SAFE TRANSPORT: SECURITY BY DESIGN ON THE WASHINGTON METRO

by

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Abstract: *Most successful crime prevention efforts take the approach of "designing out crime" through the identification of highly specific crime problems and the development of preventive efforts to reduce them (Clarke, 1992). A study of the design, maintenance and management of "Metro," Washington, DCs subway system, allows for the novel approach of evaluating an effort to design in security at the outset. This paper examines the crime prevention characteristics of Metro's environment. It sets out a series of tests documenting Metro's success in keeping crime rates on the system at an unusually low level and demonstrating that these low crime rates are explained by Metro's environment.*

INTRODUCTION

Since it began operating in 1976, "Metro," Washington, DCs subway system, has been recognized as one of the safest, relatively "crime-free" subway systems in the world. Metro officials explain the success of the system as stemming from a combination of three factors: (1) architectural design, which employs crime prevention principles; (2) vigilant maintenance policies; and (3) stringent enforcement of rules and laws. While Metro authorities did not intentionally apply a specific theory or group of theories to the philosophy behind Metro's design and the way in which it is managed and maintained, the philosophy employed is nonetheless compatible with situational crime prevention (Clarke, 1992) and the earlier Crime Prevention Through Environmental Design (CPTED) model (Jeffery, 1977). In addition, because crime prevention techniques were built into Metro's original design, the system presents an example of a comprehen-

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sive design that avoids the pitfalls of measures that are implemented after a crime problem has already emerged.

These characteristics make Metro an excellent setting in which to test the comprehensive application of crime prevention principles in a "built-in" design. Thus, this paper poses two research questions: (1) Is Metro safer than one would expect, given the incidence and prevalence of crime on other subway systems and crime occurring in communities that Metro serves?, and (2) Is Metro's unusually low crime rate explained by its environment[1]—the way the system is designed, managed and maintained?

Demonstrating that Metro's environment explains its unusually low crime rates—or that its crime rates are unusually low—is not an easy task. Metro's design is highly uniform from station to station, a characteristic of the system that its architects deliberately planned to ensure that riders could recognize and use the system with ease. The only differences among stations that do exist — such as whether the station is elevated, the length of the escalators and whether the station connects two or more lines — are characteristics that are either unavoidable due to construction restrictions, or necessary to serve the needs of Metro's ridership. Likewise, the maintenance of Metro's stations is stringent throughout: graffiti and litter are removed within hours; lights are replaced promptly; and structures damaged by vandalism or wear and tear are removed or repaired immediately.

Metro's uniformity in design and maintenance, while exemplary, nonetheless makes it difficult to test the impact that design might have on crime within the system: the lack of variation in design and maintenance variables would yield little in the way of statistically significant results. Because Metro's design has remained uniform from its inception in 1976, and because there was no subway system in place before that time, this topic does not lend itself to an interrupted time-series design, as there is no appropriate "before" and "after." Nor are other traditional forms of quasi-experimental designs suitable for this study; due to the vast differences between subway systems, the use of a "control" subway system is inappropriate. Given these design limitations, this study requires a series of tests that build upon one another.

The results of no single test within this study can prove or disprove a causal relationship between Metro's environment and crime, and it should be noted that the claim to have "proven" a causal relationship in the social sciences is a highly suspect achievement, no matter how rigorous the research design. The argument for this research design is that, in combination, these tests will make a strong case that a relationship between Metro's environment and crime does or does not exist.

This paper is presented in several sections. First, the research design is set out, with descriptions of the analyses conducted to answer this study's research questions. Next, a description of Metro's environment and how it relates to theories and practical applications of crime prevention is provided. This description is followed by a comparison of Metro's crime rates to those of other systems, a comparison of Metro's variation in crime to that of Washington, DC above ground and a comparison of trends in crime rates over time for Metro versus DC. These analyses are followed by a discussion of rival hypotheses, which precede the summary and conclusions.

METHODOLOGY

As mentioned above, this study set out to answer two research questions: (1) is Metro safer than one would expect; and (2) is Metro's safety explained by its environment? These questions cannot be answered with traditional quasi-experimental designs, so a series of tests were developed that, in combination, should create a strong case that the answer to these research questions is either negative or affirmative.

The first step in this process is to determine whether there is good reason to suspect that Metro's characteristics would prevent crime. If this cannot be established, there is little use in proceeding with the remaining analyses, as we would be unable to tie crime rates to prevention in any meaningful way. Further, Metro's success (if indeed it is demonstrated) could hardly be explained by preventive characteristics that do not exist. Thus, the first test is to review the history behind Metro's design and assess Metro's environment to determine the extent to which it embodies characteristics of crime prevention that theory suggests would be successful.

Given that Metro's environment scores high on preventive characteristics, this paper moves to the question of whether the system's crime rates are unusually low. This question is explored by comparing Metro's crime rates to those of three comparable subway systems through an ANOVA and a series of significance tests designed to determine if Metro's crime rates are significantly lower than those of the comparison systems.

The finding that Metro's crime rates are significantly lower than other subway systems' would suggest that its environment is to be credited with this difference. Additional tests of Metro's environment, however, should explore the extent to which Metro has been able to insulate itself from variations and trends occurring in the corresponding areas above ground. This question is explored with three tests. First, Pearson correlation coefficients measuring the degree of association between the crime rates of the Metro and those above ground in census tracts where Metro stations are located are assessed. The argument here is that if Metro's environment explains its low crime rates, then one would expect no significant correlations in crime rates between Metro stations and the areas directly above the stations. One would also expect Metro's variation in crime rates across subway stations to be low relative to that of the above-ground areas, a point examined through F-tests comparing coefficients of relative variation for crimes in the Metro versus those occurring above ground in census tracts where Metro stations are located. Finally, a comparison of trends over time for Metro crime rates versus crime rates above ground in Washington, DC is conducted to determine the extent to which crime rates covary over time.

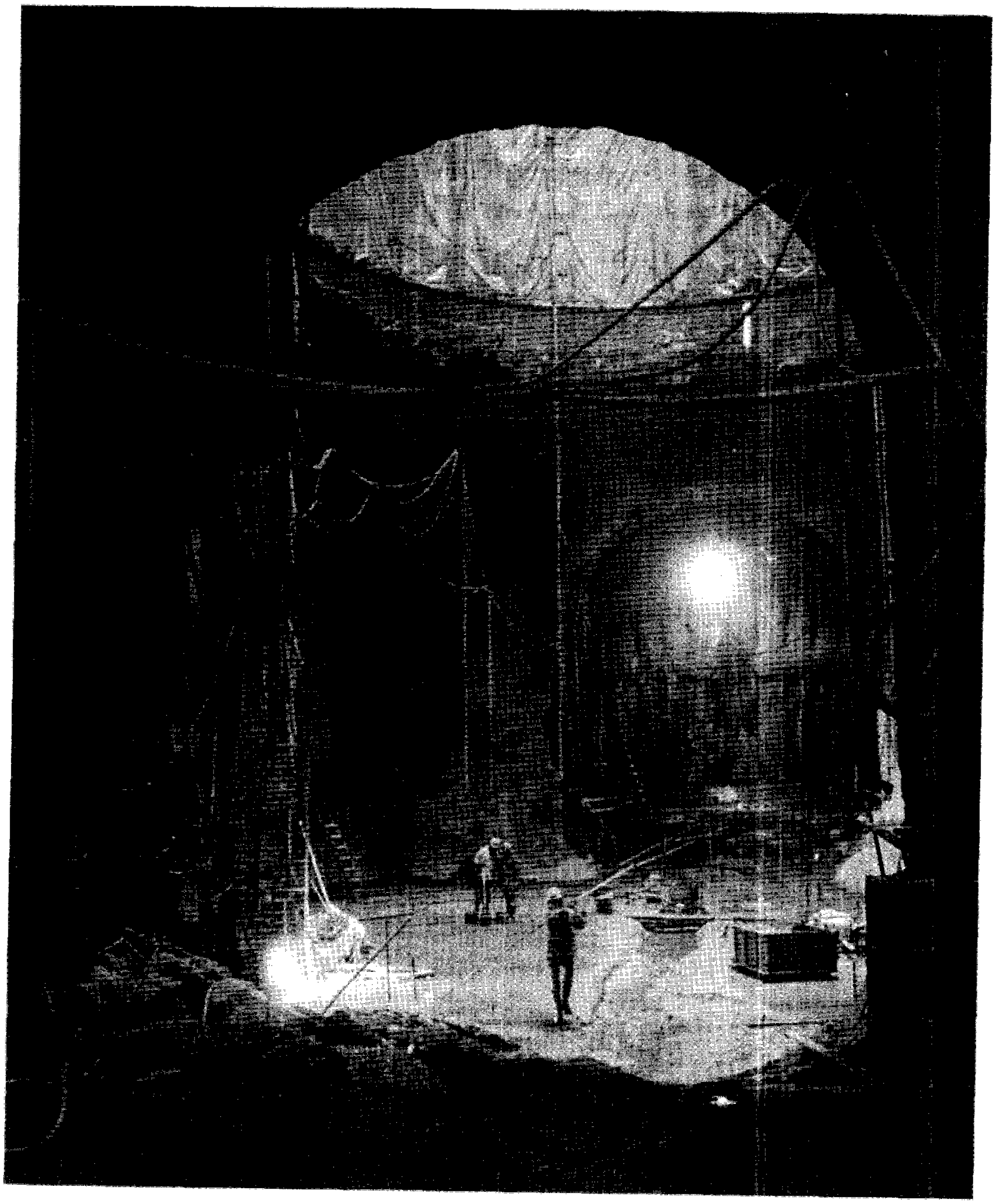
FINDINGS

Metro's Environment

Metro's planners faced a multitude of concerns in designing the rapid transportation system, not the least of which was to ensure the safety and security of its passengers and the residents living in areas serviced by the system. Concern about passenger security was underscored by the fact that, even in Metro's early planning stages in the 1960s, Washington, DC had the tenth highest crime rate in the country (Hyde, 1993).

The major players involved in the planning of Metro included the Chicago engineering firm of Deleuw, Cather & Co., and Harry M. Weese & Associates, an architectural firm also based in Chicago. These architects and engineers were joined in the early 1970s by Angus MacLean, hired to be the first chief of the Metro Transit Police, and John Hyde, hired as Deputy Chief, both of whom contributed to the planning process during its early stages in the hope that their security suggestions could be integrated into the architects' blueprints in a cost-efficient and aesthetically pleasing manner. The planning of Metro's design was also highly influenced by the involvement of the Commission on the Fine Arts (CFA), a panel composed of architects, artists and city planners that set guidelines and gave approval for all design and architectural issues relating to DCs public places. The CFA's chair, Gordon Bunshatt, directed Metro's architects to design a system with uniform architectural shapes and materials throughout in order to create a sense of identity and continuity (Deiter, 1990).

Illustration 1: Construction Site at Forest Glen Station, Metro's Deepest Station at 196 Feet Below Surface



Source: WMATA photograph by Phil Portlock, April 8, 1982.

Many have credited Metro's purported success as an example of an application of OPTED *(Nation's Cities,* 1977; Welke, 1981; Hyde, 1993). Indeed, the planning stages of Metro coincided with Jeffery's (1971, 1977) publication that coined the phrase "CPTED," and that introduced the concept of preventing crime through manipulation of the physical rather than the social environment. However, Metro's planners and architects were not operating under any pre-existing theory of the relationship between design and crime. Telephone interviews with both the original Metro Transit Police Chief Angus MacLean and his Deputy Chief John Hyde verify that Metro's design was not based on theory but rather on their years of experience with security {Hyde, 1995; MacLean, 1995). "We called it target-hardening at the time, but the same principles are referred to as CPTED today," said Hyde (1995). In addition to their reliance on prior experience in security issues, Metro's team of planners visited the world's major mass transit systems to compile the best aspects of these systems. As former chief MacLean has said, "The basic question was 'If you had to do it over again, what would you do? How would you do it?' We took the recommendations, brought them back, and that's basically what we've built" (New York State Senate Committee on Transportation, 1980).

Metro's architects and planners set out to create a design to deter criminals and make riders feel comfortable and secure (Siegel, 1995; Bocher, 1995; Hyde, 1995). "We were dealing with a clean slate. We didn't have many preconceived notions that tended to prevail. Other subway architects and designers tended to borrow directly from railroad technology and design, which tends to lack creativity. We had a creative committee [of Fine Arts] and a receptive board" (Siegel, 1995). Metro's architects were also blessed by the fortunate coincidence that many of their efforts to create good architectural form — one that was structurally sound as well as free of embellishments — also promoted a secure environment. Instead of the tension between aesthetics and security that is often observed with target-hardening and other design measures (see Weidner, this volume), these two factors were considered to make a "good marriage" (Siegel, 1995). For example, Metro's high arched ceilings resolve some structural requirements (the 600-foot platform requires high ceilings) while also providing passengers with a feeling of openness, thus reducing levels of fear.

Today, Metro consists of a route of 89 miles and 74 stations, with 9 more stations under construction; by early 2001, the total system should consist of 83 stations serving 103.06 miles. It operates from 5:30 a.m. to midnight on weekdays, and 8 a.m. to midnight on weekends and holidays to reduce operating costs when Metro services are less likely to be used. Fares on Metro are distance-based, ranging from $1.10 to $3.15, and dependent on the hours of travel, with rush-hour fares slightly more expensive than fares during off-peak times.

Metro has five lines — Orange, Green, Yellow, Red and Blue — all with different final destination points. Besides serving the District proper, Metro's lines also extend into the surrounding communities in Maryland and Virginia. Within the District, some lines share railways, enabling Metro to provide more service to within-city travelers and tourists; trains of different lines diverge at various points after leaving the District. The following discussion outlines how the specific design and management characteristics of Metro's environment were created to discourage criminals and ensure the safety of its riders.

Platforms

Metro's platforms are a uniform 600 feet long, designed to accommodate a train of eight, 75-foot-long cars. The width of the platforms is spacious, with the vaults extending as wide as 60 feet, to increase riders' perceptions of safety by ensuring an uncrowded environment. Two types of platforms exist: the single platform is a strip on either side of two tracks operating in opposite directions; the two-platform design consists of platforms on either side of two adjacent tracks operating in opposite directions. This latter platform design is found in busier metro stations and those with connections to other lines, as it provides more room for crowd control.

The platforms have a minimal number of supporting columns, which can provide cover for criminals. A high, free-standing vaulted ceiling arches above the tracks, giving the appearance of a wide-open design. As MacLean noted,"... from a security standpoint [the uniformity of stations] is very handy because you can look down and see 600 feet straight and no place to hide. Maybe if you're a little skinny thing, you might get behind one of those vent shafts, but there's not many of them." As added measures, "[e]very one of those stations has at least eight Closed-Circuit Television Cameras" and "[elvery mezzanine has a uniformed station attendant" (New York State Senate Committee on Transportation, 1980:9).

To ensure safety on the platforms during off-peak hours, trains are shortened from their maximum size of eight cars to four cars at around 8 p.m. Shorter trains keep people close together, and safety in numbers is a theory subscribed to by Metro officials (New York State Senate Committee on Transportation, 1980).

Illustration 2: Entryway at Dupont Circle, One of Metro's First Stations

Source: WMATA photograph by Paul Myatt, January 18, 1977.

Entrances, Exits and Pathways

Metro has the second-longest escalator in the world, surpassed only by one in Leningrad (Means, 1995). Planners designed lengthy escalators and stairs, used as pathways to and from the train railways, as an alternative to the winding pathways with curves and corners found in many older subway systems. Such corners were deliberately avoided because of planners' beliefs that they create shadows in which potential criminals can hide and approach their victims suddenly, and also can serve as nooks that panhandlers and homeless people like to occupy (Deiter, 1990).

Planners designed overhead crossovers at the mezzanine level of the station to serve as pathways to connecting lines and trains traveling in the opposite direction, as opposed to dark and confining tunnels below the tracks. The absence of long passageways discourages people from lingering in the station after they have disembarked from the train, reducing opportunities for crime. Some corners and passageways were unavoidable because of the installation of elevators that were built to comply with a 1970 law requiring Metro stations to be accessible to the handicapped (Deiter, 1990).

Lighting and Maintenance

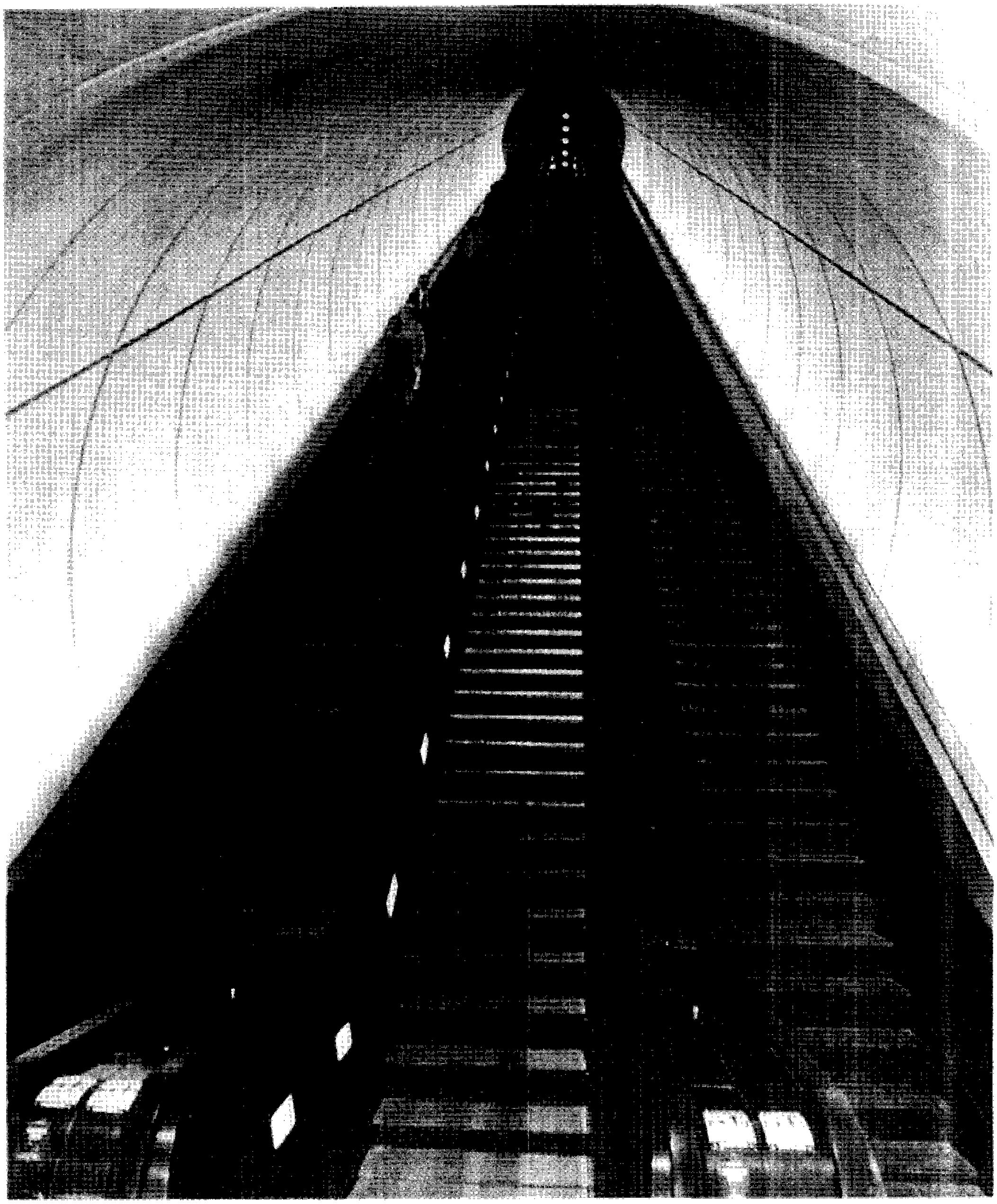
Lighting within the subway system is a minimum of one foot-candles,[2] and all new lighting is a minimum of two foot-candles. Lighting is recessed so as not to cast shadows, which can cause fear in riders and serve as cover for potential criminals. In addition, walls are indented to provide greater reflection of light. As one of Metro's original designers explained, the recessed lighting within the high arched ceilings was intended to "light the sky; enhance the environment" (Bochner, 1995; Siegel, 1995). However, the original plans for lighting resulted in pockets of dangerously dark areas, particularly under mezzanine overpasses, requiring the addition of overhead lights that were designed into later stations (Deiter, 1990).

Metro's planners chose concrete, brick, granite and bronze as the primary materials for the system because of their durability, fire-resistance and easy maintenance (Falanga, 1988). Walls are recessed and bars were installed in front of the walls in order to discourage graffiti (Deiter, 1990; Mooney, 1976). Litter bins were situated along the platform, and the *Washington Post* donated newspaper recycling bins that were installed at each station. Metro's policy is to clean graffiti and repair damages from vandalism within 24 hours.[3] Maintaining the public restrooms is not an issue, as such facilities are not available to the public in order to keep undesirable activity out of the station (Falanga, 1988).

Illustration 3: View of Metro Center Platform from Station Attendant's Kiosk

Source: WMATA, photographer unknown.

Illustration 4: Metro's Longest Escalator, at the Entry to the Wheaton Station, Extends 230 feet from Mezzanine to Platform Level



Source: WMATA photograph by Larry Levine, September 24, 1990.

Security Devices

Closed-circuit television cameras (CCTVs) are located on the end of each platform and on ceilings at entrances and exits, and are strategically placed in the few areas that could potentially offer concealment. Elevators, designed with large glass side panels to ensure greater visibility from the outside in order to deter potential criminals, are also equipped with CCTVs. Cameras are purposefully visible to riders to bolster their feelings of safety, as well as to alert potential criminals that they are being monitored. These effects, however, are often the only purposes the cameras serve. As MacLean admits, "The cameras mainly serve a psychological purpose because they read out at the station manager's kiosk, and often no one is there. If an attendant is there, they are terribly helpful" (MacLean, 1995).

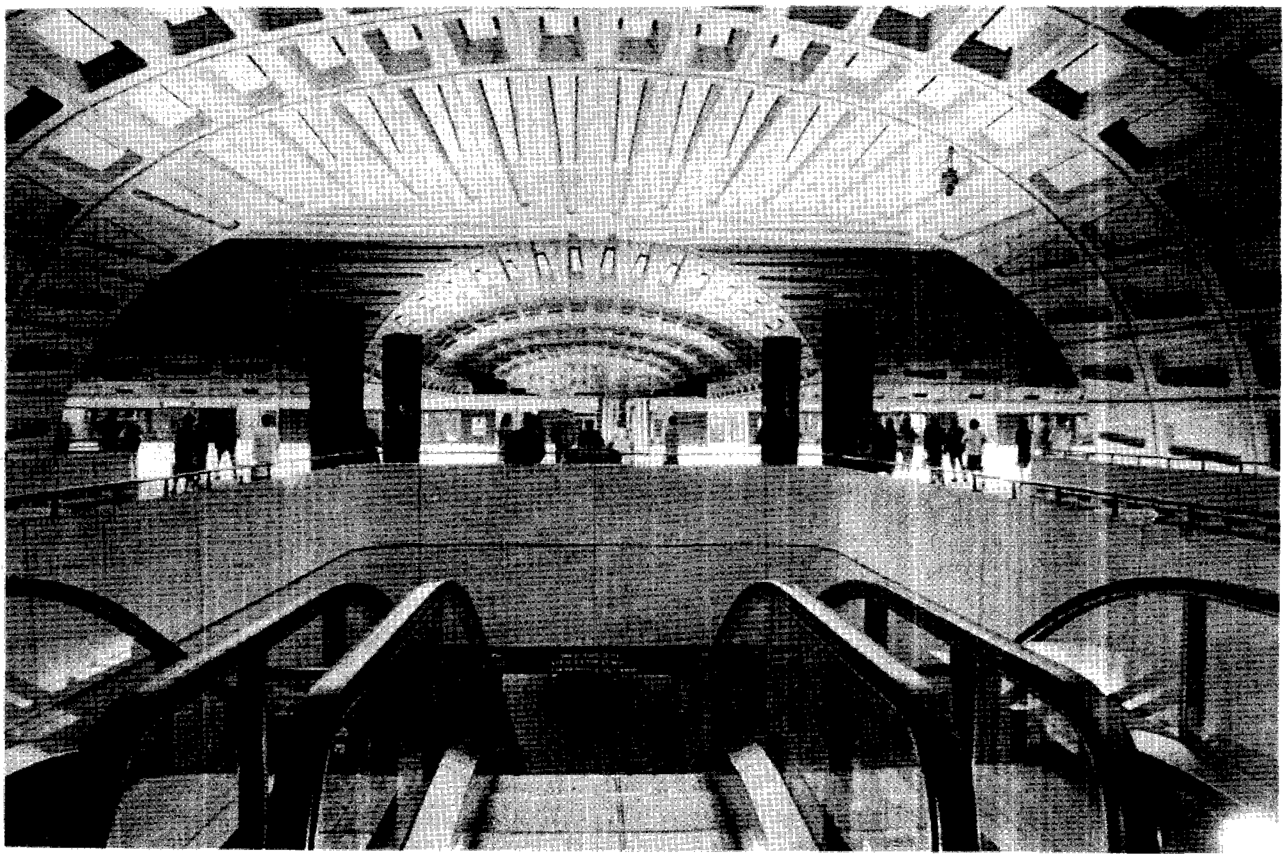
Attendants are positioned at kiosks at the entrances to the platforms to provide assistance to riders, keep an eye on potential fare evaders and monitor the CCTV screens located inside the kiosk. In addition to CCTVs, surveillance is enhanced by the high domed ceilings in the station, which allow for greater visibility to the railway below.

Another key component of Metro's security design is its communications system. All Metro employees — including maintenance personnel — are equipped with two-way radios so that they can be located or alerted at any time (MacLean, 1995). In addition, passenger-to-operator intercoms exist on each rail car to enable passengers to alert drivers of dangerous situations or crimes in progress. Blue light boxes with emergency phones and Power Take Down buttons are located every 600 feet along the right of way.

Signage

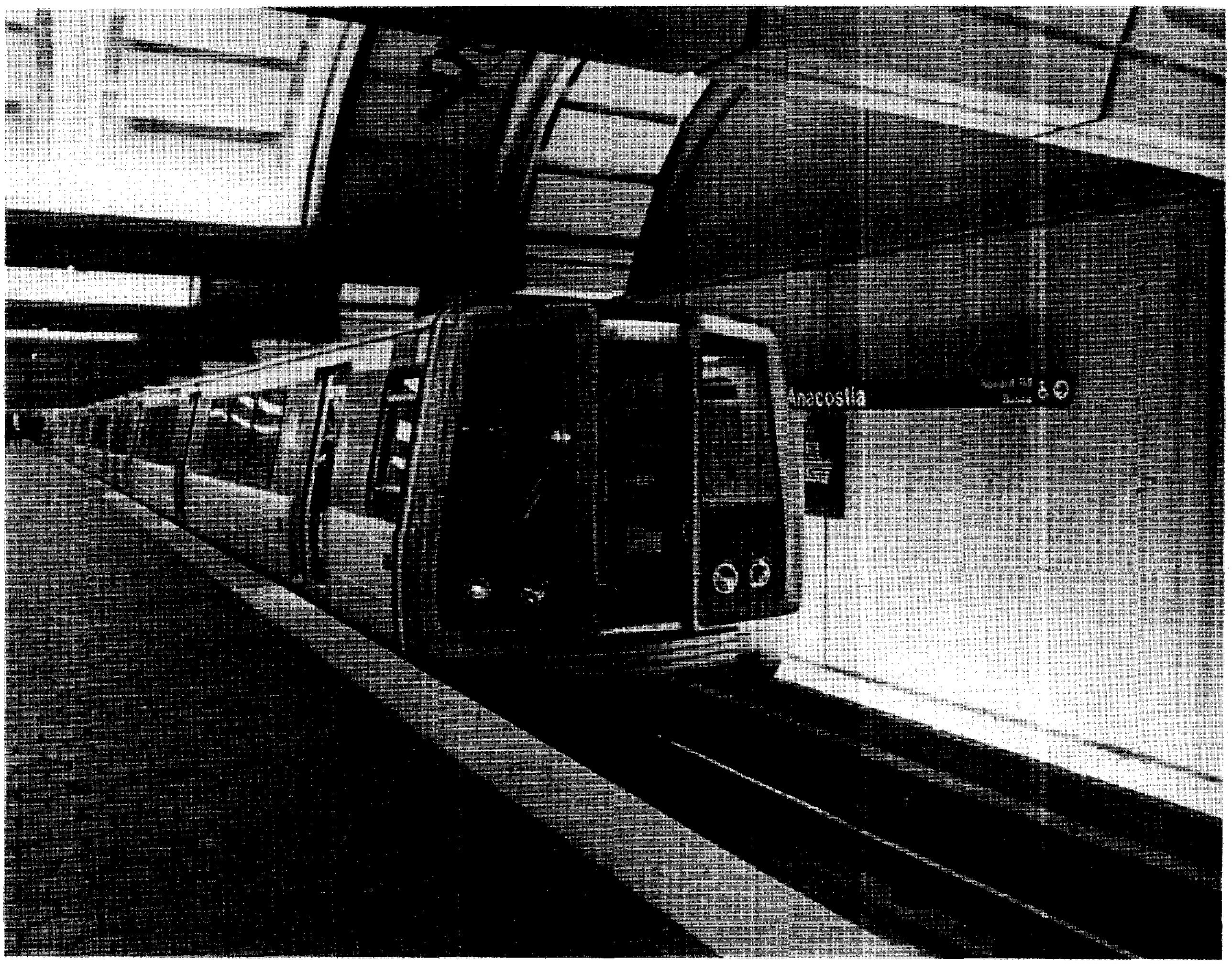
The original design of Metro's stations called for a minimum of signs on the station platforms. However, economic considerations revived the architectural firm's idea of placing backlit panels in spaced intervals along the platform for advertising purposes. These panels also display system maps, which were originally intended to appear only at mezzanine level. Station names and directions of system lines are listed vertically on pylons, and also duplicated at eye level on walls. The scarcity of directional signs is probably the weakest element of Metro's system, and even today this problem is criticized by riders despite repeated efforts to improve visibility (McGhee, 1995; Silver, 1995; LeCam, 1995). It appears that the minimal number of signs may be Metro's sole example of a conflict between form and function — a conflict that form wins hands down.

Illustration 5: Example of Metro's High Arched Ceilings at Metro Center



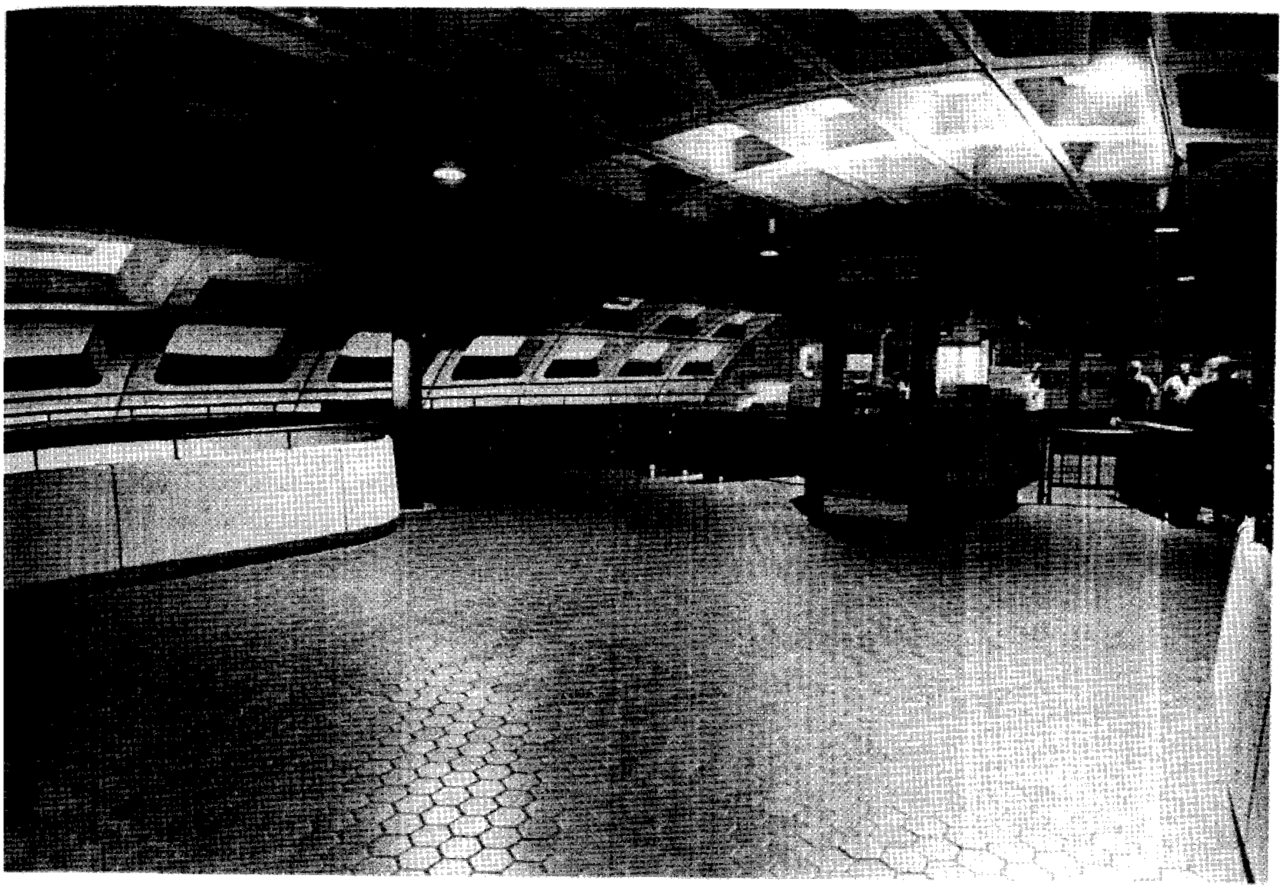
Source: WMATA photograph by *Larry* Levine, February 28, 1992,

Illustration 6: Example of CCTV Surveillance at Anacostia, One of Metro's Newer Stations



Source: WMATA photography by Larry Levine, January 8, 1992,

Illustration 7: Judiciary Square's Station Attendant Kiosk, with Fareeard Vending Machines in Foreground



Source: WMATA photography by Larry Levine, August 14, 1992.

Money-Handling Policies

Metro's Farecard system limits cash transactions and prevents fare evasion. Unlike token systems, which are susceptible to the use of slugs and require a separate token for each ride, the Farecard system allows passengers to purchase cards of any dollar amount. The cards can be used for multiple trips and enable passengers to reduce the frequency with which they must exchange cash for fares (and expose their wallets to pickpocketers). Metro encourages riders to buy high-dollar Farecards by providing a 10% bonus on all cards of 20 dollars or more.

Farecards have magnetic strips encoded with the dollar value of the card. Riders insert cards in a reader at the entry gate, which encodes the card with the boarding station and ejects it at the other end of the gate. When riders exit at the destination station, they again insert the Farecard, which calculates and deducts the fare amount from origin to destination. The card is emitted at the other end of the gate if it has a positive balance, or is retained if the dollar value is equal to the fare. When the dollar value on the Farecard is less than the fare, the encoding machine rejects the card and the passenger must use an "Add Fare" machine to make up the difference in the value of the card prior to exiting. Because Metro's distance-based fares require use of the Farecard at both entry and exit, the risk of being detected evading a fare is double that of a traditional token system.

Currently, Metro officials are experimenting with "Go Cards," which operate like Farecards that can be coded with any dollar amount ranging from $1 to $45. However, Go Cards differ from Farecards in that their value is coded by computer chip, which allows the passenger to walk through a special gate that scans the card without requiring the passenger to remove it from his or her wallet. The value of the trip is automatically deducted from the computer chip's memory, and the card can be deactivated if it is lost or stolen. Go Cards can also be used to pay parking fees; they are currently being tested by Metro employees at selected stations throughout the system.

With the exception of Farecard and newspaper vending machines, Metro planners allowed no other commercial activity in the stations in order to deter criminal activity (Deiter, 1990).

Metro Transit Police and Personnel

Metro's transit police force, consisting of approximately 286 sworn officers and officials, is trained to be vigilant and take immediate action toward "quality of life" violations by making arrests and issuing citations (Morrow, 1994). Riders are prohibited from eating, drinking, smoking, playing radios, transporting animals or moving from one rail car to another. These rules are clearly posted at the entrance and exit to the station platforms, as well as on the rail cars themselves, and they are stringently enforced by Metro police. In fact, in Metro's early years, there was a great deal of criticism by the media that transit police were too aggressive in enforcing the rules against prohibited behaviors, but the transit police continued their zero-tolerance approach (New York State Senate Committee on Transportation, 1980).[4] According to MacLean (1995), the transit police are so vigilant that "Even today the word around town is 'if you want to commit crime do it on the streets, you'll get caught doing it downstairs.'" Transit police also have a role in maintaining Metro's pristine environment. From the outset, officers have been trained that a component of their job is to report any maintenance problems, such as burnt-out lights, to the maintenance department (Hyde, 1995).

In addition to formal surveillance of the system, station attendants have an important role in contributing to Metro's safe environment. They are trained to intervene, usually through the use of the public address system, and to notify riders if they are committing violations. It has been this author's observation on countless occasions, while waiting on the platform for a train, that over the loudspeakers blasts "Please dispose of your beverage," or a similar reprimand. Despite what some consider to be an unpleasant "Big Brother" mentality of kiosk attendants, this approach is an important component of Metro's security philosophy.

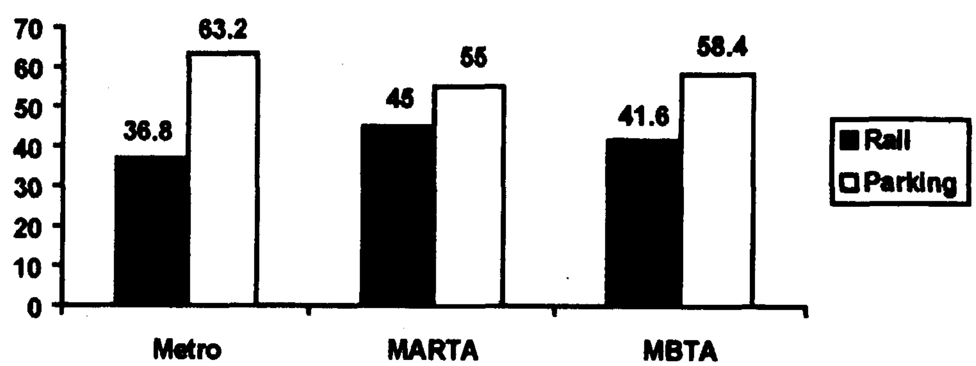
Summary of Environmental Characteristics

To summarize, Metro's environment incorporates most of the opportunity-reducing characteristics found in Clarke and Homel's (in press) 16 Situational Crime Prevention Techniques. While an itemization of each design characteristic and how it relates to individual crime prevention techniques is beyond the scope of this paper, a few are summarized here (see also Lôpez, 1996). Metro scores high on visibility, and this open environment is assisted by CCTV cameras, which optimize formal, employee and natural surveillance capabilities. Second, the environment is well-lit and well-maintained, contributing to the overall feeling of safety among Metro users. The system's rigorous maintenance policies also reduce the rewards of vandalism and graffiti to offenders — they are deprived of the pleasure of enjoying their work because it is repaired or removed within hours. Further, rule and law enforcement on the system is stringent, inducing guilt and shame among rule violators and sending a message to would-be criminals that even the most minor of violations will be observed and even the most petty of offenders apprehended. In conclusion, Metro's careful plan to create an attractive, comfortable and safe environment for its riders appears, at least in theory, to be a success.

Comparison of Rates on Subway Systems

The most obvious means of determining whether Metro's crime rates are lower than one would expect is to compare them to rates of other subway systems. While on its face this appears a simple task, differences in reporting and record-keeping practices of transit systems present difficulties in making accurate comparisons across subway systems. For example, as Figure 1 indicates, much of the serious crime on subway systems occurs outside of subway stations, particularly in and around commuter parking lots, so a comparison of crime on different systems could be misleading; one system could appear to have much higher crime rates than another, when in fact it may have twice as many commuter parking lots. Thus, a truly thorough comparison of crime rates among a number of subway systems requires data that disaggregate above-ground crimes from those occurring below ground or within the subway station. These detailed data are not always collected by transit police and when such data exist, they tend to be difficult to obtain from authorities.

Figure 1: Percentage Distribution of Subway Crime by Location: Rail versus Parking Lots



Because of the difficulties in obtaining crime data that disaggregates above- and below-ground crimes, this comparison of crime rates examines just four subway systems: Metro, Atlanta (MARTA), Boston (MBTA) and Chicago (CTA). It should be acknowledged that these systems are far from identical in terms of important factors such as ridership demographics, number of riders, number of stations or route miles. However, this sample is not strictly one of convenience, as care was taken to choose systems that are similar in size and service area but varied in design characteristics.

Table 1 outlines the differences and similarities among the systems chosen for this analysis. Metro, MBTA and CTA are similar in terms of daily ridership, but differ in terms of route miles and number of stations. MARTA is much smaller than the other systems in terms of riders, mileage and stations, and is the newest of the systems, beginning operations in 1979 —just three years after Metro. Thus, MARTA's relative youth makes it a good comparison system for Metro because its planners, like Metro's, were able to benefit from the successes and failures of other systems, as well as from a greater knowledge of crime prevention tactics. Like Boston, CTA is an old system; its first elevated line was constructed in 1892, and its first subways began running in 1943. CTA is the only system that operates 24 hours per day, with Metro, MARTA, and MBTA opening between 5 a.m. and 6 a.m. and closing between midnight and 1:30 a.m. For comparison purposes, the percentage of CTA's crimes occurring

Table 1: Comparison of Characteristics for Washington, Boston, Atlanta, and Chicago Subway Systems

Subway System	Daily Ridership	Route Miles	Stations	Year Established
Metro	500,000	89	74	1976
Boston (MBTA)	562,000	80	101	1897
Atlanta (MARTA)	219,000	40	33	1979
Chicago (CTA)	424,000	191	117[5]	1943

Sources: Washington Metropolitan Area Transit Authority, Metropolitan Boston Transit Authority, Metropolitan Atlanta Rapid Transit Authority, Chicago Transit Authority.

between 1 a.m. and 6 a.m. was subtracted from total crime counts before rates per 1 million riders were calculated.

F-tests of ANOVA results reveal that Metro's mean crime rate, at just 1.7 per million riders, is significantly lower than the rate of the other three systems (F = 8.45, p .001), and that Boston's and Atlanta's rates, at 7.81 and 8.85 respectively, do not differ significantly. Chicago's mean rate of 12.05 is significantly higher than Metro's, Boston's and Atlanta's (see Table 2).[5] While the sample of subway systems is very small, this finding of much lower Part I rates on Metro supports the hypothesis that Metro's crime rates are unusually low compared to other subway systems.

Table 2: Analysis of Differences of Mean Part I Crime Rates (per 1 million riders) on Four Subway Systems

Groups	No. of Stations	Mean	Standard Dev.	Standard Error	F
A. Metro	74	1.70	1.72	.20	8.45*
B. MARTA	33	8.85	6.07	1.06	
C. MBTA	68	7.81	12.03	1.46	
D. CTA	79	12.05	19.68	2.21	
Contrasts	**Coefficient**	**Standard Error**	**t-Value**	**Signif. *t***	
1. X_A-X_B	7.15	2.69	2.66	.008	
2. X_A-X_C	6.10	2.16	2.83	.008	
3. X_A-X_D	10.35	2.08	4.98	.000	
4. X_B-X_C	1.04	2.73	.38	.702	
5. X_B-X_D	3.20	3.16	1.01	.310	
6. X_C-X_D	4.24	2.12	1.99	.047	

*p<.001.

Sources: Washington Area Metropolitan Transit Authority Transit Police, Metropolitan Atlanta Rapid Transit Authority Transit Police, Metropolitan Boston Transit Authority Transit Police, and Chicago Police Department

Correlations between Metro and Above-Ground Crime

An examination of the independence of Metro's crime rates from the rates of the neighborhoods it serves is another means of testing the system's security. With the exception of Clarke et al. (this volume), prior research suggests that subway stations with the highest crime rates are located in high-crime areas (Shellow et al., 1974; Richards and Hoel, 1980; Falanga, 1988). If Metro's underground environment deters criminals even when they are perpetrating crimes directly overhead, one would expect a departure from prior research findings: Metro's crime rates should not be significantly positively correlated with those above ground.

A Pearson Correlation matrix of crime on Metro versus that above ground by census tract[6] for the crimes of robbery, aggravated assault and total Part I crimes,[7] indicates no significant correlations between the two data sets. An examination of scatterplots indicates that, with the exception of aggravated assault, outliers are not driving the coefficients. After excluding two outliers that appeared to be wielding undue influence on the correlations, however, the relationship between above-ground assaults by census tract and below-ground assaults by Metro station is positive and significant, at .4459 (p=.000). This unexpected finding raises a question as to whether Metro is not as successful in insulating itself from some above-ground crimes as it is from others, a question that is explored in the following section.

Table 3: Correlation Coefficients for Metro versus Above-Ground Crime Rates (N=74)

	ABOVE-GROUND CRIME		
METRO CRIME	**Assault**	**Robbery**	**Part I**
Assault	.184	.089	.073
	p=.117	p=.451	p=.535
Robbery	-.104	-.102	-.107
	p=.378	p=.388	p=.365
Part I	.165	.077	.076
	p=.159	p=.515	p=.517

Variation in Metro versus Above-Ground Crime

A different means of determining the extent to which Metro's crime rates are influenced by those occurring above ground involves an analysis of coefficients of relative variation for crime rates for the two data sets. This test is based on the premise that if Metro's environment is structured in such a way as to reduce criminal opportunities, one would expect little variation from station to station, compared to that occurring above ground. Washington, DC has great variations in crime rates above ground, with most of northwest DC being quite safe and pockets of high-crime areas existing in the northeast, southeast and southwest quadrants of the District (Gebhardt, 1996). The argument put forth here is that if Metro is doing its job, the underground environment should reflect little of this above-ground variation.

For this test, variations are measured by calculating each variable's coefficient of relative variation, which is simply the variable's standard deviation divided by its mean. Comparing coefficients of variation allows one to assess the *relative* difference in variation between variables that may have dramatically different ranges (Weisberg, 1992).

Coefficients were calculated for both data sets for the crimes of robbery, aggravated assault and total Part I crimes. As Table 4 indicates, variations are significantly smaller on Metro for Part I crimes and robberies. For assaults, although Metro's coefficients are smaller than those for above-ground rates, they do not differ significantly.[8] Again, the crime of assault is not meeting expectations; it appears that Metro is not successful in insulating itself against assaults occurring above ground in the immediate area that it serves.

These unexpected findings for assault may be explained by the journey-to-crime literature. Prior research on offender journeys suggests that 39% of aggravated assault offenders (Rand, 1986) and 66% of rapists (Amir, 1971) commit these offenses in their own neighborhoods, versus just 14% of robbers (Normandeau, 1968) and 15% of those committing larcenies (Rand, 1986). If assaults are much more likely to be committed by those living in the immediate vicinity of the Metro station, as this literature suggests, one would expect to see a smaller above-and below-ground variation in assault rates than in robberies and total Part I crime, which are mostly composed of larcenies.

Another explanation for the small difference in variations for assault is the nature of the act itself. The genesis for an assault may commence underground, but actually take place above or vice versa. Thus, it is possible that because assaults are less likely to begin and end in the same location, the difference between crime settings is less distinct to such offenders, and therefore the preventive capabilities of Metro are less likely to influence offending behavior.

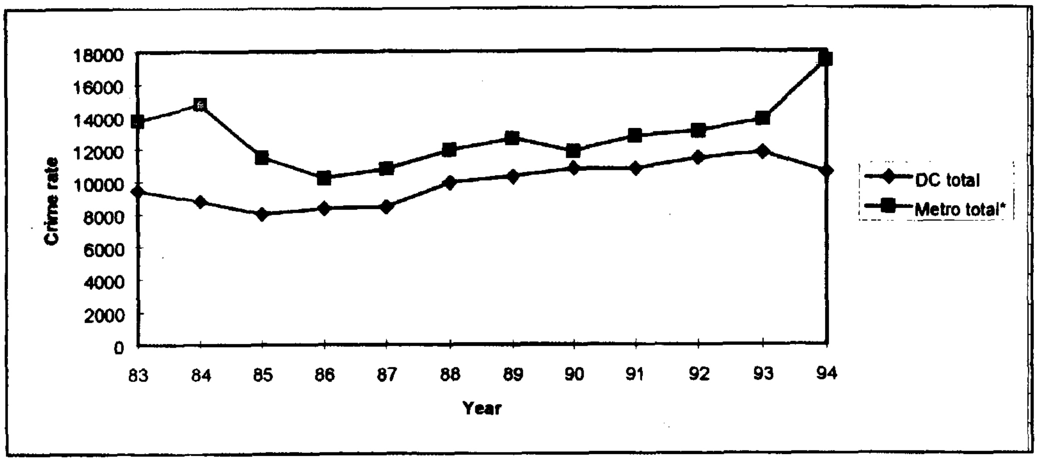
Table 4: Comparison of Coefficients of Relative Variation — Metro Versus Above-Ground Crime Rates

	Assault	**Robbery**	**Part I Crimes**
Metro Crime Rates (including car parks, bus bays, and other above-ground Metro property) N=74	2.45	1.96	1.49
Above-Ground Crime Rates by Census Tract N=74	2.56	2.82	3.19
F value:	F=1.09	F=2.07	F=4.60
Significance:	p>.25	p<.01	p<.001

Comparison of Crime Trends

The tests above, while not entirely supportive, nonetheless build an argument that Metro is indeed safer than one would expect, and that its environment has been successful in insulating itself against crime, even when it occurs directly overhead. Another means of testing this hypothesis is to determine the degree to which Metro crime rates and above-ground crime rates covary over time. Prior research indicates that crime in the New York City subway varies in the same way as crime in the rest of New York City over time (Del Castillo, 1992), and the same has been found for the London Underground (Department of Transport, 1986). Thus, the logic behind this test is that if Metro's environment has been successful in insulating itself against crime, regardless of crime above ground, one would expect to see little or no similarity in variations over time for Metro vis-a-vis variations in crime above ground.[9]

Figure 2: Comparison of Metro and DC Total Crime Rate Trends, 1983-1994 (per 1 million riders/100k inhabitants)

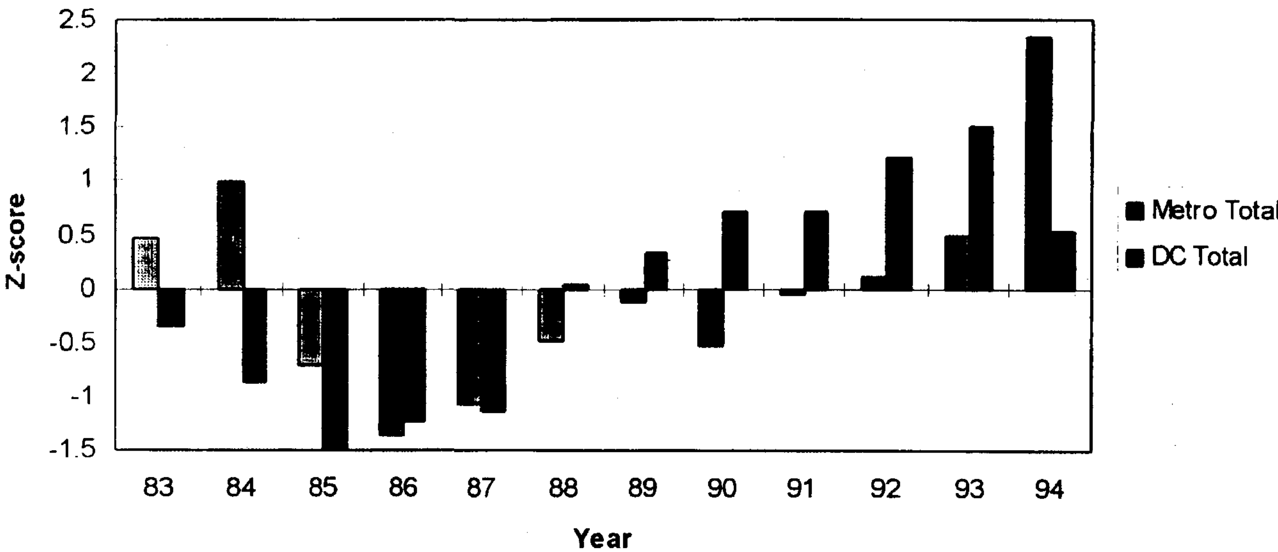


Source: Washington Metropolitan Area Transit Association and FBI Uniform Crime Reports. (*Metro crime rates multiplied by five for comparison purposes.)

The first iteration of this test is to compare crime rates over time. Figure 2 depicts total crime rates for the District of Columbia versus Metro. The Washington crimes are per 100,000 inhabitants, while Metro crimes are per 1,000,000 riders; to make the two data sets suitable for graphical comparison purposes, the Metro data were multiplied by 5 for total crimes. Visually, it appears that these two trend lines do not covary consistently, although the two trends for the years of 1986 to 1989, and 1991 to 1993, look similar.

An alternative to comparing trend lines, which offer a somewhat skewed visual depiction because the two data sets have different denominators and are scaled differently, is to compare rates after they are standardized as Z-scores. Figure 3 depicts the changes in Z-scores for the total crime rates of each data set over time.

**Figure 3: Comparison of Trends for Metro versus DC, 1983-1994
Standardized Total Rates (per rider/inhabitant) Represented as Z-Scores**



Source: Washington Metropolitan Area Transit Association and FBI Uniform Crime Report.

In comparing changes in Z-scores over time, half of the pairs changed in the same direction, and the other half changed in opposite directions. It appears, then, that changes in crime rates over time for Washington above ground are not mirrored by Metro crimes below.

Rival Hypotheses

The apparent weakness of this paper's research design is that other rival explanations exist that might explain Metro's unusually low crime rates. Some may argue, for example, that Metro has such low crime rates because riders do not represent a cross-section of DCs population; rather, they are predominantly white, middle- to upper-middle-class working people. An analysis of a 1991 Metro ridership survey conducted in a previous study indicates that Metro riders are more advantaged than the general population (measured as those residing in the DC Standard Metropolitan Statistical Area [SMSA]) in terms of employment, income and education, but they are roughly representative of the population in terms of racial representation, and, on average, are much younger than the general population (La Vigne, 1996).

These findings suggest that the argument that Metro riders are more advantaged than the overall DC SMSA population may have some validity to it. However, the survey did not include all those riders living in areas that Metro currently serves, because it does not capture riders using Metro's green line stations, which did not begin operating until mid-1991 and which were expanded up through 1993. These green line stations are located in areas with lower income levels and higher unemployment than most other Metro station locations. In addition, the survey did not capture two important Metro rider subpopulations: tourists and persons under the age of 18, such as college and high-school students who ride Metro to and from school. While one would guess that tourists are much more likely to be victims than offenders, students and youths in general are more prone to offending than working people.

Another way of exploring this hypothesis is to examine changes in crime rates as Metro expanded its service area. Some believe that Metro's unusually low crime rates are explained by the fact that Metro serves a very small area, and that the area it serves is predominantly white and middle- to upper-class. This argument became significantly less valid in 1991, when Metro's new green line began serving some high-crime, inner-city points and southeast to Anacostia, adding six stations. By the end of 1993, the green line was further extended northwest to Greenbelt, adding another four stations. However, a prior analysis of crime rate trends before and after this additional construction does not indicate a significant increase in crime rates for total crimes, Part I property crimes or Part I violent crimes (La Vigne, 1996). Looking more specifically at crime types, auto theft, pick pocketing and assault declined from 1989 to 1995, while robbery increased slightly and grand larceny increased more markedly (La

Vigne, 1996). These trends do not suggest a dramatic change in crime following the addition of the green line, which can be interpreted as further supporting the hypothesis that Metro has been relatively successful in insulating itself against crime occurring above ground.

Given the information at hand, the argument that Metro riders are more advantaged than the general population can be neither refuted nor supported on statistical grounds. The ridership and service area arguments are, in themselves, troublesome because their assumptions have little or no basis in prior research. The ridership argument implies that regular subway riders are the same people who are perpetrating crimes, rather than the occasional, opportunistic rider or the potential offender who loiters above ground without paying a fare and using the system. There is no basis in prior research or theory to support or refute this hypothesis. The service area argument suggests that the type of people who offend are in a racial minority, poor, uneducated and unemployed. One does not have to search far in the literature to refute such an argument (see Gabor's [1994] *'Everybody Does It!': Crime by the Public).* Suffice it to say that the answer cannot be gleaned from the data at hand, but that there is no convincing support for these rival hypotheses.

The other criticism addressed here does not question the fact that Metro's environment has been successful in preventing crime. However, it argues that these findings have limited generalizability because most systems do not have the amount of money to spend maintaining, operating and policing their systems that Metro has. This premise is investigated through a comparison of operating expenses and capital-funding levels among subway systems. A prior analysis indicated that Metro falls somewhere in the middle of a sample of subway systems in terms of expenses per passenger mile and vehicle mile, as well as for capital funding (La Vigne, 1996). Thus, Metro does not appear to devote substantially more funds to its system than other subway systems, suggesting that the amount of money a system invests does not appear to predict how much crime occurs there.

SUMMARY AND CONCLUSIONS

The impetus for this paper stemmed from the need to explore and document the purported success of Metro as an application of crime prevention measures in a mass transit system that were built in at the creation of the system, rather than retrofitted. While Metro authorities did not intentionally apply a specific theory to the philosophy behind the planning of its environment, this philosophy is nonetheless compatible with theories of crime prevention, making this study a means of testing the comprehensive application of crime prevention principles in a built-in design. Thus, this paper set out to answer two research questions: (1) Is Metro safer than one would expect, given the incidence and prevalence of crime on other subway systems and crime occurring in the communities Metro serves?, and (2) Is Metro's unusually low crime rate explained by its environment — the way the system is designed, managed and maintained?

Is Metro Safer Than One Would Expect?

Tests of Metro's crime rates compared to three other systems for which detailed data were available provides evidence of its success, as Metro experiences significantly fewer serious crimes per rider than comparison systems. While data access difficulties precluded a comparison between Metro and a larger range of subway systems, the systems examined here are similar to Metro in size and service area, and, despite the age or design of the comparison system, Metro's crime rates are only a small fraction of the other systems'.

Is Metro's Safety Explained by Its Environment?

The second question, is Metro's safety explained by its environment, was assessed through an examination of the crime prevention characteristics built into Metro, and a series of tests conducted to determine the extent to which Metro has succeeded in insulating itself from crime occurring outside the system. An assessment of Metro's environment suggests that it has the majority of opportunity-reducing characteristics recommended by both theory and practice. The system is clean, well-lighted, has excellent opportunities for natural and employee surveillance, and both rules and laws are strictly enforced. Judging from Metro's environmental characteristics alone, one would expect the system to have low crime rates and be relatively crime-neutral, rather than attracting or generating crime.

Metro also experiences less crime than one would expect given the distribution of crime above ground in communities that Metro serves. With the exception of assaults, Metro crime rates by station do not covary with crime rates for the census tracts in which Metro stations are located. However, the relationship between above-ground assaults by census tract and below-ground assaults by Metro is positive and significant, suggesting that assaults may not be as situationally influenced as other crime types.

The idea that offenders are less willing to perpetrate crimes on Metro property than in the areas around it is also supported by the fact that Metro demonstrates less variation in crime rates from station to station as compared to census tract variations, indicating that the system does not reflect crime occurring above ground. In addition, a comparison of crime rates over time for Metro versus Washington, DC indicates that these trends do not co-vary, again supporting the notion that Metro crime rates are independent of those occurring above ground.

Implications for Theory and Practice

The tests conducted above, when considered in combination, support the position that Metro is unusually safe and that there is something unique about its environment that explains its low crime rates. The fact that Metro's design characteristics and maintenance and management policies reflect well-established crime prevention principles supports the hypothesis that what is special about Metro's environment is that it reduces criminal opportunities. Metro's success suggests that it is indeed possible to manipulate environments to reduce criminal opportunities. Further, it implies that offenders *do* consider the costs and benefits of their actions, weighing the risks of apprehension versus the effort and expected payoff, and considering the presence of capable guardians when weighing those risks.

Characteristics of Metro's environment, from design elements to enforcement strategies, can be applied to new or existing systems in an effort to reduce crime. While prior research indicates that the base rates of subway crime are quite low, and that individuals have a greater risk of victimization above ground than below (Del Castillo, 1992; Kenney, 1987), increasing security on subway systems is an important public policy objective. Fear of victimization has been found to be greater underground than above (Wekerle and Whitzman, 1995; Levy, 1994; Kenney, 1987; Schnell et al., 1973). Because levels of passenger fear have an impact on ridership, they also have widespread implications for urban policy, including issues of traffic congestion and pollution created by alternative modes of transportation such as taxicabs, buses and private automobiles. These indirect costs not only affect the system itself, but are ultimately translated into higher sales taxes and cutbacks in governmental services. Thus, the benefits of implementing crime prevention tactics on subways are far-reaching; reducing subway crime saves money and increases revenues at the same time, as riders will be more willing to use the system. In an urban area, the well-being of a subway system, in terms of low crime rates and ample ridership, can affect the well-being of the entire metropolitan area.

Further Research

The fact that this study's hypotheses were supported by the tests detailed above has important implications for crime prevention. The majority of evaluations of crime prevention efforts focus on interventions to address pre-existing crime problems, and these evaluations tend to study the impact of an intervention over a relatively short time period (see Felson et al., Bichler and Clarke. Weidner, and Brantingham and Brantingham, this volume). Counter to this typical approach to crime prevention evaluation, this study enables us not only to determine the impact of a comprehensive preventive effort created before a crime problem occurred, but also to assess the impact of these measures over a period of almost 20 years. Metro has had plenty of time to fail, and yet it remains as relatively crime-free as the day it began operating in 1976. This is particularly impressive considering that Washington, DC still ranks high in crime rates among cities of comparable size.[10]

Quite often in crime prevention studies, evaluations are criticized because of the difficulties in disentangling preventive measures to determine which specific tactics are having an impact on crime. Indeed, scholars have rendered evaluations of what have been termed "modification blitzes" as unhelpful from both a theoretical and policy perspective (Rubenstein et al., 1980). It is important to remember, however, that researchers are rarely involved in the intervention stage of a preventive effort, and therefore have little control over the measures implemented. In the real world, it is extremely rare for a crime problem to be addressed with a single preventive tactic. This should not, however, render these preventive efforts as unworthy of evaluation, as there is a great deal to be learned from assessments such as the one conducted in this study. Further efforts to evaluate a mix of preventive measures should be encouraged, rather than dismissed as fruitless. In addition, studies of subway offenders — in terms of who they are, where they live, where they commit their crimes and what kinds of crime they commit — are sorely needed if researchers are to truly understand the nature and distribution of subway crime and how it can be prevented.

✦

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NOTES

1. In the interests of avoiding verbosity, "environment" will be used hereafter to refer to this combination of factors (design, management and maintenance).

2. A foot-candle is a measure of illumination. One foot-candle illuminates a surface of one square foot, on which is uniformly distributed one lumen of light (Fennelly, 1989).

3. These stringent maintenance practices are supported by the author's countless site visits to various Metro stations, including observations during her daily commute on Metro. It should be noted, however, that Metro's high standard of maintenance below ground is not always practiced on Metro's above-ground properties, which may have implications for crimes occurring in Metro's bus bays and parking lots.

4. When Metro was first in operation, with only five stations and five miles of track, Metro transit police saturated the system with 100 police officers, both uniformed and plain clothes (Hyde, 1995). As former Chief Angus MacLean relates, "The first pickpocket there, the victim was an Assistant United States Attorney, and the two detectives down there almost had a fist fight over who was going to book the first pickpocket" (New York State Senate Committee on Transportation, 1980).

5. This figure does not include the Green Line, which is closed for construction and was not in operation the year the data were collected. Because this analysis involves multiple comparisons, the Scheffe correction was used to produce wider confidence intervals with which to conduct t-tests.

6. Crime statistics were obtained from each of the eight jurisdictions Metro serves: the District of Columbia; Montgomery County, MD; Prince George's County, MD; Arlington County, VA; Fairfax County, VA; and the cities of Alexandria, Fairfax and Falls Church, VA. In some cases, statistics were already collected by census tract; in other cases, patrol areas were overlaid on a map of census tract boundaries and apportioned accordingly. Because Metro crimes are reported by transit police to the police department in the above-ground jurisdiction, Metro crimes were subtracted from census tract totals prior to analysis.

7. Crime types were selected to test correlations of comparable crimes, and to avoid reliability problems associated with differences in reporting by jurisdiction; Part I crimes tend to be documented in a more uniform manner across jurisdictions than less-serious crime types (Gove et al., 1985). Robbery and aggravated assault were selected in an attempt to compare like crimes. In addition, prior research indicates that crimes against persons have high correlations between rates that are calculated with number of inhabitants as the denominator, and those with more meaningful denominators, such as those based on opportunity (Boggs, 1966; Harries, 1980).

8. Coefficients are compared to determine if the difference between the two is statistically significant through the use of an F-test, which is calculated by dividing the coefficients of variation (large over small), and squaring: $(CVlarge/CVsmall)^2$.

9. Originally, it was hoped that annual crime statistics could be obtained for the greater DC metropolitan area. However, changes in the Bureau of Census definition of the metropolitan area over the years under study were such that an examination of trends would paint an inaccurate picture of crime patterns over time. Instead, crime statistics for the District of Columbia were used for this analysis.

10. In fact, in a comparison of mean homicide rates from 1985 to 1994 for U.S. cities with populations exceeding 200,000, Washington, DC ranked the highest, at an average of 60.42 homicides per 100,000 residents (U.S. National Institute of Justice, 1995).

REFERENCES

Amir, M. (1971). *Patterns in Forcible Rape.* Chicago, IL: University of Chicago Press.

Bochner, R.J. (1995). Personal interview with Supervisor, Facilities and Planning Section, Office of Planning, Washington Metropolitan Area Transit Authority, May 21, 1995, Washington, DC.

Boggs, S. (1966). "Urban Crime Patterns." *American Sociological Review* 30(6): 899-908.

Clarke, R.V. (1992). "Introduction." In: R.V. Clarke (ed.), *Situational Crime Prevention: Successjid Case Studies.* Albany, NY: Harrow and Heston.

——and R. Homel (in press). "A Revised Classification of Situational Crime Prevention Techniques." In: S. Lab (ed.), *Crime Prevention at a Crossroads.* Cincinnati, OH: Anderson.

Deiter, R.H. (1990). *The Story of Metro: Transportation and Politics in the Nation's Capital.* Glendale, CA: Interurban Press.

Del Castillo, V. (1992). "Fear of Crime in the New York City Subway." Doctoral dissertation, Fordham University, New York, NY.

Falanga, M. (1988) "Reducing Crime Through Design in the Chicago Subway System." Doctoral dissertation, University of Michigan, Ann Arbor.

Fennelly, L.J. (1989J. *Handbook of Loss Prevention and Crime Prevention* (2nd ed). Stoneham, MA: Butterworth-Heinemann.

Gabor, T. (1994). *"Everybody Does It!": Crime By The Public.* Toronto, CAN: University of Toronto Press.

Gebhardt, C. (1996). "Metropolitan Police Department Crime Analysis and Mapping Agenda." Handout from presentation at a meeting of the Department of Justice Geographic Information System Working Group, Washington, DC, March.

Gove, W.R., M. Hughes and M. Geerken(1985). "Are Uniform Crime Reports a Valid Indicator of the Index Crimes? An Affirmative Answer With Minor Qualifications." *Criminology* (23)3:451-501.

Harries, K.D. (1980) *Crime and the Environment.* Springfield, IL: Charles C Thomas.

Hyde, J.F. (1993). "CPTED Goes Underground." Presentation made at the Crime Prevention Through Environmental Design Conference, Washington, DC, December.

——(1995). Telephone interview with former Deputy Chief of the Metropolitan Transit Police, Washington Metropolitan Area Transit Authority.

Jeffery, C.R. (1971, 1977). *Crime Prevention Through Environmental Design.* Beverly Hills, CA: Sage.

Kenney, D. J. (1987). *Crime, Fear, and the New York City Subways: The Role of Citizen Action.* New York, NY: Praeger.

La Vigne, N.G. (1996). "Crime Prevention Through the Design and Management of Built Environment: The Case of the DC Metro." Doctoral dissertation, Rutgers, The State University of New Jersey, Newark, NJ.

LeCam, D. (1995). "Quit Complaining About Metro Signs." *Washington Post,* September 12, p.A18.

Levy, N.J. (1994). *CrimeinNew York City's Subways: A Study And Analysis Of Issues With Recommendations To Enhance Safety And The Public's Perception Of Safety Within The Subway System.* Albany, NY: Senate Transportation Committee.

Lôpez, M.J. (1996). *Crime Prevention Guidelines for the Construction and Management of Metro Systems.* The Hague: NETH: Result Crime Management.

MacLean, A.B. (1994). "The Metro Transit Police: Metropolitan Washington's Tri-State Police Force." *Police Chief{Dec):29-30.*

——(1995). Telephone interview with former chief of Metropolitan Transit Police, September 13.

McGhee, K. (1995). "Disoriented Around the District." *Washington Post,* September 5, p.A16.

Means, H. (1995). "Why We Love Washington." *Washingtonian* (Oct):lll.

Mooney, B. (1976). *Metro: Building Rapid Rail Transit in the National Capital Region.* Washington, DC: Transcript.

Morrow, B.E. (1994). Personal interview with the chief of the Metro Transit Police Department, Washington Area Transit Authority, June 14.

Nation's Cities (1977). "CPTED and Mass Transit," December, p.25.

New York State Senate Committee on Transportation (1980). *National Conference on Mass Transit Crime and Vandalism: Compendium of Proceedings.* Albany, NY: author.

Normandeau, A. (1968). Trends and Patterns in Crimes of Robbery." Doctoral dissertation, University of Pennsylvania.

Rand, A. (1986). "Mobility Triangles." In: R.M. Figlio, S. Hakim and G.F. Rengert (eds.), *Metropolitan Crime Patterns.* Monsey, NY: Criminal Justice Press.

Richards, L.G. and L.A. Hoel (1980). *Planning Procedures for Improving Transit Station Security.* Washington, DC: U.S. Department of Transportation.

Rubenstein, H., C. Murray, T. Motoyama and R.M. Titus (1980). *The Link Between Crime and the Built Environment: The current state of knowledge.* Prepared for the U.S. National Institute of Justice. Washington, DC: U.S. Government Printing Office.

Schnell, J.B., A.J. Smith, K.R. Dimsdale and E.J. Thrasher (1973). *Vandalism and Passenger Security: A Study Of Crime And Vandalism On*

Urban Mass Transit Systems In The United States And Canada. Washington, DC: U.S. Department of Transportation.

Shellow, R, J. Romualdi and E. Bartel (1974). "Crime in Rapid Transit Systems: An Analysis and a Recommended Security and Surveillance System." In: *Crime and Vandalism in Public Transportation.* Washington, DC: Transportation Research Board.

Siegel, M. (1995). Personal interview with Deputy Director for Architecture, Office of Engineering and Architecture, Washington Metropolitan Area Transit Authority.

Silver, J. (1995). "Disoriented Around the District." *Washington Post,* September 5, p.A16.

U.K. Department of Transport (1986). *Crime on the London Underground.* London, UK: Her Majesty's Stationary Office.

U.S. National Institute of Justice (1995). *Violence in US Cities: A Project of the National Institute of Justice Intramural Research Working Group.* NIJ Intramural Milestone Report #1: Site Selection, September 21. Washington, DC: Author.

Weisberg, H.F. (1992). *CentralTendency and Variability.* Newbury Park, CA: Sage.

Wekerle, G.R. and C. Whitzman (1995) *Safe Cities: Guidelines for Planning, Design, and Management.* New York, NY: Van Nostrand Reinhold.

Welke, L. (1981). "CPTED and Mass Transit." In: B. Galaway and J. Hudson (eds.), *Perspectives on Crime Victims.* St. Louis, MO: C.V. Mosby.