UMTA-80-1

UMTA-MA-06-0048-79-7

AUTOMATED GUIDEWAY TRANSIT SYSTEM PASSENGER SECURITY GUIDEBOOK

MARCH 1980

AUTOMATED GUIDEWAY TRANSIT TECHNOLOGY PROGRAM

U.S. DEPARTMENT OF TRANSPORTATION
Urban Mass Transportation Administration
Office of Technology Development and Deployment
Washington DC 20590

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTA-MA-06-0048-79-7		

4. Title and Subtitle	5. Report Date
AUTOMATED GUIDEWAY TRANSIT SYSTEM PASSENGER SECURITY GUIDEBOOK	March 1980
	6. Performing Organization Code
7. Author(s) Jacobson, I.; Richards, L.; Leiner, C.T.; Hoel, L.; Braden, A.†	8. Performing Organization Report No. DOT-TSC-UMTA-80-1
9. Performing Organization Name and Address Dunlap and Associates, Inc.* One Parkland Drive Darien CT 06820	10. Work Unit No. (TRAIS) UM033/R0726 11. Contract or Grant No. DOT-TSC-1314
12. Sponsoring Agency Name and Address U.S. Department of Transportation Urban Mass Transportation Administration Office of Technology Development and Deployment Washington DC 20590	13. Type of Report and Period Covered Final Report January 1980 14. Sponsoring Agency Code UTD-42

15. Supplementary Notes

*Under contract to: U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Cambridge MA 02142

16. Abstract

This guidebook provides AGT system planners, designers and operators with information on available crime countermeasures and their relative effectiveness against transit crime.

Crime countermeasures on current transit systems have been reviewed and their applicability for different categories and designs of AGT systems has been evaluated. The guidebook emphasizes countermeasures which have proved effective in conventional transit systems. This emphasis is not to the exclusion of innovative countermeasures, but reflects the requirement that the guidebook present proven, reliable anti-crime strategies to its users.

Research into urban transit crime has generated only a limited amount of empirical information useful to AGT system planners and operators. Therefore, this guidebook attempts to establish a sound conceptual base for AGT personal security planning. Consequently, AGT personnel can follow the planning procedures presented herein, and develop a reasonably effective security program despite the current scarcity of useful transit security data.

†The authors of this report are located at the University of Virginia, Thornton Hall, Charlottesville VA 22901, which is a Dunlap sub-contractor.

17. Key Words	18. Distribution Statement
Automated Guideway Transit, Countermeasures, Security Human Factors	DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	136	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

EXECUTIVE SUMMARY

A. INTRODUCTION

Automated Guideway Transit (AGT) systems provide unique problems in providing personal security for passengers. During normal operation, there will be few employees in the system. Since the presence of employees in terminals is usually thought to help deter crime, their absence may create problems. Similarly, since AGT vehicles will normally function without on-board operators, criminal activities (e.g. vandalism, crimes against persons) may occur in the vehicles. Finally, the high technology components necessary for an AGT system may be highly vulnerable to vandalism.

In order to insure that future AGT systems provide an attractive and desirable mode of urban transportation, designers and planners must be aware of the countermeasures they may employ to reduce the risk of crime and vandalism in such systems and enhance the feeling of security enjoyed by passengers.

B. PROBLEM STUDIED

The planners and designers of AGT systems need a comprehensive source of information on crime countermeasures and security practices. They need know what crime problems exist on current transit systems and which are likely to occur in AGT environments. Finally, they need to know how to design AGT systems for maximum security and which security procedures and equipment are likely to be most effective in such systems.

The present guidebook was developed to meet these needs. It is based on information gathered through literature searches, visits to transit properties, interviews and correspondence with transit security officials and with equipment manufacturers, vendors, and suppliers. The guidebook proceeds from current knowledge and practice, and develops procedures for selecting countermeasure strategies for AGT systems. This guidebook has been evaluated by transit security experts at an American Public Transit Association (APTA) security committee meeting and their comments have been incorporated into the test.

C. RESULTS ACHIEVED

This guidebook provides the AGT system designer and planner with current information on crime countermeasures and describes a method for developing a security strategy for a planned transit system. The guidebook has five sections and a major appendix. Section 1 introduces the guidebook. Section 2 provides a classification of crimes into four categories: those against the person, persons' property, system property, or the public. The categories provide the basis for subsequent scenario development. The several types of AGT system are distinguished, and the security considerations and problems common to all AGT systems are reviewed. Security measures are required for platform monitoring, revenue protection, emergency evacuation, and monitoring stations in high crime neighborhoods.

Section 3 contains comprehensive discussions of a large number of crime countermeasures. A crime countermeasure is any device, strategy, or procedure whose purpose is to prevent crime or the fear of crime. The various countermeasures were grouped by whether they were related to (1) hardware and equipment (2) station or vehicle design, (3) personnel and operations, (4) judicial policy, or (5) land use. For each countermeasure, a description of it is provided, its current use and effectiveness is noted, its advantages and disadvantages are reviewed, estimates of its costs are given, and its relevance to AGT environments is considered.

Section 4 examines the relative effectiveness of selected countermeasures in relation to various crimes. It also provides judged relative costs for these countermeasures - both monetary costs (initial capital investment; operating costs) and acceptance costs (acceptability of the countermeasure to the passenger and the transit operator). In terms of effectiveness, only a few countermeasures were judged to be effective against a large number of crimes of different types. Most of these involved extensive use of police manpower. One low manpower countermeasure was found to be effective against a variety of crimes: closed circuit television surveillance (CCTV). This countermeasure is acceptable both to the general public and the transit operators and its costs are moderate. CCTV is in principle capable of providing the same protection as several high manpower alternatives. Thus, it is a cost effective general purpose countermeasure which is compatible with AGT operations.

Section 4 also describes a regression methodology for forecasting the rates of different types of crime likely to occur in AGT stations from certain population characteristics of the neighborhoods around the stations. An example is worked through using data from the BART system.

Section 5 presents a synthesis of the results of the previous chapters. A methodology for selecting countermeasures for AGT applications is developed and illustrative examples are described using stations in the BART system, Chicago, and a hypothetical planned AGT system. Table 5-1 summarizes the steps in the countermeasure selection procedure and shows how they relate to each other. Each step is described in detail in the text of this Guidebook. A set of scenarios characterizing typical and extreme occurrences of each of the four types of crime are presented in detail. These scenarios provide the basis for security planning; they represent situations which must be protected against or prevented. The scenarios were developed by the research team and then evaluated by security officials from the major U. S. transit properties.

Appendix A is an annotated bibliography of the major publications on passenger security, and will provide the reader with an appreciation of prior work in this area.

D. UTILIZATION OF RESULTS

This guidebook provides AGT system planners, designers, and operators with a convenient source of current information on security equipment and procedures that is relevant to different types of AGT situations. However, the Guidebook is also useful to anyone concerned with providing passenger security on public transportation systems.

E. CONCLUSION

This AGT System Passenger Security Guidebook draws together in a single volume a great deal of information on crime countermeasures relevant to AGT systems. It includes assessments of the effectiveness, costs, applicability, advantages and disadvantages, and current use of selected security equipment and procedures; and it provides guidelines for the development of a countermeasure strategy for particular applications.

PREFACE

The U. S. Department of Transportation's Urban Mass Transportation Administration (UMTA), in order to examine specific Automated Guideway Transit (AGT) developments and concepts, has undertaken a new program of studies and technology investigations called the Automated Guideway Transit Technology (AGTT) program.

The objective of one segment of the AGTT program, the Systems Safety and Passenger Security Study (SS&PS), was the development of guidelines for the assurance of actual and perceived passenger safety and security in AGT systems. This work was contracted, through the Transportation Systems Center (TSC), to a team composed of Dunlap and Associates, Inc., the University of Virginia, and the Vought Corporation.

The System Safety and Passenger Security (SS&PS) study has involved six related but separate tasks. Three were concerned with the development of guidebooks dealing with: 1) passenger security, 2) evacuation and rescue, and 3) passenger safety and convenience services. A fourth task required the development of a passenger value structure model; a fifth involved research on the retention of seated passengers during emergency stops; and a sixth involved the conduct of a joint Government and industry workshop to review and revise the three guidebooks.

The objective of this Passenger Security Guidebook is to provide AGT system planners, designers and operators with a convenient source of easy to use information on transit system security that is relevant to different categories and designs of AGT systems. It includes an evaluation of the applicability and relative effectiveness of available countermeasures to transit crime and vandalism and provides AGT system planners and designers with data and guidelines to assist them in reducing the potential hazards of crime and vandalism on AGT systems.

The authors wish to acknowledge the time and cooperation received while visiting the various transit properties in the U. S. and Canada, the help received from transit properties' Directors of Security and/or Chiefs of Police in reviewing crime scenarios, and the many valuable comments and suggestions on this guidebook received from members of the APTA Committee on Transit Security and other professionals in the transportation and security research and development community. Without the cooperation of transit officials and other experts, completion of this task would have been impossible. The authors also wish to thank the UMTA and TSC technical personnel for their assistance in the performance and documentation of this work, and in particular, Duncan MacKinnon and Robert Hoyler, Program Manager and Monitor, respectively, for UMTA; and Donald Sussman, Project Monitor for TSC and his professional associates, Janis Stoklosa and Walter Hawkins.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

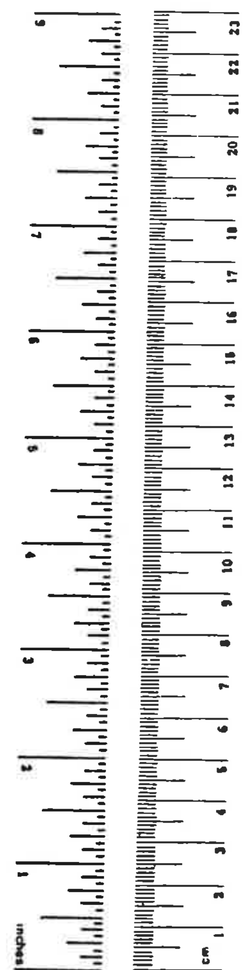
LIST OF TABLES

LIST OF ILLUSTRATIONS

METRIC CONVERSION FACTORS

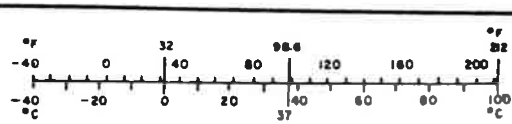
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



1. INTRODUCTION

This guidebook provides automated guideway transit (AGT) system planners, designers and operators with a convenient source of easy-to-use information on transit system safety and security that is relevant to different categories and designs of AGT systems.

In addition, the guidebook evaluates the applicability and relative effectiveness of available countermeasures to transit crime and vandalism and provides AGT systems planners and designers with guidelines to assist them in reducing the potential for, and hazards of crime and vandalism on AGT systems.

The security analysis considers the three major types of AGT systems (SLT, GRT, PRT) and major subcategories with special problems as identified in the course of the study. These are defined in the next section. The crimes and acts of vandalism common to other forms of mass transit are examined in detail in addition to special security problems anticipated for AGT systems. Crime and vandalism countermeasures herein evaluated emphasize those which have proven effective in other mass transit systems. This emphasis is not to the exclusion of other innovative countermeasures, but reflects the requirement that a guidebook present proven, reliable anti-crime strategies to users.

The AGT system presents a unique situation because there will be few employees available for assistance during normal operation. The presence of employees in terminals may be a deterrent to crime; hence, the lack of employees in AGT systems could compound the criminal problem. Similarly, vehicles in an AGT system may be more prone to criminal activities, since under normal operation there will be no operator on-board. The more serious crimes against a person may be prevalent in PRT systems because of low vehicle occupancy levels. Finally, AGT systems may be highly vulnerable to vandalism because of the "high technology" system components (e.g., user-operated control panels, communications equipment, emergency systems, etc.).

The problem for AGT system planners and designers is that: 1) they need information now on the probable nature and scope of the potential crime and vandalism problems on future urban AGT systems; 2) they need to be able to estimate the value or significance of the fear of crime to the potential ridership; and 3) they need to be fully informed on the countermeasures they can take to reduce the risk of crime and vandalism and reduce the fears of their potential ridership, thereby making AGT a more desirable mode of urban transportation.

At the present time, research into crime and vandalism on current modes of urban transportation is sparse, and our knowledge of the factors involved, of effective countermeasures and of their impact on the general public's attitude and willingness to use urban transit systems is very limited. AGT system planners and designers need a readily available source of reliable comprehensive information on crime and vandalism on current transit systems, on security methods and procedures, and guidelines on how new AGT systems can be designed for maximum safety and security and on the security methods and procedures most likely to be effective for different designs of AGT systems.

This guidebook has been evaluated by security experts at an American Public Transit Association (APTA) security committee meeting and their comments have been incorporated in the text.

The guidebook contains four sections:

- The classification of crimes into four categories and definitions of AGT systems.

- A comprehensive discussion of crime countermeasures including their AGT applications.

- An examination of the relative effectiveness and costs of crime countermeasures, and suggestions for a crime data base. This section also presents a method for forecasting crime rates and types of crime for stations in prospective AGT systems. The methodology assumes a relationship between transit station crimes and certain population characteristics of neighborhoods adjacent to a station. Census data are required for the analysis.

A synthesis of the foregoing chapters: examples of countermeasure applications and a description of an experimental application.

Appendix A offers planners the opportunity to become familiar with the reference literature cited in the guidebook. It is an annotated bibliography of the major publications in this area.

2. DEFINITIONS

A. Crime Categories

Various parts of the guidebook and its appendices utilize crime data from existing transit systems. During the data collection phase, it became apparent that there is no standardized way to report crime data. It can be useful to compare crime across different systems in order to learn more about the dynamics of system design, patronage, and crime rates. But since each system seems to have its own method of classifying crimes, cross comparison can be difficult. It was necessary to develop a scheme that would create fairly distinct but broad categories of offenses. One important reason for establishing categories of crimes is linked to the idea that there is a hierarchy of crimes, spanning the most violent (but least probable) to the relatively innocuous (but nonetheless disturbing), each of which has a different effect on the sensibilities of the transit user. Since this study is partially interested in how a transit user's perception of crime affects his or her patronage, it was useful to develop a conceptual hierarchy of crimes that might help to indicate the extent to which certain crimes do or do not alter patronage.

This guidebook uses four crime categories; each category is associated with specific offenses:

- Crimes Against Persons
  - assault
  - battery
  - rape
  - homicide
  - abduction
- Crimes Against Persons' Property
  - robbery
  - pocket picking
  - purse-snatching
- Crimes Against System Property
  - robbery
  - burglary
  - fare evasion
  - vandalism
  - petty theft
  - trespassing
  - arson
  - missiling (rock throwing)
  - theft of system property

Crimes Against the Public

- drug law violations
- sex offenses
- drunkenness
- disorderly conduct
- carrying concealed weapons
- suicide
- terrorism

B. Automated Guideway Transit Categories

Automated Guideway Transit systems are characterized by low personnel levels and centralized control of system operation. AGT systems are usually associated with one of three possible configurations: Shuttle-Loop Transit (SLT), Group Rapid Transit (GRT), and Personal Rapid Transit (PRT). They can be differentiated in the following ways:

Shuttle Loop Transit (SLT)

- Medium to large vehicles (50-100 passengers)
- Limited amount of switching
- Scheduled service
- On-line stations

Group Rapid Transit (GRT)

- Smaller vehicles (6-50 passengers)
- More extensive switching capability
- Scheduled or demand responsive service
- On or off-line stations
- Shared vehicle service

Personal Rapid Transit (PRT)

- Small vehicles (4-6 passengers)
- Complex network
- Demand responsive
- Off-line stations

The above characterizations are those developed by the Office of Technology Assessment (OTA) of the United States Congress[43]. Currently, GRT systems are in operation at Morgantown, West Virginia and the Dallas Fort Worth Airport (AIRTRANS), and SLT systems are operating at several airports. There are currently no PRT systems in commercial use. Examples of particular current and planned AGT systems are given by MacKinnon in the proceedings of the Exeter conference[44].

A recent General Motors report[45] has revised the basis for classifying AGT systems and expanded the number of types of systems. Their scheme depends on three system parameters: (1) service type-point to point non stop service versus intermediate or multiple stop service, (2) minimum traveling unit capability - the number of passengers transported by the normal operating configuration (vehicle or train), and (3) maximum operating velocity. These variables are used to define a hierarchy of AGT system types. Five classes of system are distinguished: personal rapid transit (PRT) and four levels of group rapid transit (small, intermediate and large vehicle GRT and automated rail transit). Some of these classes are then further subdivided by vehicle speed. The resulting 8 categories are then characterized by their operational parameters, and current and planned AGT systems are fit into this scheme.

C. Security Considerations in AGT Systems

Both of the above classification schemes have implications for the security precautions which must be considered for an AGT system. The variables identified in the GM study (size and speed of the vehicles and number of stops) will affect both real and perceived security and what security measures need to be implemented. In addition, whether service is scheduled or demand-responsive and whether stations are on or off-line will also affect security.

The small vehicle systems are characterized by short waiting times, small platform size and demand responsive service. These are positive security features. A one minute waiting time limits user exposure to attack; the short platform helps surveillance activity; a demand responsive personalized ride minimizes possibilities of on-board confrontations between users and offenders. The primary security problem of small systems involves the number of vehicles and stations and the guideway length. The guideway for a small vehicle system would consist of a finely gridded network with stations spaced every two or three blocks. The question then becomes one of how to respond to crimes on such a vast network of stations.

A medium-size vehicle system will have longer waiting times, multiple-car trains, increased platform space and either scheduled or demand responsive service. There will be fewer stations and vehicles to monitor, which means station closed circuit television and two-way communication devices on vehicles may be feasible. Passengers will be more vulnerable to crimes while on vehicles, since units must be shared by six to eighteen people. A patron may be obliged to share a ride with a stranger without the security of other passengers. The medium-size vehicle system may be the least desirable of the alternate systems, since it has many disadvantages without compensating advantages. With reduced levels of vehicle occupancy, safety is a particularly serious drawback of medium-size vehicle systems.

Another type of AGT system uses vehicles that hold fifty or more passengers. The system is likely to have a simple network configuration (e.g., shuttle-loop); service is scheduled rather than demand responsive. A large-vehicle system will have long waiting times, large platforms, and relatively few stations and guideway miles. Surveillance capability is enhanced by the fewer number of stations, and vehicle capacities may be large enough to deter crimes against persons while passengers ride between stations. High-capacity vehicles may indeed deter robberies, assaults, and rapes, but crowd crimes may increase.

Scheduled service is a potential disadvantage because waiting or exposure time is prolonged.

It is apparent that each AGT system implicitly involves security trade-offs, which will in turn require corresponding surveillance and deployment methods. For example, small-vehicle systems have the shortest waiting times and a high level of vehicle occupancy safety; the short platforms would be ideal for surveillance. But the guideway length and large number of stations make surveillance and response prohibitively expensive and labor intensive. Large-vehicle systems are comparatively easy to monitor and to police, but waiting times are long and crimes against personally carried property may be prevalent. Adaptive space and reduced train length can compensate for the low-density monitoring problems of stations with long platforms. Furthermore, deviations from this depiction of security trade-offs are likely if the AGT system has atypical design features. For example, it is conceivable that a PRT system will have few enough stations to allow efficient monitoring and police response. In this case, voice monitors on each vehicle are probably adequate. An SLT system could have many stations spread over an extensive geographical area, thus making waiting time and police response times the salient security issues. It is useful, then, to note four shared features that affect policing on most AGT systems.

D. <u>Security Problems Relevant to all AGT Systems</u>

Four problems that require security measures on an AGT system are: environment or neighborhood conditions, platform monitoring, revenue security, and emergency evacuation.

A station in a high-crime neighborhood nearly always requires special security planning. Periodic saturation patrols may be valuable in this situation if post-patrol crime levels for the station are depressed for a significant period. An alternative strategy is to strive for low response times. If a line has several consecutive high-risk stations, a police sub-station may be appropriate. The sub-station personnel would have the responsibility to monitor stations and either dispatch personnel from the sub-station or alert local police units. By decentralizing monitoring of high-risk stations, the link between victims and police would be direct, response times quick, and central control would be relieved of difficult monitoring tasks.

Platforms can be hazardous for a user on any system. New systems must have platforms that allow effective CCTV monitoring. All platforms will need some monitoring throughout operating hours, and high-risk platforms will need almost constant surveillance during off-peak low-density hours. Adaptive space is, therefore, a firm requirement for large stations.

The automatic fare collection procedure on any system is likely to attract any or all of four types of criminal behavior: vandalism or attempted robbery of machines; fare evasion (often accompanied by an intent to commit a more serious crime once the system is entered); robbery of patrons who display cash while purchasing fare cards; fare system fraud by transit employees. Only the first three types of crimes will be addressed here. Fare collection machines can be constructed so they are resistant to tampering and vandalism. It is probably worthwhile to make an investment in hardened fare machines. Despite fare machine hardening, the ability of offenders to damage or rob equipment should not be underestimated. Fare card machines should be placed in heavily trafficked areas or near station entrances so that they are visible to local police patrols and non-transit users. If possible, restrooms, elevators for the elderly and handicapped, fare machines, and other sensitive equipment should be grouped so one CCTV can monitor them. Fare evasion can be combatted by using special full-height turnstiles and installing sensors to detect unpaid entries. Patrons should be encouraged to buy a fare card good for multiple rides. Daily users of the Washington Metro rail system can purchase monthly "flash passes" at local banks. As a result, patrons need not display cash on the system and can enter the system without delay. (However, counterfeit flash cards have become a problem.)

The fourth shared-risk situation involves stalled vehicles and emergency escape procedures. The system's passenger evacuation method is a potential target of criminal abuse, although it is not clear whether this could develop into a major problem. It might be possible for an offender to commit a crime while the vehicle is between stations, stop the vehicle (using the emergency brake) and escape from the vehicle by making an unauthorized evacuation.

Each of the countermeasures mentioned above will be discussed in detail in Section 3 of this report.

3. CRIME AND VANDALISM COUNTERMEASURES

A. The Countermeasures

A crime countermeasure is defined as any policy, procedure or device whose purpose is to reduce crime, or the perception of crime, within the transit system. The countermeasures in this guidebook may be loosely categorized as being useful for: 1) preventing or deterring a crime; 2) thwarting a crime in progress; and 3) apprehending an offender. Most of the countermeasures are effective in more than one category. Lighting, for example, could deter an individual from commiting a crime by convincing him that the risk of being seen is too great; it could thwart an on-going crime by allowing a witness to intervene; and it could help transit security personnel apprehend an offender by increasing his visibility. Countermeasures could also provide evidence and aid in the conviction of criminals.

The package of countermeasures adopted by the AGT security planner(s) will, to an extent, reflect the system's policy regarding security issues. A strategy which employs a primarily deterrent approach in effect says: "We will make the system an unattractive target for potential criminals, so that we won't need to rely on expensive security manpower."

The countermeasure strategy chosen needs to be flexible enough to adapt to future system changes such as increases or decreases in the rate of transit crime, changes in the kinds of crime being committed, budget changes, and increases or decreases in ridership. Even one serious and well publicized incident can force security planners to rethink their approach.

When working with an assortment of variables there seems to be an inherent tendency to group them as subcategories of a few more salient categories. Although most of the literature on crime countermeasure planning describes the countermeasure on an individual basis, for this report a more comprehensive effort has been made to address the individual countermeasures in terms of more general countermeasure categories. This classification system is shown in Table 3-1. Many alternative ways of classifying countermeasures are possible. Countermeasures could be grouped by whether they are active, semiactive, or passive, or by their function-deterrence/prevention, apprehension, conviction, etc., or by their focus - station, vehicle, guideway, environment, or operational features. Each of these alternatives provides a reasonable way to group countermeasures. The classification chosen here seems most useful in terms of the purpose of this document.

For each countermeasure, a general description and summary of known data will be presented along with suggestions on AGT application. Where specific and precise cost information is available it will be given under the "cost" section of each countermeasure discussion.

TABLE 3-1
CRIME COUNTERMEASURES

Hardward/Device Related

Video-Tape (alarm-activated)
Alarm-Activated 35mm Camera at Exit
Burglar-Type Alarms (Hidden) Movement Detection
CCTV
Chemical Detection Devices
Fare Hardening Devices
Medium-Volume Traffic Flow
Metal Detectors
Occupancy Detection
Passenger-Activated Alarms
Pre-Screen Riders
Prevention of Fare Evasion
Public Address Systems
Telephone (Radio) Communication Between Passengers and Security
Voice Monitors
X-Ray Devices

Station/Vehicle Design Related

Adaptive Space
Attractive, Clean Transit Property
Automatically Sealed Exits
Barriers and Fences
Climate Control
Elevated Guideways
Eliminate Station Restrooms
Good Lighting
Non-Breakable Windows
Open Design
Single Exits
Translucent Doors in Restrooms
Vandal-Proof Surfaces

Personnel/Operations Related

Aerial Patrols
Curfews
K-9 Patrols
Non-Scheduled Train Stops
Plain-Clothes Detectives
Police Decoys
Presence of Transit Personnel
Publication of Incidents

TABLE 3-1 (continued)

Reduce Number of Cars During Off-Peak Hours
Reduce Operating Hours
Saturation Patrols/Random Patrols
School and Community PR Programs
Selective/Off-Peak Closing of Stations
Visible, Uniformed Security Force

<u>Judicial Policy Related</u>

Differential Penalties
Mandatory Sentencing
Rapid Processing

<u>Land Use Related</u>

Site Selection
Station/Use Integration
Landscaping

Several problems with providing accurate cost figures should be mentioned at this point. (1) The cost of installing a security system depends on the total configuration. Equipment distributors like to bid on an integrated system; the cost of the total system will usually be less than the total of the separate parts. Furthermore, a suppliers bid will often depend on who the competition is (or is thought to be). (2) Agency procurement practices often raise the costs of a system. Many agencies overspecify their acquisitions - often dictating particular pieces of equipment. It may be cheaper to write performance specifications - state what you want the equipment to do - and then let potential suppliers come up with ways of meeting those specifications. Novel and inexpensive equipment combinations might result. (3) Specific cost estimates will rapidly become obsolete. Most product costs are rising due to inflation. However, advanced technology in electronics and computers has been declining in price for several years.

For all countermeasures, estimates of relative costs will be summarized in matrix format in Section 4. Judgements of the acceptability of the countermeasures to the public and to transit officials will also be presented there.

B. Details of Particular Countermeasures

1. Hardware/Device-Related Crime Countermeasures

Various combinations of alarms and surveillance devices are currently in use in several rail-rapid transit systems. Included in this array of hardware are public-address systems, closed circuit television (CCTV) and two-way radio communication. As a crime countermeasure, monitoring devices and alarms are generally considered to be an adjunct to the transit police force. The primary function of surveillance equipment is to detect crimes in progress, although systems which incorporate public address and video-tape capabilities may also thwart an on-going crime and aid in the identification and apprehension of criminals. Apparently, surveillance systems are, in themselves, deterrents to crimes--dummy CCTV cameras have been successfully used in stores to curb escalating shoplifting rates.[1]

Currently, no transit authority depends exclusively on its surveillance hardware to protect its riders and property. However, in keeping with the fully automated nature of an AGT system, AGT security planners may wish to investigate the feasibility of using monitoring devices as the system's principal security feature.

Findings indicate that electronic security devices tend to suppress criminal activities and improve police response capabilitites.[2] Major shortcomings of mechanical and electronic surveillance systems include: vandalism of equipment, frequent false alarms and monitor-viewer fatigue.

Some of the hardware components either currently employed by transit security departments or which can be adapted for use in an AGT system include closed-circuit television, communication devices and alarms and sensors. They are discussed individually in the following pages.

Without detailed equipment specifications, reliable estimates of costs for security hardware systems are not available. Manufacturers are loath to disclose even approximate cost figures without these specifications. The transit system itself will determine the capital outlay and operating expenses for a security hardware system. The usual procedure is for the transit authority to prepare system specifications and solicit bids. Important cost variables include: the number of stations, station configuration, levels of lighting, types of ancillary equipment desired and price variations between manufacturers. For example, RCA manufactures four different lines of closed-circuit cameras, four different sizes of monitors and a variety of special video equipment. The range of prices is wide, but, as with any product, there is no upper-price limit. Because of the custom-design nature of surveillance hardware it would be presumptuous to even attempt to estimate total system costs. Where possible, costs of particular components have been included in the discussion of some of the hardware countermeasures.

a. Closed Circuit Television

1) Overview

Continuous, closed circuit television monitoring is employed by several of the largest transit systems. Typically, cameras placed at strategic points pan station areas outside the purview of security officers or station attendants, and focus on specific potential crime targets such as fare vending machines. Viewers observe the activity on television screens at a remote control facility. In the Washington system, station attendants view several TV screens from within the information kiosks located near the station's entrance foyer. If an incident is observed, the attendants can alert security headquarters and, if necessary, local police and fire departments.[3] Should planners decide to adopt this arrangement, it is essential that the attendants are not required to leave the kiosks (e.g., to unjam an automatic fare machine). An offender who plans a crime in advance could create a distraction (set a small fire, jam a fare machine) and then commit a crime while the attendant is preoccupied.

Closed circuit television viewing capabilities have both technical and human limitations. Station lighting and configuration can preclude the use of TV cameras altogether. However, a solid state television camera, capable of taking pictures in candlelight, has been recently developed.[4] The effectiveness of a CCTV system in detecting and responding to crime depends on signal detection and interpretation by human operators. Since the effectiveness of CCTV is inextricably connected to human capabilities, every effort must be made to plan for human limitations. Fatigued viewers may not detect a crime, especially if the station is extremely crowded. Problems are further compounded by leaving monitors unattended while guards attend to other duties. Although CCTV systems can be coordinated with an alarm to alert the viewer to any movement on the television screen, this is obviously inappropriate for surveillance of a congested transit station.

A basic problem of CCTV systems stems from the fact that security personnel will be monitoring a panel of instruments and/or viewers that will indiscriminately transmit two types of signals: those that are not significant and those that are. If the alarms or sensors are reduced in sensitivity, the probability that a significant signal will be detected decreases. If their sensitivity is heightened, a high false alarm rate may result. Therefore, the human operator represents an essential decision-making element. But after thirty to sixty minutes of monitoring, the operator undergoes a decline in performance, called the vigilance decrement. Among the variables that can alter the vigilance of the operator are: signal duration and frequency, background noise, personal characteristics and diurnal rhythms. Several studies conclude there can be substantial differences among operators in their ability to perform tedious tasks. The implication is that personnel who are least prone to fatigue and vigilance decrement should be screened and selected for monitoring duty.

The results of recent research suggest that there are operational strategies which reduce the vigilance decrement resulting from boredom, fatigue, etc.[5] Interference with the operator's work/rest cycle can degrade monitoring performance. So any shift changes or schedule rearrangements which could displace sleep should be accompanied by adjusted work schedules and relief from monitoring duties (i.e. vacation, or other assignments) until the new sleep pattern is established.

Several additional tactics will serve to lengthen acceptable monitoring performance time:

- Operators should receive feedback concerning the quality of their performance.
- Control room panels should be designed to accommodate brief interruptions in attention.
- The control room environment should minimize stresses: noise, vibration and heat. The environment should also include mild stimulation to avoid under-arousal. For example, background music during periods of low passenger traffic.
- Work shifts should be scheduled so that viewers go on duty at the beginning of peak crime periods, before the performance decrement affects their monitoring efficiency.[6]

There are several comments that may be useful in the design of a system for a particular operation. A good rule of thumb is to use no more than 5-7 monitors per observer. The observers should have as close to perpendicular a viewing angle to the screens as possible and be 5 to 8 times the diagonal size of the screen away from it. Less than 17-inch screens should be avoided with 17-19 inches adequate. Sequential switching of cameras to a single screen is not desirable, in that it is distracting to the observer.

Unfortunately, the above recommendations yield a system which is very labor intensive. If 5 to 7 cameras are surveying a single station, then the implication is that an observer is needed for each station. Various operational strategies will have to be developed to overcome these limitations.

CCTV has been used on the AGT system at Morgantown, West Virginia. The system was designed for a single observer to view a set of sixteen screens, but the control room operators tend to work as a team. Generally there are three people watching the 16 screens at any time. Although the observers feel that 16 screens is the upper limit they can handle, a system with 32 screens will be tested in the future.

Where possible, audible alarms should be added for system tampering, heavy traffic, etc. Audio monitoring of the area covered in conjunction with CCTV enhances detection. Experiments with CCTV at the New York City transit authority concluded that the audio link to the monitored station increased the detection of incidents and helped alert the observer.

The primary effectiveness of CCTV may lie in its capacity for improving response time of police officers to the scene of an incident. False alarms can be eliminated if the alarm system can be monitored by closed circuit television cameras. The validity of the alarm could be verified before dispatch of police or guards. A further refinement of the CCTV system is video recording which can provide a permanent record of any action observed thus aiding in later apprehension and conviction of the offender.

2) <u>AGT Application</u>

Closed circuit television may be the ideal countermeasure for use in AGT systems. CCTV complements the high technology - low manpower requirements of an automated system. Ongoing tests of CCTV in two transit systems (Chicago, New York) may provide insightful and useful information regarding the application of TV monitoring in transit environments. Other work is in progress at PATCO, PATH and Morgantown.

The value of narrow band TV units for use on board AGT vehicles is not clear. Such units on vehicles would significantly expand monitoring responsibilities; this can be costly. Vehicle cameras could be within reach of passengers and so could be vulnerable to vandalism. Therefore, TV units on vehicles might require extraordinary vandal-proofing, which will also raise costs.

Voice monitors as part of a CCTV system can be effective on small systems, but their role on large systems needs to be studied.

One countermeasure might be to place CCTVs (with video tape capability) or motor-driven 35mm cameras at station exits. If a passenger is victimized on a vehicle, he or she presses an alarm which simultaneously alerts transit security and activates the cameras, thereby providing the police with an accurate photograph of the offender leaving the station.

3) <u>Costs</u>

Precise cost estimates for CCTV systems are not available due to the wide range of installation problems. A good <u>estimate</u> would be on the order of \$1000 to \$1500 per camera and <u>monitor for</u> a 3 to 10 camera installation using coaxial cables. Video recording should add approximately \$1000/camera. A major part of the cost is in the installation and maintenance, hence a leasing arrangement may prove more desirable.

b. Communication Devices

1) Overview

Voice monitors permit a security officer to eavesdrop on activities outside his viewing range or where CCTV cameras could not be used. If a police officer detects an emergency or what may be a crime-in-progress, he can dispatch assistance to the area. Voice monitors can be used in conjunction with a public address system, allowing security personnel to signal that the incident had been detected.

Two-way radio communication may have a passenger-activated feature which would enable a transit patron to communicate with station officers. Washington's Metro and San Francisco's BART have equipped each of their cars with intercoms to facilitate communication between passengers and the operating attendant.

Communication devices such as voice monitors, two-way radios and public address systems are also valuable for their non-security related benefits. Electronic communication systems enable station attendants to answer passenger inquiries and give instructions during emergency situations. In the decision to install a communication system these support functions are usually given as much weight as their potential security benefits.[7]

2) AGT Application

The PRT system in Morgantown, West Virginia, is equipped with closed circuit television and provides radio communication between each vehicle and the central monitoring facility. Viewers at the central monitors use a public address system to communicate with passengers waiting at any of the station platforms.

3) Costs

Exact cost figures will depend on the particular installation. Voice monitors and public address systems are relatively inexpensive.

c. Alarms and Sensors

1) Overview

Alarms are probably the most frequently used and widely accepted of hardware countermeasures. There is a wide variety of alarms now in use. "Hidden alarms" are intended to detect intrusion into a guarded area. Several types of sensors may trigger the alarm, which can be heard in the immediate vicinity of the protected area (a local alarm system) or only at a remote monitoring center. Disadvantages of the local system are:

The detection equipment is usually very simple and subject to defeat or compromise.

- Audible alarms are annoying to neighbors in built-up areas and ineffective in remote locations.

- Intruders are not disturbed by bells or other audible alarms if the alarm is sounded only when the intruder is leaving the premises.

- On-the-spot alarms may disturb or deter but rarely result in the capture of the intruder.[8]

Remote alarms are received at a central station--either directly to the transit security force or to a dispatcher who telephones the local police to attend to the situation. The response time, then, becomes the critical factor in apprehending the intruder. Unless there is also camera surveillance of the protected space to verify the legitimacy of the alarm, frequent false alarms may eventually undermine the urgency of a sounded alarm.

Alarms may be triggered by several types of sensors. Sensors report the presence of an intruder when he disturbs the protected environment. The detection is then converted to an electrical signal which activates an alarm. Generally, sensors should be placed at the most likely area for a break-in. Photo-electric beams, microwave/radar, balance pressure, electro-mechanical switches, vibration, metal foil, acoustic, and capacitance proximity are among the types of sensors currently in use.

A second category of alarms is the passenger activated type. These alarms are conspicuously displayed to be deliberately activated to summon assistance. Passenger-activated alarms have been used in transit vehicles to summon assistance from the transit operator. Often these alarms are used in conjunction with communication devices for direct voice contact. A major disadvantage of such alarms is that without verification equipment, such as closed circuit television, they may be prone to spurious activation.

The alarms may be activated in different ways, such as by depressing a button or bar, lifting a phone, pulling a cord or breaking a sealed glass case. The alarm itself may ring or flash near the site of activation, or it may sound at a remote monitoring station, or both.

2) <u>AGT Application</u>

Within an AGT system, hidden alarms would be most effectively used in warehousing and storage areas, rail yards, offices, or wherever money or valuables are vulnerable to theft or destruction. The passenger-activated alarms should be located in conspicuous, easily reached locations and should be simple to operate. Some transit security specialists recommend the placing of several activated-type alarms in secluded areas which would allow a witness to a crime to alert authorities without attracting the attention of the offender.

3) Costs

Alarm systems vary greatly in their complexity and sophistication with corresponding variation in price. Overall, these countermeasures would be moderate in cost.

d. Prevention of Fare Evasion

1) Overview

Any method which would prevent transit users from attempting to enter the station or board transit vehicles without paying the required fare would not only increase transit receipts, but also would very likely discourage individuals with more serious criminal intentions. This proved to be the case in New York City. During a crackdown on fare evaders, New York City Transit Police arrested more then 17,000 persons over an eight-month period. From 950 of those arrested, officers seized guns, knives, smoke grenades, brass knuckles, stolen goods and narcotics paraphernalia. An additional 450 were wanted for crimes ranging from rape to robbery. One individual attempting to vault a turnstile was caught: found in his possession were two fake Molotov cocktails and a threatening note demanding money from a bank teller.[9]

2) AGT Application

Fare evasion may be attacked in a number of ways. Deploying more security officers to observe entrances and enforcing more stringent penalties for using slugs and circumventing fare booths is the approach used by New York. The intensive manpower requirements of this strategy may not be suitable for AGT application. An alternative is to use full-size (7½-foot) turnstiles. Turnstiles such as the seven-foot high "Roto-Gates" manufactured by the Perey Turnstile Company are designed for both indoor and outdoor use. They can be unlocked by an adjacent guard or they can be mechanized to open and lock by remote control. Combined with mechanized fare-acceptance capabilities, the turnstiles could be adapted for use in AGT systems. Possible disadvantages of hardening system entry points is that the turnstiles could impede the smooth flow of traffic and cause congestion at critical rush-hour periods.

Such turnstiles also present safety problems and are impediments for the elderly and handicapped. The security planner is often faced with tradeoffs between conflicting goals. Some security procedures cause inconvenience, some interrupt the rapid processing of passengers, others conflict with safety goals. All of these tradeoffs must be considered in planning a security system, negative implications for safety must be especially fully evaluated, as well as problems created for special populations of users. Many of these tradeoffs are implicit in the judgements of acceptance costs given in Section 4 of this guidebook.

3) Costs

The most effective means of preventing fare evasion have relied on police manpower and thus this is a relatively costly enterprise. Hardware alternatives are less costly, but have inherent problems.

e. Prescreen Riders

1) Overview

As a means of preventing "potential criminals" from entering the transit system, any selective search procedure would certainly violate basic civil liberties. Perhaps a more acceptable variation of this concept would be to require transit users to be licensed to enter the transit system. Regular riders would "register" with the authority and be issued automated ID cards and could enter the system freely. Non-regular riders would enter through a special turnstile where they would be video-taped. This procedure would be tantamount to requiring a visitor's pass before entering an office building. Convicted transit offenders might have their "licenses" suspended or revoked as part of their punishment.

The registration process would also provide accurate information on destinations, peak travel times, and, based on user characteristics and trip-making habits, the need for special passenger services.

2) AGT Application

Prescreening riders for a transit system as enormous as New York's or Chicago's may be an impossibility, but it might be a workable program for a smaller AGT system. On a campus, airport, or other special-use facility, student or employee identification cards might double as entry passes to the system. Other frequent users might obtain entry cards on an annual basis.

3) Costs

Costs involved in prescreening riders would be very high, it would rely heavily on manpower and require special bureaucratic procedures and personnel.

f. Metal Detectors

1) Overview

Metal detectors are used as crime countermeasures in two areas: to detect concealed weapons and to prevent theft of protected material. Metal detection devices have been used successfully in airports since the beginning of the 1970s. The technological development of metal detection equipment has advanced rapidly during the past decade. As the technology is being refined, more and different applications are being found for metal detectors.

In a state-of-the-art review of metal detectors, Charles Wallach and Dr. Roy Ricci of Intex, Inc., report that metal detectors are now in the third generation of development.[10] These latest detectors have overcome the major liabilities of their predecessors. Their detection capabilities are so acute they can identify a weapon of a certain shape, size and composition from a collection of other metal objects. This is accomplished by "measuring secondary signals excited by magnetic fields in the time domain, or where the cost and complexity is warranted, in the frequency domain."[11]

Current technology permits detection levels to be set so they can discriminate different masses or sizes of weapons. The lower the setting, the greater is the probability that innocuous items can trigger the alarm. For this reason, the authors emphasize the importance of defining a "minimum threat level" before writing system specifications. For example, a lower threshold would detect a .22 caliber pistol and a variety of other objects which could set off false alarms. A higher setting would detect a larger weapon which would more likely be used in an armed offense and it would also screen a larger number of innocuous items, resulting in fewer ambiguous alarms and less supervisory manpower to process them.

2) AGT Application

The use of supervised portal type metal detectors in busy transit stations would undoubtedly cause many expensive and unappreciated delays. Vandalism, petty theft, fare evasion and rock throwings are among the most frequently occurring transit offenses and generally do not involve weapons. Given the small number of transit crimes committed by armed criminals, the use of supervised, portal-type metal detectors may not be warranted. There is an adaptation which may be suitable for AGT systems: The authors of the report recommend a detector-controlled barrier or turnstile to prevent armed access to public places. In an AGT system this device could be used in tandem with the fare turnstile and be set to lock whenever an attempt to smuggle a certain-size weapon is made. The turnstile could serve as a strong deterrent to criminals. No additional personnel would be required because the turnstile needs only passive supervision.

3) Costs

Consulting costs for writing specifications for a special application may run between $600 and $1500. Third-generation detection system costs begin at $5000 per set and can increase to $30,000 for a central computer-controlled installation. Maintenance costs may run as high as $100 a month if a second-generation system is used and needs continuous recalibration. Third-generation detectors may run as little as $100 a year. A completely automated interdiction system could probably be covered by the regular on-duty security guard, so direct maintenance costs would be nominal. Indirect costs due to false alarms are negligible if only one person out of twenty is delayed, but escalate rapidly when 1000 or more persons are processed in a short period at a higher alarm rate.[12]

2. Station Design-Related Crime Countermeasures

a. Lighting

1) Overview

Good lighting is basic to any new transit system; however, older stations and platforms are often poorly illuminated, giving an advantage to lurking criminals and contributing to the fears of transit users. Lighting is considered to be a good deterrent to crime because it discourages criminals by increasing their chances of being seen and caught, and it improves the vision of transit users, helping them to avoid potential criminals. Good lighting also aids security personnel and transit patrons in detecting crimes in progress.

Studies have shown that a decrease in crime rates can be directly attributable to improved lighting. In Chattanooga, Tennessee, for example, an improvement in street lighting has led to a 90% reduction in street crime.[13]

The value of lighting as a crime countermeasure lies in the first incremental improvements; obviously, once maximum levels of illumination (daylight conditions) are reached, further improvements are no longer as effective. Three (3) footcandles is a widely accepted minimum level of illumination for walkways and parking lots. All Washington, DC, Metro Stations are illuminated at a minimum of 25 footcandles.[14]

Typical Scene Illuminations[15]

Clear Sunlight	3,000 to 10,000 fc
Overcast Day	300 to 1,000 fc
Sunrise/Sunset	50 fc
Twilight	0.5 fc
Full Moon	0.003 to 0.03 fc
Starlight	0.00007 to 0.0003 fc
Overcast Night	0.000002 to 0.00002 fc

2) AGT Application

Besides deciding on the intensity of illumination needed, the transit security planner must also determine the location of lighting fixtures. Obviously, in the AGT station, platforms and vehicles should be well-lit, and light fixtures should be placed or protected so they cannot easily be vandalized. The security planner should also consider street conditions immediately beyond transit premises. The frequency of criminal incidents at the transit station tends to mirror the crime rate of the surrounding neighborhood. Evidence indicates that transit riders perceive the walk to the transit station as being among the most dangerous phases of the total transit journey.[16] If street lighting surrounding the station is determined to be inadequate the security planner may wish to explore with local authorities the provision for lighting beyond the station's property.

The amount of illumination needed inside the station will be affected by the station's layout. Fewer lighting fixtures are necessary in newer stations featuring open spaces and high vaulted ceilings. If security planners decide that CCTV will be a major component of the system's anti-crime program, illumination levels will be determined by the kind of cameras that will be used throughout stations. Cameras that operate at extremely low levels of illumination are now available but are expensive and may make TV surveillance prohibitively expensive.

3) Costs

A 175-watt mercury vapor lamp (7,000 lumens), which can generate between three and five footcandles, costs about $500.[17] This price includes the pole, anchors, and fixture. Replacement bulbs cost approximately $20. These outdoor light fixtures are usually spaced every 150 feet. Operating costs per month are approximately $6.80 for each lamp.[18]

b. Open Station Design

1) Overview

Narrow, doglegged corridors, long stairways and ramps, isolated waiting rooms, recessed doorways and storage areas are common in older transit stations. These secluded spaces and obstructions provide ideal hiding places for skulking miscreants. By designing the station without locations for concealment, lines of sight are optimized for both transit personnel and security monitoring equipment. The Washington Metropolitan Transit Authority (WMATA) has incorporated open-space design as a feature of their stations. Any portion of the station outside the viewing range of the station attendant is covered by electronic surveillance. Metro Security feels that this has inhibited criminal activity.

2) AGT Application

It is unlikely that any AGT station will be as monumental as some of the major Washington Metro Stations; but in spite of the size of the station, the open-space concept is an essential architectural feature.

Concession stands are convenient to users and can sometimes act as a deterrent to crime by providing personnel on site who can provide information and/or a feeling of security. However, they can interfere with the flow of traffic throughout the station, can obstruct lines of sight and are attractive crime targets in themselves. For these reasons, the Washington Metro has prohibited these non-transit operations. These considerations may make such revenue-generating operations less desirable in the final analysis.

3) Costs

No reliable estimates can be made on the cost of the Open Design Concept. If adopted early in the planning process, before land acquisitions, these costs should be no more than other designs except in topographically unusual areas.

c. Climate Control

1) Overview

Controlled station climate has been suggested as a means of reducing frequency of assaults and battery. A study of crime on the Chicago Transit System (CTA) shows that the number of violent incidents tends to peak during the evening rush hour, when the system is most crowded and tempers are short.[19] An air-conditioned environment on transit vehicles and throughout the stations might help alleviate these tensions and lower the number of assaults and batteries. Air-conditioned vehicles may also attract new riders to the system, which could help offset the costs of installation and operation.

2) AGT Application

The role that climatic conditions play in transit security and safety has not been studied, but an analysis of crime on the Chicago Transit System reported that transit riders, at least, believe that crimes occur most often during colder winter months. (These perceptions are partially correct: Statistics based on the ratio of monthly transit ridership to bus and transit crime indicate that transit crimes are at their highest levels during the fall and winter months, with peaks in September and December.[20]) During these months the days are shorter and rush-hour commuters find themselves traveling home in the dark. It is also the time when derelicts seek refuge in the warmer transit stations. The presence of these loiterers may also increase the fears of transit riders. Given these facts, the AGT security planner should be conscious of the possibility of cyclic changes in passenger attitudes toward transit safety and security; this suggests that security measures be made more visible during certain times of the year.

3) Costs

Costs are variable, based primarily on station characteristics, but moderate in relation to total system costs.

d. Transparent Barriers and Adaptive Space

1) Overview

"Safety in numbers" is the principle behind the use of adaptive space in transit stations and on platforms. During the hours when transit ridership is at its lowest levels, waiting passengers may be scattered too thinly over a large area, outside the protective view of security police or TV monitors, and not within the range of other devices. The possibility of robberies and molestation can be reduced by consolidating patrons into a smaller area. Barriers or partitions to foreshorten train platforms and waiting rooms could be used to keep transit users in the range of television monitors, call boxes, voice monitors or security personnel.

Transparent, movable partitions or barriers have been proposed as a component of a comprehensive teleview-alert security system. During peak travel time the partitions would remain flush against the platform walls and passengers would move freely along the platforms. During the off-peak hours, the partitions would be pulled forward to confine users to the viewing range of camera monitors and to prevent them from moving into forbidden sections of the station. This concept could be easily employed in older stations to improve non-electronic observations or may be used as part of a complete Teleview Alert System (TVA). (See page 94.)

2) AGT Application

Depending upon the size of the particular AGT system, the adaptive space concept may be desirable in the context described above.

3) Costs

In 1973 the cost for a movable barrier was estimated to be between $1,000 and $2,000 per section, with two needed for an island, one for each side platform.[21]

e. Attractive, Well-Maintained Environment

1) Overview

Clean, attractive stations and comfortable air-conditioned vehicles may indirectly produce a crime-deterring effect for a number of reasons. Patrons will have pride and respect for a new or well-maintained transit system and they may, therefore, be less likely to tolerate incidents of vandalism and crime. Once a system has been allowed to fall into disrepair, however, this self-policing tendency may be undermined and transit users may be less likely to censure and report witnessed acts of vandalism and crime.

Washington Metro's "pride-in-ownership" campaign seems to be working; as the maintenance chief has commented: "I have watched a whole platform of people wait ten minutes to get on a train and leave only one gum wrapper behind.... I have seen people discipline kids for putting their feet on the seat."[22] Whether there is any direct connection between this attitude and the surprisingly low crime rate, remains to be tested.

Although an unappealing station may not actually increase criminal incidents, it may produce an unsafe image--which often has a deleterious effect on ridership. It has been speculated that in such cases the patronage lost will be composed primarily of the marginal, choice riders. Unfortunately, this may initiate a spiraling trend; as fare revenue declines, the budget for station maintenance shrinks, ridership falls again, and the cycle is repeated.

2) AGT Application

This countermeasure should be incorporated in all AGT systems.

3) Costs

Costs are minimal for new stations.

f. Mid-Volume Traffic

1) Overview

Certain transit crimes have been correlated with different levels of passenger traffic. Pocket-pickings occur most frequently under crowded conditions; because transit riders are accustomed to being jostled and bumped during rush hours, they are easy marks for pick-pockets and purse snatchers. Crimes against persons, such as robberies and rapes, usually happen in nearly deserted isolated areas.

By setting standards for maximum and minimum levels of traffic, these kinds of crimes might be prevented. Movable barriers, mentioned earlier, could be used to contain a constant density of riders within a particular area. When the terminals are very crowded, "open station design" would permit a free flow of traffic from the entrance to the waiting platforms. The actual number of passengers could be controlled by installing counting devices in ticket turnstiles which would lock after a certain number of patrons were admitted. However, as anyone who has even spent an hour in line only to be confronted by a "Sold Out" placard would know, this policy would probably cause more problems than it would prevent! Closer surveillance of crowded areas by security officers is probably the most workable solution to preventing crime in heavily trafficked areas. This could be done remotely by closed circuit TV or "in situ" by police or transit personnel.

2) AGT Application

As a crime countermeasure, mid-volume traffic control has never been tested, but an awareness of the kinds of crowded conditions that contribute to certain kinds of crimes is necessary to commission the most appropriate surveillance methods. The AGT security planner must also be able to anticipate problems associated with the occasional increases in ridership due to special events or weather. An emergency deployment program should be prepared.

3) Costs

Although no accurate cost estimates can be made due to lack of available information, it is anticipated that the costs will be moderate.

g. Provision of Convenience Services (Restrooms)

1) Overview

Because transit station restrooms are usually isolated from the heavily trafficked and guarded areas of the station, they have a reputation for being dangerous places. Certain crimes such as sexual harassment, vandalism, con games and robberies are associated with station restrooms. By excluding restrooms from the station's design, a number of these incidents might be deterred or displaced. It should also be a relatively easy task to eliminate restrooms from older stations; however, it could inconvenience an occasional transit rider. A compromise solution would be to provide toilet facilities for the public in emergency cases. Access to the facilities would be at the discretion of the transit operator in charge. This is the policy advocated by SEPTA. Single occupant restrooms, such as those used on planes, may also be an acceptable compromise.

Translucent doors on the toilet stalls in restroom would provide privacy yet prevent deviates from ambushing unsuspecting patrons.[23]

2) AGT Application

The Morgantown PRT system has opted for the no-restroom policy. This decision should be based on the size of the system, the size of the station, the amount of traffic, and the average amount of time spent in the system per patron.

3) Costs

Elimination of restrooms would reduce costs.

3. Personnel/Operations Related Crime Countermeasures

a. Police Patrols

1) Overview

Survey results suggest that from the perspective of the transit-riding public, police patrols provide the best protection.[24,25] Whether they are assigned to the transit beat of a municipal police force or belong to a special transit authority security team, the presence of uniformed police has proved to deter criminal activity and to allay the fears of transit users.

As a crime deterrent, a full force need not be maintained at all times to be effective. Periodic "saturation patrols" have been known to lower the crime rate for up to eight months after normal deployment methods have been resumed.[26] Knowing that the AGT security force employs random patrol and surveillance techniques also discourages criminals. However, transit patrons feel more comfortable knowing that there will always be a security officer at every station and on every train. Even though a sophisticated CCTV and monitoring system may actually be more effective in detecting and responding to a crime in progress, transit-sponsored programs to educate the public on the use and effectiveness of the equipment may be necessary to bolster their confidence and perceived security.

2) AGT Application

Unfortunately, the long-term costs of maintaining a large security force can be prohibitively expensive for many transit authorities. This poses a major problem for automated guideway transit systems; a fundamental characteristic (and selling point) of AGT systems is that operating staff is minimized. Manning every station with a security officer would, therefore, run counter to a major purpose of having a fully automated transit service. Staffing each vehicle with a police officer would not be cost effective. Consequently, relying on a transit police force to function as the primary security component may not be a feasible AGT crime countermeasure.

i. Security Force Deployment

A possible solution to this dilemma would be to capitalize on some of the proven deployment strategies. One such technique is to use random police patrols and to count on their "phantom effect" to deter potential crime during nonpatrolled hours. Perceived dangers can be prevented if the public can be assured of a safe riding experience from the onset of operation. Heavy deployment of police officers during the first year of operation could be used to test response capabilities, identify "problem" areas, allay public fears and unnerve potential offenders. (Note that when Washington's Metro began service, there were two police officers at every station. This represented the entire system force covering a partially complete system, raising user expectations. Because of system expansion and other personnel requirements, the initial level of police visibility was reduced, causing some negative user reaction.) Once the security system is "de-bugged," a switch to random patrolling techniques could sustain the attained level of security.

From an operations perspective, the optimal security force configuration is in part a function of the size of the AGT network. Since there are many types of AGT networks, a single deployment strategy probably will not satisfactorily meet the security needs of each one. System planners must evaluate the system and prepare a deployment policy specifically for their system. (This policy should be an early product of the planning process, since the development of police services will require a considerable lead time. The policy will have to be acceptable to local police officials and labor union leaders. In addition, legislation will be needed and personnel must complete training programs.) Failure to coordinate deployment with the characteristics of a system will increase response times. This can not only make apprehension of a criminal more difficult, but in the long run diminishes the deterrence value of a countermeasure. On a large system, with numerous stations, several hundred vehicles, and relatively long waiting times, the loss of the deterrence function is unacceptable.

Aside from fiscal and personnel constraints, the following variables will help to define deployment policies and personnel requirements:

- Geographical size of the system
- Number of stations
- Population characteristics
- Headway and waiting times
- Support operations: mail, freight, packages, etc.
- Operating hours
- Number of jurisdictions
- Station crime ranking
- Method of fare collection
- Presence of transit personnel
- Number and location of service yards
- Security budget
- Criminal justice system

ii. Departmental Arrangements

A major issue confronted by transit security planners is deciding who bears the fundamental law enforcement responsibility for the system. Three alternatives are possible: The municipalities served may provide police protection for the transit system; the transit authority may have its own in-house security force; or, the law enforcement responsibilities may be shared by the authority and the involved jurisdiction(s). The last approach has been adopted by Washington Metro. The 132-member Transit police force has full apprehension and arrest authority throughout the transit system. Because the Metro police will eventually coordinate with 29 different police jurisdictions through Maryland, the District of Columbia, and Virginia, all Metro officers are given multi-jurisdictional law enforcement training.

The relationship between the CTA police and the Chicago Police Department has not developed along such well-defined guidelines. Until 1967 the 104-man CTA police force had sole jurisdiction over CTA property, personnel and patrons. Then, in the late 60s, vehement public reaction to several serious CTA crimes provoked the involvement of the Chicago Police Department in patrolling CTA facilities. The size of the CTA's own security force and its responsibilities attenuated to the point that, by 1971, the CPD had assumed a major share of responsibility which included passengers' protection. The authority of the 58 officers of the CTA police force was narrowed to the protection of transit property.[27]

A final police deployment arrangement for the BART system emerged only after prolonged debate between police officials from three counties and fourteen municipalities on the one hand, and the BART Board of Directors on the other. The transit system began operation with only a temporary (90-day) agreement by six local jurisdictions to extend police services to the BART system. Rather than provide security funds to local police, BART managers eventually organized a dedicated in-house transit unit of nearly 100 officers who perform almost all security duties.

Controversy over the planning and develop ment of policing policies should be avoided not only because bickering can be detrimental to the image of the system, but also because it is not always clear which transit policing arrangement will be most effective: There are advantages and disadvantages associated with every arrangement. Consultants, studying transit police organization for the BART system, concluded that there are "good and bad attributes and results without regard to the approach taken."

b. Contract vs. Proprietary Security Personnel

1) Overview

Unless the transit authority intends to arrange for local jurisdictional policing of the system, security planners will be faced with the decision of providing for personnel on a proprietary (in-house), contract (an outside agency is hired to provide security personnel), or a combination basis. The pros and cons of each of these arrangements are discussed in a recent article in Security Management Magazine.[28] According to author Ken Slutzky, a proprietary security force is chosen for its professional commitment when cost is not a concern. The dictum "you get what you pay for" has characterized the reputation of contract security services. This reputation is in part due to billing practices which have minimized the value of the labor factor. The individual's wage is the primary component of the total hourly charge; typically, 60 to 70% of that rate is added to cover the agency's overhead and profit margin. This technique may be appropriate when the hourly wage rate is low, but as it increases the proportionate share of variable costs should decrease. This, in effect, would minimize overall costs and insure high caliber services by offering competitive professional wages. In other words, the individual hiring agency services should make sure that the greatest proportion of the charges is for wages.

2) Costs

Slutzky identifies three wage levels representing expected quality of services: (The following wage rates have been adjusted for inflation.)

\$2.25 - \$3.50/hr	Generally skills, education and professional standards are low. Probably 90% of all contract security falls in this category.
\$3.50 - \$5.50/hr	Represents a labor pool of skilled and educated individuals with good work habits. Proprietary forces are frequently in this group.
\$5.50/hr and up	Represents highly skilled and/or "unionized" wages. Employee performance is generally comparable to that of the above group.

Mr. Slutzky concludes that "a progressive wage structure in the \$3.25 to \$5.00 range should provide security personnel of the right calibre with sufficient motivation for a professional security force. As the \$5.00 figure is exceeded the degree of improvement in performance diminishes."[29] These labor costs obviously vary and may be expected to be highest in the major metropolitan areas that could support AGT systems.

Private security forces have been criticized on a variety of bases. Often, they hire personnel who fail to meet usual police qualifications. Such individuals may not have the training, qualifications and experience required by formal police agencies. Public confidence is greatest when the security force is a duly constituted formal police agency.

c. School Programs and Community Involvement

1) Overview

Establishing and maintaining a strong, positive image of the transit system through an active community relations and education program is intended to counteract abuses of station property. This strategy has been employed by the major rapid transit systems.

The security department of the Washington, D. C., Metro, for example, actively solicits the involvement of school-age children in protecting the transit system. Two popular Redskin football stars deliver anti-vandalism talks at area schools. The children are given tours of the Metro system and the importance of taking care of "their" subway is stressed. Children also compete in city-wide poster contests. Inspector Hyde, of WMATA, feels that these programs have been helpful in limiting the amount of juvenile crime.

An active community services division promotes Metro by giving tours and publishing colorful guidebooks, schedule information, newsletters and a "Metro-Owner's Manual." Although it is a difficult variable to attempt to measure, WMATA's security department believes that the enthusiasm for Metro may be the reason that after more than a year of operation, it remains almost crime-, vandalism- and litter-free.

2) AGT Application

Any community building an AGT system will undoubtedly provide a community education program to acquaint riders with the new transit system. Emphasis on security and safety measures should be built into the program and continued throughout the years of operation.

d. Deployment Strategies of Transit Vehicles

1) Overview

Typically, most transit systems reduce train length during off-peak hours for purposes of operational efficiency, not for the explicit purposes of deterring crime. However, as an on-train crime countermeasure, this strategy is analagous to the adaptive space concept of station design.

2) AGT Application

By reducing the number of cars on each train during the more dangerous off-peak hours, passengers would be consolidated into smaller areas. This technique is doubly advantageous because monitors can more efficiently observe activity within a car and, with more persons in an area, perpetration of a crime would be less likely, especially the more serious crimes against persons. In an AGT system where vehicles arrive individually rather than as a train of cars, headway between arriving vehicles could be increased during the very late hours so that more people will be riding together. However, this procedure would increase station waiting time which would expose passengers for a longer period.

Another manner of deploying AGT vehicles for security purposes is to preempt the destination of a vehicle--this tactic has been used on several occasions in Morgantown, West Virginia. By definition, a GRT car will accommodate more than six passengers.[30] Consequently, as often occurs on an elevator, a transit rider will be obliged to share a unit with other parties. Under these circumstances a passenger may find himself trapped in a dangerous or threatening position vis-à-vis other occupants of the vehicle, with no opportunity to escape until the vehicle reaches its pre-programmed destination. Robbery, assault and harassment are crimes which could easily be committed during the course of the ride. Even if these fears are unfounded, the system stands to lose ridership if the public believes there is a possibility that such a situation could arise. Vehicle vandalism may also be a problem for either an SLT or PRT. The GRT system in

Morgantown has equipped its stations with closed circuit television. The monitoring headquarters and security installation is located at the main downtown station. Voice communication is available between vehicles and the central monitoring office and between the stations and the monitoring center. Attendants at the control station have the capability to pre-empt the destination of a moving vehicle and divert it to the security station.

On-board security of AGT vehicles may pose special security problems which are different from those one might encounter even on a fully automated rapid transit train, such as BART. From the individual's point of view, the GRT system may seem the least safe of the three subclassifications of AGT being studied. A Group Rapid Transit system offers neither the "security in numbers" found on larger capacity vehicles, nor the exclusive privacy and security of a personal rapid transit (PRT) system.

The Morgantown system operators have successfully used their pre-emption capability in two security-related incidents.[31] In one case, a vehicle of rowdy, drinking university students was diverted to the security station and the students were reprimanded for carrying liquor on board the system. The other incident occurred during the winter, when the central station received a report that a masked gunman had boarded a vehicle at another station. The transit security officer announced over the car radio that the vehicle had to be "rerouted for special servicing." The officer then alerted local police who rushed to the station in time to seize the diverted vehicle and its passenger. The incident proved to be a good drill for the security department--the masked man was returning from play rehearsal and the gun was a prop he had been using in the performance. He was wearing his own ski mask because it was cold!

Pre-emption capability, integrated with a reliable TV monitoring and radio communication system, is valuable from both security and safety perspectives.

3) Costs

Costs will entail both capital outlays for the hardware and some fraction of the operating expenses attributable to security monitor operators.

e. Reduce Operating Hours

1) Overview

Crimes on conventional rail rapid transit systems are almost never spread uniformly throughout the system; there is a strong direct relationship between neighborhood crime rate and the level of crime at a station within that neighborhood. There is also a distinct peaking of crime, particularly robbery, during nighttime operating hours.

These characteristics suggest that curtailing evening operating hours or limiting off-peak use of high-crime stations may be effective countermeasures. Their application will require considerable skill and tact. For example, a majority of crimes occur during the 6 p.m. to 6 a.m. period, but shutting a system promptly at 6 p.m. or not opening until 6 a.m. is likely to interfere with commuters' schedules.

Shutting only high-crime stations also raises serious equity questions. If transit system trains shuttle between downtown districts and suburban stations, high crime area residents may perceive this to be a discriminatory transit policy.

2) AGT Application

Security planners may be able to fine-tune operating hours so that high-risk operating hours are reduced without substantially estranging transit patrons.

Limiting late evening operating hours may have most value in terms of the system's image. If crimes of violence can be limited or eliminated by manipulating operating hours, transit users may perceive the system as being reasonably free from violent crimes.

3) Costs

Limiting system or station hours should reduce operating costs. To some degree revenues, too, will decline, but this trade-off is unavoidable.

f. Canine Patrols

1) Overview

The use of guard dogs may be an underemployed means of enhancing police patrol capabilities and moderating transit-patron insecurities. Responding to a questionnaire, Chicago transit riders indicated that, more than any other single countermeasure, deployment of more police (including K-9 patrols) would give the most reassurance.[32] The use of trained attack dogs to accompany transit security officers on their rounds is a practice employed by the CTA.

A case study of the use of guard dogs at the J. Paul Getty Museum in California strongly recommends K-9 patrols on the grounds of the cost-effectiveness: "One guard dog that works well with his handler provides a more efficient and cost-effective security operation than a number of security officers."[33]

An acute sense of smell and hearing are the animal's greatest assets. Should an intruder circumvent mechanical or electronic surveillance equipment, a well-trained dog can detect him from more than 100 feet away. Because police dogs are renowned for their terrifying viciousness when commanded to attack, their presence accompanied by a trained handler may act as a deterrent to potential criminals as well as reassurance to the transit-riding public.

German Shepherds and Dobermans, both intelligent and aggressive breeds, are the most frequently trained attack dogs.

The Getty Museum has trained three nighttime security officers as handlers of the Museum's guard dog operation. Working as a team, the three officers make up their own schedule, but must work the required number of 12-hour shifts per pay period. The K-9 patrol has reduced the size of the needed security force by two persons and has resulted in increased security and an annual savings of over $15,000 in salaries. In addition, the guard dog operation seems to have boosted the morale and effectiveness of the security team members.

2) AGT Application

If the AGT system's manpower budget is limited, a K-9 patrol may be a feasible alternative to a two-person patrol force. Because of their keen senses, the use of dogs is ideal for nocturnal policing--particularly in transit rail yards where expensive equipment may be exposed to theft or vandalism.

3) Costs

Fully obedient and attack-trained dog: $550

Food and maintenance: $30 per month

g. Aerial Surveillance

1) Overview

Helicopter patrols have been effective in combating severe vandalism of SEPTA property.[34] Besides the more common problem of graffiti, the Philadelphia commuter train network was plagued with serious rock-throwing incidents with damages totaling almost $1 million in 1971. Originally sponsored as a Federal Railroad Administration demonstration grant project, SEPTA initiated a helicopter surveillance program.

The helicopter searched the tracks for trespassers. If observed, the trespassers were told over a loudspeaker to leave. A ground patrolman was dispatched to the scene if the trespasser did not leave. The short-term demonstration program was so successful that SEPTA assumed sponsorship in May of 1973.

2) AGT Application

Aerial surveillance is a proven success in diminishing vandalism on a rail rapid transit system. Unless the AGT network runs mostly at grade or on an elevated guideway, covers an extensive portion of the metropolitan area, and is the object of severe vandalism, it is doubtful whether aerial surveillance can be cost-effective.

3) Costs

Reference 35 gives a good discussion of helicopter surveillance costs, which are approximately $112/hr for helicopter operation.

h. Differential Penalties and Curfews

1) Overview

There is a sub-class of operational countermeasures that can be available to security planners, but require special legislation. These countermeasures usually involve some revision of municipal or state criminal statutes, an administrative or bureaucratic reorganization of the criminal justice system, or a law that restricts the behavior of a particular class of people. The security planner can initiate consideration of these types of countermeasures, but has relatively little control over whether they become available for use.

Differential penalties are used on at least one transit system. A person convicted of vandalism or robbery while on transit authority property can receive a harsher penalty than if the crime were committed in a different setting. However, it is left to legislatures and city councils to make the distinction between transit and street crime.

A high percentage of offenders are young. Therefore, imposing a curfew on users below a certain age could be an attractive countermeasure. There are several obstacles that could prevent the use of curfews. What age and time constraints are appropriate? There may be equity objections, especially if the curfew limits the ability of low-income youths to travel to part-time jobs in the evening. Finally, would a curfew be enforceable at AGT manpower levels?

A suggestion that entails an administrative change would be to give a few judges jurisdiction for all trials involving transit crime. The rationale is that a core of special judges, exposed to the seriousness of transit crime, will hand down penalties stiff enough to deter offenders.

2) AGT Applications

It is difficult to indicate under what conditions curfews, differential penalties or reorganization of the judiciary can be effective. For large systems, curfews and designated transit judges may be impractical. Differential penalties may be an effective countermeasure that has low manpower requirements.

3) Costs

Costs are intangible. Security planners may have to spend a considerable amount of time lobbying for differential penalties or consulting with administrators and judges in the criminal justice system.

4. Land Use Related Countermeasures

If there is one fact about which transit crime experts agree, it is that high-crime stations and routes are in high-crime neighborhoods.[36, 37] There is also a correspondence between the type of transit crime and the magnitude of street crime; the more serious crimes against persons occur in the stations or on the route segments of inner-city systems, whereas suburban commuter systems are troubled by fare evasion, pocket-pickings and vandalism.

The AGT planner should understand the context within which the system will operate and the security implications of this context. AGT systems now in service operate in unique settings. Shuttle-loop transit, the simplest class of AGT service, has been used in six airports, two commercial centers, and eight amusement parks. Group rapid transit service is available at one airport and on a university campus. If future AGT systems continue to be used in these specialized contexts, then it is doubtful that security will play an important role in determining system design, since crime has been found to be a minor factor on these systems.

This is not to say that AGT systems will never replace the kinds of services provided by current rail rapid transit systems. Clark Henderson, of the Stanford Research Institute, envisions AGTs as providing "an excellent circulation service for an activity area." He believes that both Shuttle-Loop Transit (SLT) and Group Rapid Transit (GRT) "could be constructed in fine mesh networks with closely spaced routes and many stations that will be needed to serve all travelers and all trips throughout a metropolitan area."

If tomorrow's guideway systems supplant today's conventional rail rapid transit, we may expect more of the same in terms of the nature and extent of transit crime. This suggests that changing or improving the context or setting of the transit system may, in itself, be a crime countermeasure. To assure good, efficient service which can compete successfully with the automobile, an AGT system in a metropolitan area is required to provide average vehicle speeds of 25 mph. For reasonably direct access, a grided network is needed and grid intervals should be between ¼ to ½ mile apart. Stations should also be located within ¼ to ½ mile of each other.[38]

It would be a difficult task to design a transit network which meets these density requirements and circumvents all high-crime neighborhoods. It is no coincidence that a great proportion of captive transit patrons live in the urban neighborhoods with the highest rates of serious crime. Transit dependency and high crime rates may both be represented as functions of the economic condition of many of these inner-city neighborhoods. If one assumes that a principal goal of public transit is to increase accessibility for those who have no other means of transportation, then security should not be a significant constraint in selecting routes and station locations for an AGT network. On the other hand, if an AGT system is to provide an attractive alternative to the choice riders who rely exclusively on their automobiles for transportation, then security may prevail as an important criterion for selecting the best context for the system.

The Institute of Urban and Regional Development at the University of California, Berkeley, has designed a procedure for evaluating transit security based on several indicator variables (e.g., station elevation, number of levels, etc.).[46] In using the procedure, it is assumed that station security is directly related to these variables. Thus a station that attracts trips is assumed to be less safe than one that generates trips; a trip attractor would be near a stadium, factory, school or business, while a trip generator would be near residences. Each station in a system is evaluated and receives a score on a scale of one (relatively hazardous) to three (relatively secure). A "General Station Score" for a particular station is simply the sum of its scores on each of the indicators. The higher the resulting score, the better station security is supposed to be. Stations can be ranked according to their resulting scores, and those with potential security problems can be identified. The indicator variables, their levels and associated scores are shown in Table 3-2.

This assessment method has its limitations, but a more refined and less subjective version, which would include importance weightings for the indicators, could be used to evaluate potential sites for AGT Station/Route segments. (Section 4 uses regression analysis to examine the relationship between demographic characteristics and station crime.) Selected station sites that ranked below a specified score would be relocated if the particular site were of marginal importance (i.e., relocating the site to a safer area would not result in drastically impaired service for transit dependents). Non-discretionary sites with low security ratings would require extra fortification. This could be accomplished by instituting particular countermeasures or by selectively integrating the transit stations with existing public uses. Combined with an office building, a commercial center, or a municipal or institutional facility, the transit station and patrons would be afforded better protection. If not actually enclosed within one of these establishments, locating a station within the influence of recognized "safe areas" may decrease the potential for crime. This particular strategy has been investigated by Architect Oscar Newman, author of Defensible Space and Architectural Design for Crime Prevention. Newman has conducted extensive research on the relationship between architectural design and security. Although his work focuses primarily on the design of crime-free environments in residential developments, some of his suggestions for securing the "context" of a project provide adaptable guidelines for the selection and design of a transit station site.

Newman contends that security can be improved by juxtaposing public zones and entrances to a building with areas which have a safe image. These safe areas are most frequently identified as being "heavily trafficked public streets and arteries combining both intense vehicular and pedestrian movement; commercial retailing areas during shopping hours; institutional and government buildings. Even though the crime rates may actually be higher in these busy areas, the presence of potential witnesses apparently allays the fears of many persons."[39]

TABLE 3-2
BART STATION SECURITY ASSESSMENT SCALE

Context Variable	Score
1. Station elevation	
Surface	2
Subway	1
Aerial	2
2. Number of levels (including street level)	
Two	3
Three	2
Four	1
3. Passenger volume (estimated ADT for 1975)	
0 - 10,000	1
10 - 25,000	2
More than 25,000	3
4. Line situation	
Through	1
Transfer	1
Terminal	2
5. Trip attraction/generation	
Attractor	1
Generator	3
Balanced	2
6. Predominant land use immediately surrounding station	
Suburban	
residential	3
commerical	2
mixed	2
Urban	
residential	2
commercial	1
mixed	1
Industrial	1
Freeway	1
Vacant, rural, or agricultural	1
7. Land use density immediate surrounding station	
Low	3
Medium	2
High	1

TABLE 3-2 (continued)

Context Variable	Score
8. Parking	
No	2
Yes	1
9. Number of paid-area exits	
One	3
Two	2
Three or more	1

Evidence gathered by Newman indicates that residential developments located near high schools, junior colleges, and commercial establishments that cater to a teenage clientele experience substantially more crime than developments removed from the activities. Assuming these findings are applicable to transit site selection, designers of AGT sites would be advised to avoid juxtaposition with teenage hangouts, or at least to orient station entrances away from their activities.

The decision to integrate transit station operations with activity-generating uses for safety's sake should be "critically evaluated in terms of intended uses, their identification with the area, periods of activity, nature and frequency of presence of concerned authorities."[40]

C. Summary of Selected Countermeasures

Aspects of selected countermeasures are reviewed in Table 3-3. For each countermeasure, sites where it is employed are listed and its effectiveness, advantages, and disadvantages are summarized.

TABLE 3-3
SUMMARY OF SELECTED COUNTERMEASURES

Countermeasure	Where Employed	Effectiveness	Advantages	Disadvantages
· Lighting	All Systems	· Improved Lighting Reduced Street Crime in Chatanooga, Tenn. by 90%	· May Improve Riders' Perceptions of Security · Aids Both Camera/Human Monitoring Capabilities · Supportive of Other Transit Operations: Safety, Fare Collection, Etc.	· Light Fixtures May Be Subject to Vandalism · May be Affected by Power Outages/Shortages
· Open Station Design	WMATA	· Riders Have Accurately Iden-tified Confined Dark Areas of Transit Systems As Being The Most Dangerous	· Improved Lines of Vision · Makes Station Appear Spacious, More Attractive · "Floating Platform" May Decrease Vandalism by Keeping Subway Walls out of Reach of Graffiti Artists	· Revenue May be Forfeited by Pro-hibiting Concessions · May Inconvenience Transit Riders New to the System Unless Adequate Information Aids are Provided
· Climate Control	WMATA	· Speculative	· May Attract New Riders to The System	· May Attract Loiterers · Breakdown May Anger Patrons Who Have Come to "Expect" Comfort · Costs
· Adaptive Space	CTA (Component of TVA Test)	· Currently Being Tested as Part of TVA System	· Simple Concept · May Boost Moral and Effectiveness of Patrol Persons	· Requires Personnel to Open and Close Barriers · May be Subject to Vandalism · Abnormally Large or Small Crowds May Cause Scheduling Problems

TABLE 3-3 (continued)

Countermeasure	Where Employed	Effectiveness	Advantages	Disadvantages
• Alarms and Sensors Two Types: -Passenger Activated -Hidden	Use Is Extensive: Alarms Used To Protect Valuables/ Other Property Most Vehicles Equipped With Alarms to Alert Operator	• Effectiveness Improves When Used in Conjunction With Monitoring And Communication Devices	• Relatively Easy To Install • Passenger Activated • Alarms May Improve Sense of Security for Riders	• Victims May Be Unwilling Or Unable to Trigger Alarm • False Alarms • Not Effective Against Professionals
• Video-tape	Banks; Part Of TVA System	• Appears To Be Effective in Aiding In Identification	• Provides A Record Of Criminal Activities • Provides Support for Other System Functions	• Vandalism May Pose A Problem
• Education and Public Relations Programs	WMATA, BART	• Limited Mainly to Juvenile Crimes (Vandalism, Fare Evasion, and Petty Theft)	• May Improve Public Image of The System • May Decrease Maintenance Costs	• May Not Be Effective Against The Most Serious Crimes
• Aerial Surveillance	SEPTA	• Limited Mainly To Offenses Against Transit Property - Yards, Track, Parking Facilities	• Air-Ground Communication Improves Response Capabilities	• Costs
• Vandal Resistant Surfaces	WMATA		• Reduces Maintenance Costs • Indirectly Supports Other Transit Objectives, e.g. Safety	

TABLE 3-3 (Continued)

Countermeasure	Where Employed	Effectiveness	Advantages	Disadvantages
• Communication Devices (Includes Voice-monitors, 2-way Radios and Public Address Systems)	To Some Extent, All Systems. Use Has Been Prolific In Other Environments as Well		• Supportive of Other System Functions/Services, Emergencies, Passenger Guidance • Requires Minimal On-site Personnel, Remote Surveillance is Possible • New Technical Improvements Permit Installation on Vehicle as Well as Station	• Susceptible to False Alarms • Interference Due to Operator Fatigue or Inattention • Background Noise • Victim/Witness May Be Too Intimidated to Use Devices
• Prevention of Fare Evasion (Vault-Proof Fare Turnstiles)	Industrial Complexes	• Crackdown on Fare Evaders In New York Resulted in Arrest of Individuals with More Serious Criminal Intentions	• Increases Fare Revenues • May Curtail More Serious Crimes	• May Require At Least Some Personnel Supervision • May Impede Traffic Flow • Safety Problems
• Uniformed Security (Police) Force	All Major Rapid Transit Systems	• Use of Random, Saturation and Decoy Patrols Have Increased Arrests and Have Had At Least Temporary Improvements in Transit Security	• May Improve Riders Perceptions of Security • "Human Element" Adds Greatest Flexibility • Supportive of Other System Needs	• Costs, Total Coverage Difficult • Requires Administration/ Management Outlays • May Be Legal/Jurisdictional Conflicts in Provision of Services
• K9 Patrols	CTA, Municipal, Industrial Uses, Airports, PATCO	• Effective for Detecting Particular Crimes and Apprehending Offenders During Commission of Crime	• Can Decrease Security Personnel Requirements • Animal's Keen Senses May Detect Crimes Not Otherwise Apparent to Human Observation	• Requires Repeat Training • Dogs Work Best With One Handler • Passengers May Be Frightened of Dogs

TABLE 3-3 (continued)

Countermeasure	Where Employed	Effectiveness	Advantages	Disadvantages
• Attractive, Well-Maintained Environment	Most New Systems (Bart, WMATA, Morgantown)	• Speculative	• May Attract and Retain Non-Captive Riders • May Improve Perceptions of Security • Supportive of Station Safety	• Requires Constant Maintenance To Be Truly Effective
• Restroom Restrictions	BART: WMATA: Morgantown: No Rest-rooms SEPTA: Restrooms Opened At Discretion Of Transit Personnel	• Prevents Some of the The Crimes Which Often Take Place in Restroom Areas	• "Stream Lines" Station Design • Less Area Requiring Surveillance	• May Give Operator Opportunity to Discriminate • Removes Operators Attention From Routine • If No Restroom Available Travellers May Be Extremely Inconvenienced • Restrooms May Be Vital In Emergency Situation
• Screening Devices (Includes Metal Detectors and ID Entry Procedures)	Airports, Entrances To Security Complexes	• Have Proven Successful in Airports in Deterring Potential Sky-Jackers From Boarding Planes	• Minimizes Personnel Requirements • Gives User An Opportunity to Retreat From Situation Without Major Confrontation	• Doesn't Affect/Deter the Commission of Unarmed Crimes • May Be Personnel Intensive
• Closed Circuit Television (CCTV)	WMATA, BART Mortantown	• Electronic Security Devices Tend to Suppress Criminal Activties and Improve Police Response Capabilities • Effective in Other Applications	• Minimizes Size of Security Force Needed • May Permit Centralized, Remote Surveillance with Local Police/Fire/Rescue Communication • Can Be Integrated into a More Comprehensive Security Hardware System Such As Public Address, Telephones, and Video-Taping Capabilities	• Costs • Station Design May Impede Camera's Viewing Range • Response Time May Be Too Slow • Requires Constant Monitoring

4 COUNTERMEASURE COST AND EFFECTIVENESS

A. Measures of Cost

Of paramount concern to transit security planners is the issue of costs. Basing the selection of countermeasures strictly on incurred expenses presents difficulties because there are several other measures of costs that are equally important. The countermeasure costs addressed in this section take both incurred costs and other types of costs into account.

The first cost measure is acceptance--by both the transit users and transit authorities. While the actual impact on crime is primary, the passengers' or users' perception of safety and security resulting from a countermeasure is also very important. Passenger acceptance of an anti-crime strategy has two aspects: (1) Does the countermeasure have face validity; that is, does it seem like a procedure or device that would stop crime? And (2) is the countermeasure generally acceptable--is it free of legal, convenience and cost aspects that would cause the public to reject it on those grounds? A procedure may work very well in reducing crime, but be so inconvenient that users will not accept it or, if the users believe the choice of countermeasures to be ineffective, unreliable or objectionable, they may opt for another mode of transportation and fare revenue will then be lost.

Another set of sub-costs has to do with the acceptability of the countermeasure to the transit authorities--both general management and security personnel. Certain procedures may be viewed as bad from a public relations point of view; others may be seen as a admission that a security problem exists--some officials are unwilling to publicly acknowledge a crime problem. Others may violate the biases of officials--if one is convinced that closed circuit television is of no value, then it will not be acceptable, by fiat. If security personnel do not accept the countermeasures, they may be used ineffectively or ignored. This cost is the wasted investment of equipment and training. It could also result in reduced ridership if transit patrons do not feel that the crime countermeasures have the full support of operators.

The second cost measure considers monetary aspects directly and includes both capital and operating expenses, both of which will influence the feasibility of using a countermeasure. Some of the crime countermeasures are characterized by high initial investment but require marginal maintenance or operating expenditures. Because construction and implementation costs represent a major share of these capital expenses, a countermeasure's feasibility may depend on whether it is to be installed as part of a new system or incorporated into an existing system. If the latter, it must be evaluated or incorporated in terms of the amount and expense of any system alteration required. Other countermeasures, though inexpensive to implement, may be costly in the long run. Manpower involvement can be a major operating cost consideration. Clearly, one needs to distinguish the cases where (a) one or more persons must be physically present in the station or on the trains, (b) one or more persons are required at a location remote from the stations and trains, and (c) manpower is not involved in the countermeasure. The cost of any manpower involvement must of course enter the cost computations for any proposed countermeasure. It is extremely difficult to specify the costs involved in installing many countermeasures. A detailed analysis of the characteristics of a particular system is necessary to be at all precise. The analysis should not neglect the versatility of certain countermeasures. Passenger-activated alarms, CCTVs, public address systems and two-way communication equipment can fulfill additional roles beyond their primary functions as countermeasures. For example, CCTV is a primary or secondary detection method for problems associated with passenger safety and convenience services. (See Table 4-1 below and pages 86-94 of the Passenger Safety and Convenience Guidebook, report number UMTA-MA-06-0048-79-5.) CCTV is useful for monitoring special access gates and elevators used by elderly and handicapped riders. At a well-designed station entrance, the same camera(s) could be used not only to improve station access and egress by the elderly and handicapped, but also to detect a criminal attack on the automatic fare system. On station platforms, CCTV could be used to detect criminal behavior and, additionally, provide central control with information on crowd conditions and inoperative graphics. A two-way communication system is an invaluable aid for providing information to lost or injured passengers. A transit user could also activate the system to communicate with security personnel if a crime occurs. For every additional application within the capabiliy of a device, the unit cost is unchanged, and the cost effectiveness of the equipment is therefore enhanced. This provides management with a rationale for spreading the cost justification of certain countermeasures over several functions. This is preferable to a situation in which one function, particularly passenger security, must alone justify the capital cost of countermeasure hardware.

In an attempt to illustrate how to assess these costs, individual evaluations of the countermeasures in terms of their acceptability to transit riders and transit operators, and the level of required capital and operating costs were obtained. For each countermeasure the four costs were obtained. For each countermeasure the four costs were rated as being "high," "medium" and "low." The averaged results are shown in Table 4-2. Plus and minus scores indicate the divergence of opinion on costs. These estimates will change over time and are in need of periodic re-evaluation.

B. Measures of Effectiveness

The primary criterion for a countermeasure is whether or not it works and how well it does so. Unfortunately, few countermeasures have been empirically evaluated; the effectiveness of many is taken on faith--not based on any real data or on controlled observation. Such countermeasures are assumed to work because they function in some way we believe influences crime occurrence. The effectiveness of a countermeasure may also be judged by how many crimes it affects and

TABLE 4-1

HARDWARE AS PRIMARY OR SECONDARY DETECTION METHODS

HARDWARE	FUNCTION	PRIMARY RESPONSE OR DETECTION METHOD	SECONDARY RESPONSE OR DETECTION METHOD
CCTV	Monitoring Equipment		
	• Turnstiles	*	
	• E & H Access Gates	*	
	• Vehicle/Station Alignment	*	
	• Critical Switch Areas		*
	Passenger Convenience		
	• Ill or Injured Passenger		*
	• Accommodation of Crowds	*	
	Passenger Safety		
	• Fire/Smoke Detection		*
	• Monitor Evacuation and Rescue Operations		*
TWO-WAY RADIO COMMUNICATION SYSTEM	Passenger Convenience		
	• Lost/Strayed Children	*	
	• Illiterate Passenger	*	
	• Lost/Confused Passenger	*	
PA SYSTEM	Passenger Convenience		
	• Direct illiterate, lost, confused passengers to courtesy phone	*	
	• Provide destination information when graphics fail	*	
	• Aid in locating separated passengers	*	
EMERGENCY POWER	Aid in Evacuation and Rescue		
	• Emergency Lighting	*	
	• Power for Two-Way Communication	*	

TABLE 4-2
JUDGED RELATIVE COSTS OF CRIME COUNTERMEASURES

COUNTERMEASURE	Acceptance Costs: Objectionable to Transit Riders	Acceptance Costs: Objectionable to Transit Operators	Monetary Costs: Capital Costs	Monetary Costs: Operating Costs
Pre-Screen Riders	H	H-	M+	H
Alarms & Sensors	L	L	M	M
CCTV	L	L	M	M
Voice Monitors	L+	L	M	M
Barriers	L+	L	M	L
Sealed Exits	M	L+	L+	L
Fare Box Hardening	L	L	M	L
Good Lighting	L	L	M	L+
Open Station	L	L	M	L
Climate Control	L	L	M	M
Adaptive Space	L	L	M	L+
Attractive Environment	L	L	M-	M
Restroom Restrictions	M+	L+	L	M-
Single Exits	H	L	L	L
Community Relations	L	M-	L	M
Police Patrols	L	L	L	H
Vehicle Deployment Strategies	L	L	M-	M
Canine Patrols	L+	M-	L+	H
Aerial Surveillance	L	M	H	H
Reduced Service	H	L+	L	L
Legal Sanctions	L	L+	L	M+
Land Use Considerations	L	M		L
Teleview Alert System	L	L	H	M

H = high M = medium L = low/little
+ better, - worse

which crimes those are. A countermeasure is better if it influences many crimes rather than only a few, and it is preferable if it influences frequent or probable crimes than if it influences rare and unlikely ones.

The actual operation of the countermeasure and its usefulness depends on the state and reliability of the technology on which it is based. One must consider how long "things like this" have existed and how well they have functioned, and how stable the costs involved are. How likely are breakdowns and equipment failures? Furthermore, what is known about how easy it is to overcome or disable the countermeasure? How susceptible is it to vandalism?

Finally, what specific function does the countermeasure serve vis-à-vis crime and how does it do so? Is it useful in the tasks of (a) detection of a crime, (b) prevention of a crime, (c) identification of a criminal, (d) apprehension of a criminal, (e) providing hard evidence for apprehension and conviction of an offender? Each of these functional specifications can be further elaborated. For example, (b) prevention might be achieved by (i) keeping possible offenders out of the system or (ii) minimizing the amount of cash in the system or (iii) having patrons effectively protected in some manner.

With these effectiveness criteria in mind, a panel evaluated the perceived usefulness of certain countermeasures in preventing each of the most common transit offenses. Each countermeasure was judged as being very effective (X), marginally effective (/), or ineffective (0) in reducing the various crimes.

Ten persons supplied the ratings for Tables 4-2 and 4-3. All were familiar with at least one major transit system. They varied from experts in the transit field to relatively naive respondents. There were 4 women and 6 men. Four respondents had extensive knowledge of transit security problems. For each entry, in the table a consensus judgment was obtained - that is, the most frequently occurring rating was entered. There was a very high degree of agreement, in most cases, 8 or more judges made the same judgment.

As can be seen from table 4-3, the countermeasures most effective against all types of crimes are: a visible uniformed security force, CCTV, K-9 patrols, presence of transit personnel, and saturation patrols. There are also crime specific countermeasures which can be determined by looking at the table. Thus assault, battery and homicide are best deterred by the presence of police and transit personnel. Alarm systems and metal detectors are useful against trespassing and arson.

This exercise illustrates a procedure for evaluating countermeasure effectiveness. The results are not intended to be conclusive; they are based on the knowledge, experience and perceptions of a limited number of individuals and are, of course, highly subjective. This evaluation process should produce more reliable estimates of effectiveness if completed by a panel of transit security officials.

TABLE 4-3

COUNTERMEASURE EFFECTIVENESS*

	CRIMES	GOOD LIGHTING	"OPEN" DESIGN	CLIMATE CONTROL	ADAPTIVE SPACE	VISIBLE, UNIFORMED SECURITY FORCE	MEDIUM-VOLUME TRAFFIC FLOW	SCHOOL/COMMUNITY PROGRAMS	ATTRACTIVE, CLEAN TRANSIT PROPERTY	REDUCE NO. OF CARS DURING OFF-PEAK HOURS	PRE-SCREEN RIDERS	ELIMINATE STATION RESTROOMS	TRANSLUSCENT DOORS IN RESTROOMS	PNEUMATIC TUBES TO COLLECT END-OF-DAY RECEIPTS	VOICE MONITORS	CCTV	PASSENGER-ACTIVATED ALARMS	ALARM-ACTIVATED VIDEO-TAPE	BURGLAR-TYPE ALARMS	PUBLIC ADDRESS SYSTEM	TELEVIEW ALERT SYSTEM	METAL DETECTORS	K-9 PATROLS	PRESENCE OF TRANSIT PERSONNEL	PLAIN-CLOTHES DETECTIVES	SATURATION PATROLS	POLICE DECOYS	NON-SCHEDULED TRAIN STOPS	AERIAL PATROLS	NON-BREAKABLE WINDOWS	VANDAL-PROOF SEAT COVERINGS	CLEANABLE, GRAFFITI-PROOF SURFACES	AUTOMATICALLY SEALED EXITS	SINGLE EXITS	PREVENTION OF FARE EVASION
AGAINST PERSON	ASSAULT	/	/	/	/	X	/	0	0	/	/	0	0	0	/	X	/	/	0	/	/	/	X	X	/	X	/	/	0	0	0	0	/	/	0
	BATTERY	/	/	/	/	X	/	0	0	/	/	0	0	0	/	X	/	/	0	/	/	/	X	X	/	X	/	/	0	0	0	0	/	/	0
	HOMICIDE/ MANSLAUGHTER	/	/	/	/	X	0	0	0	/	/	0	0	0	/	X	/	/	0	0	/	/	X	X	/	X	/	/	0	0	0	0	/	/	0
AGAINST PERS. CARRIED PROP.	ROBBERY	X	X	/	/	X	/	0	0	/	/	/	/	0	/	X	/	/	0	/	/	/	X	X	/	X	X	/	0	0	0	0	/	/	/
	PURSE-SNATCHING	/	/	0	/	/	0	0	0	0	/	/	0	0	/	X	/	/	0	/	/	0	X	X	/	/	/	0	0	0	0	0	/	/	/
	POCKET-PICKING	/	/	0	/	X	0	0	0	0	/	0	0	0	0	/	/	/	0	/	/	0	/	X	/	X	/	0	0	0	0	0	/	/	/
AGAINST STATION PROP.	STATION BURGLARY	/	X	0	0	X	/	0	0	0	/	0	0	X	/	X	/	/	X	/	X	/	X	X	/	X	/	0	0	0	0	0	/	/	/
	FARE EVASION	/	/	0	/	X	/	/	0	0	X	0	0	0	0	X	0	/	X	/	/	0	X	X	/	X	0	0	0	0	0	0	/	/	X
	VANDALISM	/	/	0	/	X	/	/	/	/	/	/	/	0	/	X	/	/	/	/	/	0	X	X	/	X	0	0	/	/	/	/	/	/	/
	PETTY THEFT	/	/	0	/	X	0	/	0	0	/	0	0	0	0	X	/	/	/	/	/	0	X	X	/	X	0	0	0	0	0	0	/	/	0
	TRESPASSING	/	0	0	/	X	0	0	0	0	/	0	0	0	/	X	0	/	X	/	/	0	X	X	/	X	0	0	/	0	0	0	/	/	0
	ARSON	/	/	0	0	X	/	0	0	0	/	0	0	0	0	X	/	/	X	/	/	0	X	X	/	X	0	0	0	0	0	0	/	/	0
	MISSILINGS	0	0	0	0	X	0	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	/	/	/	/	0	0	/	0	0	0	0	0	0
AGAINST PUBLIC	DRUG LAW VIOLATIONS	/	/	0	/	X	0	0	0	0	X	X	/	0	0	/	0	0	0	0	/	0	X	/	/	X	/	0	0	0	0	0	/	/	0
	SEX CRIMES	X	/	0	/	X	/	0	0	/	/	/	/	0	/	X	/	/	0	/	/	0	X	X	/	X	X	0	0	0	0	0	/	/	0
	DRUNKENNESS	0	0	0	0	/	0	0	0	0	X	/	0	0	/	0	/	/	0	0	/	0	/	/	/	/	0	0	0	0	0	0	0	0	0
	DISORDERLY CONDUCT	/	/	0	/	/	/	0	0	/	/	0	0	0	/	X	/	/	0	/	X	0	/	/	/	X	0	0	0	0	0	0	0	0	/
	CONCEALED WEAPONS	0	0	0	0	/	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	X	/	/	/	/	0	0	0	0	0	0	0	0	0

* X = very effective against the crime, / = somewhat effective, 0 = no effect.

C. Relative Crime Importance

Data on crime for existing transit systems are available in a wide and varying range of detail. Cross comparison of data is difficult because most jurisdictions maintain their own recording procedures and classification systems. For example, San Francisco's Bay Area Rapid Transit System (BART) accounts for twenty different offenses, reporting them on a monthly, station-by-station basis, but the crime statistics available from the Port Authority Transit Corporation (PATCO) are reported in generalized crime categories and it is not possible to discern which specific offenses have occurred.

Annual crime statistics from four transit systems (BART, MBTA, WMATA and Montreal Metro) are reported in Table 4-4. Arrayed in this manner, the importance of consistent and comprehensive record-keeping becomes evident to the transit security planner; the percentage breakdown of total transit crimes by type highlights the relative importance of each offense. This is an essential step in preparing a countermeasure strategy because it enables security planners to identify the most prevalent and serious crime problems. The countermeasures most effective in deterring these priority crimes may then be selected. Crime data for individual stations are also important and can be similarly compiled.

Security planners must have access to accurate, standardized crime statistics for their systems. AGT system managers should develop a data base that conveys enough information to create valid crime profiles for a system, a part of a system, or an individual station. The location of a crime (platform, vehicle, lobby, stairway), the time, method of detection, type of weapon used (preferably ".22 pistol" not "gun"), and the tactics of an offender (mask, approach, means of escape) should be standard components of a system's crime statistics. Ideally, given relevant data, security planners could track crime patterns on the system and note emerging problems. The planners might be able to set a threshold of criminal activity beyond which a station or line automatically becomes a candidate for an appropriate countermeasure. The assumption is that recent problems could be identified and perhaps suppressed before they become serious. A well-designed data base will also permit constant evaluation of an anti-crime strategy, serve as an indicator of personnel requirements, and allow cross comparison of data. Cross comparison of crime statistics would be particularly valuable. Given compatible, comprehensive information, planners would have an empirical basis for judging the effectiveness of different countermeasures in similar situations on different AGT systems. It would still be impossible to have complete confidence in the relative effectiveness of countermeasures (because it is difficult to isolate specific variables); nonetheless, it would broaden our knowledge of countermeasure effectiveness.

D. Estimating Crime Levels

The task of selecting and implementing a security program for an existing transit system is simplified by the knowledge of the security problems expected at individual stations. For example, often transit

TABLE 4-4
SELECTED CRIME STATISTICS

	CRIMES	San Francisco Bay Area Rapid Transit (BART) 1976 No.	(%)	Massachusetts Bay Area Rapid Transit (MBTA) 1976 No.	(%)	Washington Area Metropolitan Transit Authority (April to end of 1976) No.	(%)	Montreal Transport (Metro) 1976 No.	(%)
AGAINST PERSON	Assault*	6	(.21)	240	(8.21)	1	(3.33)	9	(.91)
	Battery	54	(1.89)						
	Homicide/Manslaughter	0	(0)						
	TOTAL	60	(2.10)	240	(8.21)	1	(3.33)	9	(.91)
AGAINST PERSONALLY CARRIED PROPERTY	Purse-Snatching	7	(.24)						
	Pocket-Picking	5	(.17)						
	Robbery	49	(1.17)	292	(9.99)	4	(13.33)	6	(.61)
	TOTAL	61	(2.14)	292	(9.99)	4	(13.33)	6	(.61)
AGAINST STATION PROPERTY	Station Burglary	24	(.84)			3	(10.00)	3	(.31)
	Fare Evasion	846	(29.65)					396	(40.00)
	Vandalism	410	(14.37)	295	(10.09)			3	(.31)
	Petty Theft	563	(19.73)	1372	(46.94)	5	(16.6)	23	(2.32)
	Trespassing	66	(2.31)	124	(4.24)	5	(16.6)	89	(9.00)
	Arson	9	(.31)						
	Missilings	244	(8.55)	567	(19.40)	1	(3.33)		
	TOTAL	2162	(75.78)	2358	(80.67)	14	(47.00)	514	(52.00)
AGAINST PUBLIC	Drug Law Violations	82	(2.82)			2	(6.66)	1	(.10)
	Sex Crimes	41	(1.44)	33	(1.13)			18	(1.82)
	Drunkenness	318	(11.15)			2	(6.66)	3	(.31)
	Disorderly Conduct	129	(4.52)			6	(20.00)	438	(44.20)
	Concealed Weapons	18	(.63)			1	(3.33)	2	(.20)
	TOTAL	588	(20.48)	33	(1.13)	11	(37.00)	462	(47.00)
	TOTAL	2871		2923		30		991	

*includes rape

police identify particular stations which have an inordinate number of robberies or are frequently vandalized. Based on this knowledge, it is easier to select the most suitable security strategy on a station-by-station basis.

The designer of a security program for a planned transit system is at an obvious disadvantage; it would be helpful to the designer to be able to predict the crime rate and types of crime for each planned station. Previous studies have shown that there is a "typical" transit criminal and have suggested that the crime rate of a particular station may be a function of the socio-economic characteristics of the station's surrounding neighborhood.

This section presents a procedure for examining the relationship between the type and number of transit-station crimes and certain characteristics of the population residing in the vicinity of the station. Using regression analyses, a mathematical formula (or model) can be derived which expresses this relationship; i.e., it is possible to predict the amount of crime expected for a particular station, based on the characteristics of the population residing near the station. This capability would enable a transit security planner to forecast station crimes and plan accordingly, based on demographic statistics readily available from U. S. Census Reports.

San Francisco's BART system was selected for analysis for four reasons:

- Of the existing U. S. rapid transit systems, BART's automated operations bear the most resemblance to AGT technology;
- Neighborhood disruption and displacement due to BART construction was relatively small;
- BART has been in service long enough to have an "established crime record"; and
- BART crime statistics are detailed and current.

Two assumptions were required in order to make use of existing data:

1. The majority of transit-station crimes are committed by or on persons living within one-third of a mile from the station; and
2. The character of the neighborhoods surrounding each station has not changed significantly since 1970.

Multiple regression analysis is a standard statistical procedure. The goal of multiple regression is to predict the values of one variable from a simple additive combination of other variables. The variable whose values are to be predicted is called the criterion, or the *dependent* variable. The set of variables used to form the additive combination are called the *predictors* or *independent* variables. In the analyses presented here, four separate criteria were used in turn; that is, four separate multiple regression analyses were done-each with a different dependent variable. The same set of predictors, or independent variables were used in all four analyses; these were the demographic characteristics of neighborhoods surrounding the transit stations. The regression analysis selects from among the set of possible predictors those that are most useful in predicting the criterion. Thus in the four equations presented below, different independent variables proved to be useful in predicting each of the different dependent variables. The four criteria were the four categories of crime discussed in Chapter 2 (on pages 3 and 4): crimes against persons, crimes against persons' property, crimes against system property, and crimes against the public. In each case, demographic information about the neighborhood surrounding a set of transit stations was entered into an analysis to see which set of variables were most strongly related to crimes of each type. Each variable has a weight (a regression coefficient) in the simple additive combination; these weights help interpret the relative influence of the several variables in the equation. A measure of how well the equation fits the data (predicts the criterion) is provided by the multiple correlation coefficient (R). R has an upper limit of 1.00, and the larger R is, the stronger the relationship between the additive combination of predictors and the criterion.

The regression analyses produced the following models:

Crimes Against Persons:

$$\#\ \text{Crimes}_1 = .12\ (\%\ \text{male } 20\text{-}54) + .23\ (\%\ \text{black}) + .04\ (\%\ \text{Spanish}) - .055\ (\%\ \text{professional}) - .189 \qquad (R = .6)$$

Crimes Against Personally Carried Property:

$$\#\ \text{Crimes}_2 = .13\ (\%\ \text{male } 20\text{-}54) + .25\ (\%\ \text{poverty families}) - 1.69 \qquad (R = .5)$$

Crimes Against Station/Transit Property: R = .609

$$\#\ \text{Crimes}_3 = 17.88\ (\%\ \text{male through } 14) + .72\ (\%\ \text{female over } 20) - 16.20\ (\%\ \text{female through } 14) + 9.68 \qquad (R = .6)$$

Crimes Against the Public:

$$\#\ \text{Crimes}_4 = 1.32\ (\%\ \text{male over } 55) - .34\ (\%\ \text{professional}) - .46\ (\%\ \text{female over } 20) + 28.82 \qquad (R = .7)$$

These models were generated using a standard computer program for stepwise multiple regression analysis from the Statistical Package for the Social Sciences (SPSS). As an example of how to interpret these equations, the second equation tells us that the number of crimes against persons' property can be predicted from the percentage of males between 20 and 54 and the percentage of families at the poverty level. The fourth equation shows that crimes against the public are dependent on the number of males over 55 in the neighborhood; the other two predictors are statistically significant but much less important.

These equations are derived from data in hand for both the predictors and the criterion. Having arrived at these equations, the investigator now wishes to use these models to predict crime levels for situations where the demographic information is available but the crime levels are unknown.

The results of these equations, computed with the appropriate variable values, would be interpreted as an indication of the propensity of the individual station for certain crimes. After the values have been computed for all the stations in a new system, it is then possible to rank-order them by the magnitude of their expected security problems and take remedial action where needed. Thus, these types of models are a tool for anticipating crime problems at stations yet to be built.

A detailed explanation of how values were derived for both independent and dependent variables in this example are given below with extensive illustrative material.

The Independent Variables: Population Characteristics

1. Station Location. Thirty-two of the thirty-four BART stations were pin-pointed on the 1970 Census Maps for the Urbanized area of San Francisco - Oakland, California. Street addresses were provided by BART. In some instances, the station may be a block or two away from the actual site. The El Cerito del Norte and Fremont Stations were not included in the analysis because they could not be located in the Census Maps from the addresses provided.

2. Determination of Station Analysis Zones. The area within a one-third radium from the station was circumscribed. In six cases the zones overlapped. For these stations the shared area was divided between the two stations. (See Figure 4-1.)

3. Zone Study by Census Tract. The population and economic characteristics (variables) used for the analysis are reported by census tracts.* Typically, each station analysis zone included portions of two or more census tracts (although in a few cases an entire census tract was included in a zone). The census tracts for each zone were identified.

---

*Census Tracts are small areas into which larger cities and metropolitan areas are divided for statistical purposes. Tract boundaries are established cooperatively by a local committee and the Bureau of the Census and are generally designed to achieve some uniformity of population characteristics, economic status, and living conditions. Initially, the average tract had about 4,000 residents. Tract boundaries are established with the intention of being maintained over a long time so that comparisons can be made from census to census.

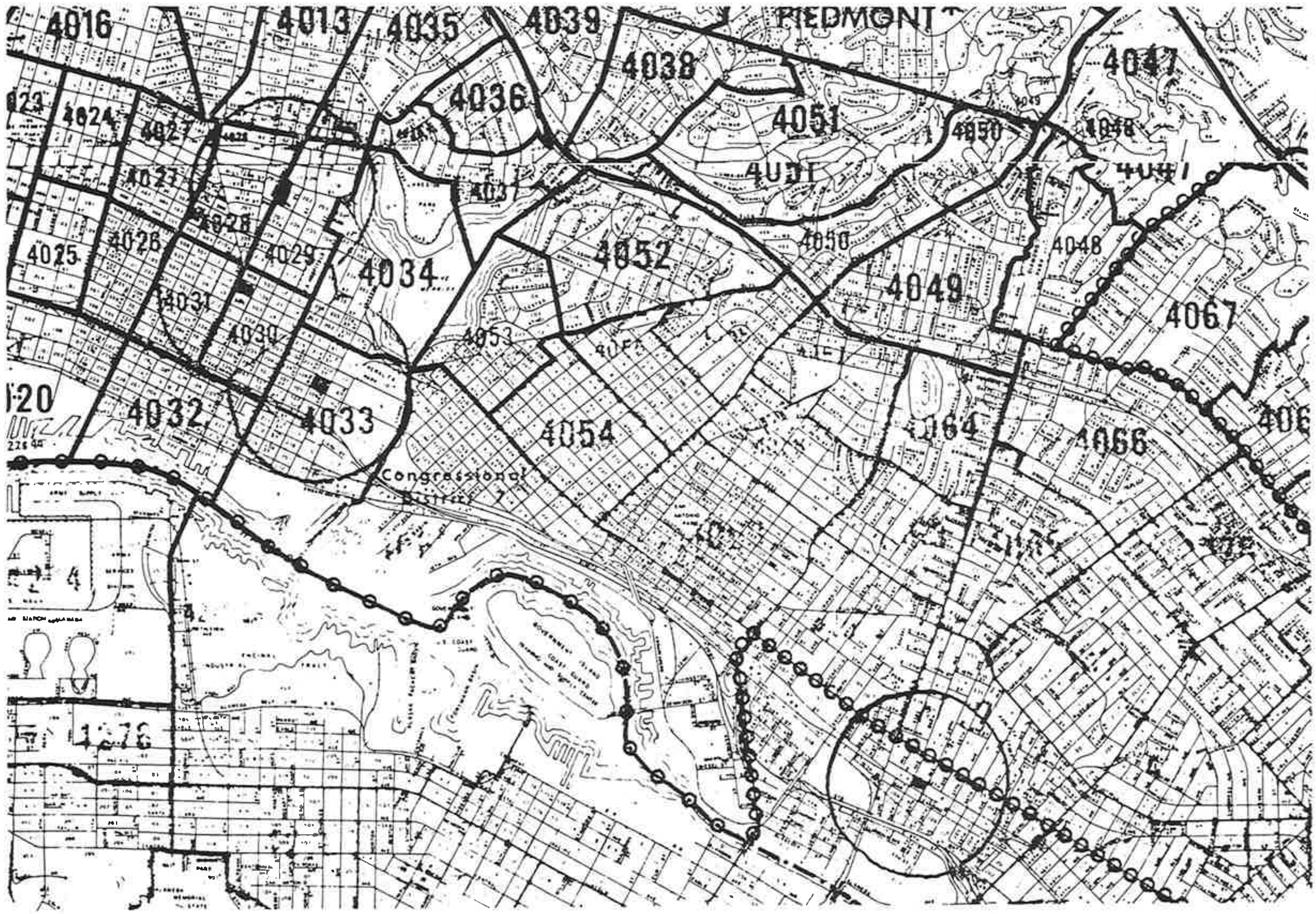


Figure 4-1
STATION ZONES ON CENSUS MAP

4. Estimation of Share of Census Tract(s) in Each Zone. Census tracts are subdivided into numbered blocks.† Exact population counts and percentage of residents by numerous demographic characteristics for each block are available. To determine the portion of the Census Tract lying within the station analysis zone, the blocks contained within the encircled portion of the Census Tract were hand-counted. The block populations were summed and then divided by the total Census Tract population. This percentage represented that portion of the Census Tract included in the station analysis zone. The black population for each census tract was computed by first multiplying each block's population by its respective percentage of black residents, and then summing the products. (See Table 4-5.)

5. Calculation of Variable Values for Each Census Tract. The total tract values (subpopulation counts) for each variable were multiplied by the percentage share of that tract. (See Table 4-6.) For some values it was necessary to aggregate several subpopulation counts first. For example, to determine the number of males between the ages of 0 to 14, the subpopulation counts for males under 5 years, from 5 to 9 years and from 10 to 14 years were summed.

6. Calculation of Total Variable Values for Each Station Analysis Zone. The variable values for all the census tracts within each analysis zone are summed. These totals represent the actual subpopulation counts for the Station Analysis zone. (See Table 4-7)

7. Conversion of Total Variable Values to Percentages. The total variable values were recomputed as percentages for input to the computer program. Table 4-8 summarizes the percentage values for each of the variables. These values have been rounded to the nearest 0.5 of a percentage point.

The Dependent Variables: Crimes

The Bay Area Rapid Transit System maintains relatively detailed crime statistics. Offenses are recorded, by tape, on a station-by-station basis and are published monthly. For the analysis, the total number of offenses committed in 1977 was divided into four categories.

†A block is usually a well-defined rectangular piece of land bounded by streets or roads. However, it may be irregular in shape or bounded by railroad tracks, streams or other features.

TABLE 4-5

BLOCKS WITHIN CENSUS TRACTS

Block number	Total population	Percent of total population			
		Black	In group quarters	Under 18 years	62 years and over
502....	142	6	-	26	20
503#...	95	2	-	27	21
504....	171	9	-	19	19
505....	70	4	-	16	13
506....	155	7	-	28	10
507....	123	9	-	19	16
508....	155	10	-	33	7
509....	108	8	-	20	9
510....	151	7	-	38	13
511....	121	6	-	21	15
512....	129	8	6	23	19
312.......	6066	54	2	30	14
101....	44	43	-	23	23
103....	105	82	-	35	16
104....	108	53	-	35	17
106....	90	68	-	36	8
107....	114	67	-	40	11
108....	77	68	-	40	12
201#...	93	82	-	33	7
202#...	54	56	-	26	6
203....	49	69	-	31	12
204....	16	75	-	44	6
205#...	123	91	-	46	7
206....	160	81	-	36	7
207....	143	76	-	41	7
208....	100	94	-	27	9
301#...	273	76	3	36	9
303....	141	61	-	32	11
304....	140	66	6	23	14
305....	140	62	-	35	9
306....	139	71	-	27	8
307....	134	69	-	37	13
401....	167	46	5	28	19
402....	139	40	-	27	12
403....	155	42	5	31	14
404#...	181	51	-	37	14
405....	149	32	-	36	11
406....	97	31	4	14	35
407....	202	48	8	32	11
408....	78	72	-	30	10
409....	294	38	9	21	22

TABLE 4-5 (continued)

BLOCKS WITHIN CENSUS TRACTS

Block number	Total population	Percent of total population			
		Black	In group quarters	Under 18 years	62 years and over
501....	110	37	3	24	10
502....	140	36	6	24	15
503#...	133	38	12	23	23
504#...	146	49	-	18	14
505#...	206	30	4	21	21
506....	189	25	3	24	22
507#...	40	-	-	20	13
601....	30	7	-	7	60
602#...	64	17	-	27	19
603....	47	6	-	9	43
604....	115	28	10	25	11
605....	163	22	-	30	15
606#...	115	18	-	15	30
701#...	83	70	7	28	13
702....	174	48	-	28	17
703#...	125	39	6	22	27
704#...	157	78	-	31	5
705....	160	94	-	41	7
706....	164	74	-	39	12

Shaded blocks are those in Tract 312 which lie within the analysis zone.

Source: 1970 Census of Housing, Block Statistics for San Francisco - Oakland, California, Bureau of the Census, U. S. Department of Commerce, p. 221.

TABLE 4-6

DEMOGRAPHIC INFORMATION BY CENSUS TRACTS

	San Francisco								
	Tract 0309	Tract 0310	Tract 0311	Tract 0312	Tract 0313	Tract 0314	Tract 0326	Tract 0327	Tract 0328
RACE									
All persons....	7 090	3 046	5 706	6 066	7 640	4 201	7 119	5 893	6 635
White................	6 418	2 784	4 841	2 348	2 534	761	6 182	5 291	6 032
Black................	414	107	348	3 251	4 635	3 285	59	58	32
Percent Black......	5.8	3.5	6.1	53.6	60.7	78.2	0.8	1.0	0.5
AGE BY SEX									
Male, all ages.	3 342	1 438	2 733	2 864	3 619	2 080	3 200	2 723	2 977
Under 5 years.......	160	80	185	198	209	170	197	150	141
3 and 4 years......	69	34	80	92	90	59	79	69	56
5 to 9 years.........	243	105	205	245	317	216	173	195	141
5 years............	40	21	39	46	53	34	34	25	27
6 years............	44	19	43	42	64	50	29	52	39
10 to 14 years.......	355	107	225	234	401	209	207	181	170
14 years...........	76	22	45	32	89	34	35	32	43
15 to 19 years.......	333	147	213	295	337	240	209	190	223
15 years...........	81	32	49	68	65	52	41	37	50
16 years...........	76	28	41	61	74	45	51	38	43
17 years...........	69	38	49	60	77	61	47	39	50
18 years...........	54	21	35	58	61	41	35	44	37
19 years...........	53	28	39	48	60	41	35	32	43
20 to 24 years.......	214	81	278	278	281	161	253	177	186
20 years...........	52	21	60	64	59	45	40	36	35
21 years...........	49	14	37	57	66	30	51	31	31
25 to 34 years.......	201	130	379	368	407	193	404	283	320
35 to 44 years.......	354	145	302	293	409	249	327	281	297
45 to 54 years.......	496	199	299	356	515	294	359	307	357
55 to 59 years.......	259	109	187	149	256	98	211	209	244
60 to 64 years.......	241	98	150	169	196	96	235	224	261

TABLE 4-6 (continued)

	Tract 0309	Tract 0310	Tract 0311	Tract 0312	Tract 0313	Tract 0314	Tract 0326	Tract 0327	Tract 0328
AGE BY SEX (cont.)									
65 to 74 years.......	227	151	211	193	202	108	411	351	442
75 years and over...	149	86	99	86	89	46	214	175	195
Female, all ages	3 748	1 608	2 973	3 202	4 021	2 121	2 919	3 170	3 658
Under 5 years.......	127	79	158	222	235	123	159	142	138
3 and 4 years.....	55	37	53	98	102	49	65	50	44
5 to 9 years.........	239	111	196	259	293	203	165	162	126
5 years...........	44	18	25	55	52	42	37	41	24
6 years...........	44	16	39	53	43	38	22	32	25
10 to 14 years.......	323	118	224	292	386	237	206	166	181
14 years...........	58	17	34	66	88	49	54	36	49
15 to 19 years.......	351	117	223	272	350	210	219	192	212
15 years...........	71	20	41	52	69	52	46	42	41
16 years...........	79	33	42	54	72	51	29	29	38
17 years...........	84	28	48	58	78	38	45	46	64
18 years...........	57	16	49	59	67	36	43	34	32
19 years...........	60	20	43	49	64	33	56	41	37
20 to 24 years.......	196	85	263	269	297	138	342	196	261
20 years...........	46	16	50	50	63	31	57	26	53
21 years...........	48	19	59	54	70	28	71	25	52
25 to 34 years.......	256	143	376	338	452	213	415	327	347
35 to 44 years.......	421	146	336	363	536	257	377	276	352
45 to 54 years.......	565	242	388	436	629	324	495	409	475
55 to 59 years.......	311	118	197	172	267	136	277	275	333
60 to 64 years.......	281	112	176	174	208	90	318	287	377
65 to 74 years.......	447	205	279	249	244	121	583	482	527
75 years and over...	231	132	157	156	124	69	363	256	329

The underscored values are aggregated (when necessary) and multiplied by 35.38% to obtain Tract 312 variable values for the Balboa Park Station Analysis zone.

Source: 1970 Census of Population and Housing, Census Tracts, San Francisco - Oakland, California, Table P-1, General Characteristics of the Population, p. P-50.

TABLE 4-7

DEMOGRAPHIC INFORMATION FOR A PARTICULAR STATION ZONE

San Francisco Market Station:	TOTAL POPULATION	Non-Black Population	Black Population	Males - Under 14 years	15 Through 19	20 Through 54	55 and Over	Females - Under 14 years	15 Through 19	20 and Over	Female Heads of Household	Spanish Speaking and Surname	Less Than College	College Educated	Males Employed	Males Unemployed	Males 16-21 Unemployed/No School	Professional, Managerial, Administrative	Other Occupations	Median Income	Mean Income	Families Below Poverty
Balboa Park																(164)						
0261 (31.19%)	1181	1155	26	92	34	230	193	97	42	493	39	227	692	134	305	16	4	91	408	11417	12612	15
0312 (35.38%)	2146	905	1241	240	140	458	211	273	96	763	93	314	970	260	484	41	15	121	765	10245	10992	39
TOTAL	3327	2060	1267	332	138	688	404	370	138	1256	132	541	1662	394	789	57	19	212	1173	-	-	54
PERCENTAGE		61.92	38.08	9.97	4.15	20.68	12.14	11.12	4.15	37.75	3.97	16.26	81	19	93.26	6.74	11.58	15.30	84.7	10661		1.62

TABLE 4-8

DEMOGRAPHIC ANALYSIS (BY PROPORTIONS) FOR SELECTED STATION ZONES

% of Respective Population

Station		Crimes	% Non-Black Population	% Black Population	% Males - Under 14 years	15 Through 19	20 Through 54	55 and Over	% Females - Under 14 years	15 Through 19	20 and Over	% Female Heads of Household	% Spanish Speaking and Surnames	% Less Than College (25 years +)	% College Educated (25 years +)	% Males - Employed (16 years & older)	% Males - Unemployed (16 years & older)	% Males - Unemployed/No School (16 - 21 years)	% Prof., Mgr., Admin. (of total employed, 16 years +)	% Other Occupations (of total employed, 16 years +)	Median Income (weighted by total population)	Mean Income	% Families Below Poverty	TOTAL POPULATION
CONCORD	CON	26	100	00	13	4.5	22.5	8.5	12.5	5	33.5	2.5	6.5	70.5	29.5	94	6	5.5	23.5	76.4	12115		1	1976
FRUITVALE	FRU	22	83	17	14	4	19.5	10.5	13.5	4	33.5	4.5	39.5	79	21	85	15	13.5	10	90	7034		5.5	2973
COLISEUM	SOL	19	7	93	20	6	14.5	6	19	5.5	29	16	10	92	8	86	14	13.5	6.5	93.5	5450		8.5	2095
BAYFAIR	BAY	18	100	00	13	4.5	23	7.5	12.5	5	35	3	20.5	86.5	13.5	93.5	6.5	8	18	82	10677		2	2588
HAYWARD	HAY	18	100	00	12.5	3.5	22.5	9	12	4	37	4	39	87	13	89	11	4.5	8	92	8928		3	3230
UNION CITY	UNI	18	100	00	19.5	5	20	5	18.5	5.5	26.5	2.5	8.5	96.5	3.5	92	8	5.5	6	94	8396		3	945
POWELL	POW	18	95.5	4.5	2.5	1.5	35	27	2.5	1.5	30	1	11	78	22	81	19	13	17	83	6026		2	6391
12th STREET	TWL	17	77	23	2.5	2.5	37	27	3	2	26	1.5	8	81.5	18.5	82.5	17.5	15	16.5	83.5	7340		2	3564
WALNUT CRK	WAL	16	100	00	8.5	3	26	9	8.5	4.0	41	2.5	5.5	58.5	41.5	97.5	8.5	4.5	31	69	10777		-	1539
MacARTHUR	MAC	14	34	66	11.5	3.5	20.5	11.5	11	4	38	6.5	7.5	84	16	89.5	10.5	7.5	12.5	87.5	7153		4	5484
OAKLAND W.	OAK	14	5	95	15.5	5.5	16.5	10.5	15.5	5.5	31	8.5	6	92.5	7.5	73.5	26.5	15	11	89	4523		7.5	3920
LAFAYETTE	LAF	14	100	00	11.5	4.5	22	9.5	11	4.5	37	2	5	43.5	56.5	98	2	2.5	44	56	16029		1	1190
LAKE MERRITT	LAK	14	96.5	3.5	6.5	3	28	16.5	5.5	3.5	37	2	7	78.5	21.5	94	6	4.5	18	82	7380		3.5	5973
CIVIC CENTER	CIV	12	9.45	5.5	3	1.5	36	28	2.5	2.5	27.5	1	1	78	22	81	19	8.5	13.5	86.5	6426		1.5	11218
PLEASANT HILL	PLE	12	100	00	15	5	22	7	14	4.5	32.5	2	6.5	61	39	97	3	-	34.5	65.5	13554		1	1258
16th STREET	SIX	11	92.5	7.5	11.5	3	25.5	12	10.5	3.5	35	5.5	37	81.5	18.5	87	13	10.5	12.5	87.5	6707		4.5	11305
DALY CITY	DAL	11	89.5	15.5	14	4	23	9.5	12.5	4.5	34.5	4	20	79	21	93.5	6.5	1.5	13.5	86.5	10567		1.5	5185
S. HAYNARD	SOU	11	100	00	17.5	5	22.5	5.5	16	5.5	28.5	2	22	84.5	15.5	94	6	12	15	85	10371		2	1489
ORINDA	ORI	10	100	00	14	5.5	22	8	14	5.5	31	1.5	3	26	74	98	2	1.5	60	40	21000		.5	1255
SAN LEANDRO	SAN	9	100	00	9	3.5	22	12	9	4	41	3.5	26	83.5	16.5	94	6	10	17	83	10415		2	2262
ASHBY	ASH	9	27.5	72.5	10.5	3.5	25.5	8	10	3.5	39	6	4	55	45	88.5	11.5	5	26	74	7787		3.5	5225
BERKELEY	BER	9	95	5	3	5	39	5.0	2.5	5	40	.5	2.5	3.3	67	88.5	11.5	.5	44	56	7079		2	5396
N. BERKELEY	NOR	9	69	31	10	3.5	27	8	9.5	3	39	4.5	8	53.5	46.5	93	7	7	35.5	64.5	7978		3	5932
RICHMOND	RIC	9	84	16	14	3.5	21	9.5	14.5	4.5	33	5	18	15	85	89.5	10.5	13	12.5	88.5	7899		4	4185
EL CERRITO PLZ	ELC	7	97.5	2.5	8	3	23.5	12.5	8	3	42	3	8.5	72	28	96	4	-	27	73	10729		1.5	3767
EMBARCADERO	EMB	7	95	5	2	.5	35	18.5	2	1	41.5	1.5	3	45.5	54.5	90.5	9.5	-	53	47	18162		1	2081
19th STREET	NIN	3	91.5	8.5	2	1	26.5	22.5	2.5	2	43	1.5	5	75.5	24.5	88.5	11.5	6.5	22.5	77.5	6509		2	2446
ROCKRIDGE	ROC	3	91	9	8.5	2.5	24.5	10.5	8.5	3.5	41.5	.4	5.5	58	42	92.5	7.5	7	34	66	10930		1.5	5039
MONTGOMERY	MON	3	98	2	4	1.5	31	28	4	2	29	1	6	78	22	92.5	7.5	-	15	85	6658		2.5	2578
BALBOA PARK	BAL	2	62	38	10	4	20.5	12	11	4	37.5	4	16.5	81	19	93.5	6.5	11.5	55	45	10661		1.5	3327
GLEN PARK	GLE	1	92.5	7.5	11.5	3.5	22	11	11.5	3.5	37.5	4	26.5	75	25	94	6	5	22	78	11052		2	6620
24th STREET	TWN	1	96	4	13	3.5	22.5	9.5	12.5	4	36	5	48.5	83	17	92	8	12	11	89	7904		4	15882

These four categories were designated as the dependent variables in the regression analysis:

1) Crimes Against Persons (Crimes 1)

- assault
- battery
- homicide/manslaughter

2) Crimes Against Personally Carried Property (Crimes 2)

- purse snatching
- pocket picking
- robbery

3) Crimes Against Station Property (Crimes 3)

- burglary
- fare evasion
- vandalism
- petty theft
- trespassing
- arson
- rock throwing

4) Crimes Against the Public (Crimes 4)

- drug law violation
- sex crimes
- drunkenness
- disorderly conduct
- concealed weapons

Incidents involving auto theft and auto burglary were not included because not all of the stations have parking lots. Nor were "other" offenses and "miscellaneous reports," as well as incidents occurring along the right-of-way (outside the station) included in the total. (See Table 4-9.)

An annual total for each crime category was computed for each station by summing the monthly data. (See Table 4-10.)

<u>Caution</u>: The primary source of population statistics is the census. Since the census is conducted only every 10 years, the user must be alert to problems with it. Its accuracy will generally decrease each year after its completion. Furthermore, significant population shifts can occur in relatively short periods of time and these will influence the reasonableness of modeling efforts. Such shifts are likely to occur in the major cities which are likely candidates for AGT systems.

Modeling efforts should be based on the best data available. If census information is believed to be inaccurate, other sources of data will have to be developed for reasonable conclusions to follow from the model.

TABLE 4-9

SAMPLE EXHIBIT OF MONTHLY CRIME REPORTS

BAY AREA RAPID TRANSIT DISTRICT - POLICE SERVICES DEPARTMENT

Report of Offenses and Miscellaneous Reports

"M" Line

Month Of: DECEMBER, 1977

CLASSIFICATION	EMBARCADERO	MONTGOMERY	POWELL	CIVIC CENTER	16th	24th	GLEN PARK	BALBOA PARK	DALY CITY	M LINE RT-OF-WAY OTHER	TOTAL
Aggravated Assault											
Arson											
Auto Theft									6		6
Battery					1	2			1		4
Burglary:											
A. Structure		1	1								2
B. Auto									5		5
Disorderly Conduct		1	3	2					1		7
Drunkenness		1	4	1	1	1	1	1			10
Fare Evasion			4	1	1	2		1	3		12
Grand Theft:											
A. Pocket Picking		1	1								2
B. Purse Snatching			1								1
C. Other		1							1		2
Murder and Non-Neg. Manslaughter											
Narcotic Drug Laws											
Petty Theft			7	1	1		2	2	7		20
Robbery				1			1		1		3
Rock Throwing Sec. 219.2 P.C.										1	1
Sex Offenses - Indecent Exposure			1						1		2
Trespassing											
Vandalism			1	1	1				4		7
Weapons, Carrying, Etc.		1	2								3
All Other Offenses		1	2						2		5
Total Crime Reports:	-	7	27	7	5	5	5	5	32	1	92
Total Misc. Reports:	15	19	25	10	8	9	7	3	18	-	114
Grand Total Reports:	15	26	52	17	13	14	11	7	50	1	206

TABLE 4-10

SAMPLE EXHIBIT OF TOTAL ANNUAL CRIME REPORTS
(aggregated by crime category)

	Powell	Civic Center	16th	24th	Glen Park	Balboa	Daly City
Crimes 1 (persons)	3	2	3	2	1	2	5
Crimes 2 (property)	11	1	1	0	2	1	6
Crimes 3 (stations)	69	27	23	22	21	20	110
Crimes 4 (public)	82	31	14	15	31	3	19

Source: Bay Area Rapid Transit District-Police Services Department, 1977.

5. SYNTHESIS OF PASSENGER SECURITY SYSTEM

A. Methodology

The information, methods and measures discussed in the preceding chapters can be used to develop a systematic procedure for selecting and integrating the crime countermeasures most suitable for a planned transit system. (See Table 5-1.) The Scenarios (Table 5-4) and Cost/Effectiveness matrices (Tables 4-2 and 4-3 on pages 48 and 50) are meant to be illustrative of the results that may be achieved using the described evaluation methods. Once this evaluation is completed, the following outline may be used to develop an integrated passenger security program:

1. The first step is to select from the table of cost measurements (Table 4-2 on page 48) those counter measures which have been rated as having low monetary costs and low acceptance costs (L, L, L, L). These countermeasures represent the minimum number of security features which should be incorporated into the original design. "Good Lighting," for example, is a basic security feature in any new transit system.

2. Based on area crime statistics and crime problems encountered by similar transit systems, the next step is to select typical crimes which may be expected at each station and vehicle route in the system. (The questions posed in Table 5-2 on page 69 may help determine crime problems based on relevant system factors.)

3. The third step is to select candidate countermeasures from the Countermeasure Effectiveness Matrix (on page 50) which would be particularly useful in countering the anticipated crimes.

4. For each expected crime, the methods described on page 73 can be used to construct typical and extreme scenarios. By selecting a variety of variable values, the crime may require different countermeasure applications.

5. The effectiveness of each of the candidate countermeasures chosen in the third step should be evaluated in terms of these scenarios and the costs expressed in the Measure of Cost table (Table 4-2 on page 48).

(Text continues on p. 73.)

TABLE 5-1

COUNTERMEASURE SELECTION PROCEDURE

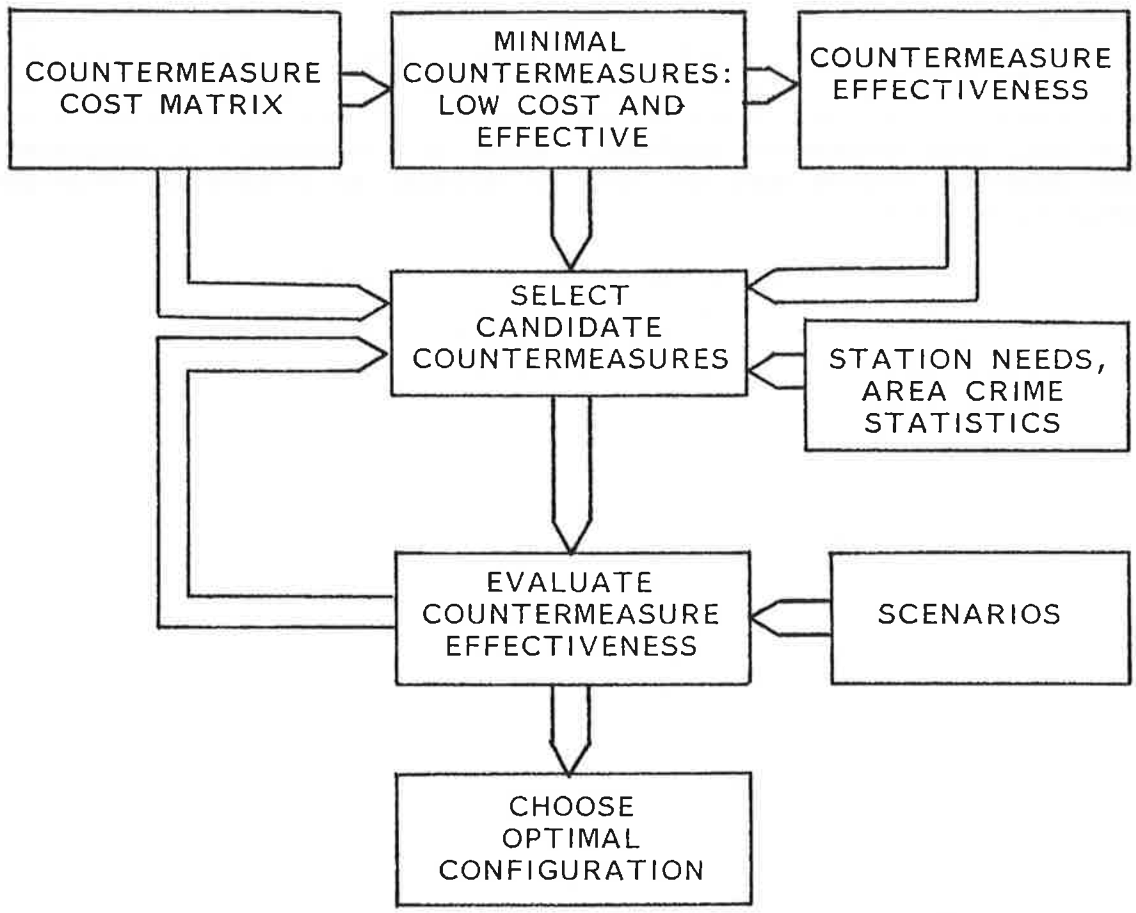


TABLE 5-2
SYSTEM FACTORS INFLUENCING COUNTERMEASURE SELECTION

FACTORS	POSSIBLE INFLUENCE ON CRIME POTENTIAL
A. SYSTEM SETTING	
1. System Configuration -- linear; radial -- loop; circuit -- grid -- type of AGT: SLT, GRT, PRT	• How will this affect vehicle deployment capabilities? • Can high-crime areas be avoided? • Will passengers share vehicles with others? If so, how many co-passengers per vehicle?
2. Environment -- size of service area • large, metropolitan • urban, CBD • special use--campus, airport, amusement park, etc.	• What are expected crimes and their levels? • What will be the expected revenue--could this affect cost-effectiveness index for countermeasure expenditures? • Will there be special events which could attract crime?
-- overall socio-economic profile • area-wide crime rate • composite age/sex of resident population • average income • basic industry (government, manufacturing, agricultural, etc.) • growth rate/rate of decline	• To what degree will street crime be displaced to the AGT? • Who are likely victims of crime? Will they be a large percentage of captive riders? • Will ridership be expected to increase over the years?

TABLE 5-2 (continued)

-- climate/natural environment • seasonal (temperature, number of daylight hours) • topography	• Can crime rates be expected to have seasonal fluctuations? • Can topography handle particular design concepts?
3. Administrative/Jurisdictional Responsibility -- regional transit authority -- municipal-sponsored -- number of jurisdictions served -- responsibility for security/safety/ maintenance -- funding sources	• Who will be responsible for providing police • services? • What will be the limits of their responsibilities? • What kinds of compacts are necessary for an interjurisdictional approach?
4. Duration of Operation -- full-time (24 hrs, 7 days/wk) -- day only -- week-end services	• When will countermeasures be most needed? • Are alternative deployment patterns possible? • What will be the evening ridership levels? • How many persons will be waiting on platform/in lobby/in parking lot at any given time?
5. Uses to Be Served -- primarily CBD • offices • commercial centers • entertainment centers	• Will downtown businesses be supportive of the countermeasures? • Will the transit system interfere with CBD establishments? • Will there be a "spillover" effect from the transit system to the establishments and vice versa?

TABLE 5-2 (continued)

-- special centers • civic/cultural • recreation/amusement • schools • industrial parks • other	• Will special events/activities cause periodic crime problems? • Will a particular "type" of criminal be attracted to these surrounding uses? • Can vandalism and other juvenile crimes be expected?
-- suburban-CBD linkages	
-- suburb-suburb	
B. STATION SETTING	
1. Physical -- age -- condition/maintenance -- design -- station neighborhood (land use)	• Do station design, signs and graphics encourage smooth passenger flow through system, or are passengers confused and more vulnerable? • Can older stations be refurnished to include electronic equipment, if desired? • Can structural changes be made? • Will maintenance be a major problem? • What will be the effect of the particular neighborhood on its stations--spillover of juveniles from nearby schools, recreation centers, etc.?
2. Users -- amount of traffic/hr -- socio-economic profile of patrons	• What will be the average platform waiting time? (i.e., What is the crime exposure time?)

TABLE 5-2 (continued)

• captive/non-captive • age/sex • perceptions of safety/security	• Can the users be characterized as typical victims or offenders of particular crimes? • How familiar will most patrons be with the station?
3. Operational -- method of fare collection -- services available (information booth, kiosks, lockers, etc.) -- transit personnel • availability • duties -- connecting lines (transfer station) -- presence of a yard or garage -- availability of E & H services	• How are fares collected? • Will services planned be attractive targets? • Where will transit personnel be stationed? • Will transit personnel have training in emergency situations?

6. The optimum mix of countermeasures should then be selected for implementation. Throughout this step the security planning team must keep in mind the synergism which may exist between many of the countermeasures. For example, closed circuit television may be selected as a necessary security feature, but its utility may be reduced if the station is designed with low ceilings, obstructions, angles and poor lighting. Similarly, what may be a marginally feasible countermeasure could become extremely effective if used in conjunction with other security features or procedures.

B. Scenarios

A crime scenario is simply a description of the situation or circumstances under which the crime occurs or might occur. The key problem is to develop plausible scenarios for each crime or category of crimes. The factors that enter into the scenarios may be easily specified as situation variables. Values or descriptors are assigned to each of the situation variables. These values represent the possible levels of the variable. To construct a scenario one simply selects a value for each of the situation variables. Together, these values will describe a scenario. Presumably, any possible scenario can be constructed by different combinations of these values.

Table 5-3 shows the situational variables involved in crime and vandalism scenarios (column 1) and their respective values (column 2). Examples for many of the values are shown in column 3 and, where appropriate, comments specific to AGT systems are made in column 4. Although not every variable will always be relevant to the event and outcome of the scenario, the variables selected and displayed in Table 5-3 should cover all potentially critical factors. Incidental information may be added. These variables are selected not to reflect increased or decreased propensity toward crimes but rather to provide identification for security personnel. Race is included as a descriptive variable only.*

To illustrate the method used to construct crime/vandalism scenarios, an "extreme" and a "typical" scenario have been developed for a crime in each of the four crime categories. (The appropriateness of the combination of chosen values has been "verified" through comments of transit security officials.) These eight scenarios are shown in Table 5-4.†

---

* The descriptors for race used in Table 5-3 differ from those currently accepted by the U. S. government. According to a Federal Personnel Management Letter, 72D-1, dated July of 1979, the official categories are Black, White, Hispanic, Asian-Pacific Islander and Indian.

† Descriptors involving race have intentionally been left out of these scenarios.

(Text continues on page 86)

TABLE 5-3
SITUATIONAL VARIABLES FOR CRIME SCENARIOS

SITUATION VARIABLE	VALUE	EXAMPLE	COMMENT
1. Severity of Crime	mild moderate critical	fare evasion harassment homicide/rape	
2. Time			
a) of day	peak hour off-peak hour (daytime) off-peak hour (nighttime)		Depending on AGT use, "peak" hours may be different from conventional transit systems--for example, in an amusement park the peak usage may be mid-morning.
b) of week	week day week end holiday	Tuesday Sunday 4th of July	Significance of day of week variable may change depending on AGT use.
c) of year	Summer Fall Winter Spring	mid July-August (very warm) September (cool) January (very cold) April (cool)	Significance of season variable may change depending on AGT use. Of course, location affects temperature.
3. Surrounding Environment	high-crime area downtown major activity center suburban, high income	most major cities San Francisco, Embarcadero National Airport (Washington, DC) Arlington, VA	Systems may cross more than one of these environments
4. Station Design	new, open ↓ old, confined	BART, WMATA NYCTA, MBTA	Although many AGT systems will be brand new, conversion of conventional transit stations into or for sharing with AGT may be possible.

TABLE 5-3 (continued)

SITUATION VARIABLE	VALUE	EXAMPLE	COMMENT
5. Station/Guideway	at-grade	Washington, DC, WMATA	
	elevated	"EL"-Chicago	
	subway	New York	
6. Location Within System	conspicuous	lobby, crowded vehicle	
	↓	platform	
	inconspicuous	restroom, elevator, stairwell	
7. Passenger Density	low	PRT	May be critical factor on PRT.
	medium	GRT	
	high	SLT	
8. Station Security			
a) extent of stations' security personnel	full security force	police and K-9 at all all stations	Typically, the automated nature of AGT means low level of manpower in all operational phases
	some	random police patrols	
	none	no one on duty	
b) extent of non-personnel security	completely monitored ↓ completely unmonitored	teleview alert system ↓ no monitoring/ communication	Monitors (CCTV voice) may be installed in vehicles as well as stations.
c) extent of security--operational procedures	extreme procedures ↓ no procedures	closing all high-crime stations ↓ no changes in schedules or stops	

TABLE 5-3 (continued)

SITUATION VARIABLE	VALUE	EXAMPLE	COMMENT
9. Victim(s) or Target			
a) appearance (physical)	able-bodied ↓ vulnerable		
b) appearance (dress)	well-to-do appearance ↓ indigent appearance		
c) age	child teen-ager adult old adult mixed group	6-year old high-school student white collar worker retiree family of parents with children	System setting/use may determine the expected age of victim; for example, an AGT on a college campus would have a large share of teen-agers and young adults.
d) sex	none male female mixed group unknown	parents and children transit property	
e) race	black white oriental indian mixed group unknown		

TABLE 5-3 (continued)

SITUATION VARIABLE	VALUE	EXAMPLE	COMMENT
9. f) number	single	commuter	
	multiple	Cub Scout pack	
	public station property	station walls/vehicle	
g) familiarity with location	very familiar	"home" station	Both the victim's vulnerability and ability to effectively respond to a criminal incident may be tempered by his familiarity with station layout and operation.
	somewhat familiar	has ridden system but is not familiar with particular station	
	not familiar	never ridden system	
h) encumberances	many	carrying three suitcases	AGT systems which interface with other modes of travel or commercial centers may have a high number of "encumbered passengers."
	none	carrying nothing	
10. Offender			
a) appearance	dangerous	masked, armed, terrorists	
	harmless	young child	
b) age	child		
	teenager		
	adult		
	old adult		
	mixed group		
c) sex	male		
	female		
	mixed group		

TABLE 5-3 (continued)

SITUATION VARIABLE	VALUE	EXAMPLE	COMMENT
10. d) race	black white oriental indian mixed group		
e) number	single multiple	 youth gang members	
f) familiarity with location	very familiar somewhat familiar not familiar	"home" stations has ridden system but is not familiar with particular station never ridden system	Familiarity with the system and station may improve offenders ability to escape detection/apprehension.
g) weapons	heavily armed unarmed	bomb gun unarmed	
h) criminal record	multiple offender no record		Multiple offenders may have avoided conviction but may still be easily recognized by transit security personnel. This could prove troublesome in automated system unless there is some means to identify these persons.

TABLE 5-4

CRIME SCENARIOS

1. CRIMES AGAINST PERSONS

A. Typical Scenario

1. Severity of Crime:	moderate, assault
2. Time:	rush hour, 5:30 p.m. Tuesday evening Summer, mid-July, temperatures and humidity in high 90s
3. Surrounding Environment:	downtown
4. Station Design:	old, confined
5. Station/Guideway:	at-grade
6. Location within System:	platform
7. Passenger Density:	extremely crowded, due to vehicle breakdowns
8. Station Security:	station personnel only no monitoring no change in schedules or stops
9. Victim:	physically fit moderately well-dressed adult, late twenties male single very familiar with station encumberances, lunch box, umbrella
10. Offender:	harmless adult, mid thirties male single very familiar with station unarmed no record

Comment: Fist fight breaks out between two passengers arguing over entrance to transit vehicle. "Offender" throws first punch.

TABLE 5-4 (continued)

B. Extreme Scenario

1.	Severity of Crime:	critical--rape
2.	Time:	off-peak, night 10:30 p.m. Saturday night late spring
3.	Surrounding Environment:	high-crime area
4.	Station Design:	renovated, but not "open design"
5.	Station/Guideway:	subway
6.	Location within System:	end of platform
7.	Passenger Density:	very low--no other persons on platform
8.	Station Security:	passenger-activated alarm random police patrols no change in schedule or stops
9.	Victim:	fairly vulnerable moderately well-dressed adult, late thirties female single not familiar with station carrying purse
10.	Offender(s):	fairly dangerous early twenties male single familiar with station carrying a gun previous offender

Comment: At gunpoint, the woman is abducted from station and raped. The man escapes.

2. CRIMES AGAINST PERSONALLY CARRIED PROPERTY

A. Typical Scenario

1.	Severity of Crime:	mild, pick-pocket
2.	Time:	peak, daytime, 11:00 a.m. Friday morning day after Thanksgiving, first "official" day of Christmas shopping
3.	Surrounding Environment:	commercial center

TABLE 5-4 (continued)

4.	Station Design:	new, open design
5.	Station/Guideway:	at-grade
6.	Location within System:	at station exit
7.	Passenger Density:	extremely busy
8.	Station Security:	station personnel CCTV within stations only vehicles capable of being rerouted
9.	Victim:	vulnerable well-dressed adult, late forties female accompanied by friend not familiar with station carrying large, open-style purse, umbrella, and fold-up shopping basket
10.	Offender:	"harmless" looking adult, mid twenties male single (but "working" the station with two teen-age boys) very familiar with station unarmed no record

Comment: Offender unobtrusively lifts woman's wallet from her pocket book. The victim does not realize and does not report the theft until two hours later.

B. Extreme Scenario

1.	Severity of Crime:	moderate-critical - robbery
2.	Time:	off-peak - evening 7:30 p.m. Thursday mid-Winter
3.	Surrounding Environment:	downtown
4.	Station Design:	old, renovated
5.	Station/Guideway:	elevated
6.	Location within Systems:	on stairs to platform
7.	Passenger Density:	very low
8.	Station Security:	random patrol CCTV vehicles capable of being rerouted; no other operational procedures

TABLE 5-4 (continued)

9. Victim:	able-bodied well-dressed adult, late thirties male single familiar with station carrying briefcase
10. Offenders:	moderately dangerous mixed group 18 and 20 years old male two very familiar with station armed with knife and gun several offenses

Comment: CCTV in stairway is vandalized by offenders. Transit patron is robbed of his watch and then is knocked to ground by assailants who then flee.

3. CRIMES AGAINST STATION PROPERTY

A. Typical Scenario

1. Severity of Crime:	moderate - vandalism of vehicles
2. Time:	off-peak, day, 1:30 p.m. Wednesday, Spring semester break early Spring, March
3. Surrounding Environment:	suburban
4. Station Design:	new, open platform
5. Station/Guideway Design:	elevated
6. Location within System:	on vehicle
7. Passenger Density:	low - no other passengers on vehicle
8. Station Security:	no security patrol during day, conductor on board CCTV cameras in stations no operating strategies in effect
9. Target:	transit vehicle; seats
10. Offenders:	"typical" appearance for age junior high age, 12-14 three boys, one girl four familiar with system armed with pocket knives no offenses

TABLE 5-4 (continued)

Comment: The teen-agers occupy a car to themselves; within minutes they manage to do extensive damage to the seats. Train operator calls ahead for police who meet the train and remove offenders.

B. Extreme Scenario

1.	Severity of Crime:	severe - missiling of moving vehicle
2.	Time:	beginning of peak, day, 4:30 p.m. Tuesday early August, school is closed for Summer vacation
3.	Surrounding Environment:	high-crime neighborhood
4.	Station Design:	old
5.	Station/Guideway:	at-grade
6.	Location within System:	along grade-level tracks
7.	Passenger Density:	high
8.	Station Security:	random patrol, aerial surveillance conductor on train has communication capabilities no special operating strategies in effect
9.	Target:	transit vehicle, commuter train
10.	Offenders:	harmless junior high and grade school (12, 10) males familiar with system armed with rocks have engaged in this activity before

Comment: The boys use the transit vehicles as moving targets. They hurl a rock at one of the cars; it breaks a window and nearly hits a traveling passenger. The boys are spotted by helicopter patrol.

4. CRIMES AGAINST THE PUBLIC

A. Typical Scenario

1.	Severity of Crime:	moderate; passenger harassment and disorderly conduct
2.	Time:	off-peak, day 4:00 p.m. Saturday February
3.	Surrounding Environment:	High crime area
4.	Station Design:	new, open
5.	Station/Guideway:	subway

TABLE 5-4. (CONTINUED)

6.	Location within System:	on vehicle
7.	Passenger Density:	moderate
8.	Station Security:	random patrol conductor on train trains may be detoured to security center
9.	Target:	vulnerable moderately well-dressed mixed group: 2 elderly adults, I young woman and 3 children older male, 2 woman, 2 girls, I boy familiar with system carrying packages, purses
10.	Offenders:	"harmless" ages, 14-15 males four very familiar with station unarmed no offenses

Comment: The teenagers harass and annoy the passengers. The frightened elderly couple report the incident at their destination.

B. Extreme Scenario

1.	Severity of Crime:	moderate - drunkeness
2.	Time:	off-peak hour day: 5:00 p.m. Holiday - Memorial Day Late spring
3.	Surrounding Environment:	inner-city, residential
4.	Station Design:	old, enclosed
5.	Station/Guideway:	at grade
6.	Location with System:	platform
7.	Passenger Density:	moderate
8.	Station Security:	patrol man on duty conductor on train w/radio communication no operating strategies in effect
9.	Victim:	moderately vulnerable mixed group of passengers - mostly young adults, some families mix of races

TABLE 5-4. (CONTINUED)

10. Offender:	drunk and noisy elderly, 60+ male familiar with station when sober unarmed no offenses

Comment: The obviously intoxicated man climbs onto tracks. He is seen by operator of approaching train who stops in time. The man is dispatched to detox center by policeman on duty. Causes some confusion and minor delay.

C. Example Applications

Using crime statistics from one existing system, and postulating some demographic and AGT characteristics for a hypothetical system, two applications of the countermeasure selection methodology are presented below. Both examples will help to clarify the role of crime scenarios in AGT security planning. The first example is an application to the BART system. The second example will illustrate the value of developing models for predicting crime levels at stations in a prospective AGT system. Finally, a Teleview Alert system, in use on the Chicago Transit system, is described.

1. BART Application

1977 crime statistics for the BART system indicate that serious crime problems (assaults, homicides, robberies) exist at the Daly City and 12th Street stations. Powell and Walnut Creek stations have moderate crime problems. After the minimal countermeasures are selected and the stations classified as critical, moderate or non-critical, then candidate countermeasures are chosen from Table 4-3 on page 50. Security planners then select values for the scenario variables and evaluate the countermeasures as they apply to these scenarios. Finally, an optimal combination is developed, based on effectiveness, applicability to the scenarios, acceptance costs, and either operating or capital costs. (See Table 5-5 for a graphic representation of this six-step process.)

2. Planned System Application

Although security considerations may not be the determining factors in the design of an AGT system, they should be made as early in the system's planning stage as possible. The following procedure is a method for identifying AGT security needs so that the countermeasure selection methodology can be used to design an effective security program before the system is fully operative. The first step is to specify those characteristics of the system which could contribute to security problems. For this example, the following AGT system is postulated:

- Type of AGT: Group Rapid Transit
- Setting:
  - a. Special use - airport
  - b. Metropolitan
  - c. Suburban
- Guideway:
  - a. At grade - 50 miles
  - b. Subway - 25 miles
- Vehicles:
  - a. Capacity - 20 persons
  - b. Number - 300
  - c. Express capability

TABLE 5-5

BART APPLICATION

1. Select Minimal Countermeasures:

- lighting
- fare box hardening
- adaptive space

2. Evaluate Stations for Potential Crime Problems:

Critical:	12th Street, Daly City
Moderate:	Powell, Walnut Creek
Non-Critical:	Embarcadero, Balboa Park

3. Select Candidate Countermeasures:

<u>Typical: Purse-Snatching</u>

Primary:	CCTV, personnel intense
Secondary:	pre-screen riders, voice monitors, K-9 patrol

<u>Extreme: Robbery</u>

Primary:	CCTV, personnel intense
Secondary:	passenger-activated alarms, scheduling

TABLE 5-5 (continued)

4. Construct Scenario:

Severity of Crime:	extreme - robbery
Time:	7:30 p.m.
Surrounding Environment:	metropolitan
Station Design:	new, open
Station/Guideway:	at-grade
Location within System:	station
Passenger Density:	low
Station Security:	random patrols
Victim:	male, twenty, well-dressed, familiar with station, briefcase, package
Offenders:	three, males, armed, criminal records, familiar with station

Comment: Victim is robbed of cash and package. He activates alarm after robbery. Two of the offenders are apprehended.

5. Evaluate Candidate Countermeasures and Select Most Effective:

- passenger-activated alarms

6. Choose Optimal Combination

- lighting
- fare box hardening
- adaptive space
- passenger-activated alarms

- Track: 75 miles
- Stations: 40
  - 5 transfer stations
  - 1 airport station
  - 5 parking lots
- Hours of Operation: Daily, 0500-2300
- Patronage: Peak hour 30,000
  Off-peak 8,000
- Attendants: Only at transfer stations at peak hours
- Fare Collection: Fully automated
- Trip Characteristics:
  65% work
  15% recreation
  20% school, shopping

  average time on vehicle: 19 minutes
  average time on platform: 7 minutes

The next step is to evaluate the stations in terms of demographic characteristics of their adjacent neighborhoods. The models generated in Section 4D are applied to the planned system. In this example, three generic stations are considered as described in Table 5-6. Station A, by virtue of the high proportion of males, ages 20-54, in the neighborhood adjacent to the station, and a high neighborhood crime rate, is identified as a potential security problem. Station B is on the periphery of the metropolitan area, but not quite in the suburbs. The neighborhood population includes a high proportion of males to the age of 14 and females over 20. This indicates vandalism, missiling, fare evasion and graffiti are likely problems at Station B. Although airports are nearly always characterized by tight security in a controlled environment, an airport AGT station nonetheless may require special countermeasures. Patrons are likely to be carrying suitcases and a large amount of cash, and may be unfamiliar with the station. They are attractive, vulnerable targets, especially when exiting the system.

Once those stations and sections of the network which have the greatest potential for crime problems have been identified, they must be ranked according to the magnitude of the expected crime rate.

The fourth step begins the process of selecting and integrating the crime countermeasures most suitable for the planned system. Each station can be given minimal treatment and high ranking stations may be hardened further. An alternate approach is to treat each station individually, based on its potential for crime. Inasmuch as the safety and security problem exists on two levels--real and psychological--the former approach is recommended so there are some tangible countermeasures at every station.

TABLE 5-6

PLANNED SYSTEM

1. Select Minimal Countermeasures:

- lighting
- fare box hardening
- adaptive space

2. Evaluate Stations for Potential Crime Problems:

Critical:	Station A, Station B
Moderate:	Airport
Non-Critical:	

3. Select Candidate Countermeasures:

<u>Robbery</u>

Primary:	CCTV throughout station
Secondary:	voice monitors, pre-screen riders

<u>Vandalism</u>

Primary:	vandal-resistant interior
Secondary:	transit personnel on trains, CCTVs on vehicles, voice monitor on vehicles

TABLE 5-6 (continued)

4A. Construct Scenario:

Severity of Crime:	critical - robbery
Time:	off-peak, 7:30 p.m., Thursday Winter
Surrounding Environment:	metropolitan, high-crime neighborhood
Station Design:	new, open (Station A)
Station/Guideway:	subway
Location within System:	elevator to platform
Passenger Density:	medium
Station Security:	random patrol, no monitoring in elevator, CCTV on platform
Victim:	elderly, well-dressed, male, familiar with station
Offenders:	two males, 18 and 20, familiar with station, knife and gun, criminal records

Comment: Transit patron is robbed of watch and wallet, and then assaulted.

↓

5A. Evaluate Candidate Countermeasures and Select Most Effective:

- CCTV
- voice monitors on elevator

↓

6A. Choose Optimal Combination:

- lighting
- fare box hardening
- adaptive space
- CCTV at elevator access points
- voice monitors on elevators

TABLE 5-6 (continued)

4B. Construct Scenario:

Severity of Crime:	moderate - vandalism
Time:	4:30 p.m., Wednesday
Surrounding Environment:	suburban
Station Design:	new, open platform (Station B)
Station/Guideway:	at-grade
Location within System:	vehicle
Passenger Density:	medium
Station Security:	CCTV in stations, random patrols
Victim:	transit vehicle
Offenders:	three boys, ages 12-16, familiar with system, no criminal records

Comment: The youths occupy a car and damage seats, etc.

5B. Evaluate Candidate Countermeasures and Select Most Effective:

vandal-resistant interiors

6B. Choose Optimal Combination:

- lighting
- fare box hardening
- adaptive space
- vandal-resistant interiors

TABLE 5-6 (continued)

4C. Construct Scenario:

Severity of Crime:	critical - robbery
Time:	off-peak, 10:00 p.m., Thursday September
Surrounding Environment:	airport
Station Design:	line, open
Station/Guideway:	at-grade
Location within System:	platform exit to parking lot
Passenger Density:	low
Station Security:	CCTV
Victim:	able-bodied, well-dressed, 40s, male, single, unfamiliar with station, briefcase and bags
Offenders:	dangerous, 19 and 23, males, familiar with station, pistol, criminal records

Comment: Patron is robbed of wallet and watch while leaving station.

5C. Evaluate Candidate Countermeasures and Select Most Effective:

CCTV

6C. Choose Optimal Combination:

- lighting
- fare box hardening
- adaptive space
- CCTV

The countermeasure selection can now be applied to potential high-crime stations. The methodology assumes that there will be a minimum level of protection for the entire system (e.g., good lighting, fare box hardening and adaptive space) and more intensive hardening for the stations that appear to warrant it: in the present example, Stations A, B and the airport's station. Table 5-6 illustrates the countermeasure selection methodology for the three prospective stations.

3. Chicago Transit Application

The Chicago Transit Authority is experimenting with an integrated alarm, surveillance and telephone communication system known as Teleview Alert. To be used in high-crime CTA stations, the advantages of a coordinated TVA system over the conventional application of single components are described in a report prepared by Carnegie-Mellon University for the CTA:[41]

> The teleview alert system would provide the public with an emergency phone and alarm system for a quick and efficient method of communicating with the authorities in the event of trouble. Television coverage would provide the police with a method of determining the legitimacy of the alarm and, by recording events, with a reference for describing the events and the offender. Finally, by linking the alarm system with the television in such a manner that the appropriate television cameras and recorders come on automatically only when an alarm is activated, the fatigue problems and manpower requirements associated with other systems of full-time surveillance are eliminated. (p. 211)

As outlined in the Carnegie-Mellon study, the essential components of the TVA system are:

1) transparent, movable barriers;

2) emergency phones;

3) CCTV;

4) teleview alert bars; and

5) lighting and highly visible signs.

Furnishing a transit system with component TVA devices should not require major structural renovation and should be adaptable to older station design, barring lighting and viewing range limitations imposed by CCTV cameras.

The following sections briefly describe how the component TVA devices work together:

Barriers

The principle of the teleview alert system is to overcome the limitations attributable to the separate use of its component anti-crime devices. See-through barriers or gates are used during low-ridership periods to contain waiting passengers within a restricted area which can be effectively monitored by no more than four television cameras. Access to the restricted platform area should be limited to only one entry-exit point.

Emergency Phones and Teleview Alert Bars

The observer at the central monitoring facility does not have to maintain constant vigilance at the television screen; with a TVA system, the observer can be alerted by one of the emergency phones or by one of several alert bars located throughout the station. However, an important assumption is that a witness to a crime or the victim has access to one of these two modes of contact. It is essential that these devices not only be accessible, but also that the public know how to operate them.

Each platform waiting area is equipped with at least two emergency telephones and several freely accessible and highly visible TVA bars, located every 20 to 30 feet along the open section of the platform, in stairwells and ramps and near the turnstile area. Either of these devices can activate a video-taping machine which immediately begins filming station areas under camera surveillance. The video tape provides a record of the events occuring in the station and can aid in identifying the criminal.

When the telephone receiver is lifted and the push button depressed, the TVA system is activated, video-taping begins and the phone rings at the central monitoring station. Upon answering the phone, the observer has direct voice communication with the caller on the platform. Based on the information given by the caller and camera views of station activity, the observer can then determine the legitimacy of the call, summon the appropriate emergency services, and, if necessary, give instructions to the caller.

The teleview alert bar should be easily identifiable but its activation should be inconspicuous enough to permit a witness or victim to trigger it without attracting the attention of the criminal. When the bar is depressed, the observer is alerted to his central monitoring console where he can verify the alarm and take the necessary action. The observer can make contact with the platform area by using a public address system.

Monitoring Equipment

The central monitoring console described in the Carnegie-Mellon study consists of five nine-inch screens which simultaneously display all views of the station and a larger screen for close-up views. As soon as the alert situation is activated by the alert bar or telephone, video-tape recorders automatically record activity viewed by the television cameras. The central monitor observer may either hold or reset the emergency sensor. Optional on-station components permit communication among the central monitor installation, local police, transit security and station attendants.

The success of a fully integrated electronic surveillance system depends on its ability to improve police response time. Evidence indicates that when patrol units have been able to respond to an incident within five minutes, in 65% of the cases an apprehension can be made. Frequent false alarms can erode the credibility of a conventional alert system and affect the reaction speed of the security force. A TVA system is designed to augment communication, increase response time and improve coding capabilities by instantaneous verification of the alarm and an immediate, visual appraisal of the situation. These capabilities should, in turn, strengthen transit user perceptions of security within monitored stations. However, it is doubtful that a victim of a crime will attempt to utilize the teleview alert bar until he or she feels relatively safe from further attack; that is, until the offender has left the victim's presence. This may reduce the probability that the security team will be able to apprehend the offender.

A possible concern may be the "Big Brother" image of a comprehensive surveillance system. This might be avoided from the start with an active campaign to publicize the merits of TVA by emphasizing some of its non-security related support features.

Another potential problem with TVA is that, as with any high technology hardware system, equipment breakdowns may threaten user confidence in the system and offset any initial increases in user perceptions of security.

D. Political and Social Constraints on Passenger Security Planning

Certain aspects of planning for personal security raise problems that cannot be completely resolved in this guidebook. Nonetheless, the planner should be aware that aside from the technological characteristics of any given system, there are other public policy and human factors issues that add to the complexity of selecting effective crime countermeasures. Therefore, it will aid the passenger security analysis to view countermeasure decisions as occurring on two levels: technological and public policy.

For part of the passenger security planning process a technical evaluation will suffice. The guidebook gives a clear indication of what these areas are. For example: before installing CCTV, ambient light levels and station design constraints must be assessed; fare boxes and ticket dispensers require at least a minimum amount of hardening; surveillance system hardware will require specific, predictable maintenance. Relatively objective measures of effectiveness can be applied to these problems. Therefore, some countermeasures can be accompanied by an index of effectiveness.

Other personal security problems are clearly in the policy intensive area. These include social and political constraints, inter-jurisdictional coordination of law enforcement agencies, displacement of crime and the role of the criminal justice system. Since these policy related questions can be subject to local and regional inhibitors it is difficult to offer general policy recommendations. The transit planner is urged to augment the guidebook's preliminary analysis of these problems with his or her knowledge of local constraints.

Designs or countermeasures chosen by using the methodology presented in Section 5-A may have to be modified because of local social or political constraints. Professional recommendations concerning the formulation of a countermeasure strategy may be unacceptable or ignored, but for reasons unrelated to the efficacy of the countermeasures. The identification of political and social constraints can help to forestall selection of unacceptable countermeasures. Although each community will have unique planning constraints, it is reasonable to anticipate certain types of intervention by aroused individuals or organized interest groups. The security planner is urged to go beyond mere public relations and instead make an early determination of the relevant issues in the community so that misapplication of countermeasures is minimized.

The political realities that can intrude on the security planner's selection of countermeasures are potentially numerous and significant. The issues can be analytically complex; until more AGT systems come on line our knowledge base will limit the discussion of political constraints.

Presumably, there are pressure groups in some communities that will be alert to the potential prestige associated with the presence of sophisticated surveillance equipment. They may actively exert pressure on the system's planners to locate costly or impressive hardware at stations within their district, regardless of the equipment's indicated need or usefulness. This is calculated to impress the constituency with their representative's commitment to "do something" about crime. If, in response to political maneuvering, the security planners maintain that certain costly countermeasures are unnecessary for a particular station, how can the local users be convinced that even without these countermeasures the system, and in particular their station, is safe enough to use? This problem is exacerbated if the system's size is large enough to prevent installation of an expensive device at every station.

In this type of situation, the system's planners can assess their adversary's position and, accordingly, accede to or reject their demands. An alternative is to offer a compromise. The planners could propose an incremental method of countermeasure installation. Security planners could agree to monitor crime patterns at the station and install additional countermeasures as they are needed. This could be a useful tactic in an area where perceived and actual crime levels are different.

An attractive aspect of a modular installation policy is that expenditures for countermeasures can be correlated with the "costs" of crime.

A cost curve could also be used to assess the cost of providing security at off-peak, low-density, low-revenue hours. At some point, the probability of a violent crime occurring may become so great and the cost of deterring that crime so high, the most effective countermeasure may be to shut the system during low density periods. (This may also be a wise precaution for protection of the system's image. Violent crimes can have a substantial impact on user perception of system security.) Security planners can establish their own cost curves to see at what point the cost of providing security will no longer bring sufficient return. As Chaiken, Lawless and Stevenson have shown in their study of police activity on the New York City transit system, a police policy may effectively deter crime, but at considerable expense. In 1965, the cost of deterring each felony on the NYC system was $35,000.[42] Since the utility of an AGT system depends on how well it satisfies certain cost criteria, particularly operating costs, security systems, which traditionally have high operating expenses, must be both effective and affordable if the AGT concept is to remain valid. Since a regional or municipal government must allocate scarce financial resources to various services, certain long-term fiscal impacts of AGT systems should be evaluated. For example: Will an effective security system overburden the judicial system so that there will be an increased demand for district attorneys, judges, correction officers and probation officials? If the community is not prepared to augment its criminal justice system staff, will a significant number of offenders receive no penalty? How will this influence the motivation of security personnel to apprehend offenders? Since a comprehensive approach to transit crime is therefore advisable, a cost-benefit analysis could be valuable. The assessment of AGT costs and benefits should attempt to analyze at least two questions: If crime countermeasures prove to be effective in apprehending offenders, what effect will this have on the criminal justice bureaucracy; and what judicial approaches (mandatory sentences, plea bargaining, parole) will be most effective in terms of protecting AGT system users?

A second salient variable to consider is the extent to which citizens will participate in the planning of the system. AGT system planning and policy decisions will be made by planners and politicians who must evaluate alternatives and negotiate with citizen participants. In order to achieve a consensus on proposed actions, trade-offs will have to be made. The underlying principle, self-interest, motivates community groups as well as politicians, but the sources and interests of citizen groups are more diversified. Some mechanisms that enable citizens to express their desires are described below.

Administrative and functional agencies at most levels of government have responsibility for soliciting comments from citizens and community associations. Other types of involvement will come from local city managers and citizens who have a professional interest in the issue. Additional input will come from community activists who may have experience in existing functional planning areas such as water resource planning or park planning. Other groups or individuals (e.g., business owners, real estate associations, labor union leaders) will become involved according to the extent to which their interests will be affected by the system.

Community participation may modify almost any facet of the prospective system. This provides the community actors with potential vetoes over station location, design, and crime countermeasures. Veto has a negative implication, but citizens may enrich the countermeasure selection process. For example, security planners may learn that certain countermeasures they assumed would have high "acceptance costs," might in fact be approved for use during off-peak, low-density periods.

An indirect benefit of planner-community interaction may be a community sensitive to the value of certain countermeasures and aware of the appropriate responses if they witness or are a victim of criminal behavior while they use the system.

A third factor relevant to personal security is the degree to which local police will be responsible for personal security on the system. Unless an autonomous transit force with full apprehension authorization is created (e.g., the New York City Transit Police), local police will have a central role in patrol and apprehension functions. Their activities may even extend to monitoring segments of the system. However, the creation of an independent transit force, with arrest authority, is encouraged. This is particularly advisable if the system crosses several municipal boundaries. A dedicated transit force will also relieve local police of low-priority duties such as: protecting revenue as it is transported to and from stations; monitoring crowds during high-density periods; and completing paperwork after an arrest is made. An independent force can also provide specialized services: for example, aid in evacuating ill or injured passengers. Daily exposure to AGT system hazards (e.g., high-voltage rails and elevated guideways) will help to ensure an adequate response during an emergency.

The transit force should have a limited staff (since low manpower is an important goal of AGT systems), so an effective system of crime detection and response by local police, complete with inter-jurisdictional liaison, is required. It is essential to query the relevant police forces on their methods, problems and priorities. Every police force will have defined its respective problems and established methods to deal with those problems. At times, their priorities may conflict with the priorities of the transit force. The extent to which the goals of the transit force can be reached could in part depend on how well these goals correspond to the self-interests of the local police. Therefore, a responsibility of the security planning staff will be to reduce institutional conflicts by identifying the AGT system security requirements that could interfere with the established routines of the local police. Local police officials will be sure to emphasize the costs of helping to service the system. Their concerns may focus on any or all of the following:

- Transportation and booking of prisoners
- Increased paperwork and record-keeping
- Court appearances
- Patrol of commuter parking lots

- Hiring and training of additional personnel

- Increased levels of crime

- New types of crime: vandalism, missiling, trespassing

- Displacement of crime

Local agencies can have their logistical and personnel objections met by funds from the AGT system security budget. Questions about displacement, increased crime levels, and new types of crime generated by the system require more elaborate analysis.

There are long-term social, economic and land use benefits linked to the presence of quality transit systems. Police may find that the combination of a well lighted station with increased pedestrian traffic may result in low crime levels for the station and adjacent areas. If traffic congestion is a major local problem, an AGT system will reduce the number of private cars on the street during rush hours. This may not only free police personnel from traffic duties, but also clear streets for emergency vehicles, thereby improving response times.

Other potential socio-economic benefits include higher property values followed by construction, business expansion, more jobs and an enlarged tax base. This can feed revenue to the local government; funds may eventually filter to the police department.

If the crime prevention program of an existing transit system is being revised, local police departments may feel that displacement of crime is an issue. Police officials may argue that if the opportunity to commit a crime on the transit system is reduced, the criminal activity will merely shift to another time or place.

There are several distinct types of displacement: temporal, tactical, territorial, functional and target. The time of criminal activity may shift; the crime may occur at the same time and place, but the tactics or procedure may change; the offender may move to an adjacent geographical area; the functional form of crime may change (e.g., from robbery to burglary); and the target may change.

Arguments supporting the displacement theory generally make two assumptions: The criminal population is inelastic (A criminal <u>must</u> commit a specific quantity of crimes per day or week.); and criminals have complete mobility concerning their activities.

Evidence suggests that these assumptions are not entirely correct. Many crimes are opportunistic. Some criminals actively seek victims and targets; others may commit a crime only if the opportunity arises. That is, motivation varies among offenders. Other factors not usually recognized include geographic and social constraints on opportunistic crime. Young offenders are generally less mobile than other criminals. They are bound to areas near their homes. Also, access to information about targets outside their territory is likely to be limited. Youthful criminal activity is also limited by social patterns. Opportunistic crimes typically cannot be committed during the offender's daily social life. If this analysis is accurate, then hardened targets, and teenage curfews may be effective crime countermeasures that also minimize displacement.

Other dimensions of the issue suggest that a re-examination of public policy toward displacement is appropriate. It is conceivable that police officials, citizens, and other policy makers might view some functional displacement as involving favorable trade-offs. Would increased burglaries and auto thefts be acceptable if accompanied by a lower level of robberies and assaults on the transit system? Even if it can be shown that crime is displaced from the AGT system to the street, does management accept a special responsibility to protect users who voluntarily enter a system in which it is especially difficult to escape from a threatening situation if one is encountered? To be successful, an AGT system must attract and hold users, not only to generate revenue, but also to provide the benefits that accompany a good transit system (e.g., improved air quality, reduced noise levels, maintenance of public open space). For these reasons, it is prudent to provide users with high-quality security, since a good AGT system with displacement provides greater community welfare than a poor AGT system without displacement.

Regional conditions certainly have a lot to do with whether or not the above benefits are applicable in a community. The point is, local police, although emphasizing intangible costs, can also appreciate the effect of socio-economic benefits on their workload.

After the local balance sheet of costs and benefits is tabulated, security planners will be guided by local decision-making criteria into advocacy of a policing policy. This will entail trade-offs and negotiations which may become quite complicated if an argument can be made for more than one type of arrangement. At this point of AGT development it is impossible to offer definitive guidelines concerning what deployment strategy works best in a given situation.

6. REFERENCES

[1]Vendor literature from Surveillance Video System, Sherman Oaks, CA, undated, 4p.

[2]Siegel, L., et al., An Assessment of Crime and Policing Responses in Urban Mass Transit Systems, The Mitre Corporation, April 1977, p. 67.

[3] Metro Owners' Manual, Washington Metropolitan Transit Authority, March 21, 1976, p. 17.

[4]Vendor literature from RCA Corporation, Lancaster, PA, circular number TC1040/H, undated.

[5]Mackie, Robert, "Some Human Factors that Influence Reliability of Signal Detection and Identification in Surveillance Systems," in The Role of Behavioral Science in Physical Security, U. S. Department of Commerce, National Bureau of Standards, November 1977, p. 43-55. (U. S. Government Printing Office Catalog No. 13.10: 480-24.)

[6]Siegel, p. 98.

[7]Ibid., p. 67.

[8]U. S. Department of Transportation, Cargo Security Equipment Applications Guide, a report of the technical coordination subcommittee, June 1, 1972, p. 57.

[9]The New York Fare evasion program was discussed in articles in the New York Times on May 30, 1975 (p. 35), July 27, 1975 (p. 34), January 26, 1976 (p. 27), and February 19, 1977 (p. 27) and in an article in New York: "Turnstile Justice: Nabbing the Slug Users", by John Berendt, February 7, 1977, p. 39-42.

[10]Wallach, Charles, and Roy Ricci, "Security Metal Detection Systems," Security Management Magazine, 21, July 1977, p. 61.

[11]Ibid., p. 62.

[12]Ibid., p. 64.

[13]Harris, Oscar, L., A Methodology for Developing Security Design Criteria for Subways, Transportation Research Institute, October 1971, p. 36.

[14]Nolte, John, "Improved Pedestrian Lighting on Campus," Security Management Magazine, 21, May 1977, p. 51.

[15]Vendor literature, RCA Corporation, circular number CCV-118C, undated.

[16]Ferrari, Neil D., and Michael Trentacoste, "Personal Security on Public Transit," Transportation Research Forum - Fifteenth Annual Meeting, 1974, p. 220.

[17]Personal communication, University of Virginia, Building and Grounds Department, 1977.

[18]Personal communication, Virginia Electric Power Corporation, 1977.

[19] Improvement of Mass Transit Security in Chicago, Carnegie Mellon University, June 1973, p. 62.

[20]Ibid., p. 65.

[21]Ibid., p. 278.

[22]Washington Area Metropolitan Transit Authority, news release, 1977.

[23]Harris, p. 21.

[24]Siegel, p. 67.

[25]Ferrari, p. 214-223.

[26]Chaiken, Jan M., et. al., The Impact of Police Activity on Crime: Robberies on the New York City Subway System, Rand Corporation, January 1974, p. 40.

[27]Wallace, P. S., and R. M. Buren, Policing Inter City Mass Transit Systems: Proposed Legislation for Chicago with A Consideration of Other Cities, March 1974, p. 7-14.

[28]Slutzky, Ken, "Upgrading Security Forces," Security Management Magazine, 21, July 1977, p. 40-44.

[29]Ibid., p. 42.

[30]Office of Technology Assessment, U. S. Congress, Automated Guideway Transit, June 1975, p. 30.

[31]Conversation with Mr. P. Bates, Director, Morgantown, West Virginia, Personal Rapid Transit System, 1977.

[32]Ferrari, p. 220.

[33]Blakely, Andrew M., "Guard Dogs as a Security Aid: A Case Study," Security Management Magazine, 21, May 1977, p. 24.

[34]Beadle, Theodore A., "Vandalism," Metropolitan, 70, May/June 1974, p. 28-29.

[35] The Center for Criminal Justice Operations and Management. The Utilization of Helicopters for Police Air Mobility, ICR71-2, February 1971, U. S. Department of Justice, L. E. A. A., NILE&CJ. This reference describes the considerations for estimating costs of helicopter surveillance, but a more up to date set of numbers is necessary.

[36]Improvement of Mass Transit Security in Chicago, p. 74.

[37]Chaiken, p. 27.

[38]Avery, William H., "The Potential Role of Mechanically Linked Systems in Urban Transportation," Personal Rapid Transit, University of Minnesota, April 1972, p. 184.

[39]Newman, Oscar, Architectural Design for Crime Prevention, U. S. Department of Justice, LEAA, p. 78, 1972.

[40]Ibid., p. 80.

[41]Improvement of Mass Transit Security in Chicago, p. 211.

[42]Chaiken, p. vi.

[43]Office of Technology Assessment, U. S. Congress. Automated Guideway Transit, June, 1975, p. 1-18.

[44]Hawkins, W. and Sussman, E. D., Proceeding of Workshop on Methodology for Evaluating the Effectiveness of Transit Crime Reduction Measures in Automated Guideway Transit Systems, UMTA-MA-06-0048-77-1, July 1977.

[45]Lee, R. A. et al., Classification and Definition of AGT Systems January 1979.

[46]Demetsky, M., Hoel, L. A. and Virkler, M. R., Methodology for the Design of Urban Transportation Interface Facilities, Final Report # DOT-TST-77-46, December 1976.

7. APPENDIX A

ANNOTATED BIBLIOGRAPHY

Background Literature

The Data Collection Effort consisted of two separate parts: (1) a literature search, and (2) interviews with transit officials and experts located throughout the United States and Canada.

An extensive computerized literature search was conducted primarily through the use of several indices. The specific indices include the following six major file sources:

- Computerized Engineering Index (COMPENDEX)
- National Technical Information Service (NTIS)
- Smithsonian Science Information Exchange (SSIE)
- Transportation Research Information Systems Network (TRISNET)
- National Aeronautics and Space Administration (NASA)
- Defense Documentation Center (DDC)

Various other sources searched for data relevant to this guidebook. These include:

- Search of card file of transit security documents provided by Northwestern University
- Review of current and back issues of Security Management Magazine for articles pertaining to countermeasures planning and implementation.
- Vendor contacts for literature on hardware-oriented crime countermeasures and the suitability and adaption for their use in automated guideway transit systems.
- Review of numerous back and current issues of weekly and monthly transit journals.
- Requests for copies of publications and in-house data which were relevant to passenger security from each transit system visited.

Results of the computerized literature searches and other efforts produced a lengthy list of titles and abstracts. Documents which appeared applicable to this study were procured and then reviewed for data pertinent to this guidebook. Each of these documents is included in the annoted bibliography.

Most of the research investigating various aspects of crime in transit systems began around 1972 and resulted in a number of reports and journal articles published a year or two later. The report An Assessment of Crime and Policing Responses in Urban Mass Transit Systems (Mitre Corporation, 1977) was published in April of 1977. It ties together recent information on transit crime problems and suggests areas where research and experimentation could provide useful information. In March of 1978, the American Public Transit Association circulated a comprehensive report, "Transit Security Guidelines Manual," dealing with a broad range of transit security topics.

1. Bell, Larry S., Prevention of Crimes of Assault and Acts of Vandalism on Demand Responsive Automated Transit Systems, Denver, International Conference on Personal Rapid Transit, 1975, mimeo, 15p.

    Existing rapid rail crime studies were examined to identify crime-correlated physical and environmental factors. These findings were extrapolated to the PRT situation, in order that PRT crime patterns might be anticipated.

    The author suggests PRT crime countermeasures involving station design and location. Emphasis should be placed on securing, by design or surveillance, those elements of the system most susceptible to criminal activity.

2. Bernard, Keith, "Planning and Development of the BART Police Services Department," Transportation Research Forum, 1974, Fifteenth Annual Meeting, p. 241-243.

    BART is a three-county special district serving 3 counties and 14 municipalities in the San Francisco area. In 1969, the BART Board of Directors stated that fundamental law enforcement responsibilities on the BART system should be borne by the jurisdictions served. Local government and police officials were strongly opposed, because they felt the BART system would create serious new crime problems, which should be covered by the BART district's budget rather than by strained local law enforcement funds. The conflict was not resolved and BART has set up its own comprehensive security system.

    BART has not resulted in large amounts of crime that would not have been present otherwise and therefore shared security would not have been an excessive burden to localities.

3. Boltwood, Charles E., et al., "Skyjacking, Airline Security and Passenger Reactions: Toward a Complex Model for Prediction," American Psychologist, 27, 1972, 539-545.

This study was undertaken to determine passenger attitudes toward the extensive security measures implemented by commercial airlines in the early 70s. An attitude questionnaire was used to measure attitudes on the effectiveness, convenience and favorability of these security measures, to isolate subgroup attitudes, and to determine if a general factor accounting for "overall concern for security" exists.

No general factor accounting for "security concern" was found. Eight passenger subgroups, varying in age, sex, and frequency of airline use and processing significantly different attitudes, were identified. The authors suggest that a complex model capable of predicting overall security concern must be developed if passenger acceptance of crime countermeasures is to be secured.

4. Chaiken, Jan M., Lawless, Michael W., Stevenson, Keith A., The Impact of Police Activity on Crime: Robberies on the New York City Subway System, Rand Corporation Report R1424, January 1974, 74p.

This study evaluated the deployment of police in the New York City subway system. Robbery data for an 8-year period, 1964-1971, was analyzed to reveal cause effect relationships between crime countermeasures and robbery incidence.

During the study period, an exact fare policy had been implemented on New York buses and an 8pm-4am "saturation" police patrol had been instituted in the subways. Two questions were addressed: have these countermeasures deterred subway robbery, and have they displaced this crime to other times, places and forms?

Increased patrol was shown to have caused a permanent decline in robbery rates where and when utilized, and a temporary "phantom" deterrent effect was evident at other times as well. Subway robbery growth rates had been depressed by the growing "popularity" of bus robbery; the introduction of "exact fare" all but eliminated bus robbery and caused subway robbery to return to its previous rate of growth.

Two alternatives to the existing fixed deployment pattern were suggested: additional daytime patrols (expensive) and flexible deployment patterns, in response to crime rates, to capitalize on the "phantom effect." Re-assignment of patrols, not immediately perceived by criminals, would result in more deterence with no increase in patrol man-hours.

5. "City Tries Numbers, Call Boxes in Subway to Speed Police Help," Chicago Police Star, March 1968, Vol. IX, p. 2.

The Chicago Transit Authority conducted a demonstration test of a numbered station and free call box crime countermeasure system. The numbering system quickly locates the crime and the free call boxes may facilitate reporting of criminal incidents. If effective, these measures were to be widely implemented by the CTA.

6. "Combating Transportation's Blight: Vandalism," Metropolitan, 70 May-June 1974, 28-29.

This article describes the countermeasures taken against rail vandalism in Philadelphia between 1972 and 1974. On city lines, graffiti was the major vandalism problem, and a combination of intensive patrol, apprehension, and conviction proved an effective deterrent. Cooperation of local merchants in making graffiti supplies less accessible was obtained. Constructive alternatives, such as art classes, were provided for graffiti artists.

On commuter lines, stonings were the most serious aspect of vandalism, and were effectively deterred by a joint helicopter/ground patrol. An additional benefit derived from this countermeasure was a reduction in deaths of pedestrians crossing railroad tracks illegally.

7. Daily, John T., and Evan W. Pickrel, "Some Psychological Contributions to Defenses Against Hijackers," American Psychologist, 30, 1975, 161-165.

American airlines and their personnel are the data source. This report traces the development of commercial airline hijack countermeasures. In the late 1960s, an FAA study team concluded that a combination of deterrents, user screening, and successful apprehension would prove an effective countermeasure. Profiles identifying potential hijackers in physical and situational terms were developed. Data from past hijackings were synthesized as was a hijack defense strategy, and a hijack command center was set up to assist crews faces with hijackings. Personnel hijack defense training became mandatory in 1972 and 100 percent screening was required in 1973.

These countermeasures have been effective; as of February 1974 there had been no hijackings of domestic airlines since the combined mandatory countermeasure program began in January 1973.

8. Dow, Janet, "Mass Transit Unit of the Special Operations Group," Chicago Police Star, September 1971, Vol. XIII, p. 4-8.

This article describes the countermeasure activities undertaken in CTA stations by the Special Operations Unit of the Chicago police. Uniformed patrol, which accounts for the majority of both security activities and arrests, also improves the public's perception of transit security. Undercover units serving as crime decoys protect citizens by deterring crime through quick apprehension.

This is clearly a public relations instrument. The successful countermeasures presently employed are publicized in a most favorable manner, probably to serve as a further crime deterrent.

9. Feldman, Laurence P., and David B. Vallenga, "The Role of Security in Marketing Urban Mass Transportation," High Speed Ground Transportation Journal, 11, 1977, 157-172.

The authors examined the security-oriented attitudes and perceptions of transit users and non-users in the Chicago metropolitan area. A Focus Group Interview technique was used in order to collect latent or repressed feelings about security. That is, the topic of personal security as a factor influencing modal choice was rarely mentioned at the start of interview sessions. After the security topic was mentioned, "it appeared to open a floodgate of responses relative to the security problem." The report concludes that patrons are unaware of what to do if victimized; and that marketing efforts alone cannot increase ridership.

10. Ferrari, Neil D., and Michael F. Trentacoste, "Personal Security on Public Transit," Transportation Research Forum, Fifteenth Annual Meeting, 1974, p. 215-223..

This article reports the findings of a user-perception survey addressing the security and safety aspects of public transit. The study was conducted in Chicago in 1973 and revealed that the reason most frequenty given for choosing between rapid transit and bus is safety, i.e., freedom from personal attack, harassment, etc. The study also indicated that passengers believed certain times of the day and seasons to be more dangerous than others; that knowledge of a public transit crime does not significantly affect ridership and that transit users and non-users feel that added protection, either by increasing security manpower or by providing a communication and an alarm system, is desirable.

The authors acknowledge the possibility of a bias in the survey questionnaires and made recommendations for further study.

11. Gray, Paul, "Robbery and Assault of Bus Drivers," Operations Research, 1971, 19, p. 257-269.

This paper evaluates three approaches to bus driver robbery and assault: exact fare (deterrence), alarms (thwarting), and photography (apprehension). Crime data indicates that most bus crime occurs at night, and that the driver usually does not suspect the criminal and has little time for a reaction. Transit officials ranked reducing driver injuries, robberies, driver fears, patron fears, and dollar loss as the most important criteria for an effective countermeasure.

In light of these results and implementation experience, the exact fare countermeasure has not proven fully effective because assaults are still a problem. Alarms involve many response delays and have rarely resulted in on-site capture in commercial use. Photography is expensive but has proven an effective aid to apprehension of bank robbers.

12. Gray, Paul, "Robbery and Assault of Bus Drivers Revisited," Transportation Research Forum: Fifteenth Annual Meeting, 1974 p. 244-245.

The 1974 bus crime situation was described in this study, with emphasis on the effectiveness of crime countermeasures. Such high-visibility tactics as rapid response to alarms, patrol vehicles following buses, and patrolmen riding or boarding buses frequently seemed most effective. Human relations education and physical shielding of drivers were considered less effective.

The incidence of assault seems cyclical and it is therefore difficult to assess the impact of countermeasures which are implemented in response to peak assaults. However, perception of safety by both drivers and passengers is much improved with use of visible countermeasures, which also appear to be the most effective crime countermeasures.

13. Greene, Robert, "A Model for Calculating Costs and Benefits of Transit Security Improvement," Research Report 6, Transportation Research Institute, Carnegie-Mellon University, 1974, p. 67-68.

The author presents an equation model which estimates annual dollar benefits from implementation of transit crime countermeasures. The effectiveness of a given countermeasure in reducing crime must unfortunately be estimated independently and used as an assumption. Other inputs include changes in ridership and medical expense levels as well as deferred commuter trips and countermeasure expenses.

A 0.3 percent increase in Chicago's transit ridership would justify an electronic surveillance system (assumed 20 percent effective) during its first year of operation. The author suggests that his model can be expanded to include pollution, energy, and employment benefits as well as judicial costs associated with crime countermeasures.

14. Harris, Oscar L., Jr., A Methodology for Developing Security Design Criteria for Subways, Transportation Research Institute, Carnegie-Mellon University, October 1971, 114 p. (UMTA URT 5-70-4).

> The purpose of this study is to present the Security Design Criteria methodology for determining the optimal combination of transit crime countermeasures. Correlation between crime and physical and nonphysical factors present in transit systems are examined. Perceived value of eliminating each crime type, relative seriousness of each crime, and cost are combined with the crime correlations already derived to determine the most effective crime countermeasure package.

15. "Ideas on Public Transportation/No. 1," Atlantic Richfield Co., 1975, 21 p.

> Citizen opinion on quality of service is presented through extensive use of quotations. A superficial examination of the problem of transit crime is included.
>
> This booklet is a public relations device including little "hard" information such as how many respondents cited which problems, etc.

16. Johnson, Ronald C., "Mass Transit Security in Chicago," Transportation Research Forum, Fifteenth Annual Meeting, 1974, p. 224-234.

> This report is a condensation of the results of the 1972 Chicago Transit Authority study on the nature and extent of transit crime and the relationship between crime and ridership.
>
> The existing security system could be improved by making communication between crime witnesses and police more convenient. Self-locating emergency phones or CCTV were suggested. Crime exposure risk is lower in the subways than on the street, and although fear of crime is a factor in ridership decisions, other system and situational factors are considered more important to modal choice.

17. "Mass Transit Units' Security System," Chicago Police Star, January 1975, Vol. XIX, p. 6-7.

This article describes the crime countermeasures in use in Chicago's mass transit system. Since 1947, the Chicago Transit Authority (rapid rail) has utilized a special detachment of the city's Police Department. The high-visibility "deterrent" approach has been taken, involving measures which increase both the criminal's perceived probability of apprehension, and the passengers' perceptions of security. Saturation patrol has proven the most effective deterrent, augmented through use of emergency phones and TV surveillance. Patrols consist of uniformed teams, plain-clothes officers, or K-9 units.

Although saturation patrols have proven effective, they are expensive and less patrol would be needed if there were not a serious problem with passenger unwillingness to report crime.

18. "Operations Saturation Paying Off for Chicago Transit System Customers," Crime Control Digest, April 1975, p. 7.

The success of Operation Saturation, implemented in 1975 by the Chicago Transit Authority, is documented in this article. Operation Saturation consisted of the assignment of the Chicago Police Department's entire Special Operations Group (200 men) to augment the regularly assigned city Mass Transit Unit. Also, transit arrests were rapidly brought to trial and a positive effort to establish support with the public was launched.

Robberies on Chicago's rapid transit system dropped 46.5% during the first three months of the program, compared with the same period in the preceding year.

19. "Public Transportation Patrol," Training Key #205, IACP, 1974, 1-5.

This police training guide presents typical scenarios and appropriate patrolmen responses for a wide variety of transit crimes. Preventive as well as reactive countermeasures are included.

20. Renstrom, K. A., "Protection of People and Equipment Against Vandalism," Public Transport and People Conference, Paris, April 1975, p. 183-184.

This article describes the countermeasures employed against vandalism on the Stockholm Underground between 1967 and 1974. A detachment of the State Police was assigned to the subways in 1967. Radio communication and TV surveillance were utilized to increase patrol and response effectiveness. Physical station modifications, employee training, and youth relations activities were also employed.

Police interventions and arrests increase every year, possibly due to more intensive patrols. Although patrols and vandal-resistant material usage reduce vandalism, the author feels that vandalism is caused by human character flaws and that the ideal solution would involve behavioral and motivational changes in the offenders themselves.

21. Reppetto, Thomas A., "Crime Prevention and the Displacement Phenomenon," Crime and Delinquency, 22, 1976, 166-177.

The author examines the argument that crime prevention programs which attempt to reduce the opportunity to commit crimes are without value because they only displace crime to other locations, time periods or victims. Criminal behavior and the influence of age, social setting, and crime type on the displacement potential of various offenders are analyzed. The results indicate that some crimes are so opportunistic that their prevention in one circumstance will not lead to their occurence in another.

The report also suggests that limitations to displacement are associated with specific types of crimes and geographic areas. Therefore, the displacement potential of an anticrime measure can be forecast, and, in some cases, be minimized.

22. Sgarzi, Julie A., "Transportation Systems: Planning for Safety and Security," Crime Prevention Review, 1, 1974, p. 33-40.

This is an intermediate report on security planning for the proposed southern California regional transit system. Surveys of existing mass transit systems and interviews with area officials were used as input into the security planning process. Among the objectives evolved were increased ridership, interjurisdictional cooperation, and preventive crime countermeasures.

To aid in designing the security system that would best meet these objectives, a security/safety impact study is proposed. The study would examine alternative security system structures (state, regional, district, or joint local authority) and would recommend physical design features based on relative countermeasure cost-effectiveness.

23. Shellow, Robert, "Central Issues in Transit Security," Transportation Research Forum, Fifteenth Annual Meeting, 1974, p. 235-239.

This study summarizes the major studies on transit security and discusses such transit security issues as countermeasure effectiveness and public reassurance.

The report concludes that previous research is inadequate to guide transit security planners because the studies done have not followed similar methodologies. Countermeasures should be chosen for cost-effectiveness and should consist of the optimal mix of manned patrol, electronic surveillance, and station location for a given transit situation. Public reassurance can be best achieved by giving high visibility to countermeasures and their success.

24. Shellow, Robert, James P. Romualdi, and Eugene W. Bartel, "Crime in Rapid Transit Systems: An Analysis and a Recommended Security and Surveillance System," Crime and Vandalism in Public Transportation, Transportation Research Record #487, 1974, p. 1-12.

The purpose of the study was to identify the influence that crime has on transit ridership and to suggest measures for improving rapid rail security. The methodology consisted of an analysis of crime patterns, ridership trends, crime perception, present security measures, and general operating procedures. The relative effectiveness of manned vs. mechanical surveillance, in terms of rapid response and perceived user security, is evaluated.

A system which effectively meets the perceived and actual safety needs in rapid rail networks must allow for inconspicuous notification, reliable descriptions, limited false alarms and vandalism, and minimal costs. A combination of alarm bars, telephones, and alarm-activated closed circuit TV is suggested. Movable transparent platform walls, which would provide flexible platform space configurations, are also proposed.

25. Siegel, L., et al., An Assessment of Crime and Policing Responses in Urban Mass Transit Systems, The Mitre Corporation, Report MTR-7497 April 1977, 100 p..

This report presents an assessment of what is currently known about crime and policing responses in urban mass transit systems. The assessment consists of: analyzing the interactions among the transit environment, crime and policing operations; examining the effectiveness of various transit policing strategies and supportive anticrime measures; and, suggesting new evaluative and experimental programs to either fill in knowledge gaps or improve policing effectiveness. Report findings are based on a literature survey, site visits and the knowledge of transit police/security officials.

26. Sinha, Kumares C., and Forrest P. Roemer, "Personal Security in Buses and Its Effects on Ridership in Milwaukee," Crime and Vandalism in Public Transportation, Transportation Research Record #487, 1974, p. 13-25.

This study deals with the effect of perceived security on bus system ridership. A route subject to above-average crime and vandalism rates and crossing through varied land uses was chosen. A sample of riders and corridor residents were given attitudinal surveys to complete; correlations between usership levels, age, sex, land use, perception of crime and security and ridership were examined.

Personal security was not considered as important a service characteristic as frequency of service, fare level, travel time, and route convenience. Negative beliefs about crime and vandalism decreased ridership more than negative experience. Although sex and socioeconomic background of the respondent did not affect beliefs about personal security, perceived security was affected by age of respondent and proximity of the bus to the central city. Although the overall problem of on-bus crime and vandalism does not result in loss of a significant amount of transit patronage, vandalism does account for significantly reduced ridership among infrequent users (10% of sample). However, prevention of vandalism would not be monetarily justifiable.

27. Thrasher, Edward J., and John B. Schnell, "Scope of Crime and Vandalism on Urban Transit Systems," Transportation Research Record #487, 1974, p. 34-45.

This report summarizes research on the extent of transit crime and vandalism in 1971. Transit crime statistics were compiled and the results extrapolated to determine total U. S. transit crime. Relationships between crime and such potential influencing factors as city size were analyzed, but no correlations were discovered. An exposure index, incorporating number of uses, trips per user, and other parameters, was developed so that transit crime exposure could be compared with FBI urban crime exposure figures.

The risk of being involved in a criminal incident is at least two times greater when using a major transit system than in nontransit situations in the same city.

28. Thrasher, Edward J., and John B. Schnell, "Studies of Public Attitudes Toward Transit Crime and Vandalism," Transportation Research Record #487, 1974, p. 26-33.

This report compiles the findings of six studies on the impact of fear of transit crime and vandalism on ridership decisions. Each study was summarized and overall conclusions were drawn. The authors concluded that a cause-effect relationship between changes in ridership and crime rates was difficult to establish, given that other variables influence ridership (i.e., alternative modes, hour of day, neighborhood crime). In general, crime was found to influence ridership more strongly on rapid transit than on buses.

29. Thrasher, Edward J., and John B. Schnell, "Summary Report on Vandalism and Passenger Security in the Transit Industry," Transportation Research Record #487, 1974, p. 46-54.

This report summarizes the UMTA Vandalism and Passenger Security study findings on transit crime countermeasures. Among the approaches discussed were design and materials, protection/surveillance devices, deterrents, and apprehension. The study concludes that a combination of several countermeasures tailored to the particular needs of a given transit system would prove most effective.

30. Tifft, Larry L., *et al.*, "How Patrons Cope with Crime and the Fear of Crime on Mass Transit," Carnegie Mellon University, Transportation Research Institute Research Report #6, 1975, p. 53-65.

This paper explores the social environment within rapid transit vehicles and describes some of the coping mechanisms used by patrons. Observations of rider behavior and interviews with riders were the methodologies employed.

Passengers respond to their perception of insecurity in the transit vehicle by avoiding interaction with others, especially those they perceive to be threatening, or by seeking out the proximity of those they consider harmless. Those who do not employ any sort of protective behavior may not recognize the dangers present, and are, therefore, likely victims for criminals.

31. Wallace, Paul, "Transit Police, A Specialty," IPA Official Journal, 21, March 1968, p. 38.

This article publicizes the success of the Chicago Transit Authority Police Department, established in 1959 by the state legislature. The CTA Police, relying mainly on auto and foot patrol, have a 95% case clearance rate and a 90% conviction rate.

No recommendations as to how other systems might emulate the CTA Police are given, nor are conclusions drawn on why the force is effective.

32. Wallace, P. S., and R. M. Buren, Policing Inter-Community Mass Transit Systems: Proposed Legislation for Chicago with a Consideration of Other Cities, Urban Mass Transportation Administration, U. S. Department of Transportation, March 1974, NTIS PB 235-677/AS).

This report investigates the adequacy of security force protection on Chicago Transit Authority lines and recommends legislation to strengthen the security force.

Ridership decline on CTA lines is attributed partially to both actual and perceived inadequacies of security. The multi-jurisdictional context in which CTA operates has caused confusion about security cost responsibility, enforcement and investigation confusion, slow response times, insufficient patrol forces, lack of a central data bank, and talk of specialized transit security training.

Legislation that would place enforcement responsibility primarily on the CTA is recommended, although the report does not suggest how this force would be funded.

33. Williams, Everard M., and Robert Shellow, A Systemic Approach to Mass Transit Security, Transportation Research Institute, Carnegie-Mellon University, 1972, 25 p.

A broad range of general crime countermeasures were discussed and an outline for the development of a countermeasure evaluation model was presented. This model would choose the most cost-effective security system for any transit network, taking into account criminal perceptions of countermeasures, passenger perceptions of security, ridership, fiscal and social costs of countermeasures, and fiscal and social costs of crime.

8. APPENDIX B

GLOSSARY

Adaptive Space - A countermeasuring using devices (barriers, moveable partitions) that expand or contract platform area during peak or off-peak periods, respectively

AFC - Automatic fare collection

AGT - Automated guideway transit: a transportation system characterized by low personnel levels and centralized system control

BART - Bay Area Rapid Transit

CBD - Central business district

CCTV - Closed circuit television

CTA - Chicago Transit Authority

Differential Penalities - A criminal code distinction that provides special penalties for transit crimes

E & H - Elderly and handicapped

GRT - Group rapid transit: medium-sized vehicles; scheduled or demand responsive service

MBTA - Massachusetts Bay Transit Authority

Metal Detector - Device used to determine whether a person is carrying a concealed weapon

Metro - Washington Metropolitan Area Transit Authority

NYCTA - New York City Transit Authority

Open Design - Concept for station design, characterized by unobstructed viewing lines, and elimination of recessed, difficult-to-monitor spaces

PATCO - Port Authority Transit Corporation

PRT* - Personal rapid transit: small vehicles; demand responsive service

SEPTA - Southeastern Pennsylvania Transit Authority

SLT - Shuttle loop transit: large vehicles; scheduled service

Teleview Alert (TVA) - A security system that coordinates passenger-activated alarms, CCTV, and communication devices.

*In other UMTA reports, PNT is also referred to as PM (People Movers).

UMTA - Urban Mass Transportation Administration

WMATA - Washington Metropolitan Area Transit Authority.

9. APPENDIX C

REPORT OF NEW TECHNOLOGY

The work performed under this contract, while leading to no new inventions, has provided guidelines and procedures for use by Automated Guideway Transit planners and designers in selecting equipment and strategies for enhancing the security of transit stations. This guidebook attempts to establish a sound conceptual base for AGT security planning. The planning procedures discussed in sections 4 and 5 represent a major contribution of this research.

☆ U. S. GOVT. PRINTING OFFICE 1980 600-668 # 27