monday to Friday	Saturday	Sundays/ Holidays
Lansdowne	6:35AM to 11:00AM 12:15PM to 3:05AM	Closed	Closed
Clifton - Alden	6:35AM to 11:00AM 12:15AM to 3:00PM	Closed	Closed
Primos	6:30AM to 8:45AM	Closed	Closed
Secane	6:30AM to 11:30AM 12:30PM to 3:00PM	Closed	Closed
Morton - Rutledge	6:25AM to 12 Noon 12:45PM to 2:55PM	Closed	Closed
Swarthmore	6:25AM to 11:30AM 12:30PM to 2:55PM	Closed	Closed
Wallingford	6:25AM to 12 Noon 1:00PM to 2:55PM	Closed	Closed
Media	6:15AM to 11:00AM 12 Noon to 2:45PM	Closed	Closed

Table 6.6 Station agents-ticket sales

Location	November 1980		November 1979		% sales decline
	Ticket sales	Revenue	Ticket sales	Revenue	
Lansdowne	5,595	\$ 19,105	5,594	\$ 13,588	0%
Clifton-Alden	3,652	16,326	4,652	13,171	21
Primos	1,778	11,431	2,370	8,980	25
Secane	6,461	30,909	7,653	23,407	15
Morton	5,331	26,910	6,755	21,171	21
Swarthmore	7,831	34,944	8,710	26,336	10
Wallingford	4,079	20,454	4,523	15,802	10
Media	6,637	32,576	6,689	24,213	0
Totals	41,364	\$192,655	46,946	\$146,668	12%



Ten-trip rate to Center City	
Zone	Fare (\$)
1	12.00
2	15.00
3	16.25
3I	18.75
4	22.75
5	27.50
6	31.25
7	36.25

Figure 6.8 Regional rail zone structure

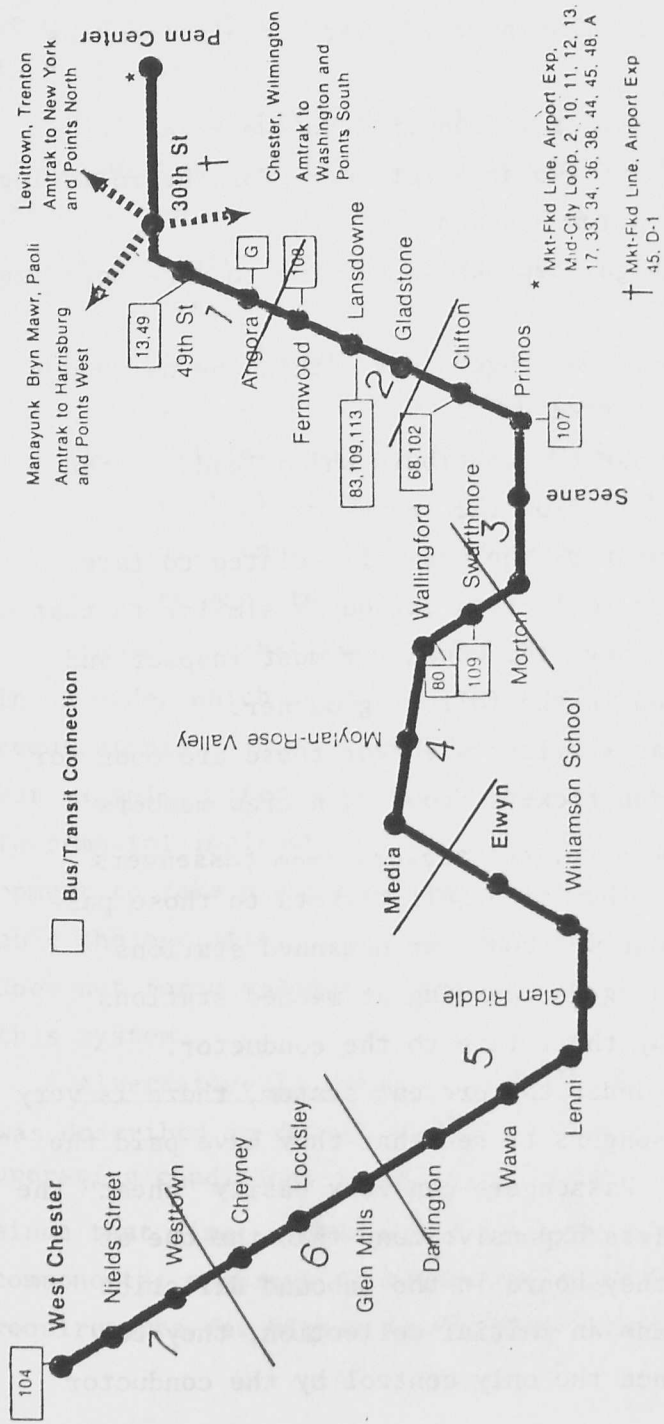


Figure 6.9 Seven fare zones

Change from low to high-level platform boarding is made by the conductor who lowers a metal plate (trap) which forms a floor above the steps. When the trap is in the vertical (open) position, the sliding door cannot be activated and the car vestibule (driver's cabin) remains open.

Currently, at least one crew member is required to supervise boarding and alighting at each set of two adjacent doors for the following reasons, imposed by the car and station designs:

1. Low-level platforms and high steps which combine to make boarding difficult and slow.

2. The need to insure that all passengers are within the passenger compartment before the train has started.

3. The inability to fully close the vestibule which leads to the possibility that a passenger may fall from the train.

The largest amount of time spent by the crews is related to fare collection tasks. The current fare collection method is similar to that of conventional railroad practice where the conductor must inspect and punch each ticket. It is performed in the following manner.

Passengers purchase tickets at stations whenever these are open for sales. Otherwise they must purchase tickets from train crew members - conductors or trainmen. Crew members collect tickets from passengers manually during the train travel. They also sell tickets to those passengers who do not have them. Those who board at unmanned stations get tickets at regular price; passengers boarding at manned stations pay a 50-cent penalty when they pay their fare to the conductor.

It should be emphasized that under the present system, there is very little or no supervision over passengers to see that they have paid the correct fare, or any fare at all. Passengers can very easily "cheat" the system by paying for a ride to a less expensive zone than the one at which they actually get off. If they board in the inbound direction after the conductor had already made an initial collection, they can often evade paying altogether, since the only control by the conductor is his memory of who had paid.

In practice, one can accurately describe the present system as one which is truly an "honor system". Moreover, this system has no penalties for violators. Therefore no fare collection method could be more lenient in dealing with violators than the present RGR system in Philadelphia.

6.3.3 Alternative Methods of Operation. Five alternative methods of train operation for the conditions on this line will be compared in this section. These alternatives are:

- I. Present method;
- II. Partial self-service fare collection with moderate crew reductions;
- III. Full self-service fare collection with modifications to vehicle doors which make operation with 2-men crews possible;
- IV. Full self-service fare collection with construction of high-level platforms, allowing operation with 2-men crews;
- V. Fully enclosed stations with automatic fare collection enabling one-man crews.

These alternatives are not mutually exclusive. They are presented in an order which results in a sequence of increasingly larger capital requirements. Thus, alternatives can be adopted on an incremental basis. For example, alternative III can be implemented after alternative II. Incremental implementation of these alternatives allows a gradual development to take place with new methods of train operations. This will enable the operating agency to accumulate experience with these methods and does not force sudden changes in operating or funding requirements for this system.

Alternative I: Present Method. This method of current operation was described in detail in the previous section. It was developed for operating conditions in the early 1900s, which have drastically changed since that time: labor wages have increased much faster than other cost components; numerous technological inventions have become available; requirements for higher speeds have increased, etc.

The primary disadvantage of the present operating method is that it is the most labor intensive of all alternatives. The present crew requirements are shown in Fig. 6.10. The use of large crews combined with the high wages of railroad workers (they are one of the highest paid blue-collar groups) results in extremely high operating costs for this transit mode.

Alternative II: Partial Crew Reduction. This alternative uses elements of both the present and self-service fare collection methods. The self-service fare collection system is employed only to ease the task of ticket collection and inspection which allows the reduction of train crews to the minimum required for safe supervision of boarding/alighting of passengers.

The major capital expense is the purchase of ticket vending and cancellation machines at some stations. This expense would be at least partially offset by a reduction in labor expense for ticket agents. No major modification would be required in vehicles or stations, so that this alternative could be implemented in a relatively short time. The same situation applies to alternative III.

This method would utilize self-service for collecting most fares. Crew members would be responsible for collection of the remaining fares and door supervision. This alternative would thus allow reduction of the crew size to the minimum number of conductors/trainmen necessary to supervise boarding/alighting of passengers. It should be emphasized that the reduced crews would not be able to perform all fare collection duties as they are performed with the present fare collection method, especially for inbound trains where many tickets are purchased on-board the trains.

Therefore this method of self-service and ticket selling procedures would be used to reduce the fare collection duties for the remaining crew members. Most passengers would be required to board the trains with pre-purchased cancelled tickets and the principal fare-related duties of the trainmen would be to inspect the validity of these tickets.

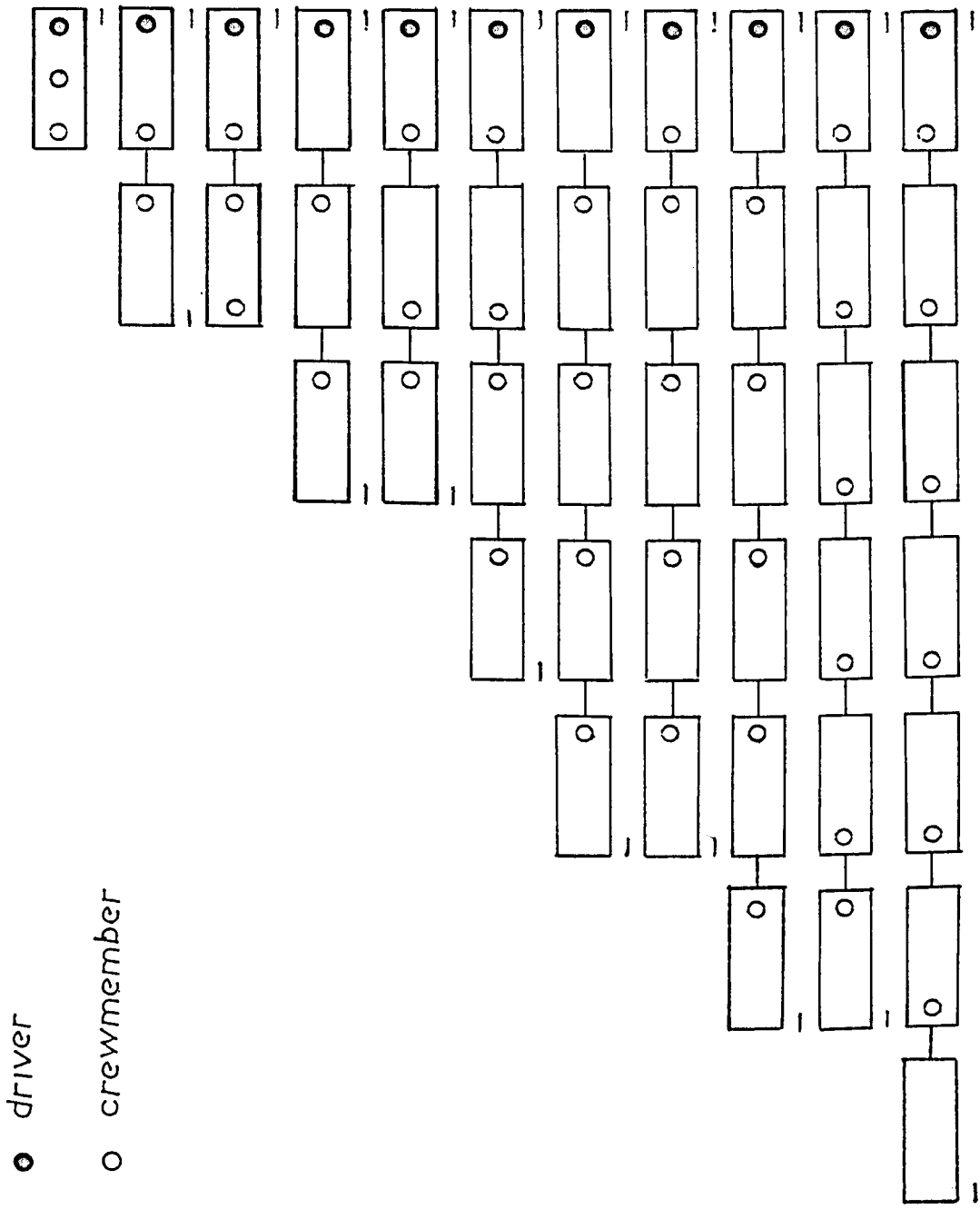


Figure 6.10 Train crews for different train consists: present practice

Since low level boarding/alighting would be retained with this alternative, and since boarding/alighting requires the presence of a crew member for safety, the crew reduction would necessitate that a smaller number of doors be opened. The operated doors and positions of crew members would be as Fig. 6.11 shows. Each crew member would supervise two doors on close ends of two adjacent cars. It should be noted that passengers in cars in the center of the trains with four or more cars would not be able to enter/exit through doors at one end of the car. This would impose certain inconvenience, but with adequate information for passengers it would not be any worse than the present operation, where, due to lack of instructions, passengers often go to the last door on the train and find it closed.

Passengers would be informed which doors are available for boarding/alighting. For alighting passengers this can be done through use of loud-speaker announcements or signs similar to the adjustable smoking/no smoking sign now in use on the Silverliner IV's. Boarding passengers would see which doors are closed as the train pulls into the station, either directly or by the automatic colored lights at each door. If passengers are informed about this procedure ahead of time, there would not be any need for special announcements.

Other important characteristics of this alternative include:

1. Placement of automatic ticket vending machines on the inbound side of heavily used stations. Passengers at the other stations could purchase tickets at special stores, kiosks and other off-line facilities, at downtown stations, or, as last resort, on-board trains. These should be simple, reliable vending type machines such as the ones currently in use on Philadelphia's Lindenwold Line.

Since the current practice of granting discounts to multiride tickets will continue, passengers will be encouraged to purchase discounted, multiride tickets from off-line locations rather than from vending machines which offer only the more expensive single ride tickets. Because of limitations in coin denominations, multiride tickets cannot be sold from vending machines. A peak hour 10-trip ticket from Media to Philadelphia costs (10 x \$2.275) \$22.75, which is too much change for passengers to carry.

● driver

○ crewmember

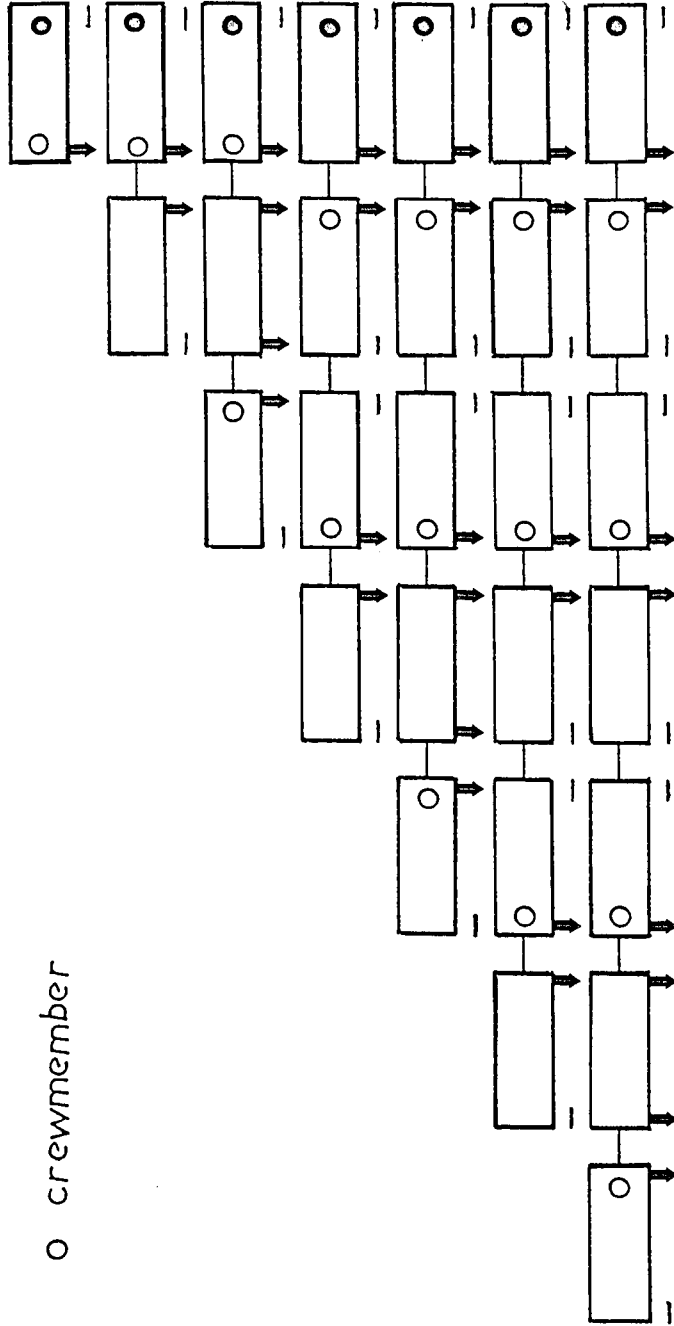


Figure 6.11 Reduced crews without door or station rebuilding

2. In order to reduce the number of ticket vending machines and on-board ticket sales, multiride tickets should be sold in as many off-line locations as possible. This includes sales by mail and through local agents such as retail stores. Several stations on the Media Line are located near local commercial centers or retail establishments, many of which may be willing to sell rail tickets for a small commission.

3. Cancellation machines should be placed on the inbound platform side of heavily used stations and on-board all vehicles. The machines would put the time, date and location on the ticket, so that it may not be used again.

Passengers at heavily used stations should be encouraged to cancel tickets before entering the train in order to speed the boarding process and avoid train delays. Passengers who fail to do this and passengers boarding at lightly used stations, can use the cancellation machines on-board all vehicles.

Cancellation machines are usually small and relatively simple in design, enabling flexibility in their location. On board vehicles, they should be placed near the entrances, so that passengers can cancel the tickets immediately after boarding. However, the machines should also be far enough from the doors so that no passenger can be hit by a closing door while cancelling the ticket. This will require installing a stanchion at each end of the car and then attaching the cancellation machine to the stanchion, as is the common practice in European cities.

4. Once on board the vehicle, passengers must keep their cancelled tickets available for inspection, preferably in the ticket slots in front of the seat. The cancelled tickets would serve as seat checks. Passengers with weekly or monthly tickets can display these tickets in the ticket slot or alternatively receive from the conductor a dated, preprinted receipt to be displayed. This would prevent any theft of expensive monthly tickets.

With this procedure, the primary fare collection duty of the conductors is to make a quick visual inspection of tickets. Passengers who board at lightly used stations may still have to purchase tickets from conductors. However, the number of fare collection transaction by crew

members would be much smaller than now because:

a) ticket vending machines would be available at some stations which now have no ticket agent to handle sales;

b) a wider network of local sources for tickets (retail stores, sales by mail, etc.) would be available;

c) the larger discount for multiride tickets (which cannot be purchased on the train) would encourage purchase of these tickets.

5. Passengers who board without a valid, cancelled ticket at a station where tickets are available would still be able to buy one from the conductor, but would have to pay a relatively steep surcharge (higher than the present surcharge of \$10.50). This should be effective in encouraging pre-purchase.

The overall effect of these procedures is to reduce crew time required to perform fare collection tasks. This permits reductions from one to two crew members depending upon the consists. A summary of crew duties for individual stations is as follows.

INBOUND

Media - supervise passenger boarding.

Media - Moylan - between stations, walk through car(s) and inspect cancelled tickets. Sell tickets (at a surcharge) to passengers without a valid, cancelled ticket. Under the proposed manning requirements showed in Fig. 6.11, the maximum number of cars a conductor must supervise is two.

Moylan - supervise passenger boarding.

Moylan - 49th Street - at all stations and stretches between Moylan and 49th Street the above procedure will be repeated.

49th Street - 30th Street - supervise tickets of any standees who do not have locations for display of fares like the seated passengers do. Raise traps for high level platforms at 30th Street and Penn Center stations.

30th Street - supervise alighting and boarding of passengers

30th Street - Penn Center - walk through cars and inspect cancelled tickets.

Penn Center - supervise alighting. Since 30th Street and Penn Center both have high level platforms, all exits could safely be used for unloading without crew members supervising them. However, this would require remote door control.

OUTBOUND

Penn Center - supervise passenger boarding

Penn Center - 30th Street - between stations walk through train and inspect tickets of passengers leaving at 30th Street. Announcement should be made for these passengers to have their tickets available for inspection.

30th Street - supervise passenger boarding and alighting. Since Penn Center and 30th Street have high level platforms, all entrances and exits should be used regardless of stationing of crew members.

30th Street - 49th Street - lower traps for low level boarding. As time permits, walk through car(s) and inspect tickets. Since Penn Center and 30th Street both have manned ticket offices, it is unlikely than many tickets will have to be sold on board the train.

49th Street - supervise boarding and alighting

49th Street - Angora - sell tickets to passengers boarded at 49th Street. Continue to inspect tickets.

Angora - Moylan - at all stations between Angora and Moylan continue the above procedure.

Moylan - Media - sell tickets to outbound passengers boarded at Moylan. Lower traps for Media Station (platform on opposite side).

Media - supervise alighting of passengers.

Since this alternative requires no modifications in vehicles or stations, it can be utilized as an intermediate step before full implementation of self-service fare collection. It provides a longer lead time in making station and vehicle modifications while allowing passengers and operating personnel to gain experience in the self-service system. Compared to the present method of fare collection, alternative II offers:

- + reduction in crew requirements by one to two crew members per train;
- + reduction in station ticket agent requirements since tickets could be purchased from vending machines or many offline location;

- + provides a system of checking the proper zone and destination for the ticket;
- requires capital and maintenance cost for installation of ticket vending and cancellation machines;
- passengers will not be able to board and alight at all train doors because of reduced crew size.

Alternative III: Vehicle Modifications. This method requires modification of doors so that they can close regardless of the position of traps. This involves long doors which would extend down to the level of the lowest fixed step, rather than only to the car floor, as is presently the case. This modification would permit two operational improvements. First, vestibules in cars would always be enclosed during train travel, eliminating the possibility of passengers falling from a moving train. And second, combined with a few other changes, this modification would enable boarding/alighting process to be carried out without direct supervision by a crew member. Thus the need to have a crew member at each door would be eliminated. After the doors are closed by remote control, it would be safe to start the train.

The problem of rather high steps on the cars, the only reason that the presence of a crew member is currently required, could be ameliorated by construction of platform edges up to the level of the lowest step so that one of the steps would be eliminated. This raising of platform edges would not be a very complicated project since it would amount to about 12 inches only. Platform edges at most stations badly need repairs anyway. This platform height would not intrude into rail car clearance profile.

In conjunction with a self-service fare collection system, this method of train operation could reduce crew requirements for all trains to two: the driver (engineer) and one conductor, as shown in Fig. 6.12.

Following are some details about the physical and operational changes this type of operation would require.

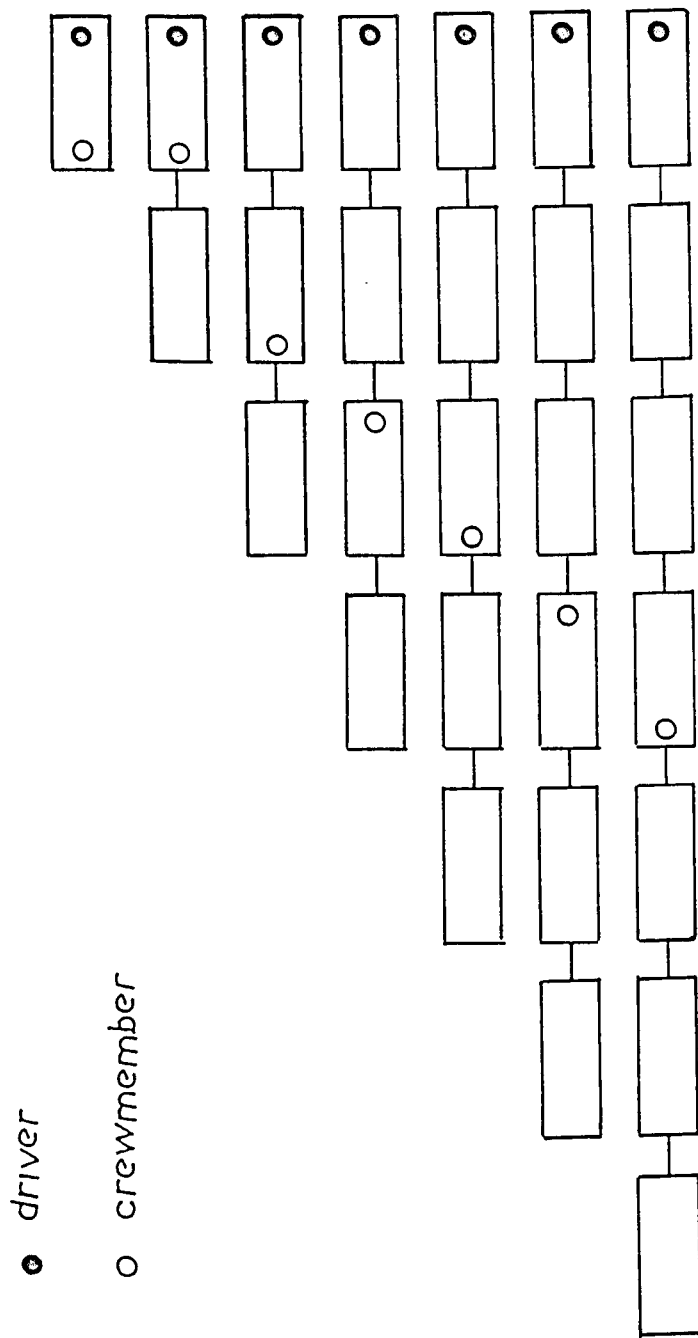


Figure 6.12 Minimum crews with rolling stock and/or station adjustments

Door modification and operation. Retrofitting the cars with long automatic doors would be a substantial project, but easily justified by the operational improvements and savings it would make possible. No detailed study has been conducted on how the new doors could be designed. It appears possible that on Silverliner IV models (majority of the cars) the longer door would be of the same sliding type as the present doors. For older Silverliner models a plug door might be more appropriate since there is no space in the walls that would accept a sliding door. However, the clearance between open plug door and high-level platform would have to be checked.

The doors on Silverliner IV cars are already centrally controlled. With reduced crews it would be highly desirable that door opening and closing be performed by the driver, since the conductor would then not be required to be at a door during every stopping and starting period. However, there should be the option that he also can control doors from some or all door or vestibule locations (as is the case now).

Driver's duties. Following the railroad tradition, drivers on RGR systems have only one regular duty - driving the train. Although this is a highly responsible duty, it is physically rather simple and it can be combined with several other duties without any difficulty or interference with driving. Thus, the driver could assume the duties of opening and closing doors and of announcing stations for passengers. This has been the practice on many rapid transit systems for many years.

Shifting station announcements and door control duties to the driver would improve their performance since stations presently are often announced erratically or unclearly. Direct control over doors would also be useful to the driver.

Details of door supervision during standing at stations, warnings about door closing and departure supervision would still have to be worked out for specific cases, depending on train size, passenger volumes, platform type, station conditions and other factors. It is likely that the conductor would remain involved in these duties, assisting the driver. Yet, he would have less duties than he has now so that he could attend to various irregular interventions anywhere along the train: sell a few

tickets, assist some passengers in boarding/alighting, assist the driver in any mechanical problems, etc.

Since the presence of crew members in each car would be reduced in comparison with current practice, it would be necessary to increase ability of passengers to call for assistance in case there are any problems: information, illness, aggressive behavior, any kind of accident or mechanical breakdown. For that purpose the existing "call" push-buttons should be installed at many more locations along the interior walls of cars. This retrofitting would not represent a major problem or expenditure.

Fare collection. In order to achieve this substantial reduction in crew size, a method must be developed to drastically decrease the fare collection tasks - tasks which are presently performed very inefficiently - so the one remaining conductor could easily handle an entire train. For this purpose a self-service fare collection must be introduced in which the vast majority of fares are paid without any involvement of the conductor. The system would work as follows.

A number of ticket-selling machines would be installed at all major stations. Tickets purchased from the machines and from regular ticket offices would cost substantially less than the tickets passengers would, alternatively, purchase from the conductor. The tickets from the machines would either be dated or passengers would cancel them on the cars upon entering, in small automatic cancelling boxes.

Ample and clear directions would explain to the passengers how to purchase their tickets.

In trains, passengers would be required to show their tickets.

Passengers would in most cases board trains, ride and alight without any control of their tickets. The conductor would, however, walk through the train and ask whether there is anybody without a valid ticket. Such passengers would purchase tickets from the conductor at a much higher price. The passengers who boarded at highly used stations which do not have ticket selling machines would request to purchase tickets from the conductor and obtain them at the same price as from the machines. Those

who failed to purchase tickets at stations with ticket-selling facilities would pay a premium price for the fares.

From time to time, one or several controllers would board the train and request to see the tickets. Passengers who do not have them, and who failed to purchase them from the conductor when given the opportunity would have to pay a penalty in the amount of approximately 10 to 20 times the regular fare.

The conductor would thus sell only a few tickets to the passengers who failed to purchase them at stations, enabling him to have enough time for other duties (departure control at stations and any special assistance or intervention). At the stations without ticket-selling facilities, they would sell more tickets, but such stations are generally on lightly travelled line sections where the conductor has few other duties anyway.

Figure 6.12 shows the "basic" position of the conductor in this type of operation. That position would allow him the easiest supervision of doors and shortest access to all cars; he would, however, walk through all cars from time to time.

Compared to the present operation, this alternative method has the following advantages (+) and disadvantages (-):

- + Reduction in train crew sizes ranging from 1 to 5 persons;
- + Reduction of the number of station agents (due to introduction of machines and sales through other outfits);
- + Increased safety due to closed doors during train travel;
- + Reduced underpayment of fares (presently undetectable in many cases);
- + Better station announcements via p.a. system;
- Requires a major investment in door retrofitting;
- Requires investment in ticket vending machines;
- Reduced assistance to passengers during boarding/alighting.

A comment about self-service fare collection is appropriate here. There has been a long and deep prejudice that such fare collection, although successfully applied in Europe, cannot be used in this country. The success in adopting this method (its acceptance by the public and operational/cost benefits from it) in many countries and cities has been so overwhelming, that in recent years many actions to introduce self-service

fare collection in North American cities have been undertaken. By the end of 1982 Edmonton, Calgary and San Diego have introduced it very successfully on their LRT systems, and Portland, OR , is preparing its introduction on buses and its future LRT line. These cases clearly demonstrate that self-service is a very viable and promising alternative for many North American transit systems. Regional rail in Philadelphia (and in most other cities) would undoubtedly be highly conducive to this service because of their type of service, moderate passenger volumes and passenger characteristics.

Alternative IV: High-level Platforms. This alternative is similar to the previous one with the exception that safe boarding and alighting would be accomplished through construction of high-level platforms, rather than through door modifications. The present door and step arrangement would not need to be modified as the trap would remain in the lowered position which fully encloses the vestibule area. Again, door control is accomplished by the driver, while the conductor would assist in door supervision and departure control. The self-service fare collection system remains unchanged from the previous alternative.

Two options are available for the construction of high-level platforms along the Media line:

- 1) Raising platform level at every station from Philadelphia to West Chester.
- 2) Raising platform levels only at stations on the heavily used portion of the line from Philadelphia to Elwyn. The light passenger loads between Elwyn and West Chester can be handled by 2-car trains which are small enough for the traps and door supervision to be handled by one conductor.

While this alternative accomplishes the same objectives as the previous alternative, construction of high-level platforms has important impacts on other aspects of the operation. They include passenger comfort, operating speeds and freight service.

Passenger boarding and alighting is much more comfortable and safer from high-level platforms as opposed to using the high steps as in present operation. Even more importantly, boarding and alighting is much faster, resulting in significantly reduced station dwell times. This is an important

benefit which increases operating speeds and may even lead to reduced vehicle requirements. If reductions in vehicle requirements are accomplished, the construction of high-level platforms would be cost effective even without any crew reductions, given the current price of approximately \$1 million for a regional rail vehicle.

Construction of high-level platforms might have a negative impact upon the existing freight service on the Media line since freight car clearances in some cases do not permit operation past high-level platforms. Other systems have overcome this difficulty by constructing an additional freight track. However, this is not possible on the Media line because it passes through several built up areas where land for an additional track would be difficult to obtain.

Freight service consists of one daily train which operates during late night hours to avoid conflicts with passenger trains. The future of this freight service would have to be reevaluated under this alternative. Passenger service accounts for a much higher service volume and improvement of this service should be given top priority.

The possibility should be explored to construct high-level platforms and restrict freight cars on the line to those which have profiles within platform clearance. It is probable that very few cars (if any) would be affected by this restriction. This might be a very easy solution to the clearance problem.

In comparison to the present method of operation, construction of high-level platforms along with self-service fare collection offers the following advantages and disadvantages:

- + Reduction in train crew sizes ranging from 1 to 5 persons;
- + Reduction in the number of station agents;
- + Safer and more comfortable boarding and alighting;
- + Faster boarding and alighting resulting in higher operating speeds and reduced vehicle requirements;
- + Reduced underpayment of fares;
- Requires a major investment in high-level platforms;
- Requires investment in ticket vending machines;
- Restrictions on freight service.

Alternative V: Fully Automatic System. This alternative incorporates a fully automated fare collection system, similar to recently completed rapid transit systems in Washington and Atlanta. Passengers would purchase tickets from automatic vending machines and enter the station area through automatic turnstiles. Exiting would also be through automatic turnstiles. Since the fare collection is fully automated, no on-board train personnel are required for fare-collection tasks and train crews could be reduced to one.

This system would require rebuilding of all stations to provide a separate, enclosed "paid" area. Present stations are designed as open and fully accessible to the surrounding environment. Therefore, construction of enclosed, barrier-type stations would require significant reconstruction. It is much easier to incorporate fully automated stations into new systems than to rebuild old stations to this type. Because of the large capital expenses involved this alternative should only be considered as a long-range plan.

6.3.4 Comparison of Alternatives

The final alternative should be selected on the basis of the most favorable economic and operating results, and service characteristics affecting passengers. To make a clear comparison of these on the basis of the preceding analyses, the major items which differ among the alternatives are summarized and listed in Table 6.7.

Economic impacts can be classified into operating and capital costs. Since labor costs represent the major component of operating costs, the relative impact of each alternative can be estimated by crew sizes for each alternative. Additional impacts are that alternatives II thru V would permit elimination of ticket agent requirements, but require maintenance of ticket vending and cancellation machines.

Capital requirements include the investments for new equipment (vending machines), retrofitting the rolling stock, and station reconstruction. Their values, expressed as high, medium, low or none, are summarized in the table. All other characteristics relating to costs, operations, passenger safety, and other factors are also listed.

Table 6.7 Comparative analysis of Alternatives I - V

Comparison items Alternatives	Crew size	Vend. mach.	Canc. mach.	Veh. mod.	High-lev. plat.	Stat. reb.	Other characteristics compared with Alternative I
I	3 - 7	none	none	none	none	none	(The present, "base" system)
II	2 - 5	low-med.	low-med.	none	none	none	+ Fewer station agents + Positive control of zone fares - Fewer doors open - Requires maintenance of vend./canc. machines
III	2	high	high	high	none	none	+ Fewer station agents + Travel with closed doors - higher safety + Reduced fare evasion - Reduced assistance to passengers for boarding/alighting - Requires maintenance of vend./canc. machines
IV	2	high	high	none	high	none	+ Fewer station agents + Reduced fare evasion + Faster and safer boarding/alighting + Higher operating speed + Reduced vehicle requirement - Restrictions on freight service - Requires maintenance of vend./canc. machines
V	1	high	high	none	high	high	+ Fewer station agents + Reduced fare evasion + Faster and safer boarding/alighting + Higher operating speed + Reduced vehicle requirement - Restrictions on freight service - Requires maintenance of vend./canc. machines

As previously mentioned, it is possible to implement these alternatives in incremental steps, going from the present system to Alternative II and then either Alternative III or IV. The extremely high costs of building enclosed, rapid-transit type stations in Alternative V, make this only a long-range consideration.

6.3.5 Conclusions and Recommendations

Each of these alternatives provides a method of bringing about reductions in on-board crew requirements. Since Philadelphia has a regional rail system which includes low-level platforms and doors which do not fully enclose vestibules for low-level boarding, it presents a "worst case" for bringing about these changes. Regional rail systems in Chicago, New York, parts of the New Jersey Northeast Corridor Line and San Francisco incorporate at least one of these features and would be easier to convert than the Philadelphia system.

It is also important to consider the impact of the Center City Commuter Connection on the alternatives. This project, to be completed in 1984, will connect the former Penn Central lines (including the Media line) with the Reading lines. Therefore, a change in fare collection and passenger loading procedures on the Media line will require a corresponding change on the Reading line with which it will be connected. The lines on the two systems are similar and it is possible to accomplish this without major difficulties. Successful implementation of one of these alternatives can lead to its introduction on the remaining regional rail lines.

7. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The present conditions on many rail transit systems in North America is, in some ways, illogical. The mode which potentially has by far the highest labor productivity, and therefore the lowest unit operating costs, does not fully utilize that potential. While several rail transit systems (Lindenwold Line, BART, Atlanta) clearly show that high level of automation is possible, there are still systems of all modes (LRT, RRT and RGR) which has as intensive labor use as it had in 1900-1920, when cost of this item was much lower.

The study has shown that train crew reductions can decrease operating labor costs very significantly: in most cases to nearly 50% (some LRT and RRT systems), and to as much as only 30% of the present costs (on some RGR systems).

Most streetcar/LRT systems cannot decrease their crews any more since they have one-person operation. Those with multiple unit operation can reduce them by introduction of self-service fare collection (following the examples of Edmonton and Calgary).

Older RRT systems can reduce their crews to one person with rather minor changes and very limited investment.

Regional rail systems have by far the greatest potential savings to realize through crew reductions. They must, however, undertake somewhat more extensive changes, such as redesign of car doors or construction of high-level platforms and introduction of self-service fare collection. This requires certain planning and capital investments, but these would be easily compensated by the large savings in operating costs from crew size reductions. Because of special operating features of RGR mode, it is not expected that these crews can be reduced below two members.

Technical problems of the proposed changes are in most cases minor. Some measures required on a few RGR systems are an exception. The major obstacle in many cases is the opposition of labor unions. The cost of this opposition is, however, so high that the existence of these modes is being threatened. Time for major changes and modernization has come — they cannot be delayed much more.

It is recommended that all transit operating agencies which potentially can benefit from crew reductions immediately initiate activities along two lines:

1. Planning of the physical/operational changes needed for crew reduction;
2. Negotiations with labor union(s) and search for its cooperation in these badly needed modernizations.

There are several measures which can make crew reductions more acceptable to labor unions. They are:

- Stipulation that most of the benefits from crew reduction are passed on to the public through higher frequency of service (so that the same number of employees is retained). This is applicable to off-peak RRT operations.

- Reassignment of the freed crew members to other duties.

- Increased wages (say 10-15%) for the reduced crew members. Thus the savings would be shared by the agency and its employees.

A number of other measures are possible, but they depend on local conditions and cannot be easily generalized.

It is recommended that UMTA strongly supports transit and rail road operating agencies in these efforts since they would result in both improved transit services and reduced public funds expenditures. The other alternative to these actions may in some cases (RGR) be catastrophic: discontinuance of services. This is obviously a case where relatively little effort can bring considerable and permanent savings. UMTA's actions in distributing information about possibilities of train crew reduction, methods to achieve it, etc., thereby helping to influence ongoing labor negotiations would be very purposeful and very much in the public interest.